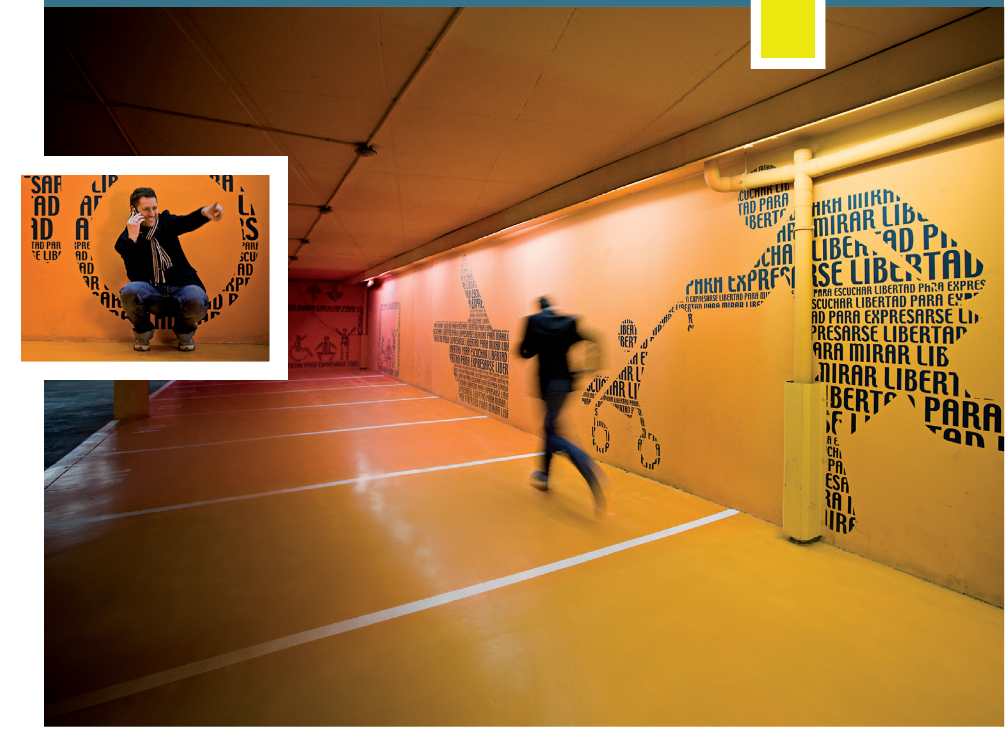
ascom

TEMS™ INVESTIGATION 15.3 HELP



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Welcome

1. Introduction to TEMS Investigation

Thank you for choosing TEMS Investigation – the industry-leading tool for troubleshooting, verification, optimization, and maintenance of wireless networks. Offering data collection, real-time analysis, and post-processing all in one, TEMS Investigation is a complete solution for all of a network operator's daily network optimization tasks. This complete solution eliminates the need for multiple tools, reducing costs and saving time and effort for operations staff.

To get the most out of TEMS Investigation, please take the time to read this documentation in order to gain an in-depth understanding of the product features.

Please note that in between product releases, the most up-to-date edition of this documentation is the one found online.

1.1. Fundamentals of TEMS Investigation

TEMS Investigation is an air interface test tool for cellular networks, supporting all of the following technologies:

- LTE (FDD and TDD)
- WCDMA/HSPA/HSPA+
- GSM/GPRS/EGPRS
- TD-SCDMA (including interaction with LTE and GSM)
- EV-DO Rev. B/EV-DO Rev. A/EV-DO Rel. 0/cdma2000/cdmaOne
- WiMAX (scanning)

TEMS Investigation enables monitoring of a wide variety of data services over packet-switched and circuit-switched connections, as well as CS voice and video telephony.

TEMS Investigation is primarily a tool for data collection and real-time analysis. It interfaces with a wide range of user terminals, scanners, and positioning equipment, collecting data from these devices and recording it in logfiles. The application also boasts a vast array of windows for presentation of logfile data.

Still more powerful post-processing facilities are provided by the product TEMS Discovery.

1.2. Packages and Other Options

TEMS Investigation can be purchased with or without data collection capability (“Base Software Package” and “Replay Package” respectively).

Supported cellular technologies can be freely selected and combined, except that WCDMA and GSM always come together.

Separate license options are offered for (among other things):

- Data collection with devices from various vendors.
- Data collection with multiple devices concurrently.
- Audio quality measurement (AQM).

1.3. Regional Editions

Please be aware that the TEMS Investigation product also exists in various regional editions, all of which are covered by the present documentation but are not differentiated here. This means that descriptions of functionality and external device compatibility are not necessarily applicable in every single respect to the TEMS Investigation edition you have purchased. Any restrictions that apply to your edition are indicated in the Release Note included in the delivery.

1.4. Overview of Documentation

This documentation contains the following volumes:

- Quick Guide
  - Tells how to install the product, configure devices, and use the core functions of the application. This is a simple “getting started” guide which is independent of the volumes that follow.

- Installation Guide
  - Describes how to install the TEMS Investigation software, also covering PC requirements and licensing issues.
- Device Configuration Guide
  - Covers the range of connectable devices and explains how to configure them for use with TEMS Investigation, along with driver installation and any other PC configuration that may be necessary.
- User's Manual
  - This is a comprehensive guide to the TEMS Investigation user interface and all its functions.
- Information Elements and Events
  - Provides full detail on all information elements and events presented in TEMS Investigation, with references to telecom and other standards. Also describes all preconfigured presentation windows.
- Technical Reference
  - Describes various TEMS product specific file and report formats, and gives other information of a technical nature.
- RouteFinder User's Manual
  - This is a tutorial on RouteFinder™, a utility for searching logfiles in TRP format recorded with TEMS products.

Some technical issues not addressed in this documentation are dealt with in the **Release Note**, which is provided alongside it.

1.5. Contact Information

1.5.1. Technical Support

As a TEMS customer, you can log in to the TEMS Portal at ▶ www.ascom.com/nt/en/index-nt/tems-support.htm in order to access the complete range of TEMS Investigation product information.

If you have a question about TEMS Investigation which is not answered in any written source, please contact TEMS technical support. Contact information is given on the page just linked.

1.5.2. Follow Us

Our monthly newsletter TEMS News contains articles on new TEMS product releases and their features, general information about the TEMS portfolio, and much more. To sign up for this free service, go to ▸ www.ascom.com/nt/en/index-nt/nt-news.htm and click the “TEMS News” link. In this section of our website you can also read our press releases and find out about upcoming events where Ascom Network Testing will participate.

You can also follow Ascom Network Testing on Facebook, LinkedIn and YouTube, as well as subscribe to our RSS feed. Links are provided in the “Follow Us” section at ▸ www.ascom.com/networktesting.

2. Recently Introduced Features in TEMS Investigation

2.1. What's New in TEMS Investigation 15.3

2.1.1. LTE Advanced Support: Carrier Aggregation

In LTE Advanced, a key strategy for increasing user bandwidth and hence the maximum bit rate is carrier aggregation. This basically means **pooling the resources** of multiple carriers (EARFCNs) in a coverage area and putting them all at the disposal of devices located there. For bursty applications especially, where the peak load is very high compared to the average load, this bundling can bring great gains in capacity.

TEMS Investigation 15.3 comes prepared for carrier aggregation by accommodating **multi-serving cell** measurements. Primary and secondary serving cells are distinguished.

2.1.2. New Connectable Devices

- Samsung Galaxy S4 GT-I9506: **LTE Category 4** device
- Samsung Galaxy Note 3 SM-N900T: **LTE Category 4** device
- Samsung Galaxy S4 mini SPH-L520
- ZTE MF821D

2.1.3. LTE: SRVCC – Moving VoLTE Calls to 2G/3G

SRVCC (Single Radio Voice Call Continuity) is an LTE mechanism devised for handing over LTE voice (VoLTE) calls to a 2G/3G network when necessary – for example, when losing LTE coverage. TEMS Investigation 15.3 recognizes SRVCC as a **special type of handover** from E-UTRAN and reports the **interruption time** elapsing before the voice call resumes on the new bearer.

2.1.4. LTE MIMO Scanning with PCTel SeeGull MX

LTE Reference Signal scanning with the PCTel SeeGull MX scanner has been extended to MIMO with **multiple receive antennas**. RSRP and RSRQ are then presented separately for each Rx–Tx combination. For 2 × 2 MIMO, the condition number and estimated channel matrix rank are computed, both indicative of the current capability of the MIMO channel to support spatial multiplexing.

2.1.5. Presentation of Measurement Data in Pinpoint Window

The Pinpoint Window now **plots RF or data service testing measurements** along routes walked, both in live mode and when loading logfiles for later study. In other words, the window now also serves as an **analysis tool**. You select for plotting a family of information elements such as “Signal Strength” or “PHY Throughput Downlink”, containing one element for each radio access technology. At any time, TEMS Investigation will then present the element from the mobile device’s current RAT, and replace it automatically when the device switches to a different RAT.

2.1.6. Trace Route Service

A new Service Control activity “Trace Route” is introduced in this release. Similar to the “tracert” command in Windows, Trace Route is a diagnostic tool for detailing the **path of packets through an IP network**, as well as measuring **latency** in terms of the time taken for each hop between network nodes.

2.1.7. SFTP (“Secure FTP”)

SFTP is a protocol which is similar to FTP but uses **Secure Shell (SSH)** to transfer files in an encrypted format. SFTP is now available as an option in FTP testing on both uplink and downlink. This feature caters primarily to testers who are required by corporate security policies to **use a secure connection** at all times.

An SSH license option is required for SFTP, and the availability of the feature is therefore subject to embargo restrictions.

2.1.8. Wi-Fi Measurements

TEMS Investigation 15.3 is capable of **collecting Wi-Fi measurements** using the Wi-Fi network card built into the PC, or an external Wi-Fi adapter. The data obtained is similar to that furnished by TEMS Pocket Wi-Fi scanning, and it is presented in the same cell list and throughput chart windows.

2.1.9. Voice Quality Enhancements

- **On-device POLQA for CS voice:** Using Sony Xperia LT25i phones in a mobile-to-mobile configuration, POLQA audio quality scores can be computed for CS voice calls without the need for an ACU R2 audio capturing unit. The POLQA computation is then done on the phones themselves (as in TEMS Pocket), thus relieving the PC processor of this task.
- The **Samsung Galaxy S4 GT-I9505** can now be used for voice quality measurement with an ACU R2.
- **Silence detection:** During voice quality measurement, if the audio goes silent for more than 100 ms when it should be present, you are notified of this by a new event (“Speech Interruption Time”). If any silence at all is detected during a handover, a further event is triggered to announce this fact.

2.1.10. ImagePositioning Utility

A new utility called ImagePositioning is provided for quick and easy **georeferencing** of an unpositioned image such as an indoor **floor plan**. Just drop the image into the tool window with its zoomable world map, and manipulate the shape and orientation of the image (by dragging its corners) until it superimposes perfectly on the building (or whatever) in the map view. Then lock the image position and a TAB file is created, recording the coordinates.

2.1.11. “Permanent” GPS Position Plotting in Map Window

To enable viewing of the entire route driven during a testing session, a new **“Track” layer** showing GPS positions has been added in the Map window. This layer is **never cleared** while TEMS Investigation is in drive testing mode (as opposed to measurement data, which is wiped from the map when you start a new logfile). The Track layer is by default hidden, but you can make it visible whenever needed.

2.1.12. Weibo Testing

Weibo is a Chinese microblogging service. This version of TEMS Investigation adds support for testing Weibo by having **two users interact**: one user posting a status update, and the other responding to that update. Performance is measured in terms of the **success rate** of such test cycles and the **average time** taken to complete them. Please note that this feature is applicable in China only.

2.2. What Was New in TEMS Investigation 15.2

2.2.1. iPhone Connectivity

With TEMS Investigation 15.2 we unveiled the addition of **iPhone 5** with iOS version 7.0 as a connectable device. The tight integration of the iPhone with TEMS Investigation as a measurement probe for PS data services and protocols as well as CS voice is unique in the network testing market. Supported activities include FTP, HTTP, email, IP capture, Iperf, video streaming, and Ping, and more.

2.2.2. Other New Connectable Devices

Besides the iPhone, the following new devices were made connectable in this release:

- LG Lucid 2 VS870
- Nokia Lumia 521
- Samsung Galaxy S III GT-I9308D
- Samsung Galaxy S4 SCH-R970
- Samsung Galaxy S4 SGH-M919N

2.2.3. HTTP Testing Enhancements

- **Internet Explorer for HTTP Post:** Internet Explorer (version 9 or later) was added as a new browser option for HTTP file upload, side by side with the Web browser built into TEMS Investigation.
- **Downloads over HTTPS:** The HTTP Get activity was extended to handle requests over the secure HTTPS protocol.

2.2.4. SMS for CDMA

The 15.2 release extended SMS support from UMTS devices alone to **LTE/ CDMA devices** built on Qualcomm chipsets.

2.2.5. Added Flexibility in Logfile Recording

- **Quick logging:** A function for quick manual initiation of logfile recording was reintroduced in this release. Options for quick logging are defined once and for all, and the logfile name is automatically generated from the current date and time, so that the capture of data can begin straight away. This feature is thus ideal for catching anomalies or any interesting phenomena that arise suddenly and might be of brief duration.
- **Limiting of logfile size:** To avoid ending up with inordinately large logfiles, it is possible to put a cap on the number of messages or the length of time recorded in a single logfile (or both). When a threshold is reached, the recording continues to a new file. Please note that this function should not be used when collecting input to statistics that require consideration of complete calls or sessions.

2.2.6. New Quick Guide and Restructuring of Documentation

A **Quick Guide** was added giving a tutorial on fundamental features of TEMS Investigation, smoothing the path for new users learning the application.

The “Getting Started” volume of previous releases was split into an **Installation Guide** and a **Device Configuration Guide**. The latter also incorporates device-related information hitherto contained in the Release Note under the heading “Known Bugs and Limitations”.

2.3. What Was New in TEMS Investigation 15.1

2.3.1. New Licensing System: Global License Server

TEMS Investigation 15.1 saw the introduction of an entirely new, electronic license management solution for TEMS products. The core benefits of this solution are:

- Improved **security** – better protection of your investment.
- Enhanced **control** of your licenses, and added **flexibility** in managing them.
- **Electronic** software download and license activation.

The new licensing solution is completely **software-based**. That means no more hardware dongles, and thus no possibility of losing or misplacing such physical tokens.

To manage TEMS product licenses, an appointed admin logs in to Ascom's Global License Server through a **Web interface**. From there, license options can be assigned at a moment's notice, with a bare minimum of manual steps, and revoked when no longer needed. Within a pool of purchased items, licenses can be **transferred** easily and securely from one user or department to another, or perhaps from a project that has finished its work to a new one that is beginning.

At all times, license admins will have an accurate **bird's-eye view** of where their licenses are, and the ability to reassign licenses with immediate effect to optimize their utilization.

Through the Global License Server Web interface, users can also download the TEMS Investigation base **software** as well as all upgrades.

The existing licensing solution is retained in TEMS Investigation 15.x as an alternative to Global License Server.

2.3.2. New Supplied Device: Samsung Galaxy S4 GT-I9505

Samsung's new flagship model **Galaxy S4** was made connectable in TEMS Investigation 15.1. It is the successor to Galaxy S III, and S4 GT-I9505 replaced S III GT-I9305 as TEMS Investigation supplied device in the 15.1 version.

Samsung Galaxy S4 supports available bandwidth measurement with **Blixt™** (offered as option) and is also one of the new phones on which **TEMS Pocket** 13.1 is implemented.

- Frequency bands:
  - LTE 800 (Band 20), 850 (B5), 900 (B8), 1800 (B3), 2100 (B1), 2600 (B7)
  - WCDMA 850 (Band V), 900 (VIII), 1900 (II), 2100 (I)
  - GSM 850, 900, 1800, 1900
- Throughput categories:
  - LTE Category 3 (100/50 Mbit/s)
  - HSDPA Category 24 (42 Mbit/s), HSUPA Category 6 (5.8 Mbit/s)
  - GPRS/EDGE Class 12
- Real-time control capabilities:
  - RAT lock (LTE, WCDMA, GSM)
  - Band lock (LTE, WCDMA, GSM)
- Google Android 4.2
- WLAN 802.11 a/ac/b/g/n
- Integrated GPS with A-GPS support
- Chipset: Qualcomm Snapdragon 600 APQ8064T
- CPU: Quad-core 1.9 GHz

2.3.3. New Supported Scanner: PCTel SeeGull EXflex

A Swiss army knife for today’s increasingly diverse mobile networks, the PCTel **SeeGull EXflex** scanner supports most of the world’s major cellular technologies in a single unit: LTE FDD, TD-LTE, WCDMA/HSPA(+), GSM, TD-SCDMA, and CDMA/EV-DO. It scans frequencies all the way from 300 MHz up to 3.8 GHz. This **matchless versatility** is what underpins PCTel’s own characterization of EXflex as “quite possibly the last scanner you will ever need”.

Hardware-wise, EXflex builds on the tried and tested SeeGull EX, which has long been connectable in TEMS Investigation.

2.3.4. New Supported Scanner: PCTel SeeGull CX

PCTel SeeGull CX is a high-performance, **cost-efficient RF scanner** for worldwide testing of WCDMA/HSPA(+), GSM, and TD-SCDMA cellular networks. The SeeGull CX scanner is available in single-technology as well as dual-technology WCDMA/GSM and TD-SCDMA/GSM models.

2.4. What Was New in TEMS Investigation 15.0

2.4.1. Available Bandwidth Measurements: Blixt™

Ascom has devised a method of available bandwidth measurement (ABM) in state-of-the-art wireless networks such as LTE. The patent-pending ABM algorithm, trademarked as “Blixt”, helps operators **track the bandwidth being offered** to their subscribers with great precision and millisecond resolution. It has also been carefully designed for **minimum intrusiveness**, that is to say, to have the smallest possible impact on the quality-of-experience of paying network users.

What creates the need for a novel ABM algorithm is the rapid evolution of recent mobile telecom technologies such as LTE and HSPA, with their vastly higher data rates and complex configuration options. For these technologies, traditional ABM methods are no longer adequate; what is required are metrics and measurement techniques designed **specifically for the wireless environment**.

Ascom’s Blixt technology for ABM is characterized by:

- **High peak load – low average load.** Test data is sent in short, intense bursts (“chirps”) with much longer pauses in between. The peak load is high enough to hit the network’s theoretical maximum, while the average load is kept low. This scheme allows sounding out the available bandwidth while still making minimum use of network resources.
- **Fast adaptation in time domain.** The data bursts that probe the network are short enough to track changes in radio conditions on a millisecond time scale. In this way a high-resolution profile of the available bandwidth is obtained.
- **Adaptation to network configuration.** The amount of data sent is adjusted according to the network’s maximum throughput (for example, when the UE moves between LTE and HSPA networks), while keeping the level of intrusiveness to a minimum at all times.

- **Server-based design.** The device that is performing ABM communicates with a server which reflects the packets back to the device, including timestamps and other data in the packets. That means it is easy to test different parts of the network by having the device access different servers. A timestamping protocol called TWAMP is used.

2.4.2. New Supplied Device: Sony Xperia V LT25i

This is an Android smartphone operating on LTE, WCDMA, and GSM networks. Equipped with TEMS software, it offers **extensive control functionality** for all of these technologies, including LTE RAT lock and LTE band lock.

The casing of the Xperia V LT25i is **water-resistant**, making the phone less susceptible to moisture damage in wet or damp environments.

- Frequency bands:
  - LTE 2100 (Band 1), 1800 (B3), 850 (B5), 2600 (B7), 800 (B20)
  - WCDMA 850 (Band V), 900 (VIII), 2100 (I)
  - GSM 850, 900, 1800, 1900
- Throughput categories:
  - LTE Category 3 (100/50 Mbit/s)
  - HSDPA Category 24 (42 Mbit/s), HSUPA Category 6 (5.8 Mbit/s)
  - GPRS/EDGE Class 12
- Control capabilities:
  - RAT lock on LTE, WCDMA, GSM
  - Band lock on LTE, WCDMA, GSM

  Both RAT and band lock are real-time functions. No reboot of the phone required.

  - LTE carrier (EARFCN) lock
  - WCDMA cell lock (UARFCN/SC)
  - GSM cell lock/multi-lock, cell prevention
  - Voice codec control
  - Cell barred control
  - Access class control

- Google Android 4.1
- Integrated GPS with A-GPS support
- Chipset: Qualcomm MSM9615
- CPU: Dual-core 1.4 GHz

2.4.3. New Supplied Device: HTC One XL X325S

This LTE/WCDMA/GSM Android smartphone is primarily intended for the CALA market (Caribbean and Latin America).

- Frequency bands:
  - LTE 1800 (Band 3), 2600 (B7)
  - WCDMA 850 (Band V), 900 (VIII), 1900 (II), 2100 (I)
  - GSM 850, 900, 1800, 1900
- Throughput categories:
  - LTE Category 3 (100/50 Mbit/s)
  - HSDPA Category 14 (21 Mbit/s), HSUPA Category 6 (5.8 Mbit/s)
  - GPRS/EDGE Class 12
- Control capabilities: RAT/band lock
- Google Android 4.0
- Integrated GPS with A-GPS support
- Chipset: Qualcomm MSM8960
- CPU: Dual-core 1.5 GHz

2.4.4. Other New Supported Devices

- Huawei E3276 (LTE Category 4 device, downlink throughput up to 150 Mbit/s)
- Samsung Galaxy S III SPH-L710
- Samsung Mpower TV SCH-S239
- Cellient MX200
- ZTE AC2738

2.4.5. Video Streaming over HTTP

TEMS Investigation has long supported streaming over RTP, both live and on-demand. The 15.0 release added **HTTP streaming** to the repertoire, enabling testing of (for example) video upload websites. Behind the scenes, HTTP streaming relies on Internet Explorer 9 and Flash.

Besides a host of other information elements diagnostic of streaming session performance, the **viewer-perceived streaming quality** is evaluated using the **VQmon** algorithm. Developed by Telchemy, VQmon bases its scoring on a parametric model taking IP sniffing data (among other things) as input. The algorithm is **content-sensitive**, which means that it allows properties of the streamed video to influence the quality scores, preventing inexpertly shot or edited footage from unduly biasing the scores. For example, VQmon detects blank or frozen images as well as suspiciously blurry footage that might result from the camera not being properly controlled.

2.4.6. RouteFinder™

RouteFinder is a stand-alone utility for **searching logfiles** in TRP format recorded with TEMS products. Logfiles can be searched according to a wide variety of criteria, including:

- Originating TEMS **products** and data-collecting **devices**
- **Date** of recording
- **Location** where the recording was made
- **Services** tested or **measurements** performed in the logfile
- **Events** and **messages** occurring in the logfile
- **Information elements** having valid values in the logfile.

So this means you can now very easily and speedily retrieve from your storehouse of logfiles such things as: all logfiles recorded with your recently acquired Samsung S III device; all logfiles from the downtown leg of last Thursday’s drive test; all logfiles where audio quality was measured; or all logfiles containing dropped calls in that rural area with known coverage issues.

No matter what logfile data you want to lay your hands on, RouteFinder lets you **sift the gold from the grit**, potentially saving you massive amounts of time otherwise spent trawling manually through your collected data.

2.4.7. RouteUtility™

This is another logfile-related utility introduced with TEMS Investigation 15.0. It enables you to **split** a TEMS product TRP logfile into **several self-contained logfiles** according to various criteria:

- Data-collecting devices used
- Date and time
- Location

The benefit brought by RouteUtility is that it permits a **more relaxed approach** to logfile recording: if you wish you can simply turn recording on at the start of your drive test, then divide your data into more manageable chunks later.

2.4.8. Voice Call Sequence: MT Voice Call Support

Testing voice by trading calls back and forth between a mobile device and a fixed-side CallGenerator is a long-standing feature of TEMS Automatic and TEMS Symphony. Such call sequences can now be set up in TEMS Investigation as well. A new scripting construct ("Synchronized Call Sequence") is provided in the Service Control Designer, looping **mobile-terminated and mobile-originated** voice calls in alternating fashion and measuring voice quality with POLQA or PESQ.

2.4.9. IMAP Email Retrieval Testing

In the Email Receive script activity, IMAP was added as an option alongside POP3. The IMAP (**Internet Message Access**) **protocol** for email retrieval is a refinement of POP3, which it is gradually supplanting.

2.4.10. HTTP Post

The HTTP Post script activity offers an alternative route to testing **uplink performance**, with a Web server at the other end instead of an FTP server.

2.4.11. LTE Tx Antenna Diagnostics

A new information element in TEMS Investigation 15.0 indicates the **difference in transmit power** between the Tx antennas of an eNodeB. These measurements can be used to determine in real time if a newly deployed site has a problem with one of the Tx antennas. Compared to traditional methods of diagnosis, this feature can reduce turnaround time by several days.

2.4.12. IPv6 Support

TEMS Investigation 15.0 fully supports the **IPv6 address space**, which is now being increasingly deployed in practical use by Internet providers. This secures uninterrupted data service testing as traffic flows between the IPv6 and IPv4 domains.

2.4.13. Usability Improvements

Apart from the RouteFinder and RouteUtility tools, TEMS Investigation 15.0 boasts these usability-enhancing features:

- **Simplified voice dial.** Scripting of voice calls, both CS and VoIP, was streamlined and simplified in the user interface. A single set of dial, answer, and hang up commands now controls any voice call, regardless of bearer.
- **GPX-format planned routes.** TEMS Investigation 15.0 is capable of loading planned routes for drive testing created in the XML-based GPX (GPS Exchange) format. The point of doing that is to have the routes displayed in a Map window as a driving aid, so that you do not have to rely on your GPS to follow the correct route. One tool that can be used to create GPX files is Garmin’s freeware application Basecamp; another is Google Maps.

Quick Guide

1. Introduction

This is a quick guide to using TEMS Investigation. It is not intended to be comprehensive but tells how to install the product, configure devices, and use the core functions of the application.

For the full story on all product features and their usage, please consult the User's Manual and the rest of the documentation.

Regarding technical support, see the Welcome part, section 1.5.

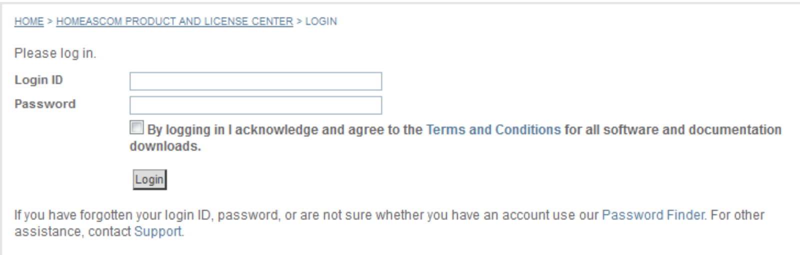
What Do You Want to Do?

- Install TEMS Investigation.
- Install licenses for the product.
- Configure your PC and devices.
- Connect devices to the PC and activate them in TEMS Investigation.
- Run service testing manually.
- Run service testing using a script.
- Record logfiles.
- Load logfiles for analysis.
- Learn about data presentation.

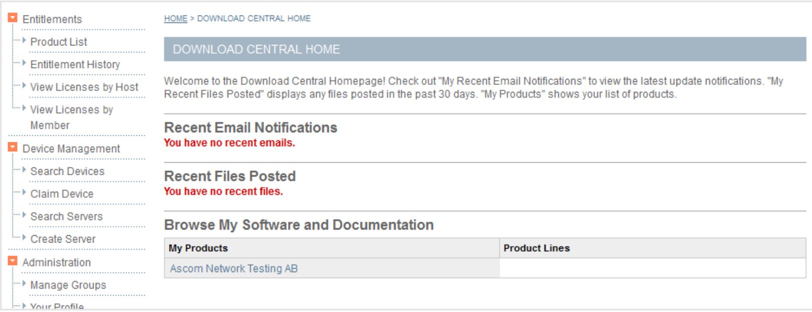
2. Installing TEMS Investigation

You either download the TEMS Investigation software from an Ascom website, or you have it delivered on a CD. This depends on which licensing solution you are using. Below we describe the download procedure with FlexNet licensing.

- Ascom will have sent out a welcome email with a download link. When you click that link, you are taken to this login page:

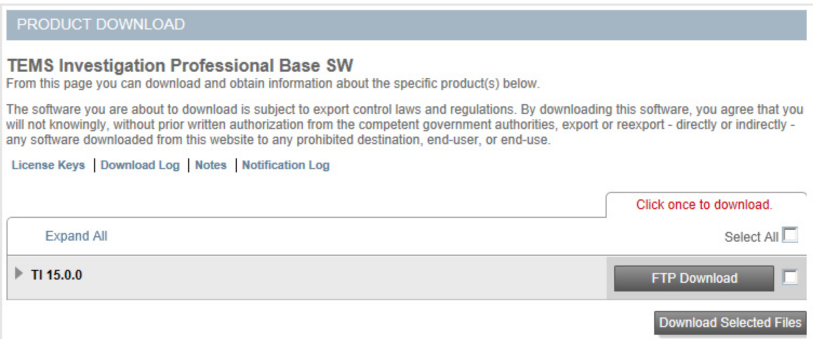


- Click the **Password Finder** link.
- Enter your email address and press **Submit**.
- You will now receive another email. In that email, click the text that reads "this link". On the web page, enter your email address (in *lowercase*) and your password as instructed.
- You are taken to a page titled **Download Central Home**.



- In the navigation column under **Entitlements**, click **Product List**.
- In the list of products, select TEMS Investigation.
- On the **Product Information** screen, click the version you want to download.

- On the **Product Download** screen, click the **FTP Download** button once for the appropriate file.



- A file named TEMSInvestigation15.3.exe is now downloaded to your PC. If you have had the software delivered on a CD, you will find the same file there.
- Before installing, make sure that your PC has a working Internet connection and that you have administrator rights on the PC.
- Run the EXE file to install TEMS Investigation.

3. Installing Licenses

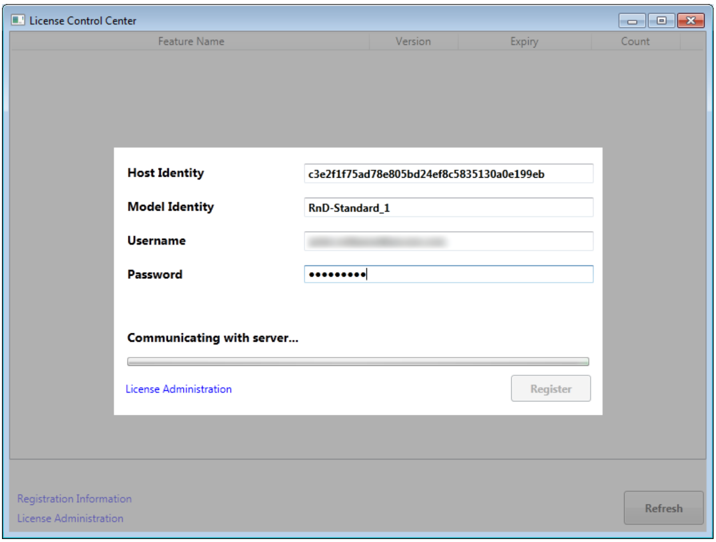
Two different licensing solutions are available for TEMS Investigation 15.3: FlexNet and HASP. FlexNet is the newer solution and is the one covered below.

When you start TEMS Investigation for the first time, your PC will automatically register with FlexNet. In the process, a device ID is created for your machine.

A window titled **License Control Center** appears, where this device ID is displayed as **Host Identity**.

You now need to log in to FlexNet:

- Under **Username**, enter your email address.
- Under **Password**, enter the password you were assigned when downloading the TEMS Investigation software.
- Click the **Register** button.

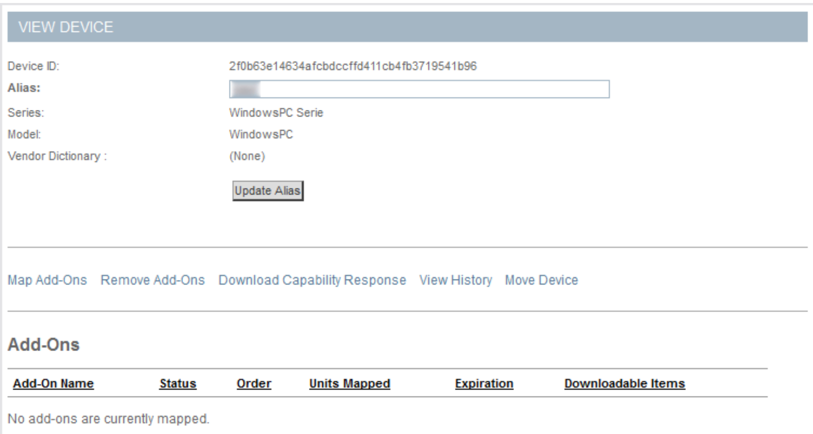


A message box saying “License check failed!” will appear at this point. This is because you have not yet installed any TEMS Investigation licenses on your PC: the basic license for the TEMS Investigation software plus all additional license options that you have purchased.

- In the FlexNet web interface, in the navigation column under **Device Management**, click **Search Devices**.

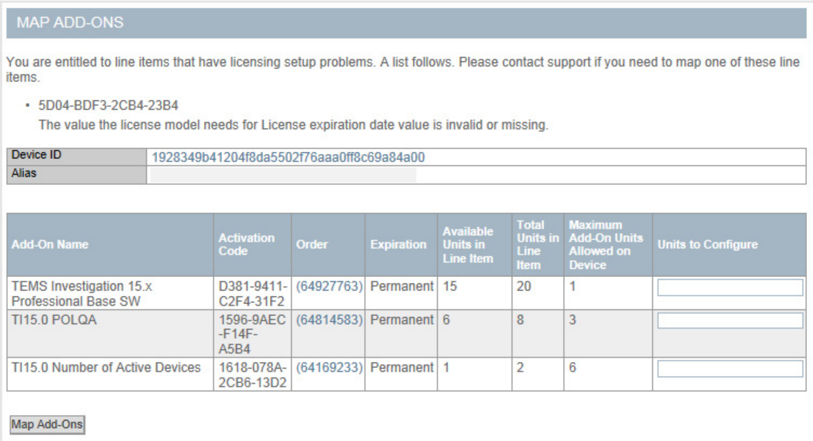
- In the list of devices, click the ID that represents your PC.

At the bottom of the **View Device** screen, all licenses (“add-ons”) that you have installed on your PC are listed. The first time around, of course, this list will be empty.



- To activate licenses on your PC, you need to *map* the relevant add-ons to the machine. Click the **Map Add-Ons** link.

The **Map Add-Ons** screen appears, displaying the entire pool of licenses at your disposal.



MAP ADD-ONS

You are entitled to line items that have licensing setup problems. A list follows. Please contact support if you need to map one of these line items.

- 5D04-BDF3-2CB4-23B4
  The value the license model needs for License expiration date value is invalid or missing.

Device ID	1928349b41204f8da5502f76aaa0ff8c69a84a00
Alias	

Add-On Name	Activation Code	Order	Expiration	Available Units in Line Item	Total Units in Line Item	Maximum Add-On Units Allowed on Device	Units to Configure
TEMS Investigation 15.x Professional Base SW	D381-9411-C2F4-31F2	(64927763)	Permanent	15	20	1	
TI15.0 POLQA	1596-9AEC-F14F-A5B4	(64814583)	Permanent	6	8	3	
TI15.0 Number of Active Devices	1618-078A-2CB6-13D2	(64169233)	Permanent	1	2	6	

Map Add-Ons

What you need to do here is to map the full set of add-ons you are going to need when using TEMS Investigation.

- You must always map the TEMS Investigation **base software** license.
- You also need to map:
  - Your license options for **cellular technologies**.
  - The license options for the **data-collecting devices** you will be using.
  - Any license options required for particular **measurements or service testing** (for example, audio quality measurement with POLQA).
- For each add-on, enter the number of add-ons you want to map in the **Units to Configure** column, then click the **Map Add-Ons** button.
- When you are done mapping add-ons, return to the License Control Center window and click the **Refresh** button there. The window will then display all the licenses that are now installed on your PC.

You are now ready to start using TEMS Investigation with all functions that you have a license for.

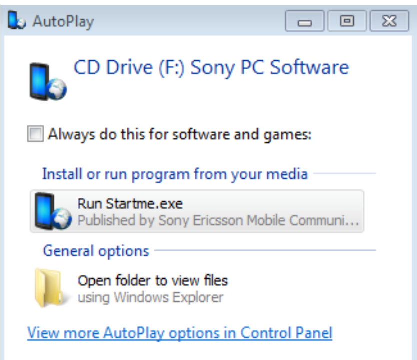
4. Configuring Your PC and Devices

With the extremely diverse range of devices that are connectable in TEMS Investigation, it is not possible to summarize both briefly and usefully what preparations are necessary for using devices. Instead, we will pick one pair of current top-of-the-line phones, the Sony Xperia LT25i and LT30a, and describe what needs to be done with these. Please refer to the Device Configuration Guide for full coverage of external devices.

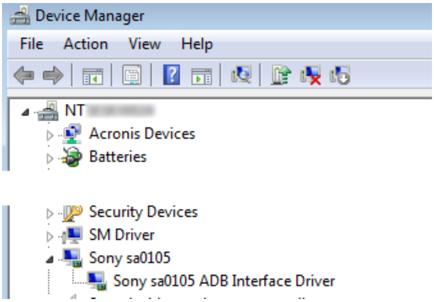
Sony Xperia V LT25i, Sony Xperia T LT30a

For these devices you need to obtain the driver from Sony PC Companion.

- When connecting the phone, you will be presented with the option to install Sony PC Companion software. Select **Install**.
- Should this dialog not be displayed, you can enable the option to display Install PC Companion on the phone as follows: **Settings** → **Xperia** → **Connectivity** → **Install PC Companion**. In the AutoPlay dialog that appears, Select **Run Startme.exe**.



- After the installation is done, enable tethering on the phone under **Settings** → **More** → **Tethering & portable hotspot** → **USB Tethering**.
- In the Device Manager, verify that the item “Sony sa0105 ADB Interface Driver” appears. See the screenshot below.



- **Important:** After successfully installing the driver, you should uninstall PC Companion. This is because the PC Companion software might interfere with other devices. Do the uninstall from the Windows Control Panel as usual.

You also need to check that USB debugging is activated, so that all relevant ports are visible.

- Press the Menu button, then choose **Settings** → **Applications** → **Development**, and make sure **USB debugging** is enabled. It should be by default.

5. Connecting and Activating Devices

Starting TEMS Investigation

- First off, before starting TEMS Investigation, plug the external equipment you are going to use into the PC

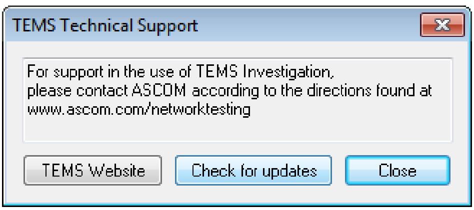
It is necessary to run the application as administrator. To set this up the first time around, do as follows:

- Navigate to **Start** → **All Programs** → **Ascom** → **TEMS Products** → **TEMS Investigation 15.3**.
- Right-click this item and choose **Properties** → **Shortcut** tab → **Advanced**.
- Check the **Run as administrator** option.

From now on, you can run TEMS Investigation as administrator by simply left-clicking the above Start menu item as usual.

Software Update Check

When starting TEMS Investigation for the first time after installation, you are invited to connect to an Ascom server and find out if there is a newer TEMS Investigation software version available.

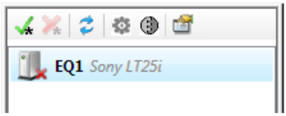


- If you click **Check for updates**, a wizard opens where you can check whether a newer version exists. If that is the case, decide whether or not to install it. Be sure to save your work before accepting an update, as the PC will shut down automatically in the process.

- Click **Close** to dismiss the update check.

Detection and Activation of Devices

All devices that you have plugged into the PC and that have been detected by TEMS Investigation are listed in the top pane of the Navigator's **Equipment** tab. For example, a Sony Xperia LT25i will appear as follows:



- You need to *activate* a device in TEMS Investigation before you can use it. To this end, right-click the device on the tab shown above, and choose **Activate** from the context menu.

If you have several devices, click the **Activate All** button on the Navigator toolbar to activate all of them.

The red cross disappears from each device icon to indicate that the device is now active.

Before You Start Testing

Here is a short list of device-related matters that you need to have sorted out before you start drive testing with TEMS Investigation. The Device Configuration Guide covers these topics in abundant detail; we condense them here to a few pieces of general advice:

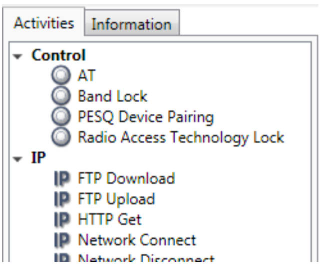
- Make sure that all external devices have adequate **power supply**.
- Make sure that appropriate **drivers** are installed for all external devices.
- When doing data collection in LTE networks or in other scenarios that entail a high CPU load, it is strongly recommended for performance reasons to **disable non-vital** PC functions that consume a lot of processing power, especially visual effects.

6. Testing Services

You can do service testing in two ways: either manually, or controlled by a script. The procedure of assigning activities to devices is similar in both cases.

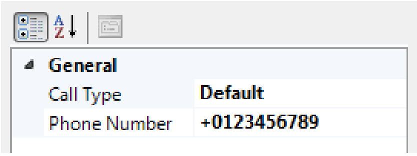
Manual Service Testing

Manual service testing is done from the Navigator's **Equipment** tab: specifically, from its bottom pane, which has a "subtab" named **Activities**. Here are listed all the activities that are supported by the device currently selected at the top of the Equipment tab.



Before you can test a service, you need to define a **configuration set** telling the device in more detail what to do. The simplest case is voice, where you essentially just have to specify what number to call. We will take voice as an example here:

- Under the **Voice** node on the Activities tab, right-click the **Dial** item and choose **Configuration Sets**.
- In the dialog that appears, create a new configuration by clicking **New**.
- Leave **Call Type** as-is ("Default").
- Under **Phone Number**, enter the number to call.



- Give the configuration a different name if you like.

You are now ready to perform voice testing:

- To place a voice call, right-click **Dial** on the Activities tab, choose **Start**, then pick the configuration set just created.
- To end the call, right-click **Dial** and choose **Stop**.

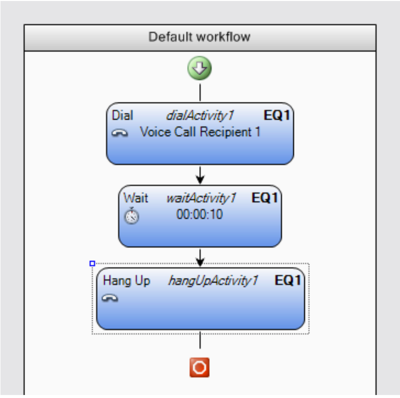
Data service testing such as FTP or streaming requires some more preparation: you must first connect to a network, and there are more parameters to fill in for the service. However, the general approach is just the same as above.

Testing Services with a Script

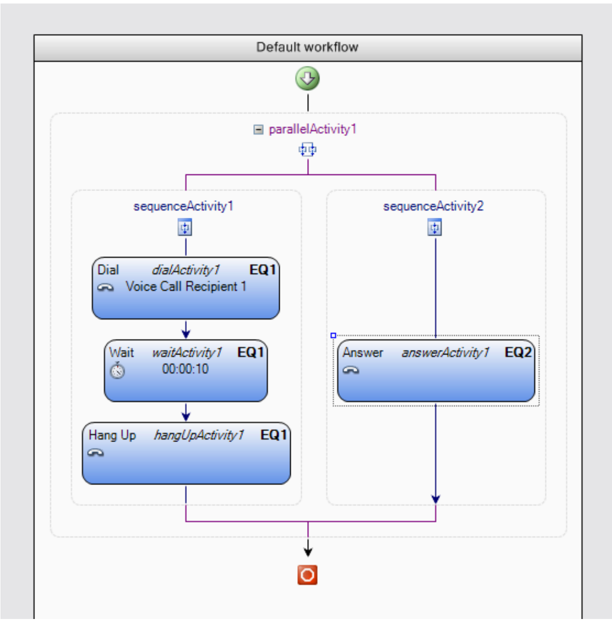
Scripts for automated service testing are composed in the Service Control Designer. Here you build script workflows in a graphical user interface. The range of available activities is the same as in manual testing, and the configuration sets you create are used in scripts as well.

Scripts allow you to create advanced testing setups that would be awkward or impossible to manage by operating devices manually. However, in this guide we will again content ourselves with a couple of basic examples.

Example 1: This script instructs the device to *dial* a call as specified in the configuration set “Voice Call Recipient 1”, then *wait* 10 seconds before finally *hanging up*.



Example 2: Below is a small glimpse of the powerful flow control mechanisms that are available in scripts. A branching structure is used, where two devices are placed in parallel. The EQ1 device (left) dials a call, just as in the preceding example. The receiver of this call is the EQ2 device (right), which is controlled by the same script. EQ2 is assigned an *answer* activity, prompting it to pick up the call when it arrives.



Ready-made script building blocks (“snippets”), similar to the one for voice above, are provided in the application for every testable service type.

7. Recording Logfiles

Any testing done in TEMS Investigation can be recorded in logfiles.

To manually initiate recording of a logfile, do as follows:

Click the **Start Recording** button on the Record toolbar. A dialog appears where you can do some optional configuration; click **OK** in this dialog.

It is a good idea to start the recording *before* you embark on any testing. This ensures that you capture all relevant measurement data in the logfile.

After you have completed your testing tasks, click **Stop Recording** to end the recording and close the logfile. Once you have closed it, you cannot log any more data to the same file.

Logfile recording can also be controlled by a script, using special activities named **Start Recording** and **Stop Recording**.

8. Loading Logfiles for Analysis

You can load logfiles that you have recorded back into TEMS Investigation in order to analyze them. One logfile at a time can be loaded in the application.

To be able to load a logfile, you must put the application in “analysis” mode as opposed to “drive testing” mode. This means that if you have external devices activated, you must first deactivate them:

Click the **Deactivate All** button on the Equipment tab toolbar.

Logfile loading is most conveniently controlled from the **Replay** toolbar:

Click the **Open Logfile** button to open a logfile.

Click the **Fast Forward** button to start loading the logfile data into the presentation windows.

You can click the same button again, now labeled **Stop**, to halt the loading of the logfile. The data loaded thus far is then displayed in the presentation windows. Click **Fast Forward** once more to resume logfile loading.

When you are done analyzing a logfile, click the **Close Logfile** button to close it.

9. Data Presentation

Finally, we will take a quick peek at the presentation windows in TEMS Investigation. These windows are used to present *information elements*, *events*, and *messages*, either in real time or during logfile analysis. Data is presented in essentially the same way in both cases.

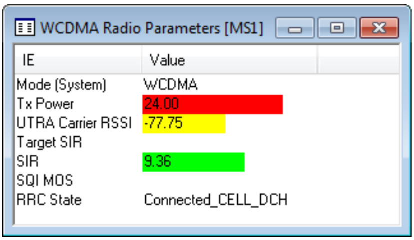
A fundamental distinction can be made between two kinds of presentation windows:

- *"Snapshot"* windows, which show the situation at one instant in time and are constantly refreshed in drive testing mode.
- *"History"* windows, which accumulate information and encompass the whole testing session or the whole logfile.

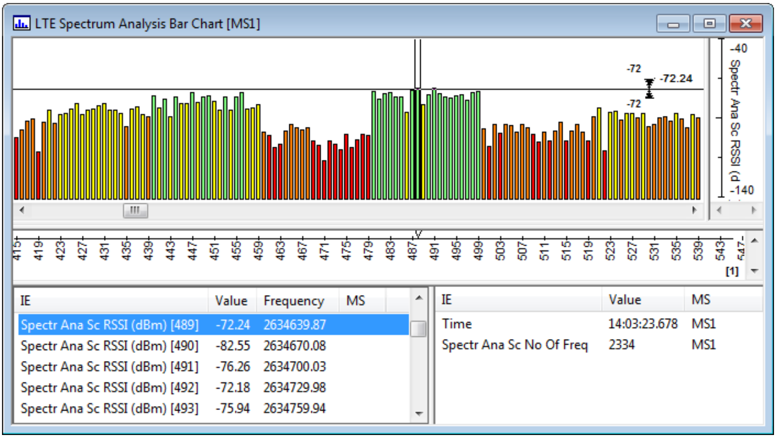
All windows are synchronized.

Examples of Snapshot Windows

- **Status windows**, presenting information elements in tabular form.

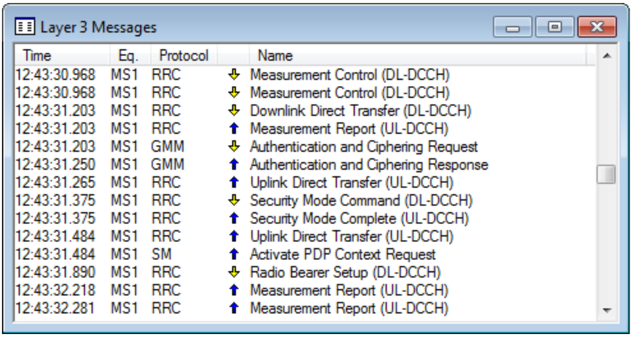


- **Bar charts**, displaying successive snapshots of a selected set of information elements.

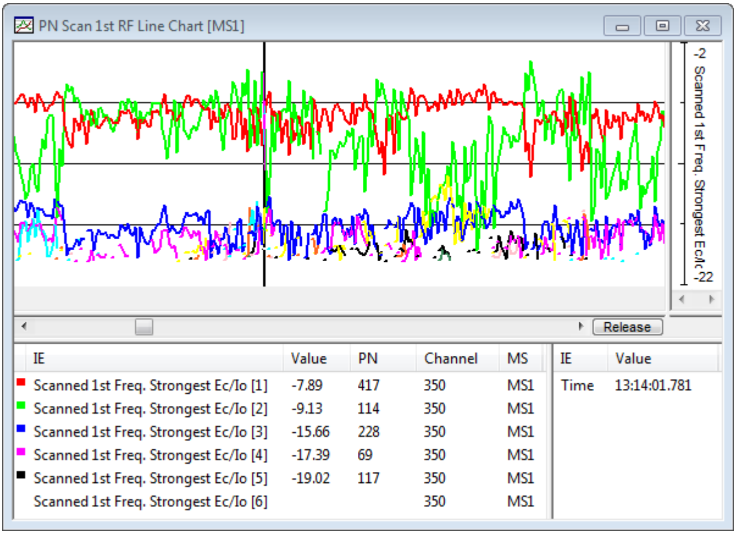


Examples of History Windows

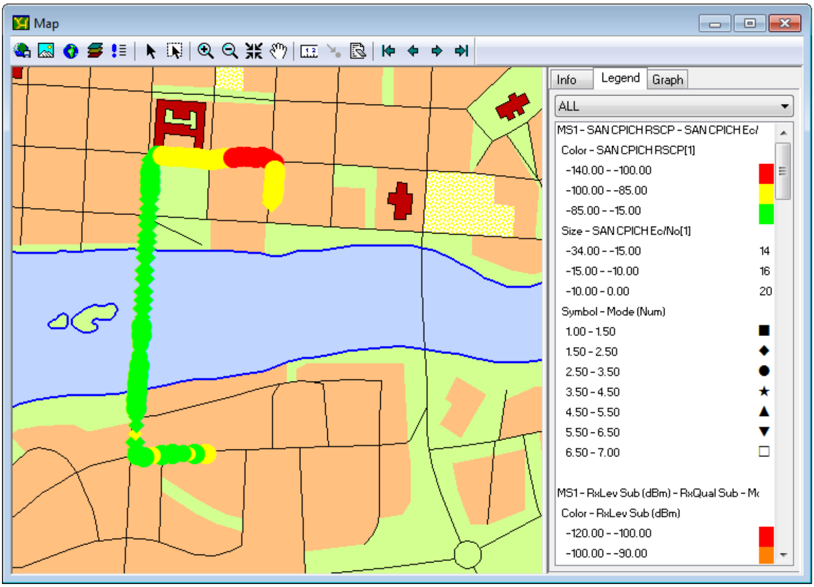
- **Message windows**, listing things like Layer 3 messages and device-specific mode reports, as well as events generated by TEMS Investigation.



- **Line charts**, tracking selected measurements over time.



- **Map windows**, presenting your drive test route graphically on a background map.



Installation Guide

Contents

1. What's In This Manual

The Installation Guide tells how to install the TEMS Investigation software, also covering PC requirements and licensing issues.

Main Topics

- Contents of TEMS Investigation product packages: chapter 3
- Installing TEMS Investigation: chapter 5
- License handling with FlexNet: chapter 6
- License handling with HASP: chapter 7

Regarding device configuration, please turn to the Device Configuration Guide.

2. Licensing: Basics

The fundamentals of licensing in TEMS Investigation 15.3 are as follows.

Two different **licensing solutions** are available for TEMS Investigation 15.3:

- **FlexNet:** see chapter 6
- **HASP:** see chapter 7.

You will be using either of these solutions (not both at the same time). Which solution you use only affects the practical handling of the licenses; taken in the abstract, the licensing framework is precisely the same regardless of solution. The chapters referenced above tell you all you need to know about retrieving, inspecting, and managing your TEMS Investigation licenses. As the two licensing solutions are completely separate, you only need to read the chapter that deals with your licensing solution.

Regarding the permissions granted by the license that goes with the basic TEMS Investigation **product packages**, see sections 3.1 and 3.2.

Regarding the range of **license options**, see section 3.3.

3. Product Packaging

TEMS Investigation 15.3 is offered in the following types of package:

- Base Software packages: section 3.1.
- Replay packages: section 3.2.

3.1. Base Software Packages

Base Software packages encompass all fundamental TEMS Investigation functionality, including data collection and realtime presentation. A base software license is always required to start TEMS Investigation.

However, Base Software packages do not in themselves include any licenses for connecting particular external devices; all of these devices (or the chipsets they are built on) require a separate license option. Special license options are offered for collecting data with multiple devices concurrently. All of this is detailed in section 3.3.2.

Separate license options are also needed for the various cellular technologies (see section 3.3.1) as well as for certain types of measurements and service testing (see section 3.3.3).

Within the technologies selected in the package, the Base Software package license permits loading of logfiles recorded with any equipment that is supported by the product, as well as logfiles from a number of other sources; see the User's Manual, section 10.3.

The following contents are part of all Base Software packages:

- TEMS Investigation PC software
- Device drivers for use with PC
- TEMS Investigation license, perpetual
- User documentation in PDF files
- USB hub, 4-port
- *If HASP is used for licensing:* USB hardware key (HASP HL) or electronic software key (HASP SL) holding the TEMS Investigation license

3.2. Replay Packages

These packages give access only to a small part of the TEMS Investigation functionality: a Replay package license allows loading of TEMS Investigation logfiles. It is not possible to do data collection or present data in real time, nor is it possible to load logfiles from sources other than TEMS Investigation (unless additional license options are purchased for various file types: see section 3.3.4).

The following contents are part of all Replay packages:

- TEMS Investigation PC software
- User documentation in PDF files
- *If HASP is used for licensing:* USB hardware key (HASP HL) or electronic software key (HASP SL) holding the TEMS Investigation license

3.3. Optional Product Features

For a full list of TEMS Investigation license options, see section 6.10.

3.3.1. Technology Options

For Base Software packages, a separate license option is required for each cellular technology that you wish to test. An arbitrary subset of technologies can be selected, except that WCDMA and GSM are combined into one “UMTS” option.

Replay packages always come with support for all technologies.

3.3.2. External Device Options

Separate license options are required for connecting various categories of equipment in TEMS Investigation.

For user terminals, the set of license options purchased grants permission to collect data with one device at a time, belonging to one of the selected equipment categories. A further license option is offered for data collection with multiple user terminals concurrently.

No such restriction on the number of connectable devices applies to scanners (or to GPS units, for which no special license is required).

Please note that in practice, the number of connectable devices is limited by the PC's processing power. The total number of user terminals and scanners that can be simultaneously visible in the user interface is also limited (currently to 8).

3.3.3. Measurement and Service Testing Options

Measurements and services not mentioned in this section require nothing more than the Base Software package license.

3.3.3.1. Available Bandwidth Measurements

A separate license option is required for available bandwidth measurements using the Blixt algorithm (covered in the User's Manual, chapter 48).

For the service testing setup, see the User's Manual, section 12.20.3.10.

3.3.3.2. AQM (PESQ/POLQA)

A separate license option is required for calculating PESQ or POLQA and making other audio quality measurements. Audio quality measurement is supported for LTE (VoLTE), WCDMA, GSM, and CDMA. For POLQA, license options are differentiated with respect to the number of devices in concurrent use, as indicated in section 6.10.

The same license option covers all AQM solutions for CS voice: see the User's Manual, sections 37.3 and 12.20.7.6, 12.20.7.6.

AQM for VoIP is licensed as part of VoIP testing; see section 3.3.3.7.

Notes on AQM Module Based Solutions

AQM modules (see the User's Manual, chapter 40) are no longer offered for sale, but previously purchased AQM modules can still be used with TEMS Investigation. An AQM license permits connecting any number of AQM modules. An AQM license is also required for merging AQM uplink data (from a CallGenerator) into logfiles, which is done using the logfile export function described in the User's Manual, section 10.7.

3.3.3.3. HTTP Streaming with VQmon

A separate license option is required for streaming over HTTP with VQmon streaming quality measurement.

For the service testing setup, see the User's Manual, section 12.20.6.4.

3.3.3.4. Iperf with Password Encryption

An SSH license option is required for Iperf testing with SSH2, where the device logs in to the Iperf server using an encrypted password.

For the service testing setup, see the User's Manual, section 12.20.3.19.

3.3.3.5. ODM (On-device Measurement)

Special license options is required for certain on-device services, as detailed in section 6.10.

See the User's Manual, chapter 15 for an overview of on-device measurement.

Over and above this, most ODM services furthermore require a *device-based* license, which however has nothing to do with either FlexNet or HASP license handling.

3.3.3.6. SFTP (Secure Shell FTP)

An SSH license option is required for file transfer over SFTP. This is an option in FTP testing; see the User's Manual, sections 12.20.3.11–12.20.3.12.

3.3.3.7. VoIP

A separate license option is required for VoIP (VoLTE) testing, including AQM for VoIP.

For the service testing setup, see the User's Manual, section 12.20.7.

3.3.4. Logfile Load License Requirements

Within the confines of the cellular technologies supported in the package, it is possible in TEMS Investigation to load and analyze logfiles recorded with devices for which you have no license. For example, even if you have not purchased the license option for data collection with Qualcomm devices, you can still load logfiles recorded with Qualcomm devices.

However, loading of logfiles recorded with products other than TEMS Investigation, such as TEMS Automatic, requires either a Base Software package (see section 3.1) or, with Replay packages, a special license option for each product.

3.4. Accessories

In addition to the standard packages and separately purchased user terminals and scanners, the following optional items can be delivered:

- GPS units
- TEMS Pocket-enabled devices
- Equipment cases
- Indoor backpack including battery solution

The indoor backpack contains everything needed to operate phones and scanners in indoor and pedestrian environments. The backpack comes in two sizes, of which the larger accommodates both phones and a scanner, while the smaller is intended for phones only.

Please contact Ascom for further information on the available accessories.

4. Hardware and Software Requirements

This chapter lists:

- hardware and software requirements on the PC where TEMS Investigation is going to run (section 4.1)
- requirements on other PCs or ancillary devices that are needed in particular service testing configurations (section 4.2).

4.1. Requirements on TEMS Investigation PC

4.1.1. Hardware

TEMS Investigation 15.3 is designed to run on a standard PC and interfaces with the connected devices mainly through USB or serial ports.

Processor and RAM requirements are strongly dependent on what external devices are connected and what tasks they perform. The recommended minimum configuration is: Pentium T7200 or AMD TL-58 class CPU, preferably with dedicated graphics card from ATI or nVidia; 1 GB RAM. Please note that it is *not advisable* to collect data with more than one device, or to collect data in an LTE or HSPA network, using this configuration.

LTE data service testing at high throughput rates (above 50 Mbit/s) with a Qualcomm chipset based device requires a very powerful PC processor, for example a second-generation Intel Core i5 or comparable Intel Core i7.

For testing with a large array of connected devices (for example, 6–8 devices plus GPS), an Intel Core i7-*nnn*QM/XM, Intel Core i7-2*nnn*QM/XM, or equivalent processor is necessary.

Other hardware requirements:

- One USB port for each user terminal
- One USB port for each stand-alone AQM module

- One or two USB port(s) for SRU (see the User's Manual, section 6.1.3)
- USB port for PCTel SeeGull EX/LX MM2/MX or PCTel PCT scanner
- USB port for Anritsu ML8780A scanner
- USB port for Transcom scanner
- USB port for equipment case
- USB port for HASP HL SRM hardware key
- USB port, Bluetooth port, or serial port for GPS
- Serial port for PCTel SeeGull LX dual-band/single-band scanner
- Serial port for Anritsu ML8720 scanner
- Ethernet port for Andrew scanner
- Ethernet port for DRT scanner
- Ethernet port for Rohde & Schwarz scanner
- ExpressCard/34 slot or PC Card slot for any data card user terminals
- Sound card and loudspeakers for event audio indications
- Enough disk space to accommodate temporary files created during installation (at least 1 GB), logfile recording, and logfile analysis

Note: During drive testing, it must be ensured that the PC and all devices connected to it have adequate power supply for the duration of the test. See the Device Configuration Guide, chapter 14.

4.1.2. Operating System

The following operating systems are supported:

- Windows 7 with Service Pack 1 (x86, x64)
- Windows Vista with Service Pack 2 (x86)

TEMS Investigation also runs under Windows 8 Pro. However, this documentation currently does not cover Windows 8 specific aspects of TEMS Investigation use.

All the latest Windows updates should always be installed.

Supported languages are English (U.S.), Chinese (simplified characters), and Japanese.

For all devices that are to be connected to the PC, be sure to use the drivers appropriate to the PC operating system. See the Device Configuration Guide, chapter 2.

4.1.3. Software

Below is a list of other third-party software that is required for various tools and actions in TEMS Investigation. When installing third-party software, administrator rights are required, and possibly (depending on UAC settings) the installation must be run using the **Run as administrator** option.

- .NET Framework version 4.5 must be installed on the PC. It is included in the TEMS Investigation installation package and will be installed automatically if not already present.
- Microsoft Network Monitor (NetMon) is used by TEMS Investigation as IP sniffer and must be present. It is installed along with TEMS Investigation.
- Internet Explorer 8 or later required for Report Generator and online help.
- Internet Explorer 9 required for HTTP download/upload testing with Internet Explorer: see the User's Manual, sections 12.20.3.13, 12.20.3.14. It is also required for streaming over HTTP. **Note:** Internet Explorer 11 *cannot* be used for these services.
- Adobe Flash Player required for streaming over HTTP.
- Microsoft DirectX 9.0c or later required for RTP streaming.

4.2. Requirements on Other Devices

4.2.1. Audio Quality Measurements

For audio quality measurements, one of the following additional hardware components is needed, unless an on-device measurement setup is used. Compare the User's Manual, chapter 37:

- Audio Capturing Unit (ACU):
  - ACU R2, optionally with CallGenerator, or
  - ACU TerraTec
- AQM module(s) and either CallGenerator or Mobile Receiving Unit, MRU.

Regarding the CallGenerator, see the Device Configuration Guide, chapter 7.

4.2.2. Available Bandwidth Measurement

ABM testing is done against one or several ABM servers, which are hosted by Ascom. Please contact TEMS support to obtain IP addresses to these ABM server.

4.2.3. HASP License Server

This section applies if HASP is used as licensing solution.

Supported operating systems are: Windows 7, Windows Vista, Windows XP, Windows 2000; Windows 2008 Server, Windows 2003 Server (32-bit versions throughout).

If HASP network licenses (see section 7.3.2) are to be used, the PC hosting the license server must have at least one free USB port.

Hardware requirements do not need to be stated since running the HASP License Manager is not a CPU-intensive task.

4.2.4. Network Bandwidth (UDP/TCP) Testing with Iperf

Network Bandwidth testing uses the Iperf software. Iperf versions 2 and 3 are supplied with TEMS Investigation.

- Iperf 2 can alternatively be downloaded from ▶ sourceforge.net/projects/iperf/ (version 2.0.5 or later required).
- For Iperf 3 it is necessary to use the Ascom supplied software. On the Iperf server machine, you need to run the installer IPerf3Beta5Ascom.msi, which will install Iperf files to the directory C:\Program Files (x86)\Ascom\TEMS Products\IPerf3Beta5Ascom. Iperf is then started by running the file IperfWatcher.exe. – See also the document “Iperf 3 Server Installation Guide”, found in the TEMS Investigation documentation package.

Iperf can be installed on a Windows, Linux, or Unix platform. TEMS Investigation is compatible with an Iperf 2 server on any of these platforms but with Iperf 3 on Windows only. TEMS Investigation has been verified with Iperf installed under:

- Windows Server 2008 R2, Windows 7
- OpenSUSE 11.2 (Iperf 2 only).

Regarding installation under Linux/Unix, see also section 4.2.4.2.

4.2.4.1. Installation for SSH2 (Iperf 2 only)

If you wish to do Iperf 2 testing over the secure SSH2 protocol, you must install TEMS Investigation by executing a special MSI file named TEMS_Investigation_15.3_SSH2.msi (instead of following the regular procedure described in section 5.1).

To run the Network Bandwidth activity over SSH2, the PC must have a HASP key installed with the SSH2 license option encoded.

4.2.4.2. Installation under Linux/Unix (Iperf 2 only)

The following requirements apply to installing Iperf 2 on a Linux or Unix server.

Network-to-terminal Mapping

The Network Bandwidth activity requires that the server map the network port to terminal vt100. Map the port by editing a line in /etc/profile as follows:

```
tset -I -Q -m network:vt100
```

An incorrect mapping will cause the following error:

```
tset: unknown terminal type network
Terminal type?
```

PS1 Variable

The PS1 variable must be changed to PS1=">" in the Unix shell Bash in order for Iperf information to be correctly displayed.

Passwords

To enable the use of passwords in Iperf testing, make sure that the /etc/ssh/sshd_config file on the SSH server has the default setting for passwords: PasswordAuthentication yes .

4.2.4.3. Iperf 3: Setup of Multiple Servers

To enable multiple TEMS Investigation users to do Iperf testing concurrently against the same Iperf server machine, multiple Iperf server instances must be defined on that machine. For Iperf 3, you accomplish this by editing the file

ConfigInfo.xml (see above for the path). By default, this file has a single “IPerfServer” line:

<IPerfServer IP="127.0.0.1" Port="5001"/>

To set up multiple server instances, add more such lines with the same IP and with Port incremented by one each time: 5002, 5003, etc. (Make sure these ports are available on the server machine.) When IperfWatcher.exe is run, it will start all Iperf server instances defined in ConfigInfo.xml.

Further information on how to install the Iperf 3 server software is found in the document “Iperf 3 Server Installation Guide”, which is part of the TEMS Investigation documentation package.

4.2.5. SFTP Testing

On a Linux/Unix SFTP server, the following setting must be entered in the file /etc/ssh/sshd_config:

add “UseDNS no”

4.2.6. UDP Testing with TEMS UDP Server

UDP testing makes use of the TEMS UDP Server application, which is installed on the PC acting as server. Requirements on the PC where TEMS UDP Server is going to be run are stated in the document “TEMS UDP Server User’s Manual”, found in the TEMS Investigation documentation package.

Please note that the UDP client in TEMS Investigation 15.3 requires a TEMS UDP Server from TEMS Investigation 12.0 or later; the client is not compatible with older TEMS UDP Servers.

Multiple TEMS UDP Servers from TEMS Investigation 12.0 or later cannot coexist on the same machine.

4.2.7. Video Streaming

For RTP video streaming measurements a streaming server is needed: Darwin Streaming Server (version 5.5.5) or Helix Mobile Server (version 10 or 11). These servers can be used for HTTP streaming as well.

4.2.8. VoIP Testing with PC-based Clients

VoIP testing with PC-based clients requires two PCs, each running an instance of TEMS Investigation. See the User's Manual, section 12.20.7.5, and the technical paper "VoIP Testing with TEMS Investigation PC-based Clients", found in the TEMS Investigation documentation package.[1]

Note that VoIP testing can alternatively be done with on-device clients, in which case only one PC is needed.

1. Two TEMS Investigation licenses are thus required for this VoIP testing configuration, as well as the VoIP license option (see section 7.4).

5. Installing TEMS Investigation

5.1. Installation Procedure

The installation is done by running the file TEMSInvestigation15.3.exe. If FlexNet is used as licensing solution, you download this file as explained in section 6.2. Otherwise, the EXE file is delivered on an installation CD.

You must have administrator rights on the PC to be able to install TEMS Investigation.

Also please note that the PC must have a working Internet connection when executing the EXE file, since various software components will be retrieved over the Internet. This includes .NET 4.5 in case the PC does not already have it installed (compare section 4.1.3). If .NET 4.5 needs to be installed, the entire installation procedure may take up to 10–20 minutes to complete. On some PCs, a reboot may take place after the .NET Framework installation.

By default, TEMS Investigation will be installed to the directory C:\Program Files\Ascom\TEMS Products\TEMS Investigation 15.3.

5.2. Accompanying Utilities

A number of utilities are installed along with the product:

- **RouteFinder™**, used to search TRP logfiles. See the RouteFinder User's Manual.
- **RouteUtility™**, used to split a TRP logfile into several self-contained logfiles by region or device, or to extract a segment from a TRP logfile into a new logfile. See the User's Manual, section 10.10 as well as the separate document "RouteUtility User's Manual" which is found in the TEMS Investigation documentation package.
- **HASP SRM Remote Update**, used to update license options in HASP keys. See the document "TEMS HASP SRM Key Information" which is found in the TEMS Investigation documentation package.

- **Manual UE Configuration**, used to assist TEMS Investigation in detecting certain types of devices. See the Device Configuration Guide, section 3.1 and the User's Manual, section 6.3.4.
- **Service Settings (Settings Manager)**, used to manage configuration sets for service testing. See the User's Manual, section 12.17.2.
- **Ascom ACU Firmware Upgrade Tool**, used to download new firmware to an ACU R2 (Ascom Audio Capturing Unit). See the Device Configuration Guide, section 5.4.
- **Computer Diagnostics**, used to rate the capabilities of the PC and check its current settings, matching the findings with the requirements posed by TEMS Investigation. This utility is launched in the course of the installation. See the Device Configuration Guide, chapter 13 for full coverage of this utility.
- **ImagePositioning**, used to position an unpositioned image, creating a TAB for it. See the ImagePositioning Utility User's Manual, which is part of the TEMS Investigation documentation package.
- **TEMS Pocket Positioning Tool**, used to assign geographical coordinates to TEMS Pocket logfiles in the old *.tpz format (versions 11.0–12.2) recorded by pinpointing (i.e. without a GPS). See the TEMS Pocket Positioning Tool User's Manual, which is part of the TEMS Investigation documentation package.

Once installed, the applications and utilities can be run by choosing **Start** → [**All**] **Programs** → **Ascom** → **TEMS Products**.

5.3. Uninstalling TEMS Investigation

To uninstall TEMS Investigation software, follow the steps below.

- Open the Windows Control Panel and select **Programs and Features**.
- Select "TEMS Investigation 15.3 Installer" in the list of installed programs. Click **Uninstall** and confirm removal if prompted to do so. The software will now be uninstalled.

6. FlexNet Licensing

This chapter applies if you are using FlexNet as licensing solution. Software download and license management are then handled through the FlexNet web interface.

What is described in this chapter is limited to the tasks a regular TEMS Investigation user needs to perform. The all-important ones are:

- Downloading the TEMS Investigation software.
- Installing TEMS Investigation licenses.

For the more extensive tasks to be handled by customers' FlexNet admins, a tutorial is provided in the document "User's Guide – Global License Server".

6.1. FlexNet Terminology

FlexNet terminology is in part different from what is used in the TEMS Investigation documentation. To prevent confusion, some preliminary notes are in order regarding the language used in the FlexNet user interface:

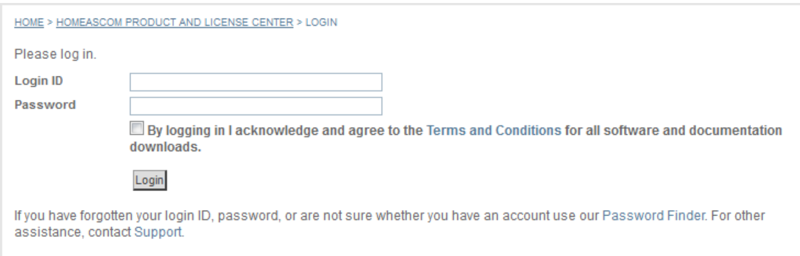
FlexNet Term	Meaning of Term As Applied to TEMS Investigation
Entitlement	TEMS Investigation software that you are entitled to download and license options that you are entitled to activate.
Add-on	Any TEMS Investigation license option (which is "added onto" your PC): not just optional ones for non-mandatory functions, but also the basic license required to run the application. An add-on contains one or several license *features*.

FlexNet Term	Meaning of Term As Applied to TEMS Investigation
Device	A device on which the TEMS Investigation software runs, that is, a PC. (It does *not* refer to TEMS Investigation data-collecting devices.)

6.2. Downloading TEMS Investigation Software

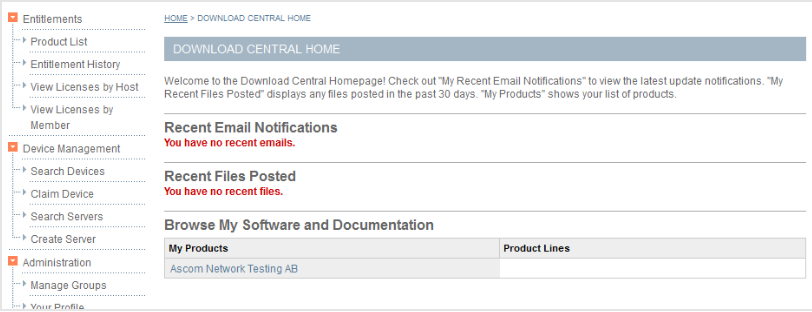
To enable download of the purchased TEMS Investigation software, Ascom sends a welcome email to the person in your organization named as email contact with a link to a FlexNet web page. That person can then log in to the web page and download TEMS Investigation software. It is assumed here for simplicity that you will be doing this yourself; alternatively, it might be done for you by the FlexNet admin in your organization.

- Click the link in the welcome email. It takes you to this login page:



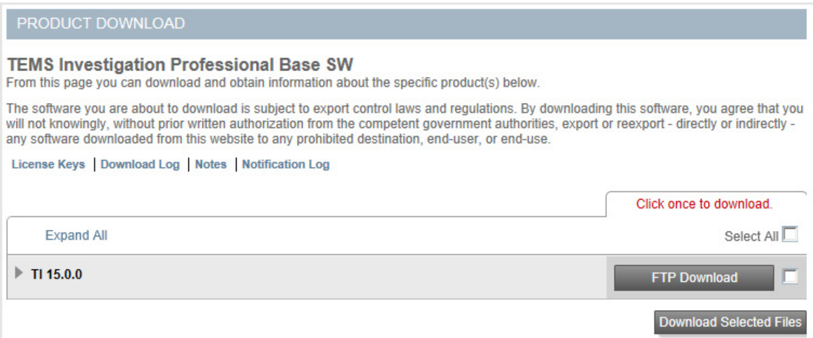
- Click the **Password Finder** link.
- Enter your email address and press **Submit**.
- You will now receive another email. In that email, click the text that reads "this link".
- Enter your email address and password as instructed on the web page. **Note** that the email address must be entered in lowercase.

You are taken to a page titled **Download Central Home**.



- In the navigation column under **Entitlements**, click **Product List**.
- In the list of products, select TEMS Investigation.
- On the **Product Information** screen, click the version you want to download.

- On the **Product Download** screen, click the **FTP Download** button once for the appropriate file.



A TEMS Investigation EXE file is now downloaded to your PC.

6.3. Installing TEMS Investigation on Your PC

Install the TEMS Investigation software as described in section 5.1.

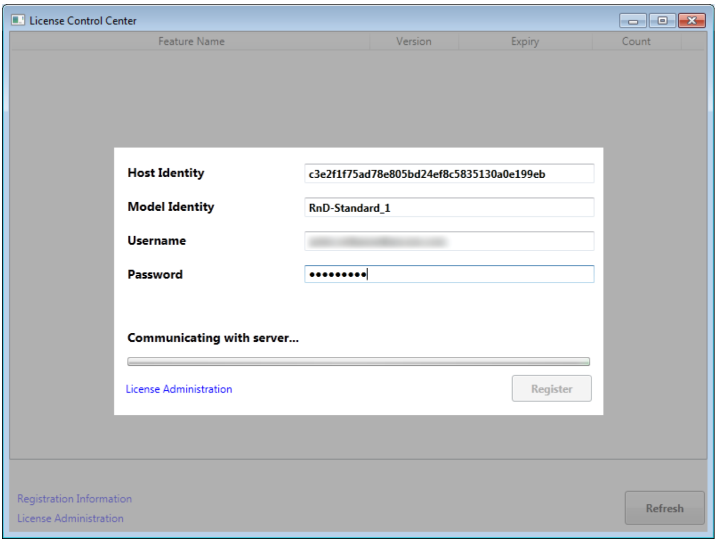
6.4. PC Registration

When you start TEMS Investigation for the first time, your PC will automatically register with FlexNet. In the process, a device ID is created for your machine.

A window titled **License Control Center** appears, where this device ID is displayed as **Host Identity**.

You now need to log in to FlexNet:

- Under **Username**, enter your email address.
- Under **Password**, enter the password you were assigned when downloading the TEMS Investigation software (see section 6.2).
- Click the **Register** button.



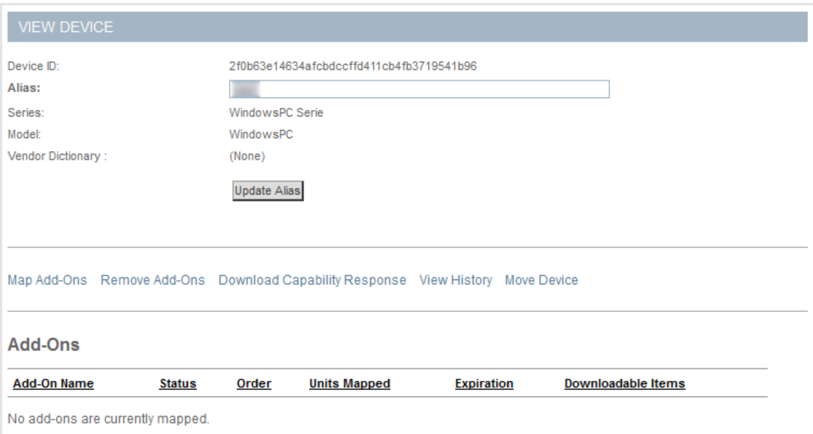
A message box saying "License check failed!" will appear at this point. This is because you have not yet installed any TEMS Investigation licenses on your PC. This is the topic of section 6.5.

6.5. Installing TEMS Investigation Licenses

What remains to be done is to install the requisite TEMS Investigation licenses on your PC. This means the basic license for the TEMS Investigation software as well as all additional license options that have been purchased. As in case of the software download, it is assumed here that you will be installing the licenses yourself, as opposed to your FlexNet admin handling this task.

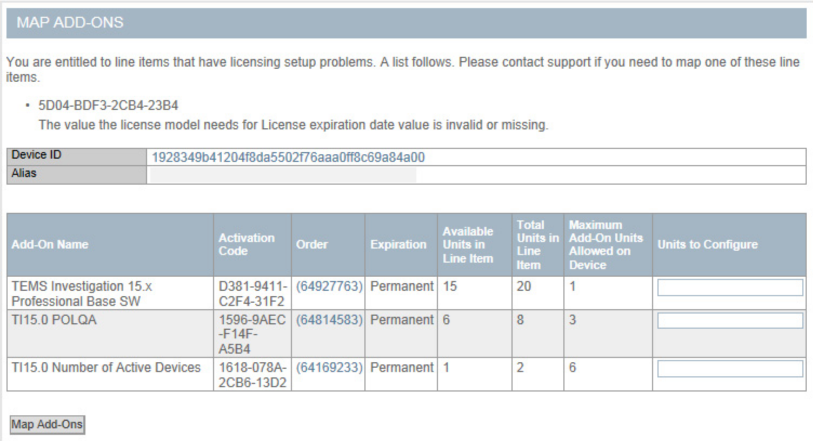
- In the FlexNet web interface, in the navigation column under **Device Management**, click **Search Devices**.
- In the list of devices, find the device ID that represents your PC by using the **Device ID** search field. It is usually sufficient to enter the last few digits of the string, preceded by a wild card, like this: “*1234”. Click the device ID link once you have located it.

At the bottom of the **View Device** screen, all license options (“add-ons”) that you have installed on your PC are listed. The first time around, of course, this list will be empty.



- To activate license options on your PC, you need to *map* the relevant add-ons to the machine. Click the **Map Add-Ons** link.

The **Map Add-Ons** screen appears, displaying a comprehensive overview of the pool of add-ons at your organization’s disposal.



MAP ADD-ONS

You are entitled to line items that have licensing setup problems. A list follows. Please contact support if you need to map one of these line items.

- 5D04-BDF3-2CB4-23B4
  The value the license model needs for License expiration date value is invalid or missing.

Device ID	1928349b41204f8da5502f76aaa0ff8c69a84a00
Alias	

Add-On Name	Activation Code	Order	Expiration	Available Units in Line Item	Total Units in Line Item	Maximum Add-On Units Allowed on Device	Units to Configure
TEMS Investigation 15.x Professional Base SW	D381-9411-C2F4-31F2	(64927763)	Permanent	15	20	1	
TI15.0 POLQA	1596-9AEC-F14F-A5B4	(64814583)	Permanent	6	8	3	
TI15.0 Number of Active Devices	1618-078A-2CB6-13D2	(64169233)	Permanent	1	2	6	

Map Add-Ons

The **Available Units in Line Item** column shows the number of licenses currently available, out of the total purchased, which is given in the **Total Units in Line Item** column.

The **Maximum Add-On Units Allowed on Device** column tells how many license options of a given type can be activated simultaneously on the same PC. For the basic TEMS Investigation software license, this number is one, since it would not make sense to have more than one base software package installed.

What you need to do here is to map the full set of add-ons you are going to require in using TEMS Investigation.

- You must always map the TEMS Investigation **base software** license; compare section 3.1.
- You also need to map:
  - Your license options for **cellular technologies**; see section 3.3.1.
  - The license options for the **data-collecting devices** you will be using; see section 3.3.2.
  - Any license options required for particular **measurements or service testing**; see section 3.3.3.
- For each add-on, enter the number of add-ons you want to map in the **Units to Configure** column, then click the **Map Add-Ons** button. The status of each add-on changes to “Waiting to add to device”.

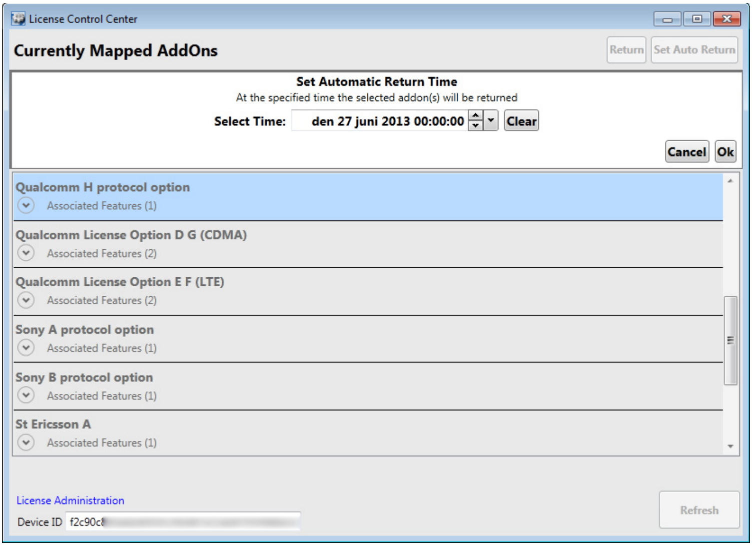
- When you are done mapping add-ons, return to the License Control Center window and click the **Refresh** button there. The status of the add-ons in the FlexNet web interface will then change to “License generated”, and the License Control Center will display all the licenses that are now installed on your PC.

You are now ready to start using TEMS Investigation with all functions that you have a license for. (If the “License check failed!” message still appears, double-check that all required licenses are present and in sync. If you find nothing amiss, reboot the PC.)

6.6. Uninstalling/Returning Licenses

To uninstall a TEMS Investigation license from your PC and return it to the pool of available licenses, proceed as in section 6.5, but on the **View Device** screen, click the **Remove Add-Ons** link instead. The table from the **Map Add-Ons** screen reappears here, and you can remove licenses selectively exactly as desired.

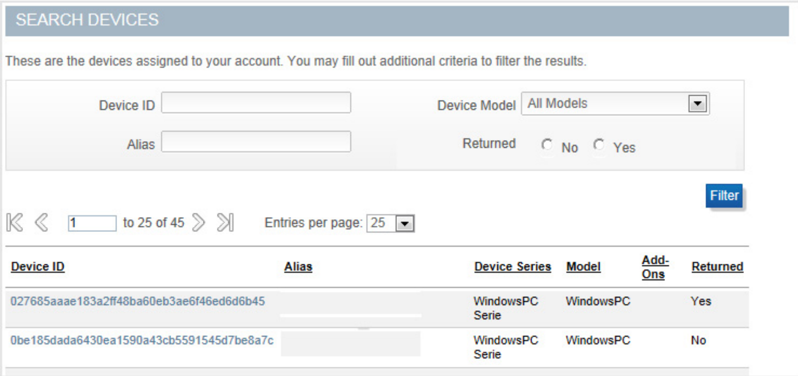
Alternatively, you can return licenses from the License Control Center window. In the list of currently mapped add-ons, you can select an add-on and then click the **Return** button. Furthermore, you can schedule returning of licenses to take place at a specified time in the future. Do so by clicking the **Set Auto Return** button and entering a date and time, as shown in the following screenshot:



6.7. Creating a PC Alias

It is a good idea to define a plain-language *alias* for your PC (preferably, your email address) so that you can identify it more easily in the FlexNet user interface.

- In the navigation column on the left, under **Device Management**, click the **Search Devices** link. Here you will find your PC added to the list of registered devices.
- In the **Device ID** column of this list, click the link representing your PC.



- On the **View Device** screen, type the alias you want into the **Alias** field.
- Click the **Update Alias** button.

This alias will now appear on the **Search Devices** screen.

6.8. Technical Notes on FlexNet Add-Ons

Unlike HASP features, FlexNet add-ons do not have underlying identification numbers, but are defined by the text string that appears in the user interface. A full list of FlexNet add-ons is given in section 6.10, analogous to the HASP Feature id list in section 7.4.

6.9. Notifications in TEMS Investigation

FlexNet will pop up a message box in TEMS Investigation in the following situations:

6.9.1. License Missing

If the set of add-ons mapped to the PC at TEMS Investigation start-up is not viable, TEMS Investigation will shut down with a message “License check failed!”, just as happens the first time around when you have not yet mapped your add-ons (see section 6.5).

6.9.2. License Expiry

TEMS Investigation will warn you when some FlexNet add-on mapped to your PC is about to expire. A message box will be displayed in TEMS Investigation a number of times over the last few days before this happens, detailing the add-ons affected.

6.10. List of FlexNet License Add-Ons for TEMS Investigation

Below is a list of FlexNet license add-ons that are currently relevant for TEMS Investigation. The list is exhaustive with respect to product *functionality* and supported connectable *devices*; however, it omits variant add-ons defined for trial packages, rental, regional editions, and the like.

An add-on contains one or several license *features*, as shown in License Control Center (under the heading **Feature Name** appearing under each add-on). License features are not listed in this manual.

License Option Name	Explanation (where needed)
TEMS Investigation product versions and packages	
TEMS Investigation 15.x Professional Base SW	See section 3.1
TEMS Investigation 15.x Replay	See section 3.2
Technology options: Compare section 3.3.1	
Technology Option CDMA Professional	–
Technology Option LTE Professional	–
Technology Option TD-SCDMA Professional	–
Technology Option UMTS Professional	Covers GSM and WCDMA
External device options: Compare section 3.3.2	
Multiple Connect Option	Connection and simultaneous use of multiple user terminals

License Option Name	Explanation (where needed)
Altair License Option A	–
Apple License Option A	–
Datang License Option A	–
DRT License Option	–
GCT License Option A	–
Hisilicon License Option A	–
LG License Option A	–
Nokia License Option C	–
PCTEL License Option	All models except EXflex
PCTEL License Option B	EXflex model
Qualcomm License Option B/C (UMTS)	HSPA(+) capable chipsets
Qualcomm License Option D/G (CDMA)	CDMA and CDMA Rev. B capable chipsets
Qualcomm License Option E/F (LTE)	LTE and TD-LTE capable chipsets
Qualcomm License Option H (IMS, VoLTE)	Devices with Qualcomm IMS client for VoLTE
Rohde & Schwarz License Option	–
Samsung License Option A	–
Sequans License Option A	–
Sony License Option A	Sony Xperia arc S
Sony License Option B	Sony phones with TEMS control functions: Xperia LT25i, LT30a
ST Ericsson License Option A	Sony devices with ST-Ericsson chipset
Transcom License Option	–
VIA License Option A	–
Measurement and service testing options: Compare section 3.3.3	
ODM SW Option ABM, Blixt™	–
ODM SW Option VoLTE, IP Recording	–
ODM SW Option VoLTE, Samsung IMS	–
PESQ Audio Quality Measurement License Option	–

License Option Name	Explanation (where needed)
POLQA Audio Quality Measurement License Option 2 channels	Up to 2 devices
POLQA Audio Quality Measurement License Option 4 channels	Up to 4 devices
POLQA Audio Quality Measurement License Option 6 channels	Up to 6 devices
POLQA Audio Quality Measurement License Option 8 channels	Up to 8 devices
SSH2 Network Bandwidth Measurements License Option	Secure Shell (login with encrypted password)
VQmon Video Quality Measurement License Option A	–
Logfile load options (Replay package only): Compare section 3.3.4	
TEMS Investigation 15.x Replay TEMS Pocket Reader Option	TEMS Pocket logfiles (*.trp)
TEMS Investigation 15.x Replay TEMS Automatic Reader Option	TEMS Automatic RTU logfiles (*.trp)
TEMS Investigation 15.x Replay TEMS Symphony Reader Option	TEMS Symphony logfiles (*.trp)

7. HASP Licensing

This chapter applies if you are using HASP as licensing solution. It covers in detail how HASP software protection is applied to TEMS Investigation and how it is handled it in practice:

- Installation of licensing-related drivers (section 7.1).
- All procedures involved in software-based licensing (section 7.3).

HASP comes in two varieties:

- hardware-based ("HASP HL"), using physical keys ("dongles") which are plugged into a PC USB port;
- software-based ("HASP SL"), using software keys which are installed as a "fingerprint" on the PC hard drive.

7.1. Drivers for HASP Key

The HASP key drivers (for HASP HL and SL alike) are installed automatically along with TEMS Investigation. If you are going to use HASP SL network licensing, you must install the HASP driver on the license server PC; see section 7.3.2 for instructions.

Note: Do not use any other HASP driver than the one delivered with TEMS Investigation. Do not update the HASP driver via Windows Update; the driver thus obtained is not identical and does not contain certain features necessary for using software-based HASP licensing with TEMS Investigation.

7.2. Hardware-based Licensing: HASP HL

HASP HL licenses are always local and embodied in a physical hardware key which is inserted into the PC. No further configuration is required.

7.3. Software-based Licensing: HASP SL

For HASP SL, there is a choice between *local* licenses and *network* licenses.

- A local license is a fixed single-user license which is embodied in a software key installed on the PC. See section 7.3.1.
- A network license can be shared among multiple users. It is obtained on the client PC by connecting to a license server and checking out a software key from that server. See section 7.3.2.

7.3.1. HASP SL Local License Installation

Here is how to install a local HASP SL license on a client machine.

- Install TEMS Investigation. In the process, the HASP SRM driver is installed automatically on the PC.
- Run the file hasprus.exe, which is found in the directory <TEMS Investigation install dir>\Application. From this session you obtain a file with extension .c2v. See also the document “TEMS HASP SRM Key Information”, available in the TEMS Investigation documentation package.
- Send the .c2v file to Ascom technical support. You will receive a .v2c file in return.
- Run hasprus.exe again to apply the .v2c file to your PC.

7.3.2. Using HASP SL Network Licenses

7.3.2.1. TCP Port Usage

By default, TCP port 1947 is used between server and client. Due to firewall restrictions or other issues, you might need to change this port. If necessary, do as follows:

- Under HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\hasplms\Parameters, create a registry entry “Port” on both server and client.
  - Type: REG_DWORD or REG_SZ. The preferred type is REG_SZ since the default display of REG_DWORD is hexadecimal, which may be misleading.
  - Value: Set the value to the desired port number.

- Restart the LLM Server (Sentinel HASP License Manager) or reboot the machine.

The port assignment can be verified with the command netstat -a.

If applicable, substitute your own TCP port number for “1947” when following the instructions below.

7.3.2.2. HASP SL License Server Installation

If you are going to use HASP SL network licenses, you must first configure the machine that is going to act as license server:

- Install the HASP SRM driver supplied in the TEMS Investigation installation package. **Note:** Do not use any other HASP driver. The server and client must run the same version of HASP License Manager.
- Run the file hasprus.exe, which is found in the TEMS Investigation installation under <TEMS Investigation install dir>\Application. From this session you obtain a file with extension .c2v. See also the document “TEMS HASP SRM Key Information”, available in the TEMS Investigation documentation package.
- Send the .c2v file to Ascom technical support. You will receive a .v2c file in return.
- Run hasprus.exe again to apply the .v2c file to the license server machine.
- Now configure the server using the Sentinel Admin Control Center web page at **Help** → **License Control Center**.
  - Go to **Configuration** → **Detachable Licenses** tab and check the option **Enable Detaching of Licenses**.
  - By adjusting the parameter **Max. Detach Duration**, you can control the maximum duration for which a license may be detached. After this time, the license will be automatically disabled on the client machine and restored to the license server. It is advisable to keep the maximum detach duration fairly short, since if a client computer crashes the license will be unavailable until the expiry date. The minimum value is 1 day.
  - Then switch to the **Access from Remote Clients** tab and enter whatever is suitable under **Access Restrictions**. By default, a license can be detached from any machine; if you want to restrict the set of machines and/or users that should have access to the HASP License

Manager, proceed according to the help provided for this tab (“**Help**” link in lower right corner).

7.3.2.3. HASP SL Network License: Online Detach/Attach

Once the license server has been configured, it can send out licenses to client machines. Here are the steps to perform on the client PC in order to check out (“detach”) a license online from the license server, and to return (“attach”) a license to the server.

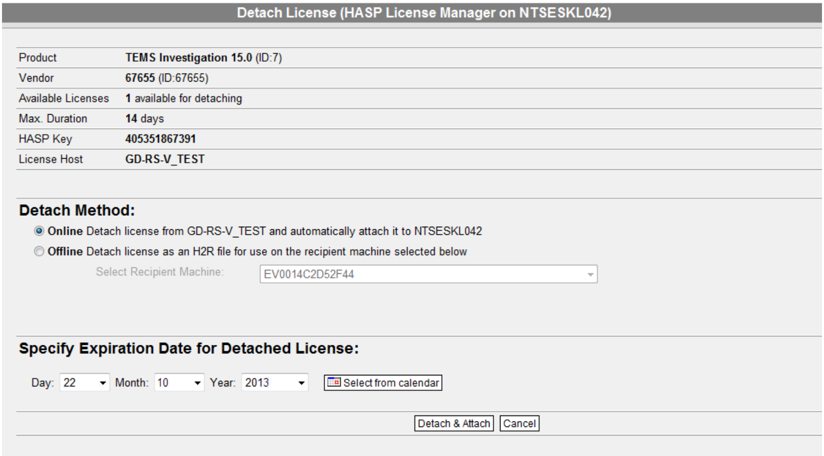
- Configure the client PC using the Sentinel Admin Control Center web page, **Help** → **License Control Center**.
  - Go to **Configuration** → **Detachable Licenses** tab and check the option **Enable Detaching of Licenses**.
  - Then go to the **Access to Remote License Managers** tab. Under **Specify Search Parameters**, enter the IP address or name of the license server machine. Regarding the other settings, see the help provided for this tab (“**Help**” link in lower right corner).
- On the ACC web page, under **Products**, locate TEMS Investigation in the list. Click the **Detach** button for that product.

Products available on NTSESKL042

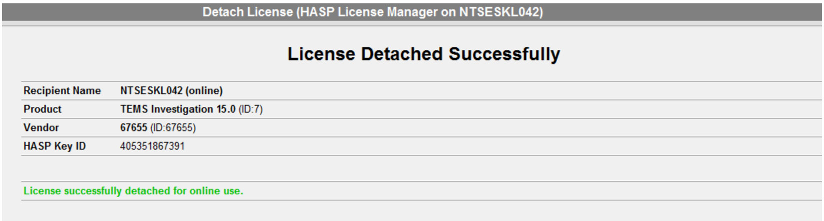
#	Product Name	Vendor	Location	Detached	Available	Actions
1	**TEMS Investigation 15.0**	67655	GD-RS-V_TEST	n/a	**1**	Detach Features
2	**ProProduct**	67655	Local	-	-	Features

Note: For practical examples of how to work with HASP SL licenses when multiple TEMS products and product options are involved, please turn to section 7.3.2.5.

- “**Online**” is the default detach method when the client has a network connection to the license server. (No action needed.)
- Specify an expiration date for the detach operation. This setting controls how long the license can be detached at a time, and it is configurable within the limit imposed by the **Max. Detach Duration** setting on the license server; compare section 7.3.2.2.
- Click the **Detach/Attach** button.



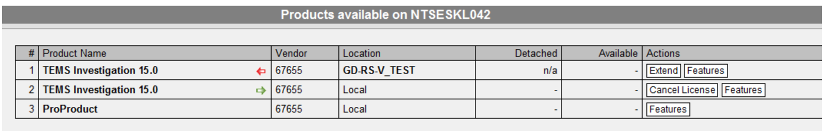
You should now receive a message “License Detached Successfully”:



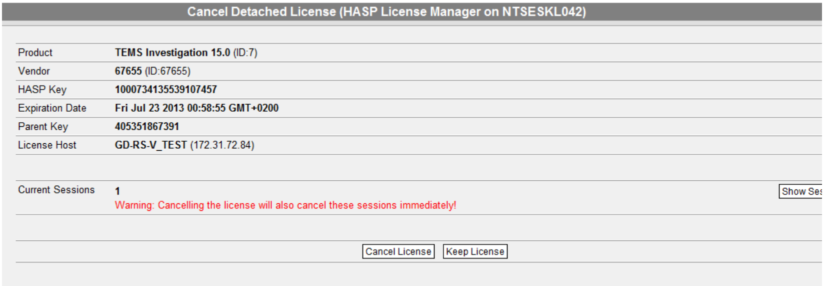
Furthermore, the **Products** page should now be updated with the information that a license has been detached for TEMS Investigation.

The license will expire after the period specified at detach time; after this time you will need to detach the license again. Alternatively, you can actively return (attach) the license to the server before it expires. This is done as follows:

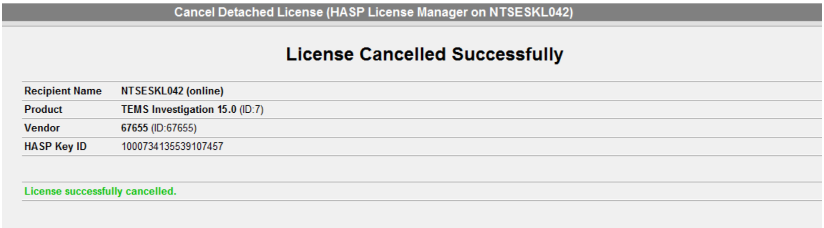
- Navigate to the **Products** page and click the **Cancel License** button for the relevant product.



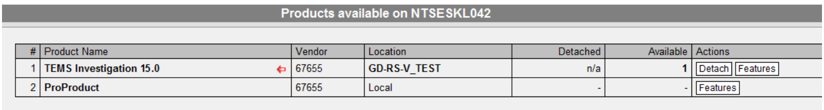
- On the next screen, confirm by again clicking the **Cancel License** button.



This message will appear:



The information on the **Products** page will also be updated once more to reflect the reattach of the TEMS Investigation license:



7.3.2.4. HASP SL Network License: Offline Detach/Attach

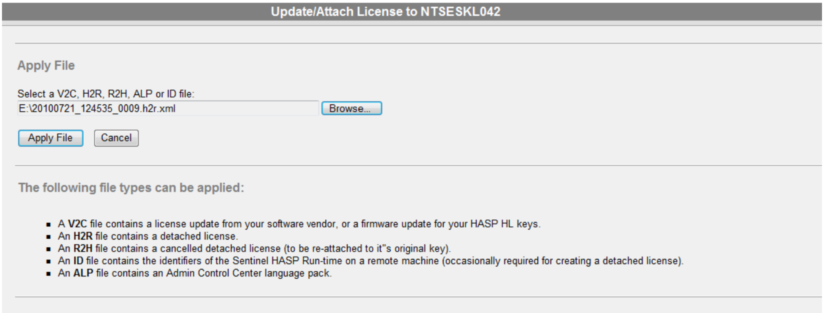
License detach and attach can alternatively be done offline, without the client and server ever communicating directly over a network connection.

- Configure the client PC using the Sentinel Admin Control Center web page, **Help** → **License Control Center**.
  - Go to **Configuration** → **Detachable Licenses** tab and check the option **Enable Detaching of Licenses**.
  - Then go to the **Access to Remote License Managers** tab. Under **Specify Search Parameters**, enter the IP address or name of the

license server machine. Regarding the other settings, see the help provided for this tab (“**Help**” link in lower right corner).

- If the client PC is not yet known to the HASP license server, you need to identify it to the server the first time around.[1] On the Sentinel Admin Control Center web page, go to **Diagnostics**, and click the button **Create ID File**. This generates a diagnostics file (with extension .id) identifying your machine.

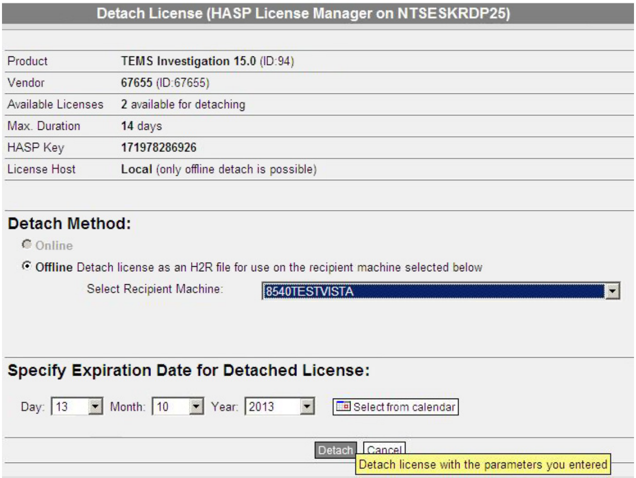
- Send the diagnostics file to the HASP license server admin.
- Here is how the server admin proceeds in order to detach a license. The admin selects the **Update/Attach** option:



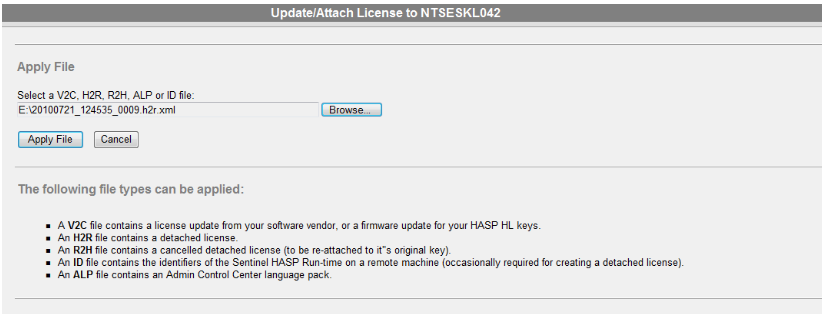
- The admin then clicks the **Detach** button next to the relevant product:

- The admin selects your client PC as recipient machine and sets an expiration date for the license.

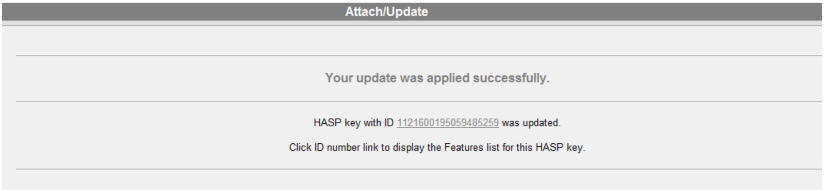
1. If (for example) you have detached a license *online* to this client PC at some point, the PC will already be known to the server, and the identification step is not needed. The license server admin can then send you an .h2r file directly.



- Finally the admin saves the detached license as a file with extension .h2r and sends it to you.
- Save the .h2r file on your client PC, then open the Sentinel Admin Control Center web page, go to **Update/Attach**, and browse for the .h2r file. Then click the **Apply File** button. (This is the same dialog that the admin used to process your .id file.)



A confirmation message will appear, and the Product page will be updated with the information that a license has been detached for TEMS Investigation. See below.

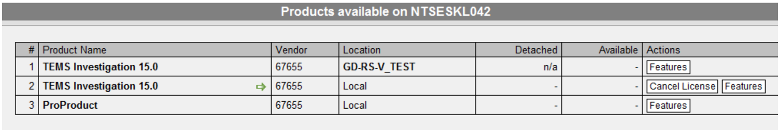


Attach/Update

Your update was applied successfully.

HASP key with ID 1121600195059485259 was updated.

Click ID number link to display the Features list for this HASP key.



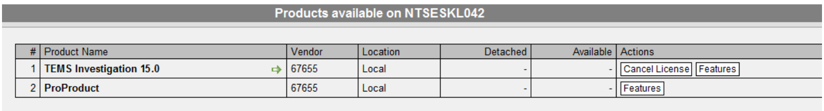
Products available on NTSESKL042

#	Product Name	Vendor	Location	Detached	Available	Actions
1	**TEMS Investigation 15.0**	67655	**GD-RS-V_TEST**	n/a	-	Features
2	**TEMS Investigation 15.0**	67655	Local	-	-	Cancel License Features
3	**ProProduct**	67655	Local	-	-	Features

Note: For practical examples of how to work with HASP SL licenses when multiple TEMS products and product options are involved, please turn to section 7.3.2.5.

The license will expire after the period specified by the HASP license server admin at detach time. After this time you will need to detach the license again. Alternatively, you can actively return (attach) the license to the server before it expires. This is done as follows:

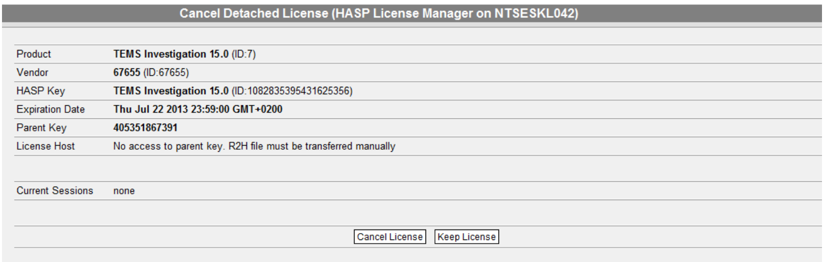
- Navigate to the **Products** page and click the **Cancel License** button for the relevant product.



Products available on NTSESKL042

#	Product Name	Vendor	Location	Detached	Available	Actions
1	**TEMS Investigation 15.0**	67655	Local	-	-	Cancel License Features
2	**ProProduct**	67655	Local	-	-	Features

- On the next screen, again click the **Cancel License** button:

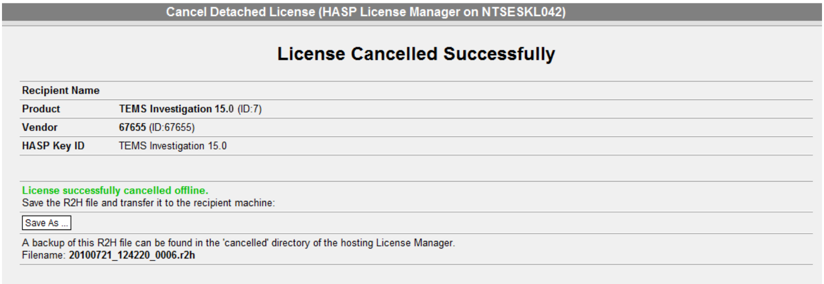


Cancel Detached License (HASP License Manager on NTSESKL042)

Product	**TEMS Investigation 15.0** (ID:7)
Vendor	**67655** (ID:67655)
HASP Key	**TEMS Investigation 15.0** (ID:1082835395431625356)
Expiration Date	**Thu Jul 22 2013 23:59:00 GMT+0200**
Parent Key	**405351867391**
License Host	No access to parent key. R2H file must be transferred manually
Current Sessions	none

Cancel License Keep License

- A file with extension .r2h is created; save this file.



- Send the .r2h file to the HASP license server admin. The server admin will then apply the .r2h file to the server, thereby reattaching the license. (The same **Apply File** procedure is used as for offline detach, which was covered earlier in this section.)

The information of the Product page will again be updated to reflect the reattach of the TEMS Investigation license.

7.3.2.4.1. Disabling Offline Detach

It is possible to disable offline detach of licenses. This may be desirable in order to decrease the risk of detaching licenses to non-existing clients. To disable offline detach, do as follows:

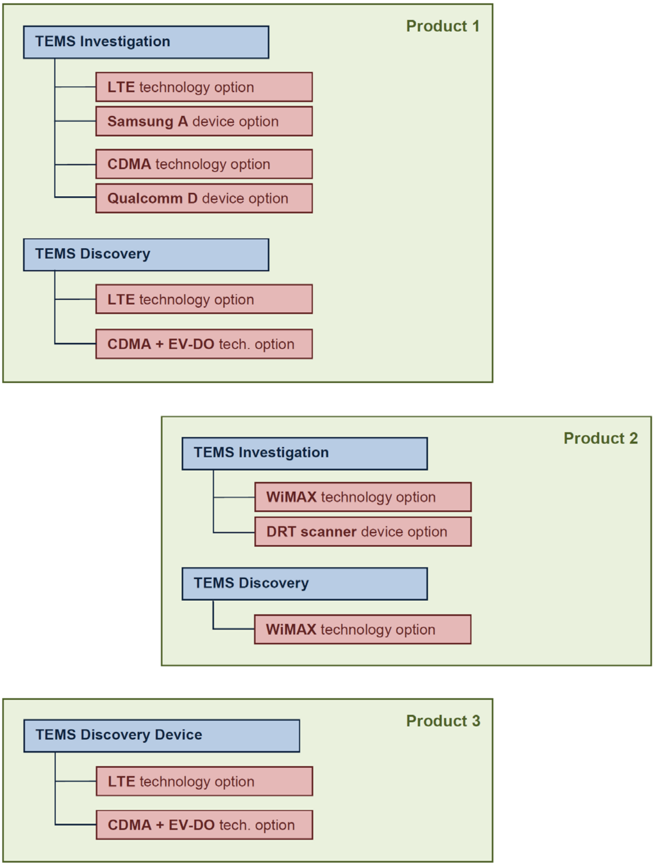
- In the file C:\Program Files (x86)\Common Files\Aladdin Shared\HASP\hasplm.ini, add the line disable_offline_detach = 1 (it does not matter in which section this line is entered).
- Then restart Sentinel Local License Manager.

When detaching a software-based license, the offline option should now be disabled, and this text should be displayed: “(Offline Detach is disabled by configuration)”.

7.3.2.5. Handling HASP SL Network Licenses for TEMS Products: Examples

For simplicity the instructions given so far in section 7.3.2 have assumed that it is immediately obvious what type of license to detach. If you have purchased multiple TEMS products, and/or multiple TEMS product packages with different options, things are slightly more complicated. This section clarifies how to proceed in typical configurations of this kind.

Consider the following set of TEMS product packages (Products 1–3) with different combinations of products and license options:



Each of these packages will appear as a “product” in ACC, as indicated in the diagram. You always check out *entire products* in the ACC interface, not individual license options. These “products”, however, do not necessarily correspond in one-to-one fashion to TEMS PC applications, as can be seen in the diagrams just given.

- If you want to do LTE or CDMA drive testing or both, you check out Product 1.

- If you want to do both LTE and WiMAX testing, you need to check out both Product 1 and Product 2; but note that you will still only be running *one* TEMS Investigation application. (You cannot just check out Product 1 and then somehow add only the WiMAX option from Product 2.)

Another fact to keep in mind is that *each* TEMS product user always needs to check out his or her *own license*.

- Suppose that Product 1 has been purchased, and user A wants to use TEMS Investigation while user B wants to use TEMS Discovery. The two users then need one license each; it is not possible to check out just one license and share it between users A and B.
- Or suppose that Product 3 has been purchased, and user C wants to study LTE data whereas user D wishes to work with CDMA data. Each of these users must likewise have his or her own license.

7.3.2.6. Monitoring HASP SL License Usage

You can monitor how many licenses are currently checked out and who is using those licenses. This is particularly useful when the number of available licenses is running low.

- Go to **Help** → **License Control Center** → **Products**.
- The **Products** page in Sentinel Admin Control Center lists all products that are available on all accessible HASP License Managers on the network.
  - In the **Detached** column is indicated the number of licenses that are currently detached from the HASP SL key to which the product is locked. Click on a cell in the Detached column to view data about the recipient machines to which the detached licenses have been allocated.
  - In the **Available** column is indicated the number of licenses that are currently available for detachment from the HASP SL key to which the product is locked.

7.4. Inspecting the Scope of Your HASP License

From the Sentinel Admin Control Center you can check what is covered by your (local or network) license.

- Go to **Help** → **License Control Center** → **Features**.

The meanings of the HASP key Feature Ids are given in the table that follows. It includes certain Feature Ids used only with older versions of TEMS Investigation.

Feature Id	Release/Option
35	TEMS Investigation 10.1
41	TEMS Investigation 11.0
42	TEMS Investigation 12.0
43	TEMS Investigation 12.1
47	TEMS Investigation 13.0
48	TEMS Investigation 13.1
51	TEMS Investigation 14.x
54	TEMS Investigation 15.x
100	ST-Ericsson A: UMTS and GSM chipsets, Sony devices
103	Nokia C: HSPA-capable devices
104	Qualcomm B: HSDPA-capable chipsets
105	Qualcomm C: HSPA-capable and HSPA+ capable chipsets
106	Qualcomm D: CDMA-capable chipsets
107	PCTel SeeGull A: All models except EXflex
108	Anritsu scanner: ML8720C model
109	DRT scanner
110	Datang A
114	PESQ
116	TEMS Automatic MTU/older TEMS Pocket logfiles (*.log, *.tpz), reading
118	MDM logfiles, reading
119	Connect of 1 device
120	Connect of 3 devices
121	Connect of 6 devices
124	WiMAX technology
125	CDMA technology
126	GSM technology
127	WCDMA technology
128	LTE technology

Feature Id	Release/Option
129	TD-SCDMA technology
130	Samsung A
131	Connect of 2 devices
132	Connect of 4 devices
133	Connect of 5 devices
136	Qualcomm E: LTE-capable chipsets
138	LG A
139	Andrew scanner A
140	PCTel SeeGull B: EXflex model
141	VoIP
142	Rohde & Schwarz scanner A
143	Secure Shell (login with encrypted password)
144	ST-Ericsson B: UMTS and GSM chipsets, non-Sony devices
145	Qualcomm F: TD-LTE-capable chipsets
146	GCT A
147	Sequans A
148	Qualcomm G: CDMA Rev. B capable chipsets
149	Altair A
150	Apple A
151	Via A
152	Compound Logfile Reader (reading pre-14.0 logfiles)
153	TRP TI Reader (reading *.trp logfiles)
154	TRP Writer (writing *.trp logfiles)
156	Sony A: arc S
158	Transcom scanner A
159	Hisilicon A
160	POLQA, devices 1–2
161	POLQA, devices 3–4
162	TRP RTU Reader (reading TEMS Automatic RTU logfiles)
163	Anritsu scanner B: ML8780A model
164	Sony B: Sony phones with TEMS control functions: LT25, LT30
165	On-device measurement: MTSI service

Feature Id	Release/Option
166	ABM, Available bandwidth measurement
167	POLQA, devices 5–6
168	POLQA, devices 7–8
186	On-device measurement: IP Sniffing service
187	TRP Symphony Reader (reading TEMS Symphony logfiles)
190	Qualcomm H: Devices with Qualcomm IMS client for VoLTE
191	HTTP streaming with VQmon
1000	TEMS Investigation (fundamental product features which do not require any specific license option)
1140	RouteFinder
1160	RouteUtility

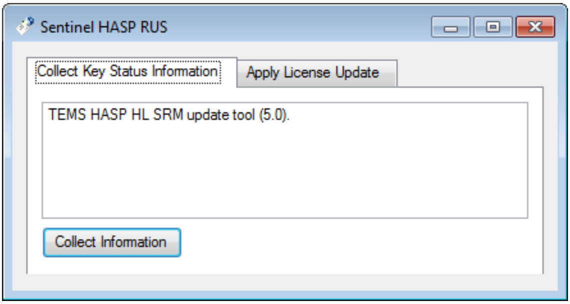
7.5. Updating HASP Keys (HL/SL)

When updating a HASP key of any type (i.e. whether HL or SL), you proceed much in the same way as when first obtaining a HASP SL (software-based) key. HL and SL are described separately below for maximum clarity.

For further information, see the document “TEMS HASP SRM Key Information” which is found in the TEMS Investigation documentation package.

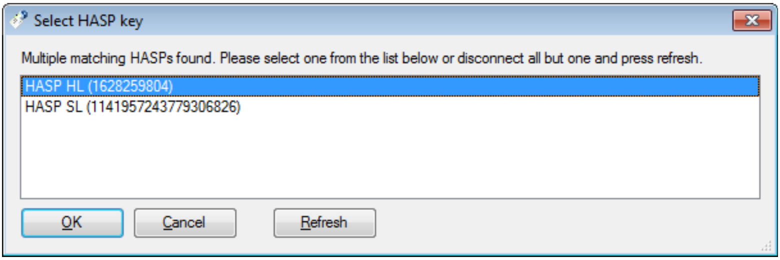
7.5.1. Updating HASP HL Keys

1. Make sure you have installed TEMS Investigation.
2. Plug your HASP HL key into the PC.
3. Navigate to the Application folder beneath the TEMS Investigation installation directory and run the file hasprus.exe. This dialog box opens:



4 Now collect the key information by clicking the **Collect information** button.

5 If you also have a HASP SRM SL (i.e. software-based) key installed on the machine, a dialog will appear at this point prompting you to choose which key to update. Select the HASP HL key.



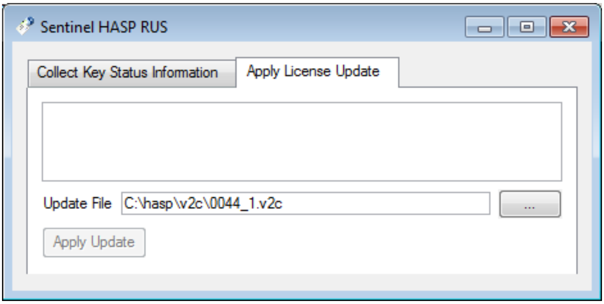
6 A file with extension .c2v is created. Choose a suitable file name and save the file.

7 Email the .c2v file to Ascom technical support. Contact information is found at ► www.ascom.com/networktesting under the link “TEMS Support”.

8 From technical support you will receive a file with extension .v2c. Once you have that file, navigate to the TEMS Investigation folder and run the file hasprus.exe. The Remote Update System dialog opens.

9 Select the **Apply License Update** tab.

10 Browse to locate the .v2c file, and click the **Apply update** button:



11 The result of the operation will be displayed in the main window of the dialog. When you have successfully applied the HASP license, exit the Remote Update System application.

7.5.2. Updating HASP SL Keys

1 Make sure you have installed TEMS Investigation.

2 Navigate to the Application folder beneath the TEMS Investigation installation directory and run the file hasprus.exe. The HASP SRM RUS dialog opens to the **Collect Key Status Information** tab (as in section 7.5.1, step 3).

3 Click the **Collect information** button. What this operation does in the HASP SL case is to take a digital fingerprint of your hard drive, uniquely identifying the drive.

4 If you also have a HASP SRM HL hardware key plugged into the PC at this point, a dialog will appear prompting you to choose which key to update. Select the HASP SL key.

5 Just as for HASP SRM HL, a file with extension .c2v is created. Save this file.

6 Email the .c2v file to Ascom technical support. Contact information is found at ▸ www.ascom.com/networktesting under the link “TEMS Support”.

7 From technical support you will receive a file with extension .v2c. Once you have that file, navigate to the TEMS Investigation folder and run the file hasprus.exe. The Remote Update System dialog opens.

8 Select the **Apply License Update** tab.

9 Browse to locate the .v2c file, and click the **Apply update** button.

10 The result of the operation will be displayed in the main window of the dialog. When you have successfully applied the HASP license, exit the Remote Update System application.

7.6. Sentinel HASP Runtime Network Activity

Note: The information in this section is reproduced from SafeNet's Sentinel HASP documentation.

This section describes the type of network activity that occurs in the communication between:

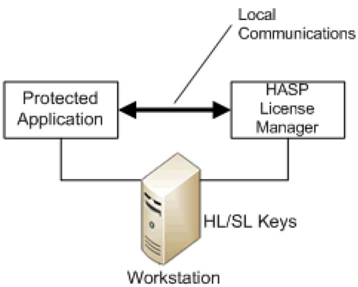
- an application (protected using Sentinel HASP) and the local HASP License Manager (referred to as "local communications").
- the local HASP License Manager and one or more remote HASP License Managers (referred to as "remote communications").

Details regarding local communications and remote communications are provided on the pages that follow.

This section is intended to assist IT managers who want to understand how runtime activity on the network may impact the way they set up their network rules and policies.

Sentinel HASP communicates via TCP and UDP on socket 1947. This socket is IANA-registered exclusively for this purpose.

7.6.1. Local Communications



This section describes communication between a protected application and the local HASP License Manager service.

A protected application communicates only with HASP License Manager on the computer where the application is running, regardless of whether the HASP HL or SL Key is located on the same computer or on a remote computer.

> **Note:** Under Windows, HASP License Manager is a service that is launched automatically by hasplms.exe. Under Mac OS and Linux, the HASP License Manager is a process launched automatically by hasplmd.

HASP License Manager service opens socket 1947 for listening (both for UDP packets and TCP packets).

- IPv4 sockets are always opened (HASP License Manager currently does not work without IPv4 installed).
- IPv6 sockets are opened if IPv6 is available.

A protected application tries to connect to 127.0.0.1:1947 TCP to communicate with HASP License Manager. If an application uses multiple sessions, multiple concurrent TCP connections may exist. If a session is unused for a certain number of minutes (at least seven minutes, but the exact number depends on several factors), the session may be closed and automatically re-opened later in order to limit resources used by the application.

These local communications currently use IPv4 only.

The communication uses binary data blocks of varying size.

7.6.2. Remote Communications

This section describes communication between the local HASP License Manager service and a remote HASP License Manager service.

This type of communication occurs when the protected application is running on a different computer from the computer where the HASP HL or SL Key is installed.

The protected application communicates only with the local HASP License Manager on the computer where the application is running, as described in section 7.6.1. The local HASP License Manager discovers and communicates with the License Manager on the computer containing the HASP Key using one of the following methods:

- The local HASP License Manager issues a UDP broadcast to local subnets on port 1947 using:
  - IPv4 (always)
  - IPv6 (if available)

  You can disable this broadcast by clearing the **Broadcast Search for Remote Licenses** checkbox in the Sentinel Admin Control Center Configuration screen.
- The local License Manager issues a UDP “ping” packet to port 1947 for all addresses specified in the Sentinel Admin Control Center field **Specify Search Parameters**. These addresses may be individual machine addresses or broadcast addresses.

All License Managers found by the discovery process are then connected via TCP port 1947, using IPv4 or IPv6 as detected during discovery, and data regarding the remote HASP Keys are transferred.

This discovery process is repeated at certain intervals. (The interval size depends on a number of factors, but it is generally not less than five minutes.)

UDP packets sent and received in the discovery process contain the License Manager GUID (40 bytes of payload data).

When starting or stopping a License Manager, and when adding or removing a HASP Key, a UDP notification packet is sent, containing the License Manager GUID and a description of the changes encountered. This is done to allow other License Managers to update their data before the next scheduled discovery process.

TCP packets between two License Managers on different computers use HTTP with base-64 encoded data in the body section.

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Device Configuration Guide

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Chapter 13. TEMS Investigation Computer Diagnostics 82

1. What’s In This Manual

The Device Configuration Guide deals with configuration of external devices and some related preliminaries that you must work through before you can start using TEMS Investigation.

Main Topics

- Overview of connectable external devices: chapter 2
- Installation of device drivers: chapter 3
- Configuration of user terminals: chapter 4
- Preparations for audio quality measurement: chapters 5–7
- Configuration of scanners: chapter 10
- Configuration of test transmitters: chapter 12
- Evaluating PC performance and configuring the PC for TEMS Investigation: chapter 13
- **Read this before you start drive testing:** chapter 14

Equipment Carrying Units: Cases, Backpacks

Ascom equipment cases and backpacks, designed to accommodate data-collecting devices during drive tests, are not covered here but have their own manuals.

Installation of drivers for equipment carrying units is explained in sections 3.6–3.7.

2. External Equipment: Overview

This chapter gives an overview of the external devices that can interact with TEMS Investigation.

The description of device capabilities is focused on those that are relevant for using the devices as probes for RF measurements and data service testing. For exhaustive information on the full range of functions and capabilities of the connectable devices, please refer to the documentation accompanying the devices. The same applies to all other third-party products mentioned in the TEMS Investigation documentation.

The number of external devices that can be connected simultaneously in the application is dependent on many factors, notably the processing power of the PC and the tasks assigned to the devices.

2.1. Quick Summary of Connectable Devices

User terminals supported by TEMS Investigation 15.3 includes ones from Sony/Sony Ericsson, Samsung, HTC, Huawei, Leadcore, LG, Nokia, Novatel Wireless, Option, Pantech, Sequans, Sierra Wireless, and ZTE. These terminals are built on chipsets from Qualcomm, Altair, GCT, Hisilicon, Samsung, Sequans, ST-Ericsson, and Via.

Together these devices enable comprehensive monitoring of LTE, UMTS, TD-SCDMA, and CDMA networks and of interaction among them (for example, E-UTRAN–UTRAN–GERAN inter-RAT handover).

A variety of devices are supported for LTE, WCDMA, GSM, TD-SCDMA, CDMA, and WiMAX **scanning**, including ones from Ascom, Anritsu, DRT, PCTel, Rohde & Schwarz, and Transcom.

GPS units can be connected for geographical positioning. For indoor environments, positioning by pinpointing (either manual or according to planned routes) is supported.

2.2. Connectable Devices in Detail

2.2.1. User Terminals

If a device that you want to connect is not detected by TEMS Investigation, you can run the **Manual UE Configuration** utility to help the application recognize the device. See the User’s Manual, section 6.3.4 for details.

2.2.1.1. Devices Offered for Sale with TEMS Investigation 15.3

The following user terminals can be delivered with TEMS Investigation 15.3:

- Sony Xperia V LT25i
- Sony Xperia T LT30a
- Sony Ericsson Xperia arc S LT18a, LT18i
- Sony Ericsson Xperia arc LT15a, LT15i
- HTC One XL X325S
- HTC Vivid PH39100
- Nokia C7-00
- Samsung Galaxy S4 GT-I9505
- Samsung Galaxy S 4G SGH-T959V
- Samsung Infuse 4G SCH-I997
- Sierra Wireless AirCard 319U

2.2.1.2. Other Connectable LTE Devices

- A range of LG LTE USB modems
- A range of Samsung LTE USB modems
- Certified devices based on Qualcomm LTE or TD-LTE chipsets, including: MDM9200, MDM9600, MDM9800, MSM8960
- Certified devices based on Samsung LTE chipsets
- Certified devices based on Sequans TD-LTE chipsets SQN3010, SQN3120
- Certified devices based on Altair TD-LTE chipset DC-E3100
- Certified devices based on GCT LTE chipset

- Certified devices based on Hisilicon LTE chipset Balong 710

Some of these devices also have UMTS, TD-SCDMA, and/or EV-DO capability.

2.2.1.3. Other Connectable UMTS Devices

- Certified devices based on Qualcomm UMTS-capable chipsets. Examples:
  - HSDPA: Various MSM62xx chipsets
  - HSPA (HSDPA + HSUPA): Various MSM72xx chipsets
  - HSPA+: MDM8200
- Sony Ericsson C702, Sony Ericsson C905, Sony Ericsson C905a
- Sony Ericsson K600i, Sony Ericsson K800i
- Sony Ericsson TM506
- Sony Ericsson W760i, Sony Ericsson W995, Sony Ericsson W995a, Sony Ericsson W995 EDGE *(GSM only)*
- Sony Ericsson Xperia X10
- Sony Ericsson Z750i
- LG CU320, LG CU500
- LG U960
- Nokia C5
- Nokia 6120, Nokia 6121, Nokia 6720
- Nokia N95, Nokia N96 EU, Nokia N96 US
- Sharp 943SH

2.2.1.4. Other Connectable GSM Devices

- Sony Ericsson K790a, Sony Ericsson K790i
- Sony Ericsson W600i

2.2.1.5. TD-SCDMA Devices

- Datang LC8130E
- Datang LC8143

2.2.1.6. CDMA Devices

- Certified devices based on Qualcomm 1x (cdma2000) chipsets: MSM5100
- Certified devices based on Qualcomm EV-DO Rel. 0 chipsets: MSM6125/ MSM65x0
- Certified devices based on Qualcomm EV-DO Rev. A chipsets, including: MSM6800/6800A, QSC6085
- Certified devices based on Qualcomm EV-DO Rev. B chipsets, including: MSM7850
- Certified devices based on Via CDMA/EV-DO chipset

2.2.2. Fixed Wireless Terminals

The following Ericsson Fixed Wireless Terminals can be connected:

- W21
- W25

2.2.3. AQM Components

See the User's Manual, chapter 37 for an overview of AQM solutions in TEMS Investigation.

- An ACU can be connected (ACU R2 or TerraTec).
- AQM modules (either stand-alone or mounted in an equipment case) can be connected.

2.2.4. Scanners

A wide range of scanner models are offered for sale with TEMS Investigation. Below a quick overview is given of scanner brands and their supported technologies.

The licenses mentioned in this section have nothing to do with TEMS product licensing (described in the Installation Guide).

2.2.4.1. PCTel

- PCTel SeeGull EXflex: LTE (FDD/TDD), WCDMA, GSM; CDMA 1x, EV-DO; TD-SCDMA

- PCTel SeeGull EX: LTE (FDD/TDD), WCDMA, GSM; CDMA 1x, EV-DO; TD-SCDMA
- PCTel SeeGull EX mini: LTE (FDD/TDD); TD-SCDMA; CDMA 1x, EV-DO
- PCTel SeeGull MX: LTE, WCDMA, GSM; CDMA 1x, EV-DO
- PCTel SeeGull LX: WCDMA, GSM; CDMA 1x, EV-DO
- PCTel SeeGull CX: WCDMA, GSM; TD-SCDMA
- PCTel PCT: WCDMA, GSM

Various features require special PCTel hardware license options, one example being LTE MIMO scanning.

2.2.4.2. DRT

- DRT4301A+: LTE; WiMAX

2.2.4.3. Rohde & Schwarz

- R&S TSMW Universal Network Analyzer
  - LTE technology option
  - UMTS technology option

2.2.4.4. Sony Ericsson

- Sony Ericsson phones with scanning capability (special option required)
- SRU: WCDMA, GSM

2.2.4.5. Transcom

- Transcom LTE

2.2.5. GPS Units

TEMS Investigation supports the NMEA-0183 GPS protocol. Some other GPS units using a different protocol are also compatible with TEMS Investigation.

2.2.5.1. Stand-alone GPS Units

This is the full list of recommended stand-alone GPS units:

- Garmin 10 Mobile Bluetooth (NMEA-0183)
- Garmin 12XL (NMEA-0183)
- Garmin 18 USB
- Garmin 18x USB
- Garmin 35 (NMEA-0183)
- Garmin 60 CSx USB
- Garmin GLO (NMEA-0183; Bluetooth; supports 10 Hz update rate)
- GlobalSat BT-359 (NMEA-0183)
- GlobalSat BT-368 (NMEA-0183)
- GlobalSat BU-303 (NMEA-0183)
- GlobalSat BU-353 S4 (NMEA-0183)
- Holux GPSlim 236 (NMEA-HS; Bluetooth or USB)
- Magnetti Marelli RoutePlanner NAV200
- Nokia LD-3W Bluetooth (NMEA-0183)
- Sanav GM-44 (NMEA-0183)
- Sanav GM-158 (NMEA-0183)

For poor receiving conditions, a GPS unit with dead reckoning facilities is useful, such as Trimble Placer Gold Dead Reckoning Unit Plus.

2.2.5.2. GPS Units Integrated into Other Supported Devices

- GPS built into PCTel scanners (non-NMEA)
- GPS built into Rohde & Schwarz TSMW scanners (NMEA-0183)
- U-blox GPS built into ACU R2 (NMEA-0183)

2.3. Capabilities of User Terminals Sold with TEMS Investigation

This section is restricted to user terminals that can be supplied with TEMS Investigation 15.3.

Device/Feature	**Sony Xperia V LT25i**	**Sony Xperia T LT30a**	**Sony Er. Xperia arc S LT18i/a**	**Sony Er. Xperia arc LT15i/a**	**HTC One XL X325S**	**HTC Vivid**	**Nokia C7-00**	**Samsung Galaxy S4 GT-I9505**	**Samsung Galaxy S 4G**	**Samsung Infuse 4G**	**Sierra Wireless AC319U**
LTE bands (for frequencies see Technical Reference, section 4.6.1.3)	1 3 5 7 20	2 4 5 17			3 7	4 17		1 3 5 7 8 20			
WCDMA 800 (Band VI)			a	a							
WCDMA 850 (V)	✓	✓	a	a	✓	✓	✓	✓		✓	✓
WCDMA 900 (VIII)	✓		i	i	✓		✓	✓			✓
WCDMA 1900 (II)		✓	a	a	✓	✓	✓	✓	✓	✓	✓
WCDMA 2100 (I)	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
WCDMA 2100 AWS (IV)						✓	✓		✓		
GSM 850/900/1800/1900	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
LTE Category	3	3			3	3		3			
HSDPA Category	24	24	10	8	14	14	9	24	14	14	24
HSUPA Category	6	6	6	6	6	6	5	6	6	6	6
GPRS Class	12	12	12	10	12	12	32	12	10	10	12
EDGE Class	12	12	12	10	12	12	32	12	10	10	10
Control functionality[1]	A	A	A		B		B	B	A	A	

Device/Feature	**Sony Xperia V LT25i**	**Sony Xperia T LT30a**	**Sony Er. Xperia arc S LT18i/a**	**Sony Er. Xperia arc LT15i/a**	**HTC One XL X325S**	**HTC Vivid**	**Nokia C7-00**	**Samsung Galaxy S4 GT-I9505**	**Samsung Galaxy S 4G**	**Samsung Infuse 4G**	**Sierra Wireless AC319U**
AQM with ACU R2			✓	✓							
AQM with ACU TerraTec			✓	✓			✓				
TEMS Pocket[2]	**13**	**13**	12	12		12		**13**	12	12	

1. A = Advanced; B = Basic. See the User's Manual, chapters 13 and 14 for details.
2. "13" = TEMS Pocket 13.0 (Xperia), 13.1 (Samsung S4); "12" = TEMS Pocket 12.x.

2.4. Supported AQM Capable Devices

2.4.1. AQM with ACU R2

Both POLQA and PESQ can be obtained with all of the listed devices.

- Sony Ericsson Xperia arc S LT18a, LT18i
- Sony Ericsson Xperia arc LT15a, LT15i
- Sony Ericsson W995, W995a, W995 EDGE
- Apple iPhone 5
- LG Optimus G F180S (LTE/UMTS)
- LG Lucid 2 VS870 (LTE/CDMA/EV-DO)
- Qualcomm MSM8960 MTP (LTE/UMTS)
- Samsung Galaxy S II LTE (GT-I9210) (LTE/UMTS)
- Samsung Galaxy S III SCH-I747 (LTE/UMTS)
- Samsung Galaxy S III SPH-L710 (LTE/CDMA/EV-DO)
- Samsung Galaxy S4 GT-I9505 (LTE/UMTS)

- Samsung Stratosphere SCH-I405 (LTE/CDMA/EV-DO)

Voice call configurations (see the User's Manual, chapter 38) are supported as indicated in the following table:

Device	M2M	M2F
Sony Ericsson Xperia arc S	✓	✓
Sony Ericsson Xperia arc	✓	✓
Sony Ericsson W995*	✓	✓
Apple iPhone 5	✓	
LG Optimus G F180S	✓	
LG Lucid 2 VS870	✓	
Qualcomm MSM8960 MTP	✓	
Samsung Galaxy S II LTE (GT-I9210)		✓[1]
Samsung Galaxy S III SCH-I747	✓	
Samsung Galaxy S III SPH-L710	✓	
Samsung Galaxy S4 GT-I9505	✓	✓
Samsung Stratosphere SCH-I405	✓	

1. Downlink only.

2.4.1.1. ACU R2 Audio Cable Kits

- Sony Ericsson Xperia arc S, arc: Ascom item no. 9001-1973
- Sony Ericsson W995*: Ascom item no. 9001-1975
- Samsung models: Ascom item no. 9001-1974

2.4.2. AQM with ACU TerraTec

Both POLQA and PESQ can be obtained with all of the listed devices.

2.4.2.1. UMTS

- Sony Ericsson Xperia arc S LT18a, LT18i
- Sony Ericsson Xperia arc LT15a, LT15i

- Sony Ericsson W995, W995a
- Sony Ericsson W995 EDGE *(GSM only)*
- Nokia C7-00

2.4.2.2. CDMA

- Huawei C8600

2.4.2.3. ACU TerraTec Audio Cable Kits

- 2.5 mm cable for Huawei C8600
- 3.5 mm cable for Sony Ericsson Xperia arc/arc S, Nokia C7
- Sony Ericsson W995 phones use the SE System Connector cable from the AQM module cable kit.

2.4.3. AQM with AQM Modules

Only PESQ is computed in this AQM configuration.

2.4.3.1. UMTS

- Sony Ericsson W995, W995a, W995 EDGE
- Sony Ericsson Z750i
- Sony Ericsson K790a, K790i, K800i
- LG CU500

2.4.3.2. CDMA

- Kyocera KX5
- Samsung SPH-M320, SPH-M330

2.5. Supported Devices with VoLTE Capability

- LG Lucid 2 VS870
- Qualcomm FFA8960
- Samsung Galaxy SCH-R820
- Samsung Stratosphere SCH-I405

2.6. Supported Devices with ABM Capability

- Sony Xperia V LT25i
- Sony Xperia T LT30a
- Samsung Galaxy S III GT-I9305

2.7. Supported Devices Capable of On-device Measurement

Regarding on-device measurement generally, see the User's Manual, chapter 15.

2.7.1. ODM for Voice

ODM MTSI

- Samsung Galaxy SCH-R820

ODM Call Control

- Sony Xperia V LT25i
- Sony Xperia T LT30a
- LG Lucid 2 VS870
- Samsung Galaxy S III GT-I9305
- Samsung Stratosphere SCH-I405

2.7.2. ODM for AQM

ODM POLQA

- Sony Xperia V LT25i (CS)
- LG Lucid 2 VS870 (VoLTE)

2.7.3. ODM for IP Sniffing

- Samsung Stratosphere SCH-I405

Fundamental requirements for ODM IP sniffing are:

- The device must be rooted.
- The device must run Android 2.2 or later.
- The device must have the Tcpdump packet analyzer installed. It can be downloaded from ▶ www.tcpdump.org.

2.7.4. Other ODM Services (Used Internally)

Certain devices make use of other ODM services which are not visible in the TEMS Investigation user interface and cannot be configured in any way. These devices must have the ODM software installed to be able to collect data and respond to control functions being applied.

At present the following devices are in this category:

- Sony Xperia V LT25i
- Sony Xperia T LT30a
- Samsung Galaxy S III GT-I9305

3. Device Drivers

Note: The device drivers are delivered in a separate ZIP archive. After installing TEMS Investigation, you need to unpack this ZIP archive to a location of your choice. That location is referred to as ...\Drivers below.

3.1. Installation of USB Drivers for User Terminals

USB drivers are provided for all user terminals that can be purchased with TEMS Investigation, as well as for many other UMTS-capable terminals. For certain user terminals, however, drivers must be obtained from the supplier.

The first time you plug in a user terminal, you will be prompted to locate its drivers by browsing to the correct directory. On your doing so the drivers will be installed. Supplier- and device-specific details follow below.

If other drivers are already installed on the PC, make sure that the correct drivers become associated with the device modem. Also make sure that you do not install other (non-TEMS-compatible) drivers from the same supplier later on.

Regarding the possible use of the **Manual UE Configuration** utility, see the User's Manual, section 6.3.4. (Normally it is not needed.)

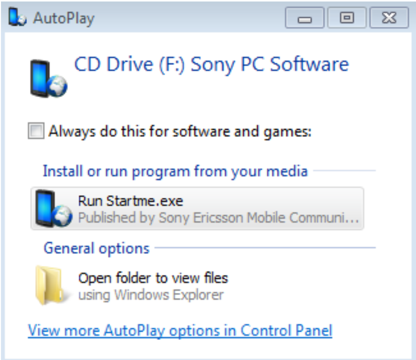
3.1.1. Sony/Sony Ericsson Phones

3.1.1.1. Sony Xperia V LT25i, Xperia T LT30a

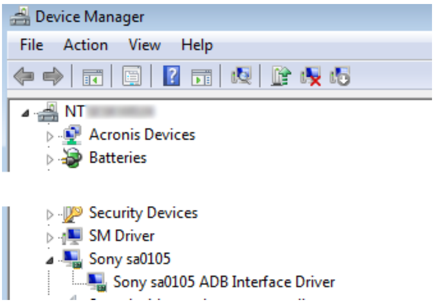
For these devices you need to obtain the driver from Sony PC Companion.

- When connecting the phone, you will be presented with the option to install Sony PC Companion software. Select **Install**.

- Should this dialog not be displayed, you can enable the option to display Install PC Companion on the phone as follows: **Settings** → **Xperia** → **Connectivity** → **Install PC Companion**. In the AutoPlay dialog that appears, Select **Run Startme.exe**.



- After the installation is done, enable tethering on the phone under **Settings** → **More** → **Tethering & portable hotspot** → **USB Tethering**.
- In the Device Manager, verify that the item “Sony sa0105 ADB Interface Driver” appears. See the screenshot below. The Xperia phone should now be detected in TEMS Investigation.



- **Important:** After successfully installing the driver, you should uninstall PC Companion. This is because the PC Companion software might interfere with other devices. Do the uninstall from the Windows Control Panel as usual.

3.1.1.2. Sony Ericsson Xperia arc S LT18, arc LT15, X10

1. Connect the phone to the PC. Windows will try to find drivers; when the automatic driver installation fails, open the Device Manager on your computer.
2. Locate the phone with missing drivers under Device Manager → **Other devices**.
3. Right-click the first “SEMC HSUSB Device” and select **Update Driver Software** → **Browse my computer for driver software**.
4. Browse all the way to the directory where the applicable driver for your operating system is stored; note that 32-bit and 64-bit Windows must be distinguished. Example of path: ...\Drivers\Sony Ericsson\Arc\Win64.
5. Click **Next**.
6. Repeat the procedure for the remaining “SEMC HSUSB Device” items.

3.1.1.3. Older Sony Ericsson Phones: W995, etc.

When prompted, point to ...\Drivers\Sony Ericsson\<model name>.

Regarding Sony Ericsson W995 phones with firmware version R1F or later, see section 4.13.1.

3.1.2. Samsung Devices

For the Galaxy S series of devices (S II, S III, and S4), run the EXE file provided in the Galaxy S directory to perform the driver installation.

Unpacked driver files are provided for certain other Samsung devices. When prompted, point to the appropriate subdirectory under ...\Drivers\Samsung.

Some Samsung devices require manual tethering: see section 4.1.1.

3.1.3. Qualcomm Chipset Based Devices

This applies to all supported Qualcomm chipset based devices.

Before plugging the device into the PC, use the software application delivered with the device to install the requisite drivers.

3.1.4. Nokia Phones

Before plugging in the phone, you must run the MSI file found in the directory ...\Drivers\Nokia. This installs the driver files to the directory C:\Program Files\Nokia\Connectivity Cable Driver.

After plugging in the phone, point to this directory when prompted. You must also select **PC Suite** in the menu that appears in the phone display.

3.1.5. Hisilicon Chipset Based Devices

To be able to activate a Hisilicon chipset based device in TEMS Investigation, you need to have a software utility called “Hisilicon UE Agent” installed and running on the PC. This software is available in the directory ...\Drivers\Huawei\E5776_E3276.

> **Note:** The “Mobile Partner” software delivered with the Hisilicon device is *not* compatible with TEMS Investigation and must be disabled.

3.1.6. Datang Phones

Before plugging in the phone, do as follows:

- Install the driver delivered with the Datang phone.
- After completing the driver installation, go to the directory <TEMS Investigation install dir>\Application and run the file DatangPostInstall.exe. This EXE writes the AT command

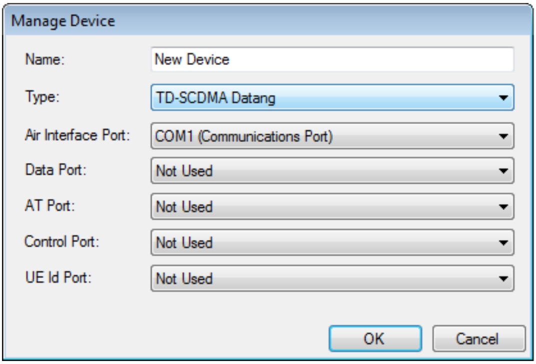
  AT+CGDCONT=1,"IP","cmnet",,,;+CGEQREQ=1,4

  to the registry, thereby accomplishing two things:

  – Changing the number of available Datang ports from 3 (default) to 4 (the number of ports needed by TEMS Investigation).

  – Setting the APN to the string “cmnet” for all Datang data modems. If you want to name the APN differently, run DatangPostInstall.exe from a Windows command prompt with the desired APN name as argument, for example: DatangPostInstall myapn. Compare section 4.7.
- Now plug in the phone.

- Finally, run the file ManualUEConfig.exe which is also found under <TEMS Investigation install dir>\Application. A window titled **TEMS Investigation Manual UE Configuration** opens.
- Select the **Port Configuration** tab.
- Click the **New** button. The **Manage Device** dialog appears:



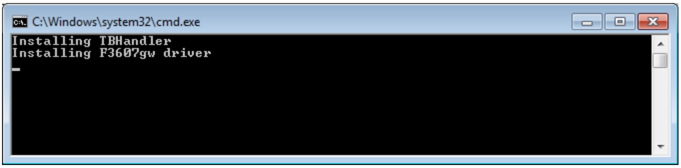
Name	Enter a name for the phone. (The string does not show anywhere else in TEMS Investigation.)
Type	Select “TD-SCDMA Datang”.
Air Interface Port	Select the port to use for air interface measurements. (Consult Datang documentation to find this out.)
Data Port	Select the port to use for data service measurements.
AT Port	Select the port to use for AT commands.
Control Port	Select the port to use for video call setup.
UE Id Port	Select the physical USB port here.

3.2. Installation of Driver for SRU

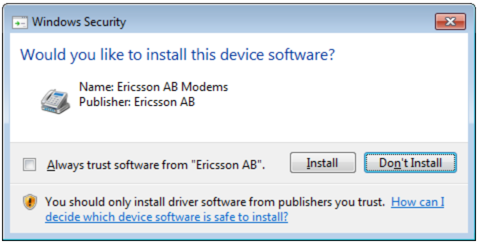
The SRU driver should always be taken from ...\Drivers\TEMS SRU and not from the SRU’s internal SSD drive, which may hold older drivers.

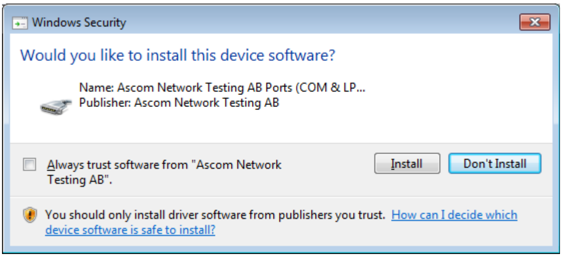
Before plugging the SRU into the PC, execute the file ...\Drivers\TEMS SRU\Install.bat in order to install the driver. For further instructions, see the readme document which is supplied in the same directory.

1 When you run ...\Drivers\TEMS SRU\Install.bat, a script window will open:

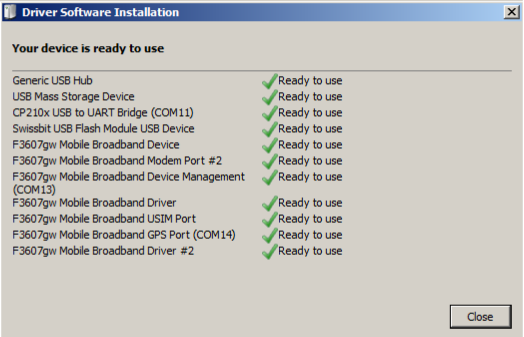


2 Some warnings will pop up during the installation. Choose to **Install** device software from Ericsson AB and Ascom Network Testing AB.





3 Connect the red and black USB connectors, or the black USB connector and the additional power cable (special 12 V adapter needed), to the computer. Windows will detect the F3607 module and install drivers.

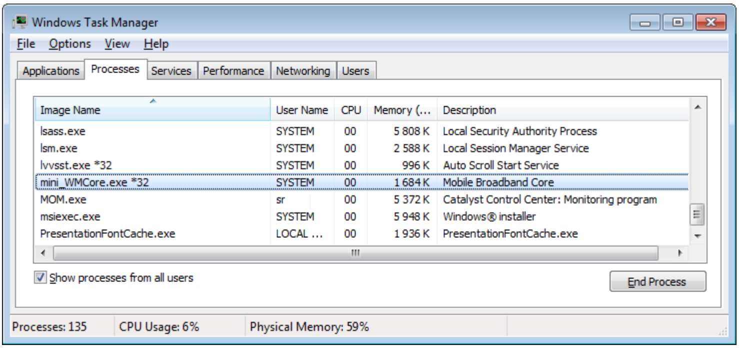


4 When the installation is finished, some AutoPlay dialogs may open. Close any such dialogs.

3.2.1. Extra Steps for Windows 7

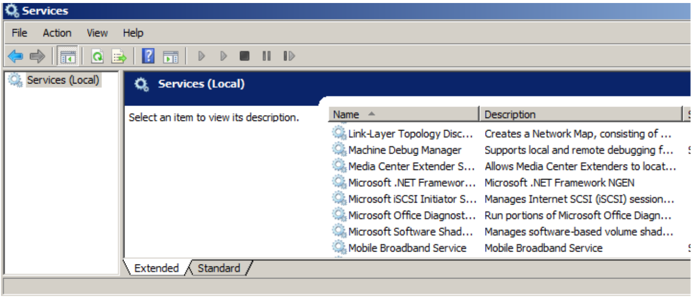
To prevent problems detecting the SRU scanner in TEMS Investigation, terminate the Mobile Broadband Service process mini_WMCore.exe.

1 To check if the process mini_WMCore.exe is running, open **Windows Task Manager** → **Processes**.

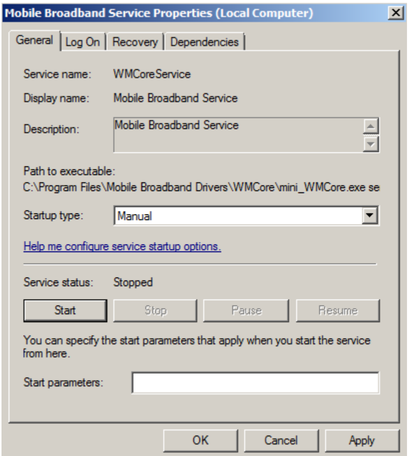


2 Stop the process by choosing **Windows Task Manager** → **Services** and clicking the **Services** button.

3 Right-click the **Mobile Broadband Service** item and choose **Properties**.



4 Configure the settings as shown below. That is, set **Startup type** to “Manual”, and under **Service status** click the **Stop** button to stop the service if it is running.



5 TEMS Investigation is now able to detect the SRU scanner.

3.3. Installation of USB Driver for Anritsu Scanners

3.3.1. Anritsu ML8780A

Use the driver files delivered with the scanner.

On plugging the scanner into the PC, when prompted to locate the scanner driver, point to the file ML8780USB.inf.

3.4. Installation of USB Driver for PCTel Scanners

3.4.1. PCTel SeeGull LX MM2

PCTel SeeGull LX MM2 scanners use an Edgeport USB driver.

The first time you plug in the scanner, you will be prompted to locate its driver. Point to the directory ...\Drivers\PCTEL\LX\MM2\Edgeport.

3.4.2. PCTel SeeGull EX/MX, PCTel PCT

These scanners use PCTel-specific USB drivers, which are found in the directory ...\Drivers\PCTEL under EX, MX, and PCT respectively. For instructions on how to install these drivers, see the readme document which is supplied in each directory.

See also section 10.2.1.1.

3.5. Installation of USB Driver for GPS Units

The first time you plug in the GPS, you will be prompted to locate its driver. Point to the appropriate directory (e.g. ...\Drivers\Garmin, ...\Drivers\Globalsat).

3.6. Installation of USB Driver for TC-2450 Equipment Case/Backpack GPS

This section applies to the TC-2450 equipment case (User’s Manual doc. no. NT12-8675) and to the backpack offered in parallel with that case (User’s Manual doc. no. NT12-5051).

When a GPS is mounted in one of these units, you need to install a driver which is found in the directory ...\Drivers\U-blox GPS.

3.7. Installation of Driver for USB-to-RS-232 Serial Converter in Equipment Cases/Backpack

This section applies to the following older units:

- the equipment cases TC-1520/1520B/1520C/1520D/1520E
- the older TEMS Indoor Backpack contemporaneous with these cases.

In order for the PC to detect the COM port of the USB-to-RS-232 serial converter in the equipment case or backpack, some driver files must be installed on the PC. These drivers are always delivered along with the case; they are also found in the directory ...\Drivers\TEMS Case USB to RS232.

The first time you connect the case or backpack to the PC, you will be prompted to locate the driver directory; on your doing so the driver will be installed.

The TC-1520C case also uses a standard driver for the Moxa hub. This driver is not supplied with the case.

3.8. Installation of Drivers for Audio Capturing Unit (ACU R2)

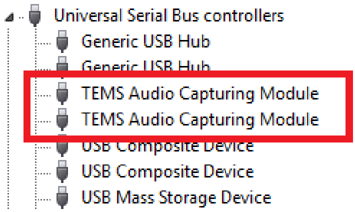
3.8.1. Drivers for Audio Capturing Modules

Drivers for the audio capturing modules of the ACU R2 are found under ...\Drivers\ACU R2. The same drivers are used for all supported Windows versions.

- Go to the folder ASCOM TEMS Driver<...>\bin.
- Run the file OS_Detect.exe to install the driver.
- Reboot the PC.

To verify that the installation was successful:

- Connect the ACU R2 box to the PC and power it up so that the LEDs turn green.
- Two items named “TEMS Audio Capturing Module” should now appear in the Device Manager:



3.8.2. Drivers for ACU R2 U-blox GPS

Drivers for the U-blox GPS built into the ACU R2 are found under ...\Drivers\U-blox GPS.

- Run the EXE file residing in this directory to install the driver.

To verify that the installation was successful:

- Connect the ACU R2 box to the PC and power it up so that the LEDs turn green.
- An item named “u-blox...” should now appear in the Device Manager under Ports.

3.9. Installation of Drivers for Audio Capturing Unit (TerraTec)

Drivers for the TerraTec box are found under ...\Drivers\TerraTec. The same drivers are used for all supported Windows versions.

Note: Do not install any of the drivers found on the CD enclosed with the TerraTec box by the supplier. (These drivers are too old.)

3.10. Installation of Drivers for AQM Modules

AQM modules, whether stand-alone or mounted in an equipment case, need to be initialized by dedicated driver files. The AQM module does not have any non-volatile memory, so all requisite software and settings must be downloaded to the AQM module each time it is powered on.

The first time you connect the case or backpack to the PC, you will be prompted to locate the drivers. For detailed instructions, see the document "Driver install instructions.txt" stored in the directory ...\Drivers\AQM.

Please note that since the AQM module drivers are not signed, you need to bypass driver signature enforcement in Windows 7.

AQM drivers supplied with TEMS Investigation versions older than 12.0 *cannot* be used with the present version of the application.

3.10.1. General Advice on Driver Installation for AQM Equipment Case/Backpack

When preparing a TC-1520B/1520C/1520D equipment case for use, we recommend that you proceed in the steps described below. The same advice applies to a TEMS Indoor Backpack with AQM modules installed.

- Before plugging the case into the PC, make sure
  - that you have installed TEMS Investigation (see the Installation Guide, section 5.1)
  - that you have installed all driver files from the TEMS Investigation driver package (section 3.1)
  - that you have rebooted the PC.
- Connect the case to the PC while the case is turned off and does not have any phones installed.
- Power on the case.
- Locate all of the drivers in sections 3.7 and 3.10.
- After the drivers for AQM have been activated, install one phone at a time in the case. For each phone, you will be prompted to locate the phone driver (see section 3.1). Wait each time until the phone driver has been activated before you install the next phone.

4. Configuration of User Terminals

This chapter is a mixed bag of items, describing procedures and properties that apply to specific device categories or individual device models.

4.1. Prerequisites for Network Connect

This subsection details the behavior and requirements of various devices with respect to the Network Connect (and Network Disconnect) activities, which are described in the User's Manual, sections 12.20.3.2–12.20.3.3.

Network Connect performed from within TEMS Investigation is referred to as “scripted Network Connect”.

The Network Connect activity that is run in TEMS Investigation in cases where the connection setup needs assistance from outside the application is referred to below as “preconnected Network Connect”.

“Tethering” means using the mobile device as a modem to provide Internet access to the PC on which TEMS Investigation is running.

For “connection manager”, the shorthand “CM” is used below for convenience.

4.1.1. Qualcomm Chipset Based LTE Devices

- Normally, no CM should be used with any such devices.
- Qualcomm **smartphones** showing an **RMNET** Ethernet adapter in the Windows Device Manager use scripted Network Connect.
- Qualcomm smartphones showing an **RNDIS** Ethernet adapter in the Windows Device Manager need to be preconnected through tethering in the phone menu system.
- If scripted Network Connect fails, enable tethering from the device menu system. TEMS Investigation will then use preconnected Network Connect instead.

- Among individual device models may be mentioned Samsung Galaxy S III **GT-I9305** and Galaxy S4 **GT-I9505** with TEMS software, for which manual tethering is required.

4.1.2. Samsung Chipset Based LTE Devices

- General procedure: If an AT port exists for the device, TEMS Investigation will try to open that port and use it to control the network connection. No CM should then be used. If no AT port is available, or if the port is blocked, then the device must be configured using a CM, or tethering must be enabled in the device menu system (preconnected Network Connect performed in either case).
- Samsung Android LTE **smartphones** do not have a CM accompanying them. If the device firmware exposes an AT port, TEMS Investigation will use that port to perform a scripted Network Connect. If no AT port is present in the operating system, a tethered connection must be set up, and a preconnected Network Connect will be performed.
  - Examples of device models: **I510**, **R820**, **R900**, **R910**, **R920**, **R940**.
- **GT-B3730, GT-B3740:** Samsung GT-B3730 and Samsung devices with AT support on the LTE Control Port (such as GT-B3740) have support for scripted Network Connect. You cannot have the CM running when executing the Network Connect and Network Disconnect activities, since a port conflict will then occur (both TEMS Investigation and the CM communicate with AT commands over the LTE Control Port).
- **GT-B3710:** Some older firmware of this device without an AT port requires that the CM should be running. TEMS Investigation then communicates with the CM to control the connection. With newer firmware, the device behaves like GT-B3730/3740.

4.1.3. LG Chipset Based LTE Devices

- For LG LTE **USB modems**, do not use a CM. Doing so will cause a port conflict. Examples of models: **AD600**, **FM300**, **G7**, **G13**, **LD611**, **VL600**.
- LG Android LTE **smartphones** using an NDIS connection require tethered network connection setup from the device menu system and preconnected Network Connect. Examples of models: **LS840**, **MS840**, **MS910**, **P936**.

- **LG Generic:** If the device is detected as “LG Generic”, the connection must be set up either from a CM or from the device menu system, and preconnected Network Connect will be used.

4.1.4. Qualcomm HSPA+/EV-DO Devices and Other Devices

- Sierra Wireless devices should not need to have a CM running, provided they are detected as Sierra Wireless devices in TEMS Investigation.
- These NDIS devices should likewise *not* require use of a CM:
  - **Axesstel MV610VR** (EV-DO Rev. B)
  - **BandLuxe C501**
  - **Huawei E1820**, **E353**, **E367**, **E372**, **K4505**
  - **Novatel MC996D**
  - **ZTE Z006Z**.

  If scripted Network Connect fails, you can start the CM or enable tethering from the device menu system, and TEMS Investigation will use preconnected Network Connect instead.
- For Qualcomm devices using a RAS connection, no CM should ever be needed, and scripted Network Connect should work fine.
- Devices not mentioned in the foregoing generally require preconnected Network Connect.

4.2. Access Point Name (APN) Configuration

To run packet-switched data services in an LTE or UMTS network, the Access Point Name (APN) must be configured for the device. For most devices, this can be done from within TEMS Investigation by defining a **Network Connect** configuration set; see the User’s Manual, section 12.20.3.2. Some exceptions to this rule are covered in sections 4.7 and 4.11.

A device that is going to use an NDIS connection must have an APN preconfigured. If an APN is not already present on the device on delivery, you need to enter one using a software application delivered with the device. Please consult documentation from the vendor for specifics.

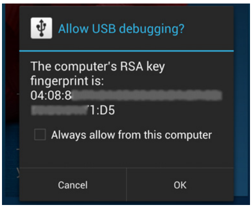
4.3. Android Devices: General Remarks

4.3.1. USB Debugging

When you connect a device running Android 4.2.2 or later to the PC, a dialog titled “Allow USB debugging?” will pop up on the device screen. Check the box **Always allow from this computer**, and tap OK.

4.3.2. Mobile Data Usage Settings

The mobile data usage “warning” and “limit” settings in Android 4.0 and later versions must be configured in such a way as not to interfere with TEMS Investigation. Set the warning level high enough that it will never be exceeded (TEMS Investigation will halt an ongoing data session if this happens). Do not set a data usage limit.



4.4. Qualcomm Chipset Based Devices: General Remarks

Some commercial Qualcomm chipset derived user terminals may not have diagnostics reporting enabled by default. The device may then be impossible to activate in TEMS Investigation, or seem to be locked to GSM, and/or only deliver low-level reports.

Ascom is not at liberty to distribute information on how to enable diagnostics reporting. Customers desiring to use such devices with TEMS Investigation therefore need to contact the relevant supplier or operator in each case.

4.5. Sony/Sony Ericsson Android Phones (Qualcomm Chipset Based)

- Xperia V LT25i, Xperia T LT30a: Manual tethering is required. See section 3.1.1.1.
- Xperia arc S LT18, arc LT15, X10: Verify that USB debugging is activated, so that all relevant ports are visible. Press the Menu button, then choose **Settings** → **Applications** → **Development**, and make sure **USB debugging** is enabled.
- Xperia arc LT15, X10: No APN must be set in the phone. Press the Menu button, then choose **Settings** → **Wireless & networks** → **Mobile networks** → **Access Point Names**, and make sure nothing is set. (If an APN is already present in the phone, then the Network Connect activity in the TEMS Investigation script, which tries to set the APN, will fail.)

4.6. Altair Chipset Based Devices

After installing the drivers (not supplied with TEMS Investigation), you need to correct an error in the file C:\Program Files\Altair Semiconductor\ALT3100\Tools\Internals\LogCreator\RunLogCreator.bat. On the line starting with LogCreator.exe -SA -FN:"50", remove the line break before -TCP. The command should read:

```
LogCreator.exe -SA -FN:"50" -E -Y4:"LOG_SOCK_IF" -D4:".\LoggerDB\LTELogDB.txt" -D1:".\LoggerDB\PhyFWLogDB.txt" -Q:"50000" -TCP
```

It is also necessary to edit a setting in the Altair Configuration Tool:

- Choose **Start** → **Altair Semiconductor** → **LTE ALT3100** → **Internal Tools** → **Configuration Tool**.
- On the **General** tab, check the option **Run LM apps from BAT files (no Multi-UE)**.
- Click **Save and Close**.

4.7. Datang Phones

The APN configuration is accomplished when you run the Datang PostInstall utility as described in section 3.1.6. If you want to change the APN later on, it is most convenient to run DatangPostInstall.exe again (with argument).

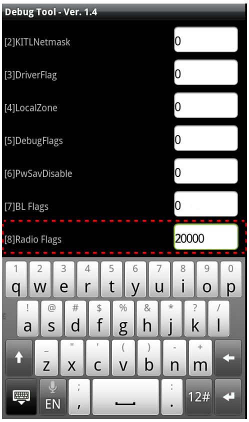
4.8. Hisilicon Chipset Based Devices

A software utility called Hisilicon UE Agent must be running on the PC to be able to activate a Hisilicon chipset based device in TEMS Investigation. The utility is included among the device drivers; see section 3.1.5.

4.9. HTC Vivid Test Key Devices with TEMS Pocket

If an HTC Vivid Test Key device has TEMS Pocket installed and has been configured to respond to TEMS Pocket control functions, it must be reconfigured before it can be used with TEMS Investigation. What you must do is to enable external diagnostics for TEMS Investigation in the HTC SSD Test Tool which is installed on the phone:

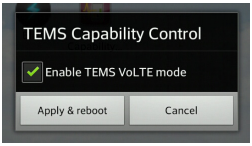
- Under **All Tools**, select **Debug Tool**.
- When the phone is configured for TEMS Pocket, **Radio Flags** has the value zero (“0”). This must be changed to “20000”.



- Press the Menu button and select **Write** to commit the change.
- Restart the phone.

4.10. LG Phones

For VoLTE testing with Lucid 2 VS870, always check the option **Enable TEMS VoLTE mode** in the TEMS Capability Control app installed on the phone:



4.11. Nokia Phones

The Net Monitor function in Nokia phones (if present) must be turned off.

The APN must be set directly in the phone’s user interface. For example, on the Nokia N96, navigate to **Tools** → **Settings** → **Connection** → **Destinations**.

4.12. Sequans Devices

The driver delivered by Sequans along with their device also installs a daemon service “sequansd” (to C:\Program Files\Sequans Communications) which must be running in order to enable communication between device and PC. The required version of the Sequans driver package is 2.0.1 or later.

TEMS Investigation manages the daemon service automatically. However, as a TEMS Investigation user you need to manually point out the LTE frequency band and EARFCN on which the device should start searching. This is done by editing an XML file sequansd.xml which resides in the same directory as the daemon (see path above). The XML file is reproduced in full below; the band and frequency are specified in the <script> section:

```
<?xml version="1.0" ?>
<sequansd>
   <server>
      <ip>127.0.0.1</ip>
      <port>7771</port>
      <host></host>
      <maxClients>5</maxClients>
   </server>
```

```
    <!-- Define the log file name -->
    <debug>
      <logfilter>finer:*</logfilter>
      <logfile>SequansdLog.txt</logfile>
    </debug>

    <ffh>
      <!-- Windows -->
      <repository>Firmwares</repository>
    </ffh>

    <!-- Startup script -->
    <script>
      <cli>setUsimmode 0</cli>
      <cli>clearScanConfig</cli>
      <cli>addScanFreq 40 39150</cli>
    </script>
  </sequansd>
```

If you edit the sequansd.xml file while the daemon service is running, you must restart the service. This is most easily done from the Windows Task Manager:

- Go to the **Services** tab and locate the "sequansd" service.
- Right-click "sequansd" and select **Stop Service**.
- Right-click "sequansd" once more and select **Start Service**.

4.13. Sony Ericsson W995 Models

Sony Ericsson W995 TEMS phones have a special setting **USB Speed**, found under **Menu** → **Settings** → **Connectivity tab** → **USB**. The choices are **High Speed** (upper limit: 480 Mbit/s) and **Full Speed** (upper limit: 12 Mbit/s).

- Select **High Speed** when running HSDPA in order to achieve the best possible throughput. (This is not applicable to W995 EDGE, for obvious reasons.)
- Select **Full Speed** when the phone is using GSM 850 or 900 in an area where it is forced to transmit at maximum power. If High Speed is used in such situations, the GSM transmissions will interfere with the USB connection, so that logfiles may be lost and the USB connection may possibly break down, necessitating a reboot of both phone and PC.

Before changing the setting, make sure the USB cable is disconnected from the phone. After you make the change, the phone will reboot automatically. This takes some time (about 15 s).

4.13.1. Sony Ericsson W995 Models with Firmware Version R1F Or Later

You need to execute the autorun application (Startup.exe) supplied with the phone. However, you must *not* install everything that comes with this application; rather, you must limit the installation to the drivers:

- In the interface of the autorun application, click the **Advanced** button.
- Select the **Drivers only** option.

Make sure AutoPlay in Windows is not disabled when you connect the phone to the PC. (On the other hand, AutoPlay *should* be disabled when running TEMS Investigation; see section 13.2.3.)

Also turn off searching for drivers through Windows Update, or abort the search manually (otherwise, this will take a very long time).

4.14. Via Chipset Based Devices

For Via chipset based devices to be detected by TEMS Investigation, the following must be installed on the PC: “Microsoft Visual C++ 2008 Service Pack 1 Redistributable Package MFC Security Update (for x86)”. Go to the page ▸ www.microsoft.com/en-us/download/details.aspx?id=26368 and download the file vcredist_x86.exe. Knowledge Base reference: KB2538243.

4.15. Connecting External Antennas to User Terminals

An external monopole antenna is connected to a phone by means of a coaxial cable (and possibly an adapter) supplied with the phone.

> **Note:** Only Ascom-specified external antennas should be used as part of the test configuration. See also the statement in appendix A.

Phone-specific details are as follows:

Sony Ericsson Xperia arc S, W995*

When an external antenna is ordered with one of these phones, the phone is delivered with the antenna adapter already mounted. Just connect the antenna to the adapter.

A Sony Ericsson phone with an external antenna mounted cannot use its internal antenna.

Sony Ericsson Z750i

The same applies as for the Sony Ericsson phones mentioned above (except that this phone is no longer a supplied device).

WARNING: To ensure personal safety and to limit the exposure to electromagnetic fields, always keep a minimum distance of 20 cm from an external antenna.

4.16. Known Device-related Limitations

4.16.1. General

- If a device is not detected by TEMS Investigation, although it is built on a supported chipset, you can run the **Manual UE Configuration** utility to help TEMS Investigation recognize the device. See the User's Manual, section 6.3.4 for details on how to operate this utility.
- If you intend to use a **USB hub** for connecting multiple devices, install the devices one at a time to avoid problems with driver mix-up in Windows. It is wise to do this in the office, before starting TEMS Investigation. When all devices have installed, start TEMS Investigation and check that all devices are detected properly and can be activated in the application.
- If the **connection manager** of a device is started automatically at device insertion, it will block the AT interrogation performed by TEMS Investigation, and the device will show up as "Unknown". To resolve this, terminate the connection manager, and click the **Refresh** button in TEMS Investigation to repeat the autodetect procedure.
- When the device is used for highly **demanding tests** of extended duration (for example, LTE data transfer), it may happen that the charging cannot keep up with the power consumption, so that the battery

eventually will be drained even if continuously recharged (by whatever method).

4.16.2. Qualcomm Chipset Based Devices

The shorthand “Qualcomm device” is used here in the sense of “Qualcomm chipset based device”.

4.16.2.1. General

- Certain Qualcomm LTE devices that require the use of a connection manager do not start reporting LL1 and Layer 3 signaling until an explicit PS Attach has been performed. A workaround is as follows:
  1. Activate the device in TEMS Investigation.
  2. Execute the Service Control activities PS Detach and PS Attach.
  3. Connect the device using the connection manager.
  4. In TEMS Investigation, execute the Network Connect activity. The device is now ready for data service testing.
- NV interface: Care needs to be taken when using the NV interface to write to a Qualcomm chipset based device, since an inappropriate NV write may damage the device. See the User’s Manual, section 13.10.
- LTE data service testing at high throughput rates with a Qualcomm chipset based device requires a very powerful processor, as detailed in the Installation Guide, section 4.1. Please note that this limitation is not TEMS Investigation related.
- AT commands in Service Control scripts are not always executed by Qualcomm chipset based devices.
- Band lock: For some Qualcomm chipset based devices that support this function, the following problem can be seen: If you exit TEMS Investigation after applying a band lock, and you do not reboot the device before next time you start TEMS Investigation, then the band lock dialog will show the band(s) you locked on as the device’s band capabilities.
- Various devices (including Sony Xperia LT25i/LT30a, Samsung Galaxy S4 GT-I9505, Samsung Galaxy S III GT-I9305) have occasionally been observed to enter a state where it is tethered to a PC, yet is unable to run IP services as directed from the PC. The workaround in this situation is to reboot the phone (retethering does not help).

4.16.2.2. Vendor or Device Specific

- **Anydata ADU-895:** The connection manager must be started once after each device insertion to have device ports installed in Windows. After this, the connection manager can be terminated.
- **Bandluxe devices:** The PS Detach and PS Attach commands do not work with these devices.
- **Bandluxe devices:** No Layer 3 messages are obtained from these devices in LTE mode.
- **HTC Touch Pro2 devices:** See section 4.16.2.3.
- **LG LTE modems** sometimes take a long time (more than 30 seconds) to perform inter-RAT cell reselection between 3G (UMTS or EV-DO) and 4G (LTE). This has been observed for both 4G $\rightarrow$ 3G and 3G $\rightarrow$ 4G transitions.
- **Samsung Galaxy S III GT-I9305** does not support MMS send/receive or streaming over RTP (but it does support HTTP streaming).
- **Samsung Galaxy S III GT-I9305:** If a CS or VoLTE call is ongoing, and you stop the script before it reaches the Hang Up activity, then the call will never be hung up.
- **Samsung Galaxy S III GT-I9305, Samsung Galaxy S4 GT-I9505:** For commercial devices (i.e. without TEMS software) of these models using RNDIS, the following applies: Only one device at a time can be connected in TEMS Investigation. That is, you can only connect one GT-I9305 or one GT-I9505, not one of each or several of either.
- **Samsung Galaxy S III SPH-L710** reboots itself after the RAT lock setting has been changed.
- **Samsung Metro GT-S5350** does not support video call dialing; however, it does have the capability to answer a video call. SMS Send works, but may generate error messages.
- **Samsung Omnia SCH-I910:** FTP sessions cannot be conducted with this device.
- **Samsung Omnia II SCH-I920** does not answer incoming voice or video calls.
- **Samsung SPH-M320:** Service testing with does not work with this device.
- **Sierra Wireless AirCard 319U:** Repeated network connects/disconnects must be avoided with this device. The Network Connect activity must

therefore not be placed inside a loop in a Service Control script; rather, it should be performed only once at the beginning.

- **Sierra Wireless AirCard 503** stops sending RF logs after 10–20 minutes of dual data session testing. To restore RF data delivery, you need to disconnect and reconnect the device.
- **Sony Xperia V LT25i, Xperia T LT30a:** When one of these phones is on an LTE network, and the network performs an RRC Connection Release with a redirect to another EARFCN, the phone might begin to use the other EARFCN even if LTE inter-frequency handover is disabled and/or Lock on EARFCN is enabled.
- **Sony Ericsson Xperia arc S LT18:** When using this device for multi-RAB testing with CS voice and a data service in parallel, it is necessary to establish the voice call before initiating the data session and to conclude the data session before hanging up the voice call. In other words, the Service Control script needs to be structured as follows: **Dial** → **Network Connect** → <data service activities> → **Network Disconnect** → **Hang Up**.
- **Sony Ericsson Xperia arc S LT18:** To run the SMS Send script activity on this device, you must set the parameter **Request Delivery Report** to False. If the default setting True is retained, sending of SMS messages will not work.

4.16.2.3. HTC Touch Pro2 Phones

HTC Touch Pro2 phones (including HTC Imagio) need some configuring before TEMS Investigation can detect them. The details of the configuration differ depending on the phone (unbranded, AT&T branded, Verizon branded, etc.). Below, a brief description is given of what needs to be done.

On all phones you need to activate tethering via USB while the phone is connected to the PC by the USB cable. The terminology used to refer to tethering differs between phones:

- On a Verizon branded phone, activate the “Modem link”.
- On other HTC Touch Pro2 phones, activate “Internet Sharing”.

In each case, this operation creates ports in Windows that TEMS Investigation can detect.

Of phones having the “Internet Sharing” function, only one phone at a time can be used with TEMS Investigation. This limitation does not apply to the Verizon branded phones.

On all HTC Touch Pro2 phones except Verizon branded ones, you also need to install TCP Router software. This is provided by Ascom in the form of a CAB file.

For HTC Touch Pro2 phones generally, IP sniffing needs to be disabled. This means that KPI data cannot be collected with these phones. For instructions, please refer to the User’s Manual, section 12.20.3.2.

4.16.3. Samsung Devices Based on Samsung Chipset

- The event IP Interruption Time cannot be generated.

4.16.4. Samsung Devices Based on Samsung and Qualcomm Chipsets

- For Samsung Android based LTE devices using a Samsung chipset for LTE and a Qualcomm chipset for CDMA (such as SCH-R920, SCH-I510), each chipset is seen by Windows as a separate device. Depending on which RAT mode the device is in, it will expose either its LTE ports or its CDMA ports in the Windows Device Manager, but never both sets of ports at the same time.

4.16.5. Samsung Devices Based on Samsung and Via Chipsets

- **Samsung Stratosphere SCH-I405:** If a scripted VoLTE call is in progress on this device and you stop the script before it reaches the Hang Up activity, then the call will not be hung up.

4.16.6. Samsung Devices Based on ST-Ericsson Chipset

- **Samsung Galaxy S 4G:** To run a SMS Send script activity on this device, you must set the parameter **Request Delivery Report** to False. If the default setting True is retained, sending of SMS messages will not work.

4.16.7. Sequans Devices Based on Sequans Chipset

- The Sequans daemon service occasionally stops during data transfer, so that no further RF signaling is obtained from the Sequans device.

4.16.8. Sony Ericsson R13 Phones (W995, etc.)

- Avoid mixing USB 2.0 (High Speed) and USB 1.1 (Full Speed) Sony Ericsson phones, as doing so will cause some SEMC devices not to communicate correctly over AT with TEMS Investigation. See also section 4.13.
  - USB 1.1 default Sony Ericsson phones are: Z750, C702 and W760.
  - USB 1.1 and 2.0 changeable Sony Ericsson phones are: C905 and W995.
- In Windows Vista, device drivers can take a while to get running after you plug in a Sony Ericsson phone, so that the detect may take some time to complete. (Look at the status indicator on the Navigator's **Equipment** tab to view the current detect status for the device.)
- When connecting a USB hub with Sony Ericsson phones to a Windows Vista PC, the phone with the lowest port number in the USB hub is sometimes not detected. This is solved by unplugging and reinserting the phone.
- When using a USB hub with a Windows Vista PC for connecting Sony Ericsson phones, it is best to plug the phones into the USB hub one at a time.
- The driver software for the memory stick needs to be installed on the PC to avoid problems when connecting a phone that is turned off. For a K790 or K800 equipped with a memory stick, do as follows when first connecting the phone:
  1. Insert the USB cable.
  2. Wait for drivers to install.
  3. Unplug and insert again to make the memory stick driver install.
- If a Sony Ericsson TEMS Pocket phone is activated in TEMS Investigation and the USB cable is pulled, TEMS Pocket will remain disabled until:
  - the phone is restarted, or
  - the phone is activated again in TEMS Investigation and then deactivated normally in the application.
- When AMR-WB speech coding is used, GSM C/I cannot be measured.
- When the phone is locked on a WCDMA cell, the signal strength measurements for other cells become invalid.

- For the message tree in the device properties (**Layer 3 Messages** item) to be fully populated, the phone must have been activated at least once in TEMS Investigation. This is where you can discard messages of selected types, as explained in the User's Manual, section 14.3.2.10.
- When sending SMS messages from Sony Ericsson phones such as Z750 and W760, the number of characters is severely limited (worst case: max 23 characters).
- GSM channel verification:
  - The phone must be on GSM before start of test; otherwise the test will stall, and after 20 seconds an error "BCCH Lost" will be displayed.
  - The channel verification function attempts to disable handover on the phone, but this does not work for phones prior to W760i and C702.
  - The channel verification function causes the W600 to be deactivated, and the phone cannot be re-activated until after restart of TEMS Investigation.
- **Sony Ericsson K600, W600:** If CKPD is going to be used to execute video calls, it is necessary to disable the keylock first.

4.16.9. Nokia NTM3 Phones

- When the Nokia phone switches from GSM to WCDMA, GSM values will remain in TEMS Investigation presentation windows. These are old values and linger because Nokia NTM3 phones stop reporting on GSM after the switch.
- If you encounter problems activating a Nokia NTM3 phone in TEMS Investigation, there is a need for a power reboot of the phone.
- When locking the Nokia phone on a band, this action should be preceded by disabling the band lock. If you click OK between selections of different bands, the phone will lock on all bands that you have selected at some point.
- When WCDMA band lock is enabled, any attempt to access a cell on any other WCDMA band will result in that cell being barred for approximately 20 minutes. Therefore you cannot immediately go back to the band you were on before applying the band lock (or to a cell on that band). Furthermore, if the phone is locked on a WCDMA band and you lock on a different band, then release that lock, you will get no substantial phone logs for 20 minutes. For the above reasons, if you do not want to wait through the 20-minute period, it is recommended that you restart the

phone before locking on a different WCDMA band or releasing the band lock.

- **Nokia 6720:** To run the SMS Send script activity on this device, you must set the parameter **Request Delivery Report** to False. If the default setting True is retained, sending of SMS messages will not work.
- **Nokia C7-00:** High data throughput may cause this device to reboot (see Nokia release notes).
- **Nokia C7-00:** The video call capability of this device is not supported in TEMS Investigation.

5. Preparations for AQM with ACU R2

This chapter describes necessary preparations for conducting audio quality measurement using an ACU R2 Audio Capturing Unit. This release of the ACU has been developed by Ascom.

Regarding this AQM configuration in general, refer to the User's Manual, chapter 38.

5.1. Installing Drivers for ACU R2

See section 3.8 of this document.

5.2. Connecting Equipment to the ACU R2

- To each phone, connect the proper audio cable. These are phone model specific.
- Connect the other end of each audio cable (the 5-pin audio connector) to one of the **Audio** connectors on the ACU R2. It does not matter which of the connectors (numbered 1 through 4) is used for which phone.
- Connect a USB data cable between each phone and the ACU R2 connector labeled **USB** next to the **Audio** connector used for the phone in question.
- Connect the three-way ACU R2 power cable to the ACU R2, to the DC power inlet, and to a USB port on the computer.

- Make sure the ACU R2 power (**PWR**) button is pressed.
- For each connected phone, the corresponding LED should light up in green, indicating that the USB port is operational.
- If you wish to make use of the U-blox GPS built into the ACU R2, connect the GPS antenna to the **GPS** connector.

5.3. Speech Samples for Audio Quality Measurement

The ACU R2 is preconfigured with speech samples that are automatically transferred to the phones and played back during AQM sessions. These speech samples have been carefully designed to maximize the accuracy and reliability of the AQM score, exhibiting specific characteristics with regard to speech content, speech volume level, speech distribution within the sample, and more.

If you would nonetheless like to replace these speech samples with different ones, please contact Ascom technical support for assistance.

5.4. Upgrading ACU R2 Firmware

A utility named Ascom ACU Firmware Upgrade Tool is installed along with TEMS Investigation. It is used to upgrade the firmware of ACU R2 units. How to operate this utility is explained in the document “Ascom ACU Firmware Upgrade Tool User’s Manual”, found in the TEMS Investigation documentation package.

5.5. Radio Environment

Note: Any GSM phones must be kept at a minimum distance of 15 cm from the ACU R2 box; otherwise they will interfere with measurements.

6. Preparations for AQM with ACU TerraTec

This chapter describes necessary preparations for conducting audio quality measurement using an Audio Capturing Unit (ACU) in the form of a TerraTec DMX 6Fire USB box.

Regarding this AQM configuration in general, refer to the User's Manual, chapter 39.

6.1. Installing Drivers for ACU

See section 3.9 of this document.

6.2. Adjusting ACU Physical Controls

- On the rear panel of the ACU, turn all five knobs (**HEADPHONE**, **GAIN 1**, **GAIN 2**, **PHONO IN**, **MONITOR**) to minimum.

The **GAIN 1** and **MONITOR** knobs must not be adjusted. Doing so will compromise the AQM score.

6.3. Connecting Equipment to the ACU

1 To each phone, connect the proper audio cable. These are phone model specific.

2 Connect an audio adaptor (generic for all phone models) to the other end of each audio cable.

3 For each phone, connect the audio adaptor RCA plugs (white and red) to the ACU as indicated below. Note that the channels on the TerraTec box must always be paired as shown here (1–2 and 3–4), and not in any other manner.

	Phone No.	RCA Plug	Connect To
First pair of phones (#1, #2)	1	White	**LINE IN 1**
		Red	**LINE OUT 1**
	2	White	**LINE IN 2**
		Red	**LINE OUT 2**
Second pair of phones (#3, #4)	3	White	**LINE IN 3**
		Red	**LINE OUT 3**
	4	White	**LINE IN 4**
		Red	**LINE OUT 4**

4 Connect each phone to the USB hub included in the ACU package.

5 Connect the USB cable between the ACU's **USB** port and the PC.

6 Connect the ACU power cable to the **POWER** inlet and to a power source.

Note: USB 3.0 should not be used in conjunction with the ACU, since it introduces noise into the recordings and degrades AQM scores.

6.4. Settings in the TerraTec PC User Interface

A user interface, mimicking a panel of physical controls, is installed along with the TerraTec driver. It is loaded into the Windows system tray by default and represented by this icon:

The user interface has three tabs. The tabs you need to edit are **MIXER** and **OUTPUT & SETTINGS**.

Throughout the user interface, text labels on buttons are color-coded thus:

- *Yellow* color means "enabled".
- *White* color means "disabled".

MIXER Tab

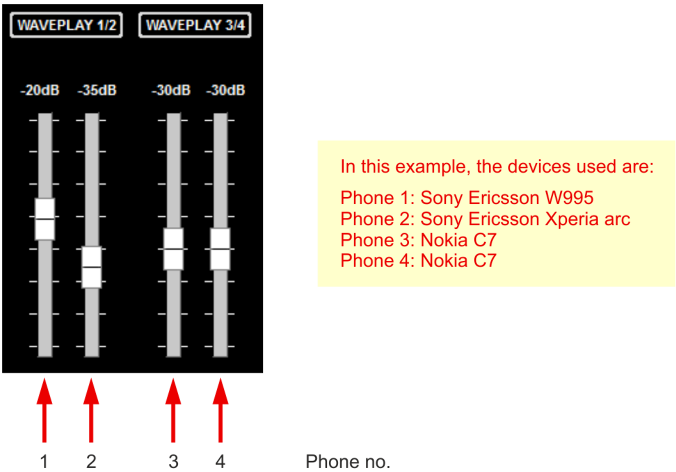
Make sure the settings are as follows:

- **LINK** disabled in all columns.
- **INPUT 1/2** column: **MONO** disabled.
- **INPUT 3/4** column: **LINE** enabled, **PHONO** disabled.
- **DIGITAL IN** column: (The **OPT/COAX** setting does not matter.)
- **WAVEPLAY 1/2** column: **1/2** enabled in bottom row.

- **WAVEPLAY 3/4** column: **3/4** enabled in bottom row.
- **WAVEPLAY 5/6** column: All buttons disabled in bottom row (these outputs are not used).
- **DIGITAL PLAY** column: All buttons disabled in bottom row.

On this tab, you also need to adjust the **WAVEPLAY** volume sliders in order to achieve suitable volume levels. Controlling the volume is essential in order to obtain correct AQM scores.

Note that if the two phones in a pair are different models, each requires a different volume setting, as tabulated below. The **LINK** button must then be disabled for that pair of sliders; otherwise the sliders will be coupled and always set identically.

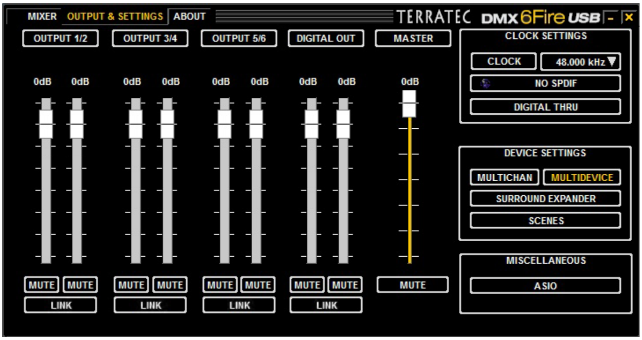


The appropriate settings are phone-specific:

Phone Model	WAVEPLAY Volume Setting
Sony Ericsson W995	–20 dB
Sony Ericsson Xperia arc	–35 dB
Sony Ericsson Xperia arc S	–25 dB
Nokia C7	–30 dB

Phone Model	WAVEPLAY Volume Setting
Huawei C8600	–27 dB

OUTPUT & SETTINGS Tab



On this tab, required settings are as follows:

- All volume sliders set to 0 dB.
- **LINK** disabled in all columns.
- **MASTER** column: **MUTE** disabled.
- **DEVICE SETTINGS** section: **MULTIDEVICE** enabled.

6.5. Configuration of Windows Settings

Volume settings must also be kept fixed in Windows for each of the devices representing the TerraTec box there. (The instructions below refer to Windows 7 user interface designations.)

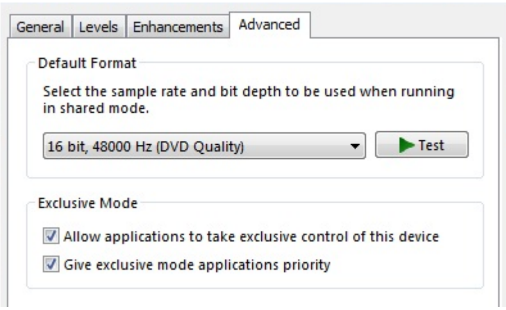
- Open the **Control Panel** and select **Sound**.
- On the **Playback** tab, under **Select a playback device ...**, three “DMX 6Fire Waveplay” devices appear (with channel suffixes “1/2”, “3/4”, “5/6”).
- For devices “DMX 6Fire Waveplay 1/2” and “DMX 6Fire Waveplay 3/4”, do as follows:
  – Select the device.

– Click the **Properties** button. The default settings should be kept on all tabs:

– On the **Levels** tab, the **Speakers** volume slider should be set to maximum.

– On the **Enhancements** tab, the box **Disable all enhancements** should be checked.

– The **Advanced** tab should look like this:



- To prevent interruptions from any other sound sources (e.g. spoken messages from TEMS Investigation), neither “DMX 6Fire Waveplay 1/2” nor “DMX 6Fire Waveplay 3/4” should be selected as default playback device. The “5/6” device, on the other hand, can be selected since it is not used.

6.6. Calibration of Phone Volume

To control volume levels throughout the measurement configuration, there is also a need to calibrate the volume in the devices themselves.

Specifics are as follows:

Phone Model	Volume Setting in Phone GUI
Sony Ericsson W995	5 steps
Sony Ericsson Xperia arc	Max
Sony Ericsson Xperia arc S	Max
Nokia C7	Max

Phone Model	Volume Setting in Phone GUI
Huawei C8600	4 steps

These settings still apply if phones of different models call each other.

6.7. Speech Samples for Audio Quality Measurement

The default speech samples used for AQM (WAV files) are stored under My Documents\TEMS Product Files\TEMS Investigation 15.3\PESQ. Different samples are used for PESQ and POLQA.

It is possible to exchange these samples for others by editing the file Investigation.QualityMeasurement.config which is found under <TEMS Investigation install dir>\Application\Configuration. Any other samples used must also reside in the directory given above.

> **Note:** Bear in mind that replacing the default speech samples could impact the accuracy of AQM scores, since the default samples have been designed to exhibit specific characteristics with regard to speech content, speech volume level, speech distribution within the sample, and more.

The number of samples should always be four. At least this many samples must be provided; on the other hand, if more samples are listed in Investigation.QualityMeasurement.config, only the first four will be used.

Samples should not be longer than 8 seconds; the default speech samples are of length 5.5 s. The speech activity in the samples should be between 40% and 80%, and there should be a minimum of 3.2 s of active speech in each sample (▶ ITU-T Recommendation P.862.3, section 7.2).

Sample rates must conform to those of the default speech samples; note that these differ between AQM algorithms as well as between the playback samples and those fed as references into the AQM algorithm.

As far as languages are concerned, the following applies:

- PESQ is expected to work for speech in any language; but since it has been tested, validated and calibrated with a limited number of languages, the accuracy of PESQ for other languages is poorly known. In practice, this means that using samples in languages other than Western European ones (e.g. British or American English, German, Dutch, Swedish, French) *cannot be recommended*.

- POLQA has been validated with a wider range of languages: American English and British English, Chinese (Mandarin), Czech, Dutch, French, German, Swiss German, Italian, Japanese, and Swedish.

6.8. Configuration of Huawei C8600

- For the Huawei C8600 to be able to perform data calls governed by TEMS Investigation, the Data Service option in the NetManager application must be turned off. To accomplish this, turn off the “up-arrow/down-arrow” button on the phone’s top-level menu. Alternatively, go to **Applications** → **NetManager** and deselect the **Data Service** option. Note that by default, the Data Service option is turned on.
- This instruction applies to prototype Huawei C8600 devices sharing the same IMEI. If you connect two such devices to the PC, and the detect in TEMS Investigation fails, do as follows:
  1. Inspect the phone IMEI in TEMS Investigation (Navigator bottom pane → **Information** tab → **Identity**).
  2. In the configuration file <TEMS Investigation install dir>\Application\Configuration\Investigation.RecurringImei.config, replace the default IMEI with the phone IMEI. Save the file.

7. CallGenerator™

To perform audio quality measurements (AQM) involving calls to the fixed side, you need a CallGenerator to serve as the other party in the calls. See the User's Manual, chapters 38 and 40.

How to install a CallGenerator is described in the document CallGenerator Installation Guide, which is included in the CallGenerator sales package. This document also states PC hardware and operating system requirements posed by the CallGenerator installation.

Please note the following:

- The CallGenerator must be a version-numbered one (version 1.0 or later; version 1.1 required for Synchronized Voice Call Sequence) to be compatible with TEMS Investigation 15.3. Older CallGenerators have no version numbering.
- The CallGenerator installation requires an English-language edition of Windows.
- If the CallGenerator PC is not running Windows Server 2008 R2, make sure that you have Windows Management Framework (Windows PowerShell 2.0, WinRM 2.0, and BITS 4.0) installed. To check what version you have, run a command prompt as administrator and type $host.version. This command should return "Major" = 2. If it does not, download the correct software version via Windows Update or by following this link: ▶ support.microsoft.com/kb/968929. – In PowerShell, also check that Get-ExecutionPolicy returns "RemoteSigned". If you get a different response, run the command Set-ExecutionPolicy RemoteSigned.

8. Notes on TEMS Pocket Devices

Certain devices that are connectable in TEMS Investigation have TEMS Pocket functionality. For these devices, a separate User's Manual deals with the TEMS Pocket functions. However, when the device is activated in TEMS Investigation, the TEMS Pocket functions are disabled. Nonetheless, it is possible to purchase such devices with TEMS Investigation with fully enabled TEMS Pocket software; see the Installation Guide, section 3.4.

9. Device and PC Configuration for Ericsson Fixed Wireless Terminals

Ericsson Fixed Wireless Terminals (FWTs) are routers offering wireless access to broadband Internet and telephony. The FWT constitutes a gateway to a network.

Regarding FWT operation in general, please consult the documentation delivered with the product.

9.1. PC Configuration

If an FWT is to be used with TEMS Investigation, the following must be observed:

- The PC must not be connected to any other network. (The “default gateway” must be unambiguously defined in the PC operating system.)
- The default IP address of the FWT is 192.168.1.1. It is possible to change this address to any value; however, TEMS Investigation requires that the IP address fall within the private address space (▸ IETF RFC 1918).
- If a firewall or other security product is installed, you must make sure that port 1895 is open, since the TEMS service uses this port.
- To enable detection of an FWT, in the file <TEMS Investigation install dir>\Application\Configuration\Investigation.Equipment.config, uncomment the line containing “QualcommNetworkDetector”. If TEMS Investigation is running, you must restart the application for the change to take effect.

9.2. FWT Configuration

The FWT itself must be configured as follows:

- Connect the PC and FWT with a LAN cable.

- Configure the network interface on the PC with either a static IP address in the range 192.168.1.0/24[1] or DHCP.
- Using Telnet[2], log in to the FWT (192.168.1.1)[1] as root. The root password will be different in each custom configuration. Please contact your supplier or operator for assistance.
- Run the following commands:

  # cf set tems.enabled true

  # cf commit

  The TEMS service will now always be running on the FWT whenever it is turned on. There is no need to restart the TEMS service after the FWT has been rebooted.

  To disable the TEMS service, run these commands:

  # cf set tems.enabled false

  # cf commit

9.3. Service Testing Limitations

- When an FWT is activated, it is not possible to do data service testing with any other devices at the same time.
- Data service testing with FWTs is limited to FTP, HTTP, and Ping.

---

1. This is the default network on the FWT LAN, though it is possible that the FWT has been configured differently.
2. In Windows 7/Vista, the Telnet client is by default not activated. To activate it, do as follows: Open the Control Panel and navigate to **Programs and Features**. Click “**Turn Windows features on or off**”. In the feature list that appears, check **Telnet Client**.

10. Configuration of Scanners

10.1. DRT Scanners

10.1.1. Firmware Requirements

Firmware version 02.03.xx or later is required.

10.1.2. Device and PC Configuration

This chapter applies to all currently supported DRT scanners (models listed in section 2.2.4).

A DRT scanner can either be connected directly to the PC by means of a cable, or it can be accessed over a local area network. The instructions that follow tell how to configure the PC in each case.

See also the User's Manual, section 6.1.3.

10.1.2.1. Direct Connection

The DRT scanner is shipped configured for a direct connection and is assigned the static IP address 192.168.5.2. The PC's Ethernet adapter must likewise have its TCP/IP address configured as static and equal to 192.168.5.1.

Follow these steps:

1. Access the Windows user interface showing your network connections:
   - (Windows 7) **Start** → **Control Panel** → **Network and Sharing Center** → **Change Adapter Settings**.
   - (Windows Vista) **Start** → **Settings** → **Network Connections**.
2. Double-click **Local Area Connection**.
3. Click the **Properties** button. (Not applicable for Windows 7.)
4. In the box below "**This connection uses the following items:**", select "Internet Protocol Version 4 (TCP/IPv4)".

5 Then click the **Properties** button.

6 Select "**Use the following IP address**". Under **IP address**, enter 192.168.5.1. Under **Subnet mask**, enter 255.255.255.0. Then click OK.

7 Connect the scanner to the PC's Ethernet port with a crossover 100Base-T cable.

10.1.2.2. Local Area Network Connection

For this setup, the scanner must be reconfigured to acquire a dynamic IP address from the network.

Follow these steps:

1 Assuming the scanning receiver and the laptop are both configured for static IP addressing, and the scanner is connected to the remote PC via a crossover 100Base-T cable, connect to the scanner with a web browser by entering the URL http://drt4301snaaaa, where aaaa is the serial number of the device.

2 On the web page that appears, under **Wired Ethernet configuration**, clear the **Static IP Address** field.

3 Click **Save Changes**.

4 Access the Windows user interface showing your network connections:

- (Windows 7) **Start** → **Control Panel** → **Network and Sharing Center** → **Change Adapter Settings**.
- (Windows Vista) **Start** → **Settings** → **Network Connections**.

5 Double-click **Local Area Connection** and click the **Properties** button.

6 In the box below "**This connection uses the following items:**", select "Internet Protocol Version 4 (TCP/IPv4)".

7 Select "**Obtain an IP address automatically**".

8 Select "**Obtain DNS server address automatically**". Then click OK.

9 Connect the PC and the scanner to available Ethernet ports on the same subnet of the LAN with normal (non-crossover) 100Base-T cables. If the remote location is not on the same subnet, then a VPN connection may be used to create an extended virtual subnet that can host the scanner as if it were on a local subnet.

10.1.2.3. Verifying the Configuration

Here is how to confirm and troubleshoot the connection to the scanner.

Before you begin, make sure your firewall is disabled; see sections 13.2.8 and 13.2.10.

1 Connect the Ethernet cable or cables as described in sections 10.1.2.1 and 10.1.2.2.

2 Open a Windows command prompt (select **Start** → **Run**, enter cmd, and press Enter).

3 Ping the unit by typing the command ping drt4301snaaaa, where aaaa is the serial number of the device, and observe if responses are received.

4 If no response occurs, you may use Wireshark to capture the Ethernet traffic and determine the unit's current IP address. Enter the filter term nbns.flags == 0x2910 to isolate the Netbios Naming Service registration messages sent out by the scanner. The IP address will be included in the message from the scanner.

10.1.2.4. Scanner Antenna Connection

On DRT scanners that have two RF inputs, the RF antenna must be connected to the RF IN B port.

10.1.2.5. Known Limitations

- For technical reasons, TEMS Investigation attempts detection of DRT scanners only at startup and when you click the **Refresh** button on the Navigator's Equipment tab. Therefore, if you plug in one of those scanners after starting TEMS Investigation, you need to click **Refresh** to have it detected.
- The DRT scanner will reboot after a period of time if it is connected via a LAN and is detected by multiple TEMS Investigation users. The scanner API does not support multiple connections.

10.2. PCTel Scanners

10.2.1. Tips and Tricks; Known Limitations

10.2.1.1. PCTel SeeGull EX

- For EX version 2.0.1.0 and later, be sure to install the driver delivered with TEMS Investigation. Do not install any driver provided on the PCTel web site. The reason is as follows: If you have PCTel's own driver installed, then if you activate the scanner in TEMS Investigation and then pull its cable, the scanner port will not disappear from Windows and thus not from the TEMS Investigation user interface either. The driver delivered with TEMS Investigation contains a modification that removes the scanner port in the situation just described.
- Start up the scanner without the USB cable connected. Wait until the LED turns green before plugging the USB cable into the scanner. Note especially that an EX LTE or EXflex scanner may take 10–15 seconds to boot up and become fully operational. If you insert the USB cable too soon, it may happen that the scanner is detected OK by TEMS Investigation and appears responsive but does not in fact respond to scan commands.
- If you need to power cycle the scanner during use, pull the USB cable before doing so, and do not reconnect it until the scanner has started up again (green LED).
- On rare occasions, the EXflex scanner fails to report installed options upon power-up, so that no scanning can be performed. Recycling power corrects this issue.

10.2.1.2. PCTel SeeGull LX

- When an LX MM2 scanner is connected to TEMS Investigation you cannot use the **Activate All** function; rather, you must activate each device separately.
- When plugging in an LX scanner that uses a serial connection, click the **Refresh** button on the Navigator's **Equipment** tab to ensure that the scanner is detected.
- LX scanners may sometimes report numerous scan drop messages. The scanner uses this message to tell the host how many scan data messages were dropped and not delivered through the data link. Scan

data is dropped automatically when the scanner is scanning faster than the data can be delivered through the data link, causing the pipeline to overfill. Therefore, scan drop messages do not necessarily indicate a malfunction.

10.2.1.3. PCTel SeeGull MX

- After the driver has installed and Windows has detected the device for the first time, reboot the scanner.
- Always wait for the scanner to boot completely (LED turns dark green) before starting TEMS Investigation. This can take up to 90 seconds (during which time the LED is pale green or orange).

10.2.1.4. PCTel PCT

- This scanner may not detect on some PCs. If this problem occurs, disable the “Intel Active Management Technology – SOL” driver if it exists on the PC, then restart TEMS Investigation.

10.2.2. Technical Notes on PCTel Scanners

10.2.2.1. Reference Point for Signal Level Measurement

This section applies to all supported PCTel SeeGull scanners.

The signal level reported by the scanner is that measured at the scanner’s antenna connector. No adjustment is made in the scanner to compensate for antenna or cable loss.

10.2.2.2. Antenna Cable Attenuation

PCTel OP216 Antenna

This is a magnetic mount antenna with +4 dBi gain. It covers the frequency range 1700 to 2700 MHz.

The antenna is delivered with a 12 ft (3.66 m) coaxial cable called Pro Flex Plus 195. In the table below is shown the total cable attenuation at various frequencies:

Frequency (MHz)	Total Cable Attenuation (dB)
1700	2.15
1800	2.22
1900	2.22
2000	2.33
2100	2.50
2200	2.50
2300	2.55
2400	2.78
2500	2.82
2600	2.82
2700	2.90

Smarteq Minimag Antenna

This is a magnetic mount antenna with 0 dBd gain. It covers the frequencies 890 to 960 MHz and 1710 to 2170 MHz.

The antenna is delivered with a Smarteq RG-174 cable whose loss at 2100 MHz is specified at 1.47 dB per meter cable maximum. The total length of the cable is 2.6 m. In the following table is shown the total cable attenuation at various frequencies:

Frequency (MHz)	Total Cable Attenuation (dB)
900	2.34
1800	3.46
1900	3.61
2000	3.70
2100	3.82

10.3. Rohde & Schwarz TSMW

10.3.1. Firmware Requirements

Firmware version 1.13 is required.

10.3.2. Device and PC Configuration

The Rohde & Schwarz TSMW scanner is connected directly to the PC by means of an Ethernet cable. The instructions that follow tell how to configure the PC for that connection. See also the User's Manual, section 6.1.3.

The R&S TSMW scanner is shipped configured for a direct connection and is assigned the static IP address 192.168.0.2. The PC's Ethernet adapter must likewise have its TCP/IP address configured as static and equal to 192.168.0.1.

Follow these steps:

1. Connect the scanner to the PC's Ethernet port with the supplied cable.
2. Access the Windows user interface showing your network connections:
    - (Windows 7) **Start** → **Control Panel** → **Network and Sharing Center** → **Change Adapter Settings**.
    - (Windows Vista) **Start** → **Settings** → **Network Connections**.
3. Double-click **Local Area Connection**.
4. Click the **Properties** button. (Not applicable for Windows 7.)
5. In the box below **This connection uses the following items:**, select "Internet Protocol Version 4 (TCP/IPv4)".
6. Then click the **Properties** button.
7. Select **Use the following IP address**. Under **IP address**, enter 192.168.0.1. Under **Subnet mask**, enter 255.255.255.0.
8. Click the **Advanced...** button and disable NetBIOS over TCP/IP under the **WINS** tab. Click OK.
9. After booting the TSMW, double-check if the connection is successfully established by pinging the scanner. In a Command Prompt window, type ping 192.168.0.2.

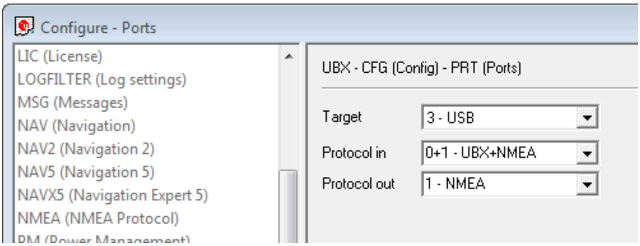
10.3.3. Known Limitations

- For technical reasons, TEMS Investigation attempts detection of R&S scanners only at startup and when you click the **Refresh** button on the Navigator's Equipment tab. Therefore, if you plug in one of those scanners after starting TEMS Investigation, you need to click **Refresh** to have it detected.

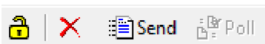
10.3.4. Disabling U-blox Messages from Built-in GPS

The R&S TSMW has a built-in U-blox GPS, which by default uses both NMEA and the U-blox specific UBX protocol. TEMS Investigation does not support UBX, so its use should be disabled when using the scanner with TEMS Investigation. Here is how to do this.

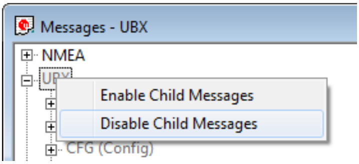
1. Plug the GPS into the PC. If it is already plugged in, and TEMS Investigation is running, make sure the GPS is deactivated in the application (as described in the User's Manual, section 6.4.2).
2. In the U-center configuration application, go to **View** → **Configuration View** and select "**PRT (Ports)**".
3. Configure the GPS ports according to the screenshot below.



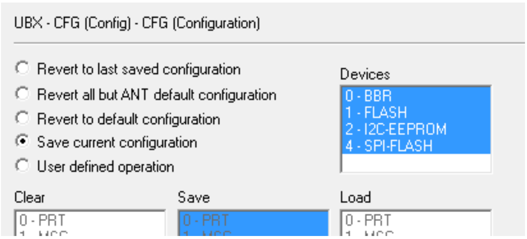
4. Click the **Send** button to transfer the configuration to the GPS.



5. Go to **View** → **Messages View**. In the tree view, right-click the **UBX** node and choose **Disable Child Messages**. The messages under this node are grayed out.



6 Navigate to **UBX** → **CFG (Config)** → **CFG (Configuration)**. In the **Devices** box, select devices 0, 1, 2, and 4. Select **Save current configuration**. Then click the **Send** button. The configuration is now written to the GPS memory so that it does not have to be redefined each time the GPS cable is reconnected.



7 Disconnect the GPS in U-center.

8 You can now activate the GPS in TEMS Investigation and verify the configuration as follows (compare the User's Manual, section 29.1.2):

- Right-click in the **Mode Reports** window and select **Properties**.
- On the **Messages** tab, uncheck the **Mode Reports** category, and check the **Position** category instead. Click **OK**.
- Verify that no "Unhandled NMEA frames" appear in the window.

10.4. SRU

- To prevent problems detecting the SRU in TEMS Investigation, stop the Mobile Broadband Service and preferably set startup type to "disable".
- To ensure that the SRU is supplied with adequate power, plug both connectors (black and red) of the Y-USB cable into an externally powered USB hub, and also connect the SRU's power cable with its accompanying 12 V adapter to a power source. Connecting the Y-USB cable directly to USB ports on the PC does not give sufficient power.
- The **Status** LED on the SRU front panel is interpreted as follows:

  - *Steady green:* The SRU has sufficient power, and the Windows service "TEMS Device Manager" has detected the SRU, so that the SRU's scanning module has started up. (All OK.)
  - *Flashing green:* The SRU has sufficient power, but the TEMS Device Manager has not started or cannot detect the SRU, and so no startup command is sent to the scanning module. Workaround: Restart the TEMS Device Manager service in Windows.
  - *Flashing red:* The SRU does not have sufficient power to start up the scanning module.
- When installing an SRU whose firmware has been upgraded, or when installing an SRU on a PC where a TEMS Device Manager already exists, the TEMS Device Manager needs to be upgraded. Please follow the readme document supplied in the driver ZIP archive in the folder TEMS SRU.

10.5. Transcom Scanner

10.5.1. Device and PC Configuration

The Transcom scanner is connected directly to the PC by means of an Ethernet cable. The instructions that follow tell how to configure the PC for that connection. See also the User's Manual, section 6.1.3.

The Transcom scanner is shipped configured for a direct connection and is assigned a static IP address (referred to here as "**A1**") which is printed on a sticker on the scanner. The PC's Ethernet adapter must likewise have its TCP/IP address ("**A2**") configured as static and residing within the same subnet as A1. *Example:* If the scanner has A1 = 192.168.0.10, then one valid address for the PC is A2 = 192.168.0.11.

Follow these steps:

1. Connect the scanner to the PC's Ethernet port with the supplied cable.
2. Access the Windows user interface showing your network connections:
   - (Windows 7) **Start** → **Control Panel** → **Network and Sharing Center** → **Change Adapter Settings**.
   - (Windows Vista) **Start** → **Settings** → **Network Connections**.
3. Double-click **Local Area Connection**.
4. Click the **Properties** button. (Not applicable for Windows 7.)

5 In the box below **This connection uses the following items:**, select “Internet Protocol Version 4 (TCP/IPv4)”.

6 Then click the **Properties** button.

7 Select **Use the following IP address**. Under **IP address**, enter the address A2 of the PC’s Ethernet adapter. Under **Subnet mask**, enter 255.255.255.0.

8 After booting the Transcom scanner, double-check if the connection is successfully established by pinging the scanner. In a Command Prompt window, type ping followed by the scanner’s address A1 (see the introduction).

10.5.2. Known Limitations

- The Transcom scanner is not capable of scanning more than one LTE band at a time.
- Transcom’s “Eagle” PC software cannot run concurrently with TEMS Investigation.

10.6. Andrew i.Scan

10.6.1. Device and PC Configuration

The Andrew i.Scan can be equipped with one or two modules, which are available in many frequency band configurations. Bands and technologies are independent. Multiple Andrew i.Scan units can be connected in a daisy chain.

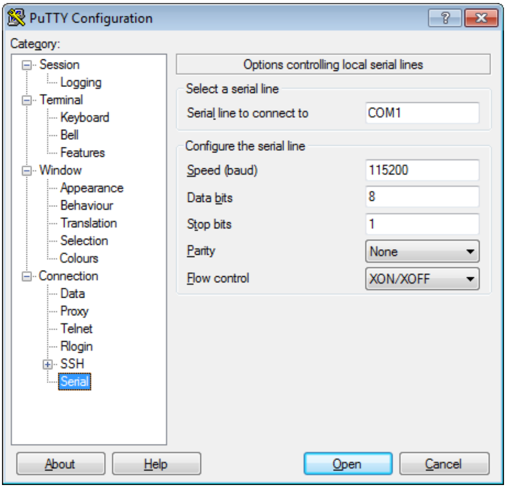
10.6.1.1. Prerequisites

- Terminal emulator application installed on the PC (for example Putty, which can be downloaded free of charge from ▶ www.putty.org).
- Serial cable with 9-pin male connector (plugged into the Andrew scanner via the accompanying serial port adapter cable) and 9-pin female connector (plugged into the PC).
- Network cable with an RJ-45 connector at either end. Note that if the cable connects the PC and scanner directly, i.e. if there is no intervening router or switch, then the cable should be cross-connected.

10.6.1.2. Setting Up the Serial Connection

- Start your terminal emulator program.

Configure the serial line between scanner and PC as shown in the screenshot below, taken from Putty (**Configure the serial line** section):



(The COM port should of course be replaced by the one to which the scanner is connected.)

- In Putty you establish the connection between scanner and PC by pressing the Return key. If you are using a different terminal emulator, perform the corresponding operation.

10.6.1.3. Configuring the Andrew Scanner

Once the connection has been established between scanner and PC, the terminal emulator should display information looking something like this (Putty again used as example):

```
Flash data
----------
Mainframe name = Andrew Corporation
IP address = 192.168.003.253
Subnet mask = 255.255.255.000
Gateway address = 000.000.000.000
Interface type = 1
```

```
Enter a number to change an item
--------------------------------
0 = done
1 = mainframe name
2 = IP address
3 = subnet mask
4 = gateway address
5 = interface type (1 = Invex, 2 = OEM)
```

The one thing that needs changing is the interface type (5).

- Press “5” and Return, then change the interface type to “2” (OEM).
- Save by pressing “0” and Return, then “y”.

```
Flash data
----------
Mainframe name = Andrew Corporation
IP address = 192.168.003.253
Subnet mask = 255.255.255.000
Gateway address = 000.000.000.000
Interface type = 2

Enter a number to change an item
--------------------------------
0 = done
1 = mainframe name
2 = IP address
3 = subnet mask
4 = gateway address
5 = interface type (1 = Invex, 2 = OEM)

> OK to update Flash (y/n)?  y
```

Note: Do not change the “mainframe name”; TEMS Investigation uses that name to autodetect the scanner.

10.6.1.4. Manual Input of IP Address If Autodetect Fails

If autodetection does not work properly, you can set the IP address manually in this file:

<TEMS Investigation install dir>\Application\Settings\TEMS.Equipment.Andrew.Settings.AndrewSettings.config

With full autodetect and scanner response:

```
<setting name="UseDetector" serializeAs="String">
   <value> true </value>
</setting>
<setting name="ScannerIPs" serializeAs="String">
   <value></value>
</setting>
```

With semi-autodetect and no scanner response:

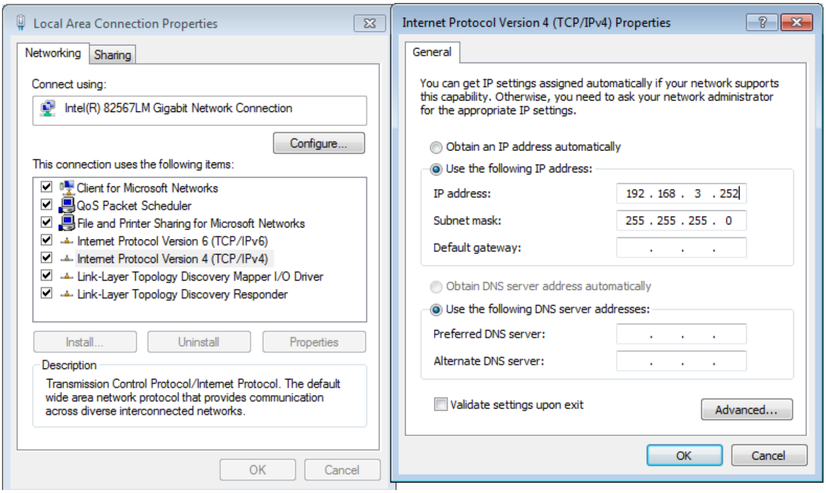
(In this example two scanners are identified. If UseDetector is false, the setting ScannerIPs will be checked for scanner IP addresses. In this setting, multiple IP addresses are separated by semicolons.)

```
<setting name="UseDetector" serializeAs="String">
   <value>false</value>
</setting>
<setting name="ScannerIPs" serializeAs="String">
   <value>192.168.1.253;192.168.1.250</value>
</setting>
```

10.6.1.5. Configuring the PC Network Adapter (for Direct Scanner–PC Connection)

If the Andrew scanner is connected directly to the PC, a fixed IP address should be selected at the PC end.

- Configure the local area connection as shown in the following screenshot, selecting the option **Use the following IP address**. Note that the IP address selected here (192.168.3.252) is adjacent to the scanner’s IP address in the example in section 10.6.1.3 (192.168.3.253). This is not a requirement, but the two addresses do have to be on the same subnet (first nine digits identical).



10.6.1.6. Connecting the Scanner

- Connect the network cable to the A or B slot on the scanner.
- Connect the other end of the cable to the PC either directly or via a switch or router. Look for a network icon in the bottom right-hand corner of the PC screen (if it is configured to show up). When you have a connection, you are done.
- Now start TEMS Investigation. The Andrew scanner should autodetect in a matter of seconds once TEMS Investigation is up and running.

10.7. Anritsu Scanners

10.7.1. Anritsu ML8720

A null modem cable must be used to connect the Anritsu ML8720 to the PC.

The serial port baud rate must be set to 115200 in the scanner. Proceed as follows:

- From the scanner main menu, select **System Configuration**, then select **Interface and Behavior**.
- Set the COM1 protocol to Direct.
- Set the COM1 baud rate to 115200.

- Set COM1 stop bit(s) to 1.
- Set COM1 data length to 8.
- Set COM1 parity to None.
- From the side menu (operated with buttons on the side of the scanner), select OK.

10.7.2. Anritsu ML8780A

This scanner has only been tested on Windows 7 (English-language version).

Only one measurement unit in the scanner is supported.

11. GPS Units

11.1. Tips and Tricks

- If a Bluetooth GPS is not detected in TEMS Investigation, try restarting the GPS. Wait for the application and PC to establish the pairing. It may be necessary to click the **Refresh** button in the Navigator if the device still does not appear.
- To activate the Nokia LD-3W Bluetooth GPS, first start up TEMS Investigation. Then connect the GPS logically in Windows, outside of the TEMS Investigation application. Only after this can the GPS be successfully activated on the Navigator’s **Equipment** tab.
- If the power to a Bluetooth GPS is lost, you may need to restart TEMS Investigation to be able to activate the GPS again.

12. Configuration of DRT Transmitter

TEMS Investigation with connected external devices can be used in conjunction with a DRT test transmitter which the devices can camp on. The transmitter then needs some configuration, the steps of which are detailed here for easy reference.

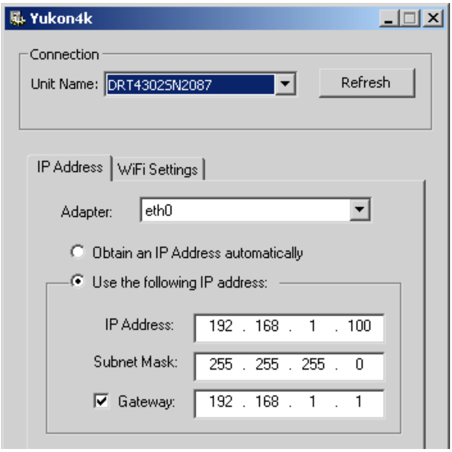
The DRT transmitter is controlled from a PC, to which it can be connected directly by means of a cable, over a local area network, or via Wi-Fi. The instructions that follow tell how to configure the transmitter and the PC in each case.

This chapter applies to the DRT4302A+ transmitter model.

12.1. Setting Up the Transmitter

Before you begin, you need to install the **Nome** application, which functions as the transmitter's user interface. Along with it, another application **Yukon4k** is installed which is used for configuring the transmitter's network connection.

1. After installing the above software, start Yukon4k. This application will find the DRT transmitter automatically and present its name as shown in the screenshot below.



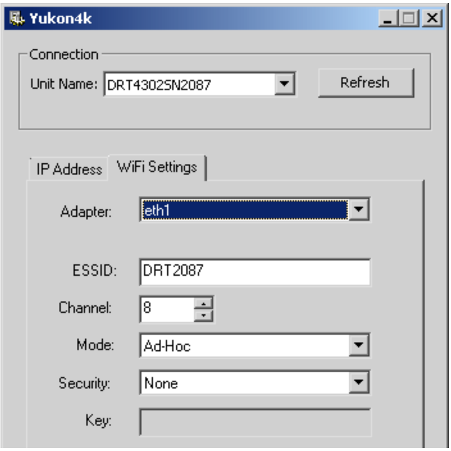
2 On the **IP Address** tab you can set IP addresses for Ethernet and Wi-Fi. The adapter for Ethernet is “eth0” and by default uses the IP address 192.168.1.100. The Wi-Fi adapter is called “eth1” and uses the default IP address 192.168.2.100.

3 If you are going to connect to the transmitter via Ethernet, then for **Adapter** = “eth0” you need to select **Obtain an IP Address automatically** and click the **Set Unit IP Configuration** button. Compare section 12.3.

4 To be able to access the transmitter over Wi-Fi, enter appropriate settings on the **WiFi Settings** tab:

- **ESSID:** Wi-Fi network name.
- **Channel:** Select an unused channel in the range 1 ... 10.
- **Mode:** Always **Ad-Hoc**. The transmitter’s Wi-Fi (802.11b/g) interface operates in an “ad-hoc” (peer-to-peer) configuration; the interface currently does not support the Wi-Fi “infrastructure” mode of operation. Control is determined when the unit is powered on. **Note** that any device that is going to receive signals from the DRT transmitter must support the “ad-hoc” mode of operation.
- **Security:** “None” or WEP.
- **Key:** If WEP is used, enter the WEP key here.

When you are done entering the parameters, click the **Set Wireless Configuration** button.



5 If you want to change between Ethernet and Wi-Fi connection mode, you must reboot the transmitter. See section 12.1.1 below.

12.1.1. Changing between Ethernet and Wi-Fi Network Configuration Modes

On power-up or boot, the transmitter checks to see if there is an Ethernet cable connected to the DATA connector. If an Ethernet cable is present, the unit is configured to use that cable for control; if not, it selects Wi-Fi for communications.

To switch between these modes, it is necessary to turn off power to the transmitter and plug in or plug out the Ethernet cable as appropriate. Then power on the unit again, and the networking mode will be selected as just described.

12.2. Configuring the PC for Direct Connection

The DRT transmitter is shipped configured for a direct connection, with the static IP address 192.168.1.100 assigned to its Ethernet (“eth0”) adapter. The PC’s Ethernet adapter must likewise have its TCP/IP address configured as static and in the range 192.168.1.nnn, where nnn is any number between 1 and 255 except 100.

Follow these steps:

1 Access the Windows user interface showing your network connections:
   - (Windows 7) **Start** → **Control Panel** → **Network and Sharing Center** → **Change Adapter Settings**.
   - (Windows Vista) **Start** → **Settings** → **Network Connections**.

2 Double-click **Local Area Connection**.

3 Click the **Properties** button. (Not applicable for Windows 7.)

4 In the box below "**This connection uses the following items:**", select "Internet Protocol Version 4 (TCP/IPv4)".

5 Then click the **Properties** button.

6 Select "**Use the following IP address**". Under **IP address**, enter 192.168.1.100. Under **Subnet mask**, enter 255.255.255.0. Then click OK.

7 Connect the transmitter to the PC's Ethernet port with a crossover 100Base-T cable.

12.3. Configuring the PC for LAN Connection

As explained in section 12.1, step 3, the Ethernet adapter of the DRT transmitter needs to be set to "obtain an IP address automatically". You need to change this setting on the PC as well.

Follow these steps:

1 Access the Windows user interface showing your network connections:
   - (Windows 7) **Start** → **Control Panel** → **Network and Sharing Center** → **Change Adapter Settings**.
   - (Windows Vista) **Start** → **Settings** → **Network Connections**.

2 Double-click **Local Area Connection** and click the **Properties** button.

3 In the box below "**This connection uses the following items:**", select "Internet Protocol Version 4 (TCP/IPv4)".

4 Select "**Obtain an IP address automatically**".

5 Select "**Obtain DNS server address automatically**". Then click OK.

6 Connect the PC and the transmitter to available Ethernet ports on the same subnet of the LAN with normal (non-crossover) 100Base-T cables. If the remote location is not on the same subnet, then a VPN connection may be used to create an extended virtual subnet that can host the transmitter as if it were on a local subnet.

12.4. Verifying the Configuration

Here is how to confirm and troubleshoot the connection to the transmitter.

Before you begin, make sure your firewall is disabled; see sections 13.2.8 and 13.2.10.

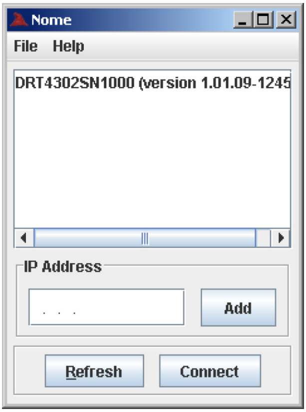
1. Connect the Ethernet cable or cables as described in sections 10.1.2.2 and 10.1.2.3.
2. Open a Windows command prompt (select **Start** → **Run**, enter cmd, and press Enter).
3. Ping the unit by typing the command ping drt4302snaaaa, where aaaa is the serial number of the device, and observe if responses are received.
4. If no response occurs, you may use Wireshark to capture the Ethernet traffic and determine the unit's current IP address. Enter the filter term nbns.flags == 0x2910 to isolate the Netbios Naming Service registration messages sent out by the transmitter. The IP address will be included in the message from the transmitter.

12.5. Configuring Transmitter Cell Information

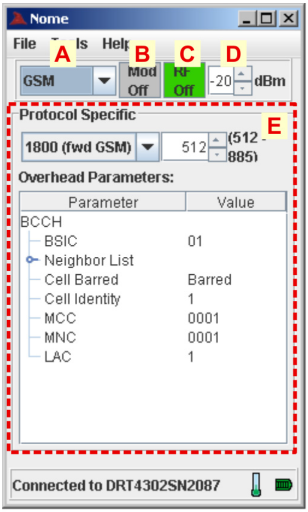
There are two ways to connect to the DRT transmitter and set up its cell information: through Nome or through a web interface.

12.5.1. Configuring the Transmitter Using Nome

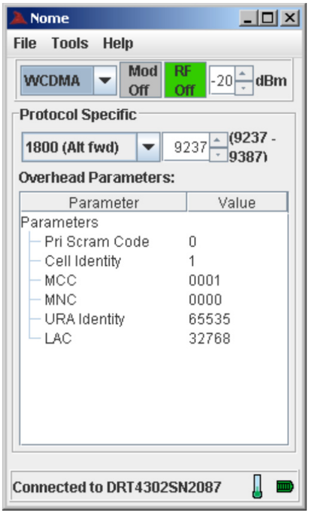
1. Start Nome and wait for the application to find the DRT transmitter. When found, it appears in the list box.



2 Select the DRT transmitter in the list, and click **Connect**. A new screen appears where you configure transmitter settings.



Technology = GSM



Technology = WCDMA

3 In the top section highlighted in the screenshot above, you can configure the following (letters refer to labels added in red):

- **A:** Cellular technology, GSM or WCDMA.
- **B:** Modulation On or Off. **Mod On** means that the transmitter mimics a GSM or WCDMA downlink channel. **Mod Off** means that a CW signal is transmitted.
- **C:** **RF Off** = transmission turned off; **RF On** = transmission turned on.
- **D:** Output power, configurable in the range –20 ... +21 dBm.

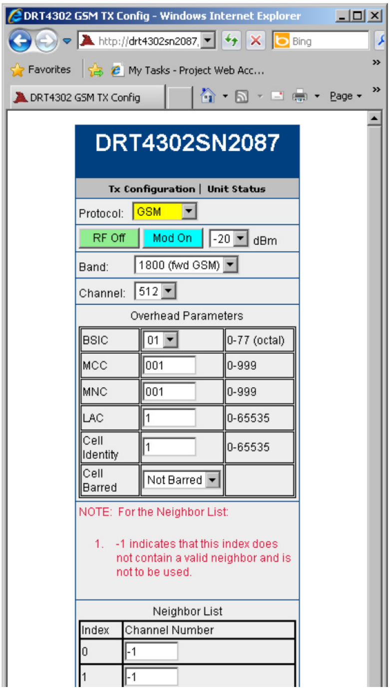
4 **Protocol Specific** section (**E**): Here you set what band and (U)ARFCN to use, along with other cell parameters.

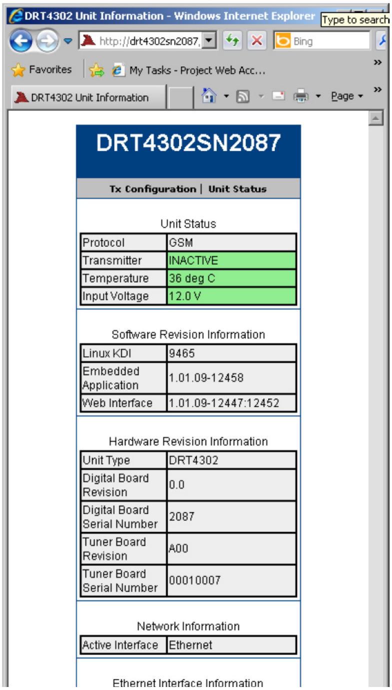
12.5.2. Configuring the Transmitter Using Web Interface

The web browser used to access the DRT transmitter interface must support Ajax, for example: Internet Explorer 8 or later, Firefox 3.0.17, Firefox 3.6.3.

1 Connect to the transmitter with a web browser by entering the URL http://drt4302snaaaa, where aaaa is the serial number of the device. Alternatively, you can also enter the IP address for the transmitter: by default http://192.168.1.100 for Ethernet or http://192.168.2.100 for Wi-Fi.

2 The web browser interface looks somewhat different from the Nome application. Click the **Tx Configuration** link to set transmission parameters (left-hand screenshot below); compare section 12.5.1, step 3. Clicking the **Unit Status** link displays device status information, as shown in the screenshot on the right.


DRT4302 GSM TX Config - Windows Internet Explorer
http://drt4302sn2087
Bing
Favorites
My Tasks - Project Web Acc...
DRT4302 GSM TX Config
Page
DRT4302SN2087
Tx Configuration | Unit Status
Protocol: GSM
RF Off
Mod On
-20 dBm
Band: 1800 (fwd GSM)
Channel: 512
Overhead Parameters
BSIC 01 0-77 (octal)
MCC 001 0-999
MNC 001 0-999
LAC 1 0-65535
Cell Identity 1 0-65535
Cell Barred Not Barred
NOTE: For the Neighbor List:
1. -1 indicates that this index does not contain a valid neighbor and is not to be used.
Neighbor List
Index Channel Number
0 -1
1 -1


DRT4302 Unit Information - Windows Internet Explorer
Type to search
http://drt4302sn2087
Bing
Favorites
My Tasks - Project Web Acc...
DRT4302 Unit Information
Page
DRT4302SN2087
Tx Configuration | Unit Status
Unit Status
Protocol GSM
Transmitter INACTIVE
Temperature 36 deg C
Input Voltage 12.0 V
Software Revision Information
Linux KDI 9465
Embedded Application 1.01.09-12458
Web Interface 1.01.09-12447:12452
Hardware Revision Information
Unit Type DRT4302
Digital Board Revision 0.0
Digital Board Serial Number 2087
Tuner Board Revision A00
Tuner Board Serial Number 00010007
Network Information
Active Interface Ethernet
Ethernet Interface Information

13. TEMS Investigation Computer Diagnostics

For TEMS Investigation to operate properly, your computer must be appropriately configured in a variety of respects. With the product is delivered a utility called **Computer Diagnostics**, which evaluates the current status of the PC and determines how well it is prepared for running TEMS Investigation. Specifically, the utility does the following:

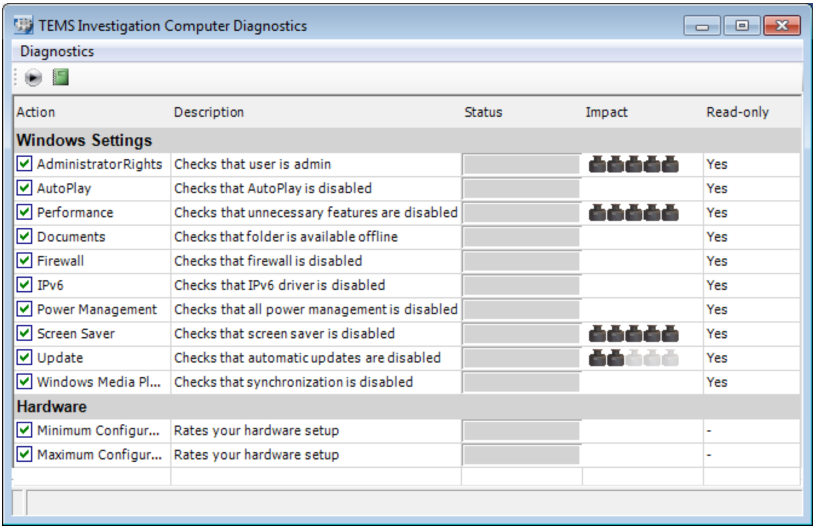
- Checks a variety of PC settings that have a significant impact on TEMS Investigation performance, particularly with regard to data collection. Feedback in plain text is given on these settings, complete with recommendations for changes. Suitable settings are detailed in section 13.2.
- Checks hardware capabilities (processor and RAM) and matches them against the requirements of TEMS Investigation. See section 13.1.2.2 for further discussion.

13.1. Running TEMS Investigation Computer Diagnostics

- Launch the Computer Diagnostics utility by choosing **Start** → [**All**] **Programs** → **Ascom** → **TEMS Products** → **Utilities** → **TEMS Investigation Computer Diagnostics**.

13.1.1. Setting Up Test Cases

The Computer Diagnostics utility has a user interface with the following layout:



Action	Description	Status	Impact	Read-only
Windows Settings				
AdministratorRights	Checks that user is admin			Yes
AutoPlay	Checks that AutoPlay is disabled			Yes
Performance	Checks that unnecessary features are disabled			Yes
Documents	Checks that folder is available offline			Yes
Firewall	Checks that firewall is disabled			Yes
IPv6	Checks that IPv6 driver is disabled			Yes
Power Management	Checks that all power management is disabled			Yes
Screen Saver	Checks that screen saver is disabled			Yes
Update	Checks that automatic updates are disabled			Yes
Windows Media Pl...	Checks that synchronization is disabled			Yes
Hardware				
Minimum Configur...	Rates your hardware setup			-
Maximum Configur...	Rates your hardware setup			-

You can run all listed test cases or a subset of them.

- To select what items to run, check the boxes on the left as appropriate.
- To select all items, right-click in the grid and choose **Select All** from the context menu.
- To deselect all items, right-click in the grid and choose **Deselect All** from the context menu.

After deciding what test cases to run:

Click the **Run Testcases** button on the window toolbar.

The results of the session are presented in the user interface. See section 13.1.2. A plain-text report with additional detail can also be generated; how to produce this report is explained in section 13.1.3.

13.1.2. Diagnostics Presentation in User Interface

13.1.2.1. Windows Settings

The color coding in the **Status** column has the following interpretation:

- *Green:* The setting is OK and does not need changing.
- *Orange:* The setting is not OK but can be changed.
- *Red:* The setting is not OK and is not editable.

Further details on the outcome appear on the status bar when you select a diagnostic in the window grid. These text strings also appear in the diagnostics report; see section 13.1.3.

13.1.2.2. Hardware

The PC hardware is evaluated with respect to two sets of rules:

- *Minimum configuration.* These are the minimum requirements for doing data collection with TEMS Investigation.
- *Maximum configuration.* These are the requirements for maintaining:
  – (GSM, WCDMA Rel. 99, and CDMA/EV-DO) Up to six concurrent voice calls or up to four concurrent data service sessions.
  – (HSPA, LTE) A maximum of four concurrent data service sessions. Limitations apply according to device driver performance and the data rates attained in the network. Note also that the NDIS driver implementation for some devices might limit the number of data service sessions to only one.

A set of Windows Experience Index (WEI) scores are computed as an assessment of the hardware capabilities, and these scores are compared to predefined thresholds to determine whether they are high enough. The Status column uses colors as follows to indicate the result:

- *Green:* All WEI part scores are OK.
- *Red:* At least one WEI part score is not OK.

Further details on the outcome, as well as the WEI score thresholds that apply, are indicated on the status bar when you select a hardware configuration diagnostic. These text strings also appear in the diagnostics report; see section 13.1.3.

13.1.2.3. Further Columns in the Computer Diagnostics Window

The **Impact** column indicates the relative importance of the various items tested. (The weighting shown does not form the basis for a composite score of any kind; it is just a visual indication.)

The **Read-only** column is currently not used.

13.1.3. Diagnostics Report

You can obtain a plain-text summary of the diagnostics session by generating a diagnostics report.

 To produce the report, click the **Generate Report** button.

A window named **Diagnostics Report** appears. You can save the report as a text file.

13.1.4. Iterating the Diagnostics Procedure

After you have made adjustments to PC settings, you can run the Computer Diagnostics utility once more to see how the status of the machine has improved. Just click the **Run Testcases** button again to repeat the diagnostics procedure.

If you install TEMS Investigation on a brand new PC, the **Documents** and **Screen Saver** diagnostics may be evaluated differently the first time around than on subsequent occasions (even if you do not change any PC settings). The reason is that on the first occasion, the relevant registry keys have not yet been initialized.

13.2. Suitable PC Settings for TEMS Investigation

This section is a survey of the PC settings that are inspected by the TEMS Investigation Computer Diagnostics utility. It also includes a few further items.

Further PC configuration, required for data collection with specific devices, is described in chapter 4.

General third-party software requirements are listed in the Installation Guide, section 4.1.3.

> **Note:** Please read this section carefully, since inappropriate PC settings may seriously impair the performance of TEMS Investigation, or even render certain functions unusable.

If you have not purchased the data collection functionality, you can disregard most of this section.

13.2.1. Administrator Rights

A number of user actions in TEMS Investigation require that the user have administrator rights on the PC:

- *Running multiple concurrent data service sessions.* In the course of such testing, TEMS Investigation must be able to modify Windows routing tables, which requires admin privileges.
- *Use of the IP sniffer.* See the User's Manual, section 12.20.3.8 and Information Elements and Events, section 10.9.
- *HTTP streaming.* This streaming service is dependent on IP sniffing. See the User's Manual, section 12.20.6.4.

13.2.2. Automatic Updating of Software

Software that uses an "auto update" function to receive automatic updates from a website over a dial-up connection should be disabled.

13.2.3. AutoPlay

Automatic launching of a PC application following device connect must be avoided. Therefore, make sure that for all connected devices used with TEMS Investigation, AutoPlay is disabled.

How to disable AutoPlay is explained at ▶ support.microsoft.com/kb/967715 under the heading "How to disable or enable all Autorun features in Windows 7 and other operating systems". The value that should be used to get a green light in the Computer Diagnostics tool is 0xFF, which means "**Disables AutoRun on all kinds of drives**".

13.2.4. Intel SpeedStep

If the PC is equipped with Intel's SpeedStep technology regulating the processor speed, choose the setting "Maximum Performance" for all types of operation ("Plugged in", "Running on batteries").

13.2.5. My Documents Folder

TEMS Investigation places certain files under **My Documents** (or **Documents**) in a subfolder called **TEMS Product Files**. If your My Documents folder is located on a network drive, be sure to make the folder available offline before disconnecting from the network (for example, when going drive testing).

13.2.6. Port-scanning Software

You should not have any software installed that periodically scans COM or USB ports, for instance Microsoft Outlook synchronization software such as Sony Ericsson PC Suite or Nokia PC Suite. The reason is that such software may cause difficult device connect problems in TEMS Investigation.

13.2.7. RTP (UDP) Ports for Video Streaming

By default TEMS Investigation uses RTP (UDP) ports 5004–5007 for video streaming. If you intend to accept this default setting, you must make sure that the ports have not been reserved by some other application. You can specify a different port usage in a Streaming activity in a script; see the User's Manual, section 12.20.6.4.

13.2.8. Security Products

Please note that hard disk encryption software, firewalls, virus scanners, and other security products may prevent multiple RAS sessions from being maintained concurrently, thus interfering with data service testing. Contact your IS/IT department for assistance in these matters.

The realtime scanning feature of antivirus software is prone to generate considerable CPU load. If you find the overall CPU load excessive, it may be a good idea to try turning off the realtime scanning feature.

13.2.9. Sleep Mode, Screen Savers, Energy Saving Features

You should make sure that the computer used for measurement and recording does not go into any kind of standby mode:

- Never put the PC in Sleep mode.

- Disable the Windows screen saver: Open the Control Panel and select **Personalization** → **Screen Saver**. Under “Screen saver”, select “(None)”. In the same dialog, make appropriate settings under **Power management** so that these features are never activated during measurement.
- Disable any other screen savers.

(If the PC does go into standby, it may be necessary to unplug your data collection devices and plug them in again.)

13.2.10. Windows Firewall

The built-in software firewall must be disabled in all Windows versions.

13.2.11. Windows Media Player

Windows Media Player and other applications that attempt to synchronize to removable mass storage devices (such as mobile phones) must be disabled. They may otherwise interfere with data collection.

13.2.12. Windows 7 Specific Settings

These recommendations also apply to Windows 8 (except that the details of user interface navigation are different).

13.2.12.1. Power Management

Power management settings should be configured as described below.

- In Windows Explorer, right-click **Computer** and select **Properties**.
- Click **Performance Information and Tools** and then **Adjust power settings**.
- Click the down arrow button next to **Show additional plans**.
- Select **High performance**.
- Click **Change plan settings**, then click **Change advanced power settings**.

Advanced settings should be as follows:

- Hard disk → Turn off hard disk after: **Never**
- Sleep → Sleep after: **Never**

- Power buttons and lid → Lid close action: **Do nothing**
- Multimedia settings → When sharing media: **Prevent idling to sleep**.

13.2.12.2. User Access Control (UAC)

In Windows 7, there are four UAC levels. UAC should be set to the lowest level, “**Never notify**”. For running multiple concurrent data service sessions or logging IP data, as well as for the automatic software update function, this is strictly necessary.

13.2.12.3. Visual Effects

For performance reasons, it is strongly recommended that you disable the Windows Aero color scheme (making window frames translucent and producing other visual effects).

To obtain the best possible TEMS Investigation performance, configure visual effects as follows (this will among other things turn Windows Aero off):

- Open the Control Panel and select **System**.
- Click **Advanced system settings**. The System Properties dialog opens.
- Select the **Advanced** tab.
- In the **Performance** section, click the **Settings** button.
- Select the **Visual Effects** tab. The default setting here is “Let Windows choose what’s best for my computer”. Change this to “**Adjust for best performance**”.

13.2.13. Windows Vista Specific Settings

13.2.13.1. Power Management

Power management settings should be configured as described below.

- In Windows Explorer, right-click **Computer** and select **Properties**.
- Click **Performance** and then **Adjust power settings**.
- Select **High performance**.
- Click **Change plan settings**, then click **Change advanced power settings**.

Advanced settings should be as follows:

- Sleep → Sleep after: **Never**
- Power buttons and lid → Lid close action: **Do nothing**
- Hard disk → Turn off hard disk after: **Never**
- Multimedia settings → When sharing media: **Prevent idling to sleep**.

13.2.13.2. User Access Control (UAC)

UAC should be turned off. For running multiple concurrent data service sessions or logging IP data, as well as for the automatic software update function, this is strictly necessary.

13.2.13.3. Visual Effects

For performance reasons, it is strongly recommended that you disable the Windows Aero color scheme. This is done in the same way as in Windows 7; follow the instructions in section 13.2.12.3.

14. Read This Before You Start Drive Testing

This chapter sums up some especially important prerequisites and necessary preparations for drive testing with TEMS Investigation.

- **Make sure that all external devices have adequate power supply.**

  During drive testing, it must be ensured that the PC and all devices connected to it have adequate and uninterrupted power supply for the duration of the test. This is especially important to bear in mind if you are using a USB hub that is not self-powered (i.e. has no external power supply). A separately powered USB hub (USB 2.0 or later) is strongly recommended for drive tests.

  With multiple devices connected, it may even be necessary to take the precaution of providing extra power via UPS or extra batteries during drive testing. If the power provided is insufficient, problems may arise with device drivers, which in turn may cause malfunctions in Windows and possibly data loss. Ascom takes no responsibility for such data loss.

- **Make sure that appropriate drivers are installed for all external devices.**

  Further information: See chapter 2.

- **When doing data collection in LTE networks or in other scenarios that entail a high CPU load, it is strongly recommended for performance reasons to disable non-vital PC functions that consume a lot of processing power, especially visual effects.**

  Further information: See section 13.2 and particularly sections 13.2.12.3 and 13.2.13.3 regarding visual effects.

15. Connecting and Activating External Equipment

See the User’s Manual, chapter 6.

Appendix A. Ascom Statement on Mobile Test Probes

Certain Ascom Network Testing products use FCC approved mobile phones as test probes. When integrated with certain Ascom products, the Ascom mobile test probes have been retested to ensure that the test probe continues to comply with applicable FCC requirements.

Ascom mobile test probes are intended for use in cellular network testing only.

Ascom mobile test probes should be professionally installed, and only Ascom-specified external antennas should be used as part of the test configuration.

No Wi-Fi[1], Bluetooth or NFC (Near-Field Communication) features of the mobile test probe should be used when using Ascom mobile test probe products.

This equipment radiates radio frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference to radio communications.

Users assume full responsibility for performance and possible interference if these instructions are not followed.

1. Except, of course, the Wi-Fi scanning function in TEMS Pocket.

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User's Manual

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Part I: Fundamentals

1. What’s In This Manual

This book describes the user interface of TEMS Investigation. It concentrates on how to use that application once it has been installed and all external devices are connected and ready for use. The manual gives a comprehensive account of all functions in the application.

2. Basics of TEMS Investigation

This chapter guides you through some fundamentals of TEMS Investigation.

2.1. Recommended Skills

Since TEMS Investigation is a Windows application, familiarity with Windows is useful. To obtain a genuine understanding of the presented information, you need a working knowledge of the wireless communication technologies concerned and of the field of data communication in general.

2.2. Installing TEMS Investigation

See the Installation Guide.

Regarding configuration of external devices, see the Device Configuration Guide.

2.3. Starting TEMS Investigation

Once installed, TEMS Investigation can be launched from the **Start** menu.

> **Note:** We recommend that you plug the external equipment you are going to use into the PC before starting TEMS Investigation.

It is necessary to run the application as administrator. To set this up the first time around, do as follows:

- Navigate to **Start** → **All Programs** → **Ascom** → **TEMS Products** → **TEMS Investigation 15.3**.
- Right-click this item and choose **Properties** → **Shortcut** tab → **Advanced**.
- Check the **Run as administrator** option.

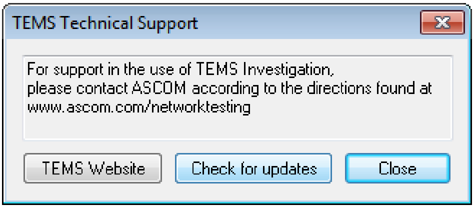
From now on, you can run TEMS Investigation as administrator by simply left-clicking the above Start menu item as usual.

Please note that the application start-up time may be prolonged if slow network shares are mounted on the machine.

2.4. Automatic Check for TEMS Investigation Software Updates

Note: UAC must be set to the lowest level (i.e. turned off) for this function to work. If an error dialog stating “The requested operation requires elevation” appears upon start-up of TEMS Investigation, that indicates there is a problem with the UAC level.

When starting TEMS Investigation for the first time after installation, you are invited to connect to an Ascom server and find out if there is a newer TEMS Investigation software version available.



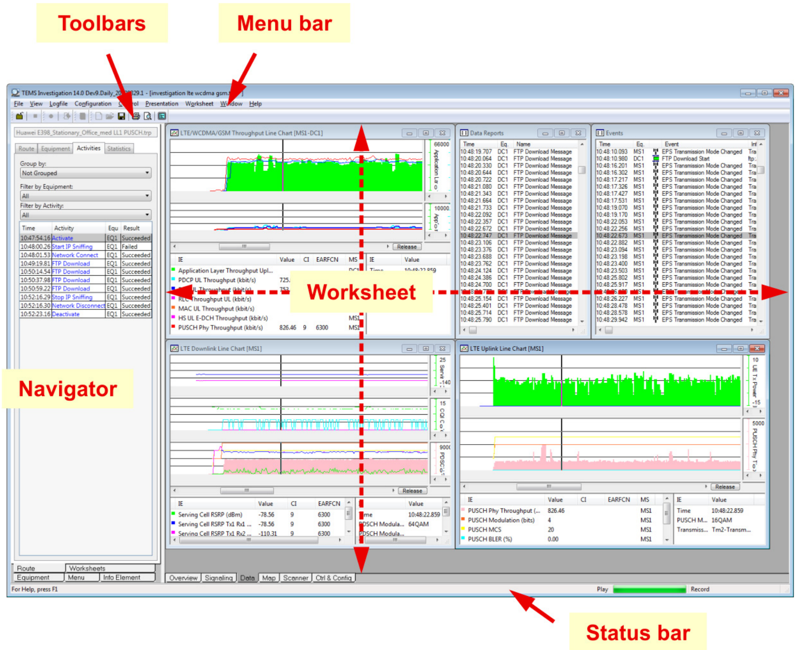
- If you click **Check for updates**, a wizard opens where you can check whether a newer version exists. If that is the case, you proceed to decide whether or not to install it. If you accept the update, it will be downloaded, whereupon TEMS Investigation terminates automatically and the update is installed. Because of the automatic shutdown that takes place, be sure to save your work before accepting an update.
- Click **Close** to dismiss the update check.

The update check prompt also appears on application start-up if no update check has been performed over the last 28 days.

Alternatively, you can manually initiate the update check from the about box (**Help** menu → **About TEMS Investigation 15.3**) by clicking the button **Tech Support** and then **Check for updates**.

2.5. Quick Guide to the User Interface

This section gives a quick overview of the TEMS Investigation user interface. The overall structure of the user interface is described in more detail in chapters 3 and 4.



Workspace and Worksheets

The entity that stores all the windows and settings used in a working session is called the workspace. Only one workspace can be open at a time.

To manage your windows more smoothly, you can divide your workspace into several worksheets. Up to ten worksheets can be active simultaneously.

Navigator

From the Navigator you manage your connected equipment or view information on the currently loaded logfile. From here you also open presentation windows, change the mode of presentation of information elements, and manage your worksheets.

Toolbars

The toolbars provide shortcuts to certain functions in the application, particularly those relating to logfile recording and analysis. Most of the toolbar buttons are mirrored in the menus.

Menu Bar

The menus mirror the toolbars as well as the Navigator’s Menu and Worksheets tabs.

Status Bar

The status bar displays various messages that indicate the current status of the application.

2.6. Definitions

This section explains a number of central concepts in TEMS Investigation which are frequently referred to in this user manual.

Data Services

This term refers to services requiring a data connection (either circuit-switched or packet-switched), as opposed to CS voice calls.

Device

The term “device” refers to any device that is connectable in TEMS Investigation (and relevant in a given context).

Event

An event is generated by the TEMS Investigation software in order to indicate that something worthy of note has occurred, either in the cellular network or in connected equipment. A number of events are predefined. Besides these, you can define events of your own.

All predefined events are found in Information Elements and Events, chapter 8.

User-defined events are specified by logical expressions which trigger the event when they evaluate to true. These expressions can contain predefined events, Layer 3 messages, and conditions involving information elements.

Information Element

Information elements are pieces of numeric or text-format data that are presentable in the TEMS Investigation user interface. All information elements handled by TEMS Investigation are found in Information Elements and Events, chapter 3.

Information Element, Argument of

Many information elements contain an array of values rather than a single value. To pick one item from the array, an argument is used.

For instance, the GSM information element Neighbor RxLev contains the signal strengths of all neighboring channels (there may be up to 32). To present the signal strength of a particular neighbor channel, you must specify an argument in the form of a neighbor index between 1 and 32.

Complete details on the arguments of information elements are given in Information Elements and Events, chapter 3.

Message

The term “message” in this user manual generally denotes an air interface message described in the wireless technology specifications, most often a Layer 3 message. A “message window”, however (chapter 29), may list either air interface messages, or mode or error reports produced by devices, or messages from various protocols, or events.

Mode Report

A mode report is a status or measurement report generated by a device.

Phone

The term “phone” covers user terminals from all supported technologies. When a subset is meant, a suitable qualifier is prefixed, and/or a more precise term is used (“Samsung smartphone”, “Sony LTE/UMTS smartphone”, “LG UE”, “Sierra Wireless CDMA data card”, etc.).

Some user terminals supported by TEMS Investigation are in fact data cards, USB modems, etc. rather than phones. The word “terminal” is therefore sometimes used instead of “phone”, without any difference in meaning from the point of view of TEMS Investigation.

Route

In connection with the Pinpoint Window, the term “route” refers to a planned route created in that window. Outside of that context, the word is used more loosely.

Scanner

The term “scanner” denotes a device dedicated to scanning, for example a PCTel scanner. Phones with scanning capabilities are *not* referred to as scanners.

Track

A track is a walk along a planned route in the Pinpoint Window.

3. User Interface

This chapter goes through the user interface in more detail, and can be seen as an expanded version of section 2.5.

3.1. User Modes

TEMS Investigation can be run in two different modes, one for testing and recording, and one for logfile analysis:

- *Drive testing mode:* The information presented on the screen is obtained from data-collecting devices connected to the PC and activated in TEMS Investigation. (Regarding the “activate” operation, see section 6.4.) In drive testing mode you can record new logfiles.
- *Analysis mode:* The presented information is read from a logfile which you have loaded in order to inspect and analyze it.

The two modes are mutually exclusive. At the beginning of a session, the application is in analysis mode. As soon as you activate external equipment, however, it switches to drive testing mode and remains in this mode as long as some external device is activated. Deactivating all external devices returns the application to analysis mode.

This means that:

- If you have a logfile open, you must close it before you can activate external devices.
- To be able to open a logfile, you must first deactivate all currently active external devices.

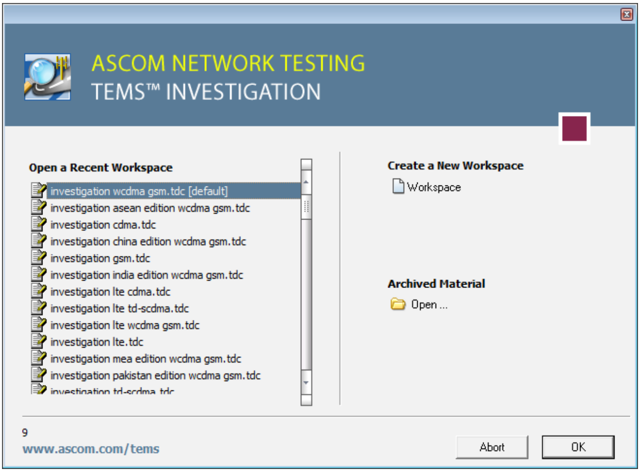
> **Note:** You do not set the working mode explicitly in the user interface, nor is the current mode shown there. The terminology is used in the manual to clarify how things work.

3.2. Workspaces and Worksheets

3.2.1. Workspaces

The environment that stores all the windows and settings used in a working session is called the *workspace*. Settings include information on connected external devices. Only one workspace can be open at a time.

When you start TEMS Investigation, a workspace selection dialog opens:



- **Open a Recent Workspace:** Here you can open an existing workspace by selecting it from a list of recently used workspace files (*.tdc).
- **Create a New Workspace:** This option creates a new, empty workspace.
- **Archived Material:** This option takes you to the regular open workspace dialog, where you browse the file system to select a workspace file. The chosen workspace is added to the workspace list in the dialog above, where it is automatically selected. Click **OK** and TEMS Investigation will start with the chosen workspace.

If you click **OK** without making any selection in the dialog shown above, the default workspace (identified in the dialog) is opened.

Clicking the **Abort** button terminates TEMS Investigation. Use this button if a software update dialog has appeared (see the Installation Guide, section 2.4): the update procedure cannot be carried through while TEMS Investigation is running.

The workspace selection dialog closes automatically after 10 seconds if there is no user interaction. A timer in the lower left corner indicates the remaining time. The dialog cannot be opened again; later on, you handle workspaces from the **File and View** toolbar (see section 3.3.4 for further details), or alternatively from the **File** menu.

3.2.1.1. Opening Workspaces from a Command Prompt

Alternatively, you can use the Command Prompt to launch TEMS Investigation with a specific workspace. All of the commands that follow need to be executed from the directory <TEMS Investigation install dir>\Application.

- If you know the exact name of the workspace you want to use, you can launch TEMS Investigation with that workspace loaded by giving the following command: investigation.exe <workspace name>.tdc
- To start the application with the most recently used workspace, give the following command: investigation.exe -recent
- To start the application without loading any existing workspace, give the following command: investigation.exe -newwksp

3.2.1.2. Predefined Workspaces

Besides the default workspace, some further predefined workspaces are supplied. They all normally reside in the following directory: C:\Users\<user>\Documents\TEMS Product Files\TEMS Investigation 15.3\Workspaces.

Note: You cannot save changes to the predefined workspaces. To save your modifications, save the workspace under a different name.

TEMS Investigation 15.3 cannot load workspaces from older TEMS Investigation versions, whether predefined or user-created.

3.2.2. Worksheets

To manage your windows more smoothly, you can divide your workspace into several *worksheets*. This is already done in the default workspace, which has a number of worksheets dedicated to different purposes, as shown by their designations. Up to ten worksheets can be active simultaneously.

Worksheets are handled from the **Worksheet** menu, which can also be accessed by right-clicking in a worksheet. When you copy a worksheet, the device channel (“MS”/“DC”) index is incremented in all windows: for example, “MS1” is replaced by “MS2”. This allows you to instantly duplicate a worksheet for a different device.

3.3. The Toolbars

The toolbars in the main window give speedy access to some of the most central functions of TEMS Investigation. The toolbars are mirrored in the menus (see section 3.5).

Equipment handling is done from the **Equipment** tab of the Navigator; see chapters 5–7.

3.3.1. Record Toolbar

Start/Stop Recording: Start/stop recording a logfile. When you stop the recording, the logfile is closed.

Insert Filemark: Insert a filemark in the logfile.

For a full description of the recording function, see section 10.1. Recording properties are set from the **Logfile** menu. See section 10.1.3.

3.3.2. Replay Toolbar

This toolbar is accessible in *analysis mode*.

Open/Close Logfile: Open a logfile/Close the logfile that is currently open. Note that this operation only presents logfile metadata, not the full contents of the file.

Fast Forward/Stop: Start or resume loading of the opened logfile/Stop loading of the opened logfile.

See section 10.2.

3.3.3. Report Toolbar

Generate Report: Generate a report from one or several logfiles. See section 10.8.

3.3.4. File and View Toolbar

New Workspace: Create a new workspace.

Open Workspace: Open a saved workspace.

Save Workspace: Save a workspace.

Print: Print the selected window.

Print Preview: Show a preview of the window printout.

Toggle Full Screen: Toggle between full screen and normal mode.

RouteFinder: Launch the RouteFinder utility. See section 10.9.

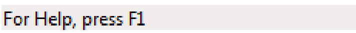
Clear Screen: Clear all open presentation windows of all currently displayed data. This function is intended for use in drive testing mode.

3.4. The Status Bar

The status bar at the bottom of the main window displays symbols and short messages concerning the current status of the application and of external devices. It is divided into the following sections:

3.4.1. Help Section

Shows a help text when you point to a button or combo box on the main window toolbars, otherwise directs you to the online help:



3.4.2. “Play” Section

This section is active in analysis mode. During loading of a logfile, the progress bar shows what proportion of the logfile has been loaded.

Compare section 10.2.

3.4.3. "Record" Section

This section is active in drive testing mode. When some form of logfile recording is ongoing, a rolling progress bar is displayed here.

Compare section 10.1.

3.5. The Menu Bar

File Menu

Apart from holding some standard File menu commands, this menu mirrors part of the **File and View** toolbar and holds certain application options.

View Menu

From here you choose which toolbars and which other tools should be visible. In Full Screen mode, the Navigator is hidden.

Logfile Menu

The Logfile menu mirrors the **Record** and **Replay** toolbars. From here you can also export logfiles and generate logfile reports (see sections 10.6 and 10.8 respectively).

Presentation, Control, and Configuration Menus

These menus mirror the **Menu** tab of the Navigator.

Worksheet Menu

From this menu you manage your worksheets.

Window Menu

This is a standard window manager.

Help Menu

- **Online Help** links to this documentation in browsable online help format.
- **Local Help** links to this documentation in the form of local PDF files contained in the installation.
- **License Control Center** takes you a Web-based user interface for product license management. What interface will appear depends on what licensing solution you are using; see the Installation Guide, chapters 2 and 6–7.
- The “**About ...**” menu item opens a window with TEMS Investigation product information.

3.6. Keyboard Shortcuts

A number of central operations in TEMS Investigation, as well as many standard file and edit operations, can also be performed from the keyboard. A list of keyboard shortcuts is found in appendix A.

4. The Navigator

The Navigator pane, located on the left in the TEMS Investigation main window, allows you to set up and manage your workspace and your external equipment.

The Navigator has the following tabs:

- the **Equipment** tab, used for equipment handling: section 4.1
- the **Menu** tab, listing the types of windows provided: section 4.2
- the **Info Element** tab, listing information elements: section 4.3
- the **Logfile** tab, showing information on the logfile currently loaded: section 4.4
- the **Worksheets** tab, giving an overview of your current workspace configuration: section 4.5.

You can hide the Navigator by switching to full screen mode (done from the **View** menu or from the **File and View** toolbar).

4.1. Equipment Tab

See chapters 5–7.

4.2. Menu Tab

The Menu tab lists most types of windows that are available in the application. They are divided into the categories **Presentation**, **Control**, and **Configuration**. To open a window, double-click the corresponding symbol, or drag the symbol from the Navigator to the worksheet where you want it. All Navigator windows can also be opened from the menu bar.

See Information Elements and Events, chapter 10 for descriptions of the contents of individual presentation windows. How the windows work and how they can be configured is covered in the present document: see chapters 26–34.

The control and configuration windows are also described in this volume. Please use the alphabetical index to locate them.

4.3. Info Element Tab

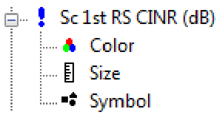
The Info Element tab lists all the information elements handled by TEMS Investigation.

Regarding information element categories, see Information Elements and Events.

4.3.1. Presentation Attributes of Information Elements

For all numeric information elements (that is, those not of type “Text”) can be defined presentation attributes which determine the graphical presentation of the element as a function of its numeric value. The attributes are:

- **Color:** Range of colors used to encode the IE value (in a variety of presentation windows).
- **Size:** Range of plot marker sizes encoding the IE value in Map windows.
- **Symbol:** Range of plot marker shapes (symbols) encoding the IE value in Map windows.



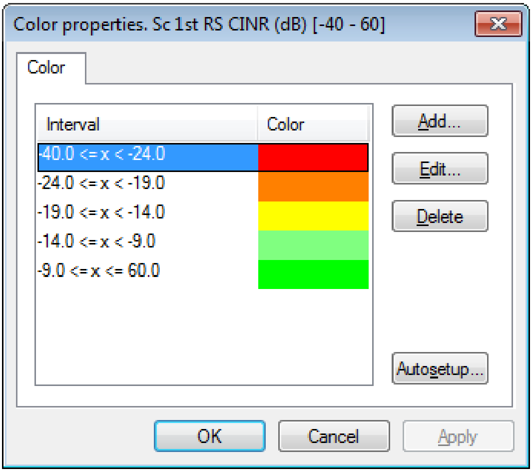
Some numeric elements have such presentation attributes defined by default; others do not. The attributes are edited from the Info Element tab; see section 4.3.2. When you add an information element to a presentation window, these settings are automatically used unless you have specified a different usage in that particular window (possible only with colors in certain window types; see section 26.6).

4.3.2. Editing the Color Ranges of Information Elements

- If you want to add color ranges to an information element, right-click the element in the Navigator and select **Add** → **Color**.

- If you want to edit the default color ranges of an information element, double-click the information element to expand it and show the presentation attributes, then double-click **Color**.

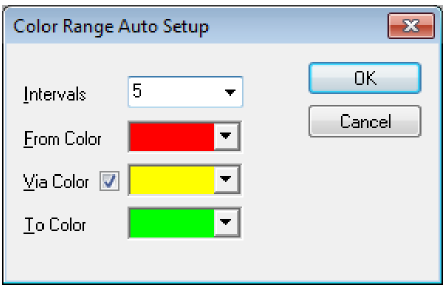
In either case, continue as follows:



4.3.2.1. Automatic Setup of Color Ranges

This is the easiest way to set up color ranges.

- Click **Auto Setup**.



- Set the number of intervals.
- Under **From Color** and **To Color**, choose colors for the extremes of the value range.

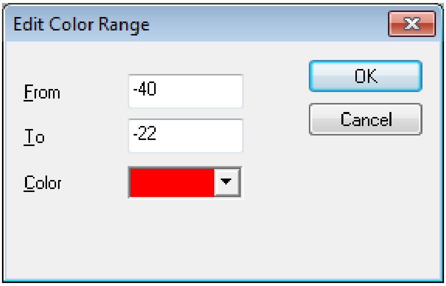
- Check the **Via Color** box if you want to use a specific color in the middle of the range. If you do not check the Via Color box, the intermediate color is chosen automatically based on the "From" and "To" colors.

When you click OK, a color range is created automatically with evenly sized intervals and suitable intermediate colors.

4.3.2.2. Manual Setup of Color Ranges

If you prefer to assemble your color range interval by interval, follow these steps:

- To add an interval, click **Add**, set the endpoints of the interval, and choose a color.



- To edit an interval, select it, click **Edit**, and make your changes.
- To delete an interval, select it and click **Delete**. A single remaining interval cannot be deleted, nor can the color range as a whole be removed.

If you delete parts of the color range so that no color is defined for some values, these values will be drawn in black.

4.3.3. Editing the Marker Sizes and Symbols of Information Elements

Ranges for map plot marker sizes and symbols are edited in exactly the same way as color ranges. See section 4.3.2 above.

4.4. Logfile Tab

See section 10.2.

4.5. Worksheets Tab

The Worksheets tab lists the worksheets currently active in the workspace. Each worksheet is represented by a folder containing the windows in this worksheet. Double-clicking on a symbol will make that particular window (and the worksheet it is placed on) active. You can rearrange windows from this tab by dragging them between the worksheet folders.

5. Managing External Equipment: General

This chapter summarizes how external equipment is handled in TEMS Investigation. Full details follow in chapters 6–7 and 25.

5.1. Connectable Equipment

The range of equipment that is compatible with TEMS Investigation is given in the Device Configuration Guide, chapter 2.

5.2. Overview of User Interface Components Dealing with External Equipment

Equipment tab of **Navigator**:

- **Top pane:**
  - Shows the devices currently plugged into the PC and has controls for *activating* and deactivating the devices in TEMS Investigation. See chapter 6.
  - Provides shortcut to device *properties*. See chapter 14.
  - One device at a time is in focus in this pane. The in-focus device can be changed with a context menu command.
- **Bottom pane:**
  - The functionality here relates to the device that is currently selected in the top pane.
  - **Activities** tab: From here you can manually apply various *commands* to and perform various *actions* with the selected device. See chapter 7. All of these tasks, and many more besides, can be automated using the **Service Control** tool, which is covered in chapter 12.

– **Information** tab: Shows some basic data on the selected device. See section 6.3.

Status Control Monitor:

This window gives a quick overview of the status of current tasks, of equipment connected, and of the PC. The information shown in this window can be found in other places in the application or can be retrieved with the Computer Diagnostics tool; its purpose is to give an at-a-glance overview of vital data in one place.

For further information, turn to chapter 25.

6. Activating External Equipment

This chapter describes how to activate external devices in TEMS Investigation for the purpose of data collection.

External devices supported by TEMS Investigation are automatically detected by the application after they have been plugged into the PC. The only exceptions to this rule are handled using the **Manual UE Configuration** utility; see the Device Configuration Guide, section 3.1.

Special PC and Device Configuration Requirements

Regarding device-specific preparations for running data services, see the Device Configuration Guide, chapter 4.

For some devices, special configuration of both device and PC is required. These steps are covered in the Device Configuration Guide as follows:

Device	DCG Reference
Ericsson Fixed Wireless Terminal	9
DRT scanner	10.1.2
Rohde & Schwarz TSMW scanner	10.3.2
Andrew i.Scan scanner	10.6.1

6.1. Plugging In External Equipment

Note first of all that devices may be mounted in an equipment case or backpack, so that they will not be plugged directly into the PC.

6.1.1. Plugging In Phones and Data Cards

Most supported phones and data cards connect to the PC via USB. A single USB cable connects the USB port on the device to a USB port on the PC.

6.1.2. Plugging In Ericsson Fixed Wireless Terminals

An Ericsson Fixed Wireless Terminal is connected to the PC by means of a LAN cable. (See the Device Configuration Guide, chapter 9.)

6.1.3. Plugging In Scanners

- PCTel SeeGull EX, LX MM2, MX, and PCTel PCT scanners connect via USB.
- PCTel SeeGull LX scanners other than LX MM2 connect to a COM port.

  For tips and tricks regarding connection of PCTel scanners, see the Device Configuration Guide, section 10.2.1.
- Rohde & Schwarz TSMW, DRT, Transcom, and Andrew i.Scan scanners connect to an Ethernet port, either directly on the PC or via a local area network.
  - If the scanner is connected directly to the PC, a 100Base-T crossover cable is used for this purpose.
  - If the scanner and PC are to communicate over a local area network, both should be connected to local area network ports with normal 100Base-T cables.
- SRUs connect via USB. For advice on how to provide the SRU with adequate power, see the Device Configuration Guide, section 10.4.
- Anritsu ML8780A scanners connect via USB.
- Anritsu ML8720 scanners connect to a COM port.

6.1.4. Plugging In GPS Units

Supported GPS units connect via USB or Bluetooth, or to a COM port.

6.1.5. Plugging In Equipment Cases

All supported equipment cases connect via USB.

6.1.6. Plugging In Stand-alone AQM Modules

The stand-alone AQM module connects to the PC via USB. An audio cable is connected between the AQM module and its associated phone. The AQM module also requires a separate 12 V power supply (the voltage provided through the USB connector is insufficient).

6.2. Starting TEMS Investigation

- Navigate to **Start** → **All Programs** → **Ascom** → **TEMS Products** → **TEMS Investigation 15.3**.
- It is necessary to run the application as administrator. This option is selected by right-clicking the Start menu item above and choosing **Properties** → **Shortcut** tab → **Advanced**.

6.3. The Navigator Equipment Tab: Basics

6.3.1. Top Pane

All devices detected by TEMS Investigation are listed in the top pane of the Navigator's **Equipment** tab:

Each device is represented by a numbered "**EQ**" item. You can change the EQ index assigned to the device: see section 6.3.1.1. Please note that in presentation windows, external devices are represented by their channels ("**MS**"/"**DC**"/"**PS**"). See section 26.3.

The icon to the left of each device shows the status of the device in TEMS Investigation:

	No symbol added	Device is activated
	Red cross	Device is deactivated

	Hourglass	Device activation or deactivation is in progress
 **NL** *Sony*	Prohibited sign and label “**NL**”; device string is red	Device has no license: see section 6.3.3.3
	Earth symbol	Device is selected as preferred GPS: see section 6.5
	Yellow triangle with exclamation mark	On-device software needs updating: see section 6.3.1.1

6.3.1.1. Device Context Menu

If you right-click an EQ item, a context menu pops up containing the following commands:

- **Activate, Deactivate:** How to activate and deactivate devices is explained in section 6.4.
- **Install ODM on Device:** This command installs the software needed for on-device measurement on a device that is going to be used for this purpose. The ODM software then automatically starts up on the device and sends a request to Ascom Network Testing to be enabled.

  If TEMS Investigation has detected that some ODM software is obsolete, the EQ icon is tagged with a yellow triangle, and you are prompted in the EQ item tooltip to run this command.

  See also section 15.4.
- **Change Equipment:** Select a number to change the device’s EQ index to that number. It is possible to select an index that is already taken by another device; the two devices will then swap indices.
- **Properties:** This menu item takes you to the device properties; see chapter 14.

6.3.2. Bottom Pane

6.3.2.1. “Activities” Subtab

See chapter 7.

6.3.2.2. "Information" Subtab

Capabilities	Capabilities of the device. Examples: IP Sniff, Data, PESQ, Air Interface, On Device, On Device IP Sniff, Position, Quality.
Identity	Device identity. Examples of identification strings: • IMEI for UMTS phones (in the EQ row) • ESN or MEID for CDMA phones (in the EQ row) • serial number for DRT scanners (in the EQ row) • the identity of an AQM module paired with the phone (in the MS row).
IMSI	Shows the IMSI of a UMTS phone's subscription.
Phone Number	The phone number of a user terminal. Editable field. See also below.
Ports	Ports exposed by the device.
Build Date	Date of device software/firmware build.
Build Version	Version of device software/firmware build.
On Device	Expand this item to view a list of all on-device software installed on the device, and the version number of each software file (APK). See also sections 15.2 and 15.5.

If a phone is going to measure AQM in an AQM module configuration (see chapter 40), the number of the phone must be known to TEMS Investigation. When you plug in a phone, the autodetect procedure sends an AT command to it in order to find out the phone number, which is usually stored on the SIM card. If this operation succeeds, the phone number will display here.

If no phone number shows, this may be because no phone number is defined on the SIM, or because the phone did not respond properly to the AT command. In such cases you need to enter the phone number manually in this field.

The number you enter will be used for this phone from now on. It will also be used on future occasions when the phone is plugged in, unless the AT command succeeds at that time. A phone number retrieved by an AT command will always override a manually entered number.

6.3.3. Detection of Equipment: Special Cases

6.3.3.1. Detection of Scanners

For tips and tricks regarding detection of PCTel scanners, see the Device Configuration Guide, section 10.2.1.

For technical reasons, detection of DRT and R&S scanners is attempted only at startup and when you click the **Refresh** button on the Navigator's Equipment tab (see section 6.6.1).

Therefore, if you plug in one of those scanners after starting TEMS Investigation, you need to click the **Refresh** button to have it detected.

6.3.3.2. Detection of HTC Touch Pro2 Phones

See the Device Configuration Guide, section 10.2.1.

6.3.3.3. Detection of Equipment Not Covered by License

If you plug in a type of device for which you have no license, it will still appear on the Navigator's Equipment tab. However, the text for this device will be red, and the icon will be tagged with a "prohibited" sign and accompanied by the text "**NL**" (for "No License"):

The same thing will happen if by plugging in a device you exceed the number of devices with which you can do simultaneous data collection, as granted by your TEMS Investigation license. See the Installation Guide, section 3.3.2.

When a device has no license, it cannot of course be activated in TEMS Investigation.

6.3.3.4. Detection of Network Adapters

Detection of network adapters (LAN, WLAN) is by default disabled. This is to prevent an inordinate number of devices from appearing in TEMS Investigation when you are doing data collection with multiple devices.

- To enable detection of network adapters, check the “Network Card” and/or “Wi-Fi Network Card” items in the Device Detection Properties dialog (see section 6.6.3). You must restart the application for the change to take effect.

You must enable network adapter detection if you want to transfer logfiles over a LAN or WLAN connection; see section 10.5.

You must enable the Wi-Fi network card in order to make Wi-Fi measurements; see chapter 23.

6.3.4. User-assisted Detection of Devices

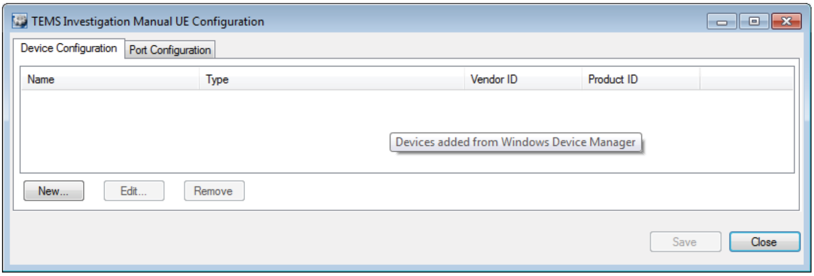
If a device is not detected properly by TEMS Investigation, although it is supported, then you can run the **Manual UE Configuration** utility to help TEMS Investigation recognize the device. Normally there is no need to do this; there are however certain devices for which you must use Manual UE Configuration as an aid to detection – see the Device Configuration Guide, section 3.1.

On the Equipment tab of the Navigator, click the button **Start Manual UE Config**.

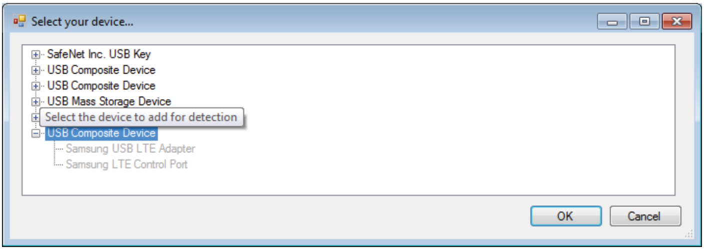
Alternatively, you can launch this utility by running the file <TEMS Investigation install dir>\Application\ManualUEConfig.exe.

The tool **Manual UE Configuration** has two tabs where you create different kinds of entries used in the detection phase: **Device Configuration** and **Port Configuration**.

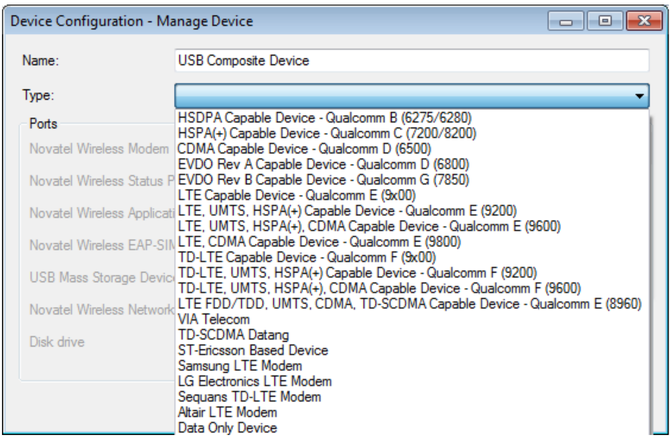
- On the **Port Configuration** tab you create an entry that is directly mapped to a COM port number on the PC. The Port Configuration tab is mainly used for Datang devices; see the Device Configuration Guide, section 3.1.6.
- The **Device Configuration** tab is the most commonly used. It creates an entry for the device that can be reused independently of the actual COM port number used for the device.



- On the **Device Configuration** tab, click the **New** button to create a new entry. A dialog titled **Select your device** appears. In the tree view, select the device root node that contains the ports of interest. Then click **OK**.

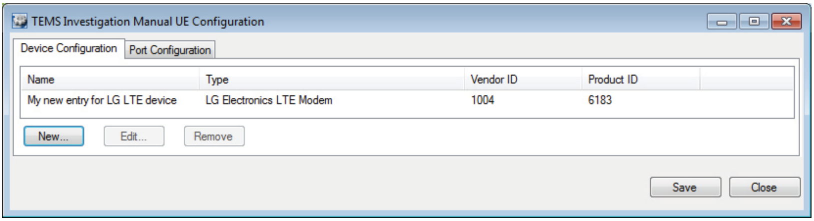


- The **Manage Device** dialog appears. Select the type of device to use and map each available port on the device to its function. Ports that do not have a mapping can be left blank or undefined.



- Under **Name**, enter a name for the device. (The string does not show anywhere else in TEMS Investigation.)
- Under **Type**, choose the correct device type according to its capabilities.
- In the **Ports** section, all ports of the device are listed. In the combo boxes on the right is indicated the functional assignment of each port in TEMS Investigation. You can change this assignment by modifying the selections in the combo boxes. See also sections 6.3.4.1–6.3.4.4.
- Finally, click **OK**.
- The device is added to the list in the main window. Click **Save** and **Close**.

Click the **Refresh** button in the Navigator. This is necessary to update TEMS Investigation with the device configuration just defined. (If you are running the Manual UE Configuration utility independently, TEMS Investigation will update itself automatically with this data when launched.)



6.3.4.1. Mapping Device Ports to Interfaces

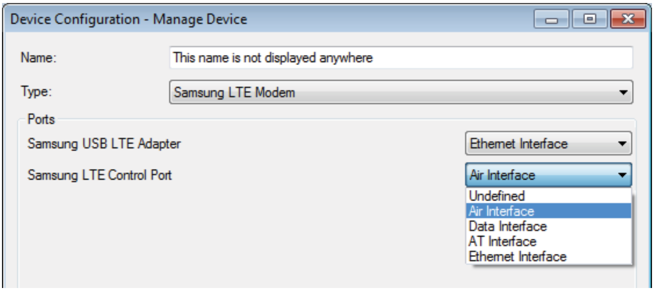
If it is not clear which port should be mapped to which interface, the entries in the existing UEDescription.xml file (found under <TEMS Investigation install dir>\Application) may give an indication. The TYPE tag is mapped towards the interfaces, and the DESCRIPTION tag is the name displayed in the tool. (See the XML code excerpt below.)

Below are some examples of mappings in UEDescription.xml:

Function	Qualcomm	LG LTE	Samsung LTE	ST Ericsson
Air Interface	Diag:xxx	LTE DM	LTE DM	Modem
Data Interface	Data Modem	–	–	Data Modem

Function	Qualcomm	LG LTE	Samsung LTE	ST Ericsson
AT Interface	AT	AT	AT	Device Management
Ethernet Interface	Ndis	Ndis	Ndis	Ndis

For a Samsung LTE modem (third column above) this corresponds to the following selections in the **Manage Device** dialog:



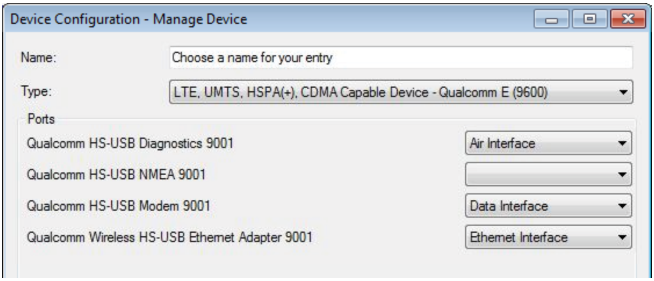
In the file UEDescription.xml itself the following entry appears:

<PRODUCT NAME="This name is not displayed anywhere" PID="6889" FAMILY="SAMSUNG">
<DEVICE DESCRIPTION="Samsung USB LTE Adapter" SETUPCLASS="Net" TYPE="Ndis" />
<DEVICE DESCRIPTION="Samsung LTE Control Port" SETUPCLASS="Ports" TYPE="AT"/>
</PRODUCT>

6.3.4.2. Qualcomm Devices with LTE/TD-LTE Capability

These are devices built on the Qualcomm MDM9x00 chipset families (TEMS Investigation license options “Qualcomm E” and “Qualcomm F”).

1. Launch the Manual UE Configuration utility and select your device as described in the introduction of section 6.3.4.
2. In the **Manage Device** dialog, do as follows. Under **Type**, select the appropriate chipset family. Then, in the **Ports** section, pair each available port to the correct port type as shown in the screenshot below. Finally, click **OK**.



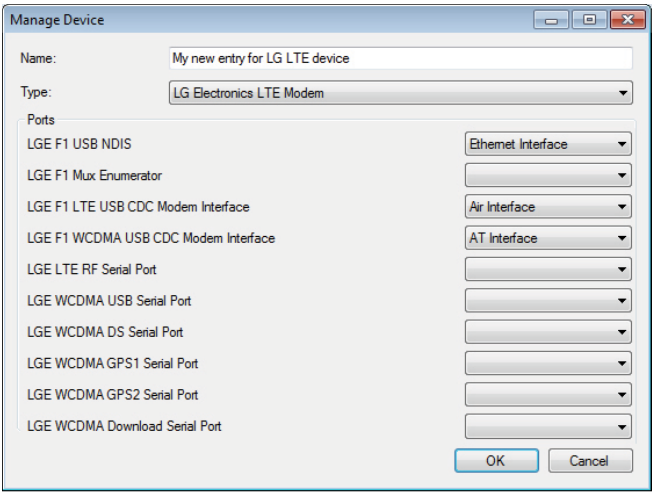
3 The device is added to the list in the main dialog window. Click **Save** and then **Close**.

From now on, TEMS Investigation will detect the Qualcomm device as being of the type you selected in step 2.

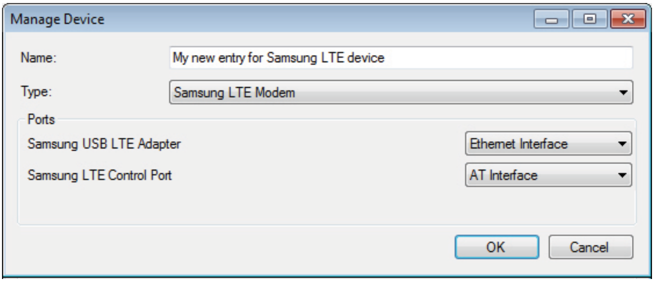
6.3.4.3. LG and Samsung Devices with LTE Capability

1 Launch the Manual UE Configuration utility and select your device as described in the introduction of section 6.3.4.

2 For an **LG** device, set **Type** to "LG Electronics LTE Modem". Under **Ports**, assign the port named "... USB NDIS" (or similar) to the "Ethernet Interface" function. Also identify and map the ports to use for air interface messages ("Air Interface") and AT communication ("AT Interface").



3 For a **Samsung** device, set **Type** to “Samsung LTE Modem”. Under **Ports**, assign the port named “Samsung USB LTE Adapter” to the “Ethernet Interface” function. If the device has a “Samsung LTE Control Port” that answers to AT commands, assign that port to “AT Interface”.

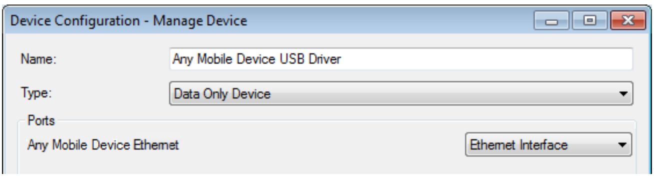


4 The device is added to the list in the main dialog window. Click **Save** and then **Close**.

6.3.4.4. Data Service Testing with Arbitrary Devices

Data service testing in TEMS Investigation can be done with any applicable device (even if not officially supported by Ascom), provided that it comes with Windows drivers enabling an IP data connection. All IP-based services can be tested (as well as video streaming), and all IP-related information elements will then be populated.

- If you want to use a device that is not officially supported, set **Type** to “Data Only Device” in the Manage Device dialog.
- Map the device ports as appropriate. Below is an example.



6.4. Activating and Deactivating External Equipment in TEMS Investigation

6.4.1. Activating External Equipment

You need to *activate* a device in TEMS Investigation before you can use it for data collection.

> **Note:** If you have a logfile open, you must close it to be able to activate equipment.

> **Note:** A device that is going to use an NDIS data connection must have an APN assigned to it. See the Device Configuration Guide, section 4.2. Once the device has an APN, you can activate it in TEMS Investigation.

- To activate a detected device, right-click it on the Navigator’s Equipment tab and choose **Activate** from the context menu.

To activate all detected devices, click the **Activate All** button on the Navigator toolbar.

The red cross disappears from each device icon to indicate that the device is now active. Furthermore, when you select an activated device in the Navigator top pane, the Activities tab in the bottom pane is populated with the operations that you can perform manually on this device. Regarding these operations, see chapter 7.

On being activated, a phone device starts delivering idle mode reports, and a GPS device starts reporting positions.

Limitations for Particular Devices

- If the device connection must be set up using an external connection manager application, only one such device at a time can be activated in TEMS Investigation (unless the connection manager supports multiple devices).
- Of HTC Touch Pro2 phones having an “Internet Sharing” function and requiring installation of TCP Router software, only one phone at a time can be activated in TEMS Investigation. Compare section 6.3.3.2.

6.4.2. Deactivating External Equipment

If you want to leave an external device plugged into the PC, but deactivate it in TEMS Investigation for the time being, do as follows:

- Right-click the device on the Equipment tab and choose **Deactivate** from the context menu.

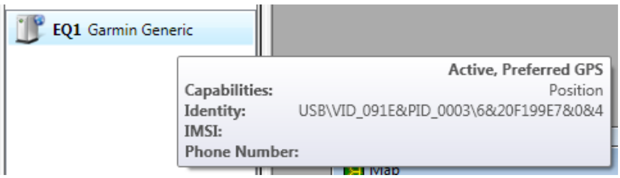
To deactivate all active devices:

Click the **Deactivate All** button on the Equipment tab toolbar.

6.5. Managing GPS Units

It is possible to have several positioning devices plugged into the PC, and they will then all be detected by TEMS Investigation. This includes GPS units built into certain other supported devices, as detailed in the Device Configuration Guide, section 2.2.5.2.

However, while multiple GPS units can be detected and activated, only one at a time can update the positioning-related information elements in TEMS Investigation. The device responsible for this will be the one tagged with an “earth” symbol on the Navigator’s Equipment tab. It is referred to as the current **Preferred GPS**, as shown in the tooltip:



The following rules apply:

- The first GPS unit detected automatically becomes the preferred one and remains as such even if further GPS units are plugged in and detected.
- If no GPS is activated, and you activate one GPS, that GPS automatically becomes the preferred one.
- If no GPS is activated in TEMS Investigation, and you click the **Activate All** button, then all detected GPS units are activated but the currently preferred GPS remains preferred (and only this one will update positioning data in the application).

- As long as a GPS or some other device is activated in TEMS Investigation, the “Preferred” setting cannot be changed.
- While a logfile is being recorded, the “Preferred” setting cannot be changed.
- To select a different GPS as the preferred one, first deactivate any devices that are activated and stop logfile recording if applicable, then right-click the desired GPS in the Navigator and choose **Preferred GPS** from the context menu. The earth symbol and “Preferred GPS” tag will then be transferred to that GPS.

6.6. Further Features of the Navigator’s Equipment Tab

6.6.1. The Refresh Function

If the devices you connected to the PC were not detected properly (for whatever reason), you can start the detection procedure over from scratch. To do this:

Click the **Refresh** button at the top of the Equipment tab.

Note that you must always do a refresh after using the Manual UE Configuration utility; see section 6.3.4.

6.6.2. Re-pairing Phones with AQM Modules

When you match phones with AQM modules manually as described in section 13.11, mappings between phone IMEIs and AQM module identities are stored by TEMS Investigation in the Windows registry.

When plugging the same phones and AQM modules into the PC on a later occasion, you can recreate the same pairings automatically in TEMS Investigation. **Note** that for this to work, the pairing must not have been undone using the **Reset** function (see section 13.11) before the phone was deactivated.

Click the **Re-pair Phones with AQM Modules** button at the top of the Equipment tab.

This function operates the same way whether your AQM modules are stand-alone or mounted in an equipment case.

At any time, on the **Activities** tab, you can inspect which AQM module is matched with a device by right-clicking the **PESQ Device Pairing** item under the **Control** node. If a device could not be matched with an AQM module, the text “UE not paired” will be displayed in the PESQ Device Pairing dialog.

6.6.2.1. Details and Limitations of the Re-pairing Function

The re-pairing function assumes that the phone-to-AQM-module mappings found in the Windows registry are still valid. No check is performed that the physical connections are in fact still the same. For example, if you are using an equipment case and let two phones swap places, the re-pairing will be incorrect for these phones and the AQM data will be garbage. To prevent this, it is a good idea to label the phones and AQM modules in some suitable manner to ensure that each phone is always hooked up to the same AQM module.

If you have been working with different equipment configurations connected at various times to the same PC, the following holds:

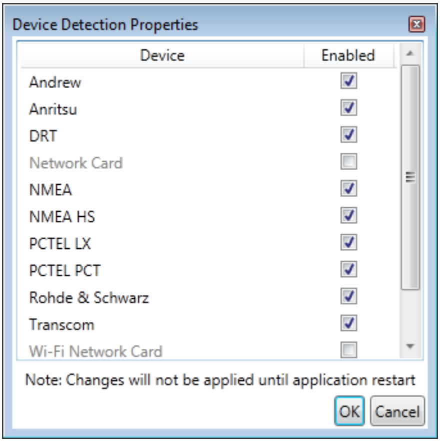
- Only AQM modules that are physically present when you click the button will be paired.
- Each AQM module can only be paired with a single phone. If several phones have previously (at different times) been using the same AQM module, only one of them will be paired with it.

6.6.3. Device Detection Properties

The **Device Detection Properties** dialog can be used to enable and disable detection of various device categories. Note that normally there is no need to do this; the dialog is provided mainly for the purpose of troubleshooting in cases of conflicts during device detection.

To open this dialog:

Click the **Device Detection Properties** button at the top of the Equipment tab.



The checkbox in the **Enabled** column determines if detection of a device type is enabled. By default, detection is enabled for most device types listed except the network cards. The latter are disabled because otherwise the PC’s network adapters – as well as other network adapters accessible via LAN/ WLAN – would always be detected as EQs in the application, which would be undesirable most of the time. Note, however, that if you wish to upload logfiles over FTP using the PC network card, you must enable the “Network Card” item. Compare section 10.5.1.3. Similarly, if you want to collect Wi-Fi measurements, you must enable “Wi-Fi Network Card”; see chapter 23.

Whenever you make changes in this dialog, you need to restart TEMS Investigation for the change to take effect.

6.7. Saving of the Equipment Configuration

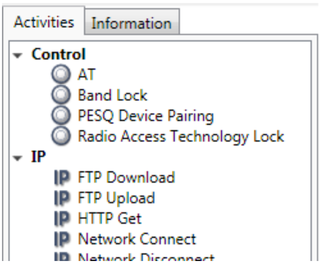
When you exit TEMS Investigation, the configuration on the Navigator’s Equipment tab is automatically saved. This means that the mappings between devices and EQ items are stored in the Windows registry. As a result, if a device is represented at one time by (say) EQ3, that device will again be mapped to EQ3 the next time it is plugged into the same PC with the same Windows user logged in.

The saving extends to all devices whose hardware permits a reliable identification. Such devices include phones with their equipment identities (e.g. IMEI).

TEMS Investigation does not save any information on equipment configuration in the workspace.

7. Operating and Controlling External Equipment Manually

From the Navigator's **Equipment** tab (bottom pane, **Activities** "subtab"), you can *manually* run various services on a device and *manually* apply control functions to it (as opposed to controlling the device with a script). These operations are the subject of the present chapter.



For all manual device operations, the same configuration sets are used as in scripts. If you do not have any configurations defined for a particular operation, then right-click the operation on the Activities tab, choose **Configuration Sets**, and create a configuration by clicking **New** in the dialog that appears. Compare chapter 12 on scripts, and particularly the reference material in section 12.16.

Once you have a configuration defined, you can do the following:

- To execute an operation, right-click the desired item on the Activities tab and choose **Start** from the context menu.
- To stop the operation, right-click and choose **Stop**.

7.1. Control Functions

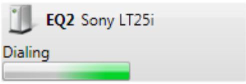
See chapter 13 for full coverage of the control functions that can be applied from the Navigator.

See also chapter 14, which covers device *property dialogs* that provide further means of controlling devices.

7.2. Voice/Video Calls

Under the **Voice** and **Video** nodes are found various operations related to CS voice and video telephony. They use the same types of configuration sets as the corresponding Service Control activities, which are covered in sections 12.20.6 and 12.20.7.

While a CS voice or video call is ongoing, its progress is displayed on the Navigator’s Equipment tab immediately beneath the device engaged in the call.



7.3. Data Services

Under the **IP** and **Messaging** nodes are found operations for running PS data service sessions. Again these operations correspond in one-to-one fashion to activities in Service Control scripts. All configuration details are covered in the Service Control chapter, sections 12.20.3–12.20.6.

For example, if you want to conduct a manual FTP download, you first need to set up a network connection using **IP** → **Network Connect**, and then you can do the actual download by initiating an **IP** → **FTP Download** operation.

Progress indicators are shown for data service sessions in the same way as for CS voice/video; compare section 7.2.

> **Note:** If you run multiple concurrent data service sessions using multiple devices, avoid starting all of these in very rapid succession. It is better to start one session at a time with at least a few seconds in between. Compare the note at the end of section 12.10.4.

7.3.1. Presentation of Data Service Testing

Testing data services will produce the following output:

- Information elements in the **Data** category: see Information Elements and Events, section 3.8. Selections of these elements are by default presented in the data service oriented line charts. See Information Elements and Events, chapter 10.
- A number of *events* pertaining to various services, and more: see Information Elements and Events, sections 8.2 and 8.4. These are by default presented in the data service oriented line charts.
- KPI-related events in the message window **Events of KPI Type**: see Information Elements and Events, sections 8.4 and 10.9.
- Messages in the **Data Reports** message window: see Information Elements and Events, section 10.9.

7.4. Scanning

Under the **Scan** node you can set up and execute scanning sessions. This can alternatively be done from Service Control scripts, as described in section 12.20.5.

General aspects of scanning are covered in chapter 16. For complete details on scanning setups for each supported cellular technology, see chapters 17–22. The configuration is done in the same way whether the scanning is manual or script-controlled.

8. Loading Maps

This chapter tells how to load map files into a TEMS Investigation Map window to prepare for drive testing. The presentation of data in Map windows is covered in chapter 33.

How to open a map set in the Pinpoint Window is explained in chapter 11, which deals with everything related to that window.

8.1. Supported Map Image Formats

Map files used in TEMS Investigation must be in MapInfo or uncompressed TIF format.

If your map is in TIF format, you must generate a *.tab file for it. This is done by positioning the map as described in section 8.2.

8.2. Positioning Unpositioned Map Images

If you try to open a map image that is not georeferenced, you are prompted to position the image. You must do this to be able to use the image in the Map window. Click **Yes**; a utility called ImagePositioning will then start up. This tool lets you fit your map image onto a background world map by dragging the image corners. For details, please refer to the ImagePositioning Utility User's Manual, which is part of the TEMS Investigation documentation package.

- Create a *.tab file in ImagePositioning. It will receive the same name as the image but takes the extension .tab.

Then click **Open Map Files** once more and load the *.tab file (or the image file itself – which one does not matter) into the Map window.

The ImagePositioning utility can also be launched manually:

Click the **Position Map** button.

The utility will then load the image currently open in the Map window. If the image is already positioned, you can revise the positioning if desired and create a new *.tab file.

8.3. Constructing a GeoSet from Map Files

A Map window in TEMS Investigation is associated with a GeoSet rather than with the workspace. If you have a new map that you want to use in TEMS Investigation, you should preferably construct a GeoSet file for it to be able to save changes to the map later on. This file can then be opened in a Map window.

It is possible to load TAB files in a Map window directly, without constructing a GeoSet, but then any changes made using the Layer Control will be lost. See section 33.4.2.

If your map is in MapInfo format, it consists of a number of map layers and a workspace which ties them together. Each layer is stored in five different files with the extensions .dat, .id, .ind, .map, and .tab. These files are from now on collectively referred to as TAB files.

Once you have your TAB files, you can construct a GeoSet.

- Copy the map's TAB files to your map directory.

On the Map window toolbar, click the **Start GeoSet Manager** button.

> **Note:** The GeoSet Manager will ask you to open a GeoSet. Click Cancel to ignore this. – Under Windows Vista, an error message about writing to the Windows registry will appear; this too can be ignored, and .gst files can still be created.

- Name your new GeoSet in the edit box of the toolbar.

Click **Layer Control**.

- Click **Add**.
- Select the TAB files you copied to your map directory and click **Open**. All the selected layers are added to the Layer Control.
- Click OK. The map is now displayed with all its layers.
- Choose **File** → **Save GeoSet**. You are prompted to name the GeoSet.
- Click **Save**. This will save your new GeoSet file under the name you entered in the **GeoSet Name** edit box. The GeoSet file must be in the same directory as the TAB files.

- Choose **File** → **Exit** to close the GeoSet Manager.

 Click **Open Map Files**.

- Select your newly created GeoSet file and click **Open**.

The map should now display in the Map window.

8.4. Creating and Loading GPX-format Planned Routes

TEMS Investigation can load planned routes for drive testing created in the GPX format. The point of doing that is to have the routes displayed in a Map window as a driving aid, so that you do not have to rely on your GPS to follow the correct route.

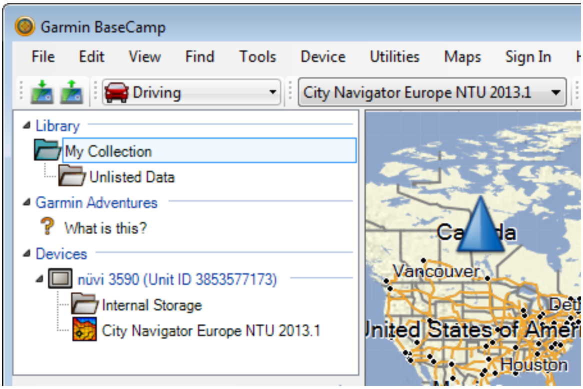
Loading a GPX route is especially valuable during scripted logfile recording that switches to a new file at regular intervals. The trail of route markers drawn on the map only reaches back to the start of the current logfile; but with a GPX route displayed you always have the entire drive test route in view.

8.4.1. Creating GPX Files

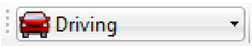
One tool that can be used to create GPX files is Garmin Basecamp. This is free software and can be downloaded from www.garmin.com. Below is a step-by-step instruction on how to create a planned route in Garmin Basecamp.[1]

1. Start the Garmin Basecamp application.
2. Connect the Garmin GPS to the PC. The GPS drivers should install automatically. The GPS will then appear as a device in Garmin Basecamp, and its maps (“City Navigator Europe ...” in the screenshot below) will become available in the application:

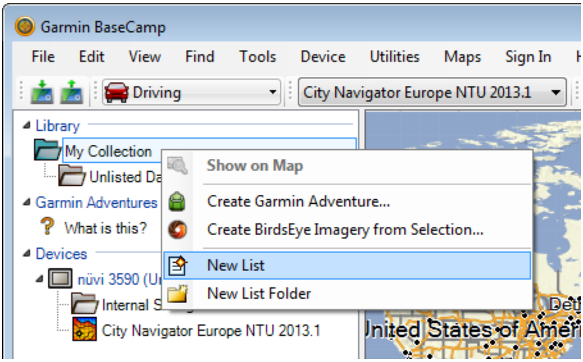
1. Version 4.1.1 was used in composing this instruction.



3 Set the activity profile to “**Driving**” if this is not already selected.

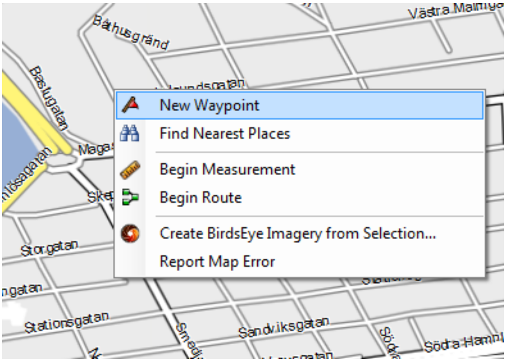


4 Right-click **My Collection** and select **New List**.



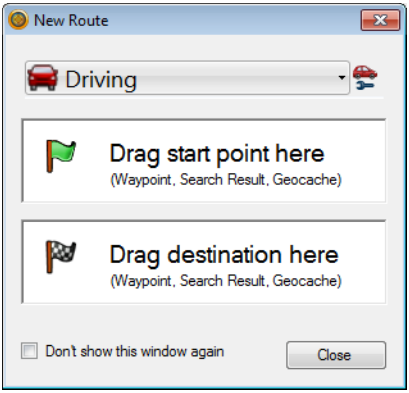
5 Pan and zoom your map as appropriate for the route you are going to create.

6 Now outline your route by marking a waypoint for each location you want to visit. To this end, right-click in the map and select **New Waypoint**.

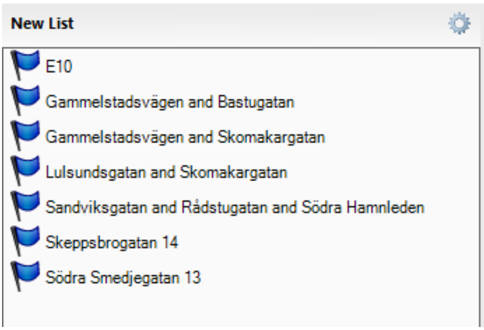


7 Below is an example of a waypoint set:

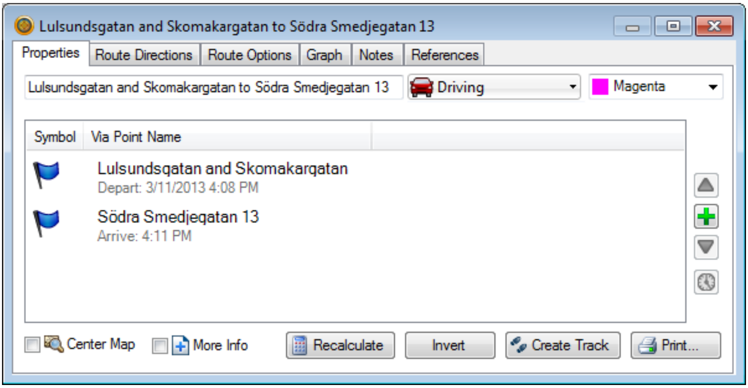
8 To create a route passing through all of these points, right-click in the map and select **Begin Route**. This dialog appears:



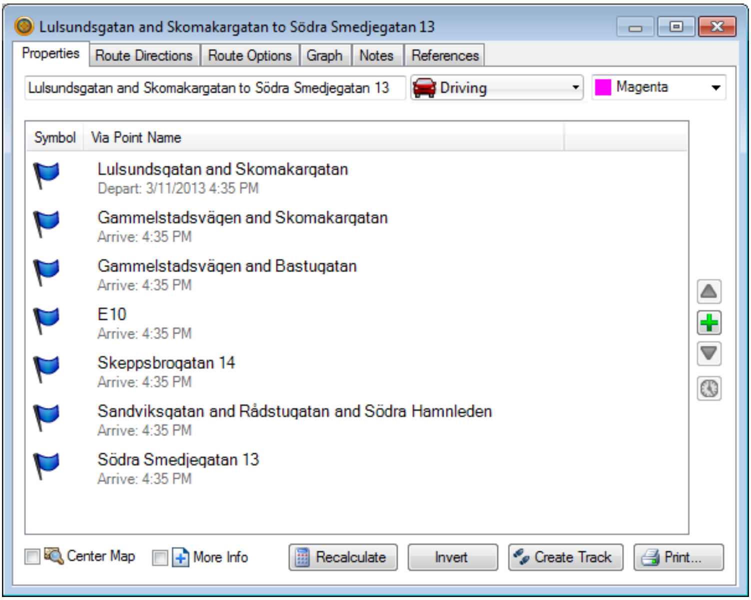
9 From the list of waypoints (shown below), drag the one you intend as start point of your route to the **Drag start point here** field in the **New Route** dialog. Similarly, drag the waypoint that is your route's final destination to the **Drag destination here** field.



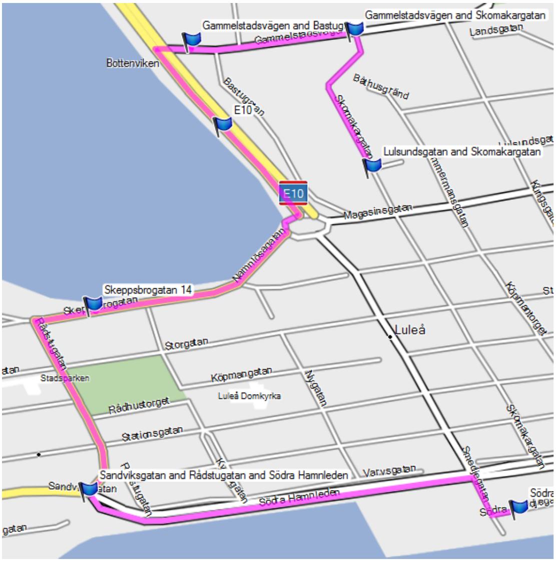
10 A new dialog appears showing the make-up of the route. Initially, the route is defined by its start point and endpoint alone:



11 Proceed to add the intermediate waypoints, one by one, by clicking the green plus-sign button on the right and making a selection from the **Insert Waypoint** dialog. Arrange the waypoints in the order you want to visit them by drag and drop within the route waypoint list. After adding and ordering all of the waypoints marked in step 7, the list might look as follows:



12 Now click the **Recalculate** button to create the route. Garmin Basecamp will compute what it regards as the optimum driving route visiting all waypoints in the stipulated order. The route is drawn on the map:



13 To transfer the route just created to the GPS, open the **Edit** menu and choose **Send To**, then select your GPS in the dialog that appears.

14 To export the route for use in TEMS Investigation, select the route on the map or in the list panel, then select **File** → **Export** → **Export Selection**. The route will be exported in GPX format. Browse to where you want to store the file, and click **Save**.

How to import a route created in Garmin Basecamp (or any other GPX file) into TEMS Investigation is explained in the User's Manual, section 8.4.2.

8.4.2. Loading GPX-format Planned Routes into the Map Window

To load GPX-format routes into TEMS Investigation, do as follows:

- From the **File** menu, choose **Options**, then choose **Recording** in the left-hand pane.

- Under **Planned route path**, browse to the directory where your planned routes are stored (file extension .gpx).

The routes will now appear in the Map window[1], plotted as diamond-shaped markers connected by straight lines. The first two markers are drawn in green, and the final marker is drawn in red. An example is shown below. The actual path taken by the vehicle will be tracked in the usual manner by means of an information element theme and its route markers (see section 33.2.3; no such markers appear in the screenshot that follows).

The routes are imported into the Map window as a separate theme, placed in a special Planned Route map layer; see section 33.2.8.

Planned routes loaded in this way will also be saved with any logfile (*.trp) that you record from now on. Once a planned route has been saved in a TRP logfile, you can load it back into TEMS Investigation on a later occasion by pointing to that logfile under **Planned route path** (see above) rather than to the GPX file itself. Compare section 10.1.3.

Note that GPX-format planned routes, intended for outdoor drive testing, are unrelated to the *indoor* planned routes that you can create in the Pinpoint Window. (The latter are dealt with in section 11.2.)

1. Please note that the Map window must already be open. (The supplied workspaces all include one.)

9. Loading Cell Data

TEMS Investigation can present information on individual cells in cellular networks. In particular, it is possible to draw cells on maps and to display cell names in various windows. Cell data is also made use of in logfile reports.

Cell data can be provided in two ways:

- in a plain-text XML file (*.xml) whose format is common to several TEMS products: See section 9.1.
- in a file with a plain-text, TEMS Investigation specific format (*.cel). This format is for GSM/WCDMA only. GSM and WCDMA cells can be mixed in one file. See section 9.2.

CDMA cell files in TEMS Investigation CDMA CSV format can be converted to the XML format using TEMS Discovery. Regarding TEMS Investigation CDMA CSV cell files in general, see the Technical Reference, section 4.3.

9.1. Creating a Cell File in XML Format

9.1.1. XML Schemas

The XML-format cell file uses two XML schemas, which are found in the directory <TEMS Investigation install dir>\XMLSchema:

- The schema TEMSDataTypes.xsd defines TEMS-specific XML data types, derived from the fundamental data types set down in the XML specification.
- The schema TEMSCell.xsd defines XML attributes and elements that embody cell and site data, relying on the data types in TEMSDataTypes.xsd.

9.1.2. Composing XML Cell Files

There are several ways to compose XML-format cell files:

- The most general method is to load the XML schemas referenced in section 9.1.1 into a suitable XML development tool, and fill in the data from there.
- Cell configurations imported into TEMS Discovery can be exported in the XML cell file format. For details, please consult TEMS Discovery documentation.
- A Microsoft Excel macro-enabled workbook file CellFileEditor.xlsm is provided with TEMS Investigation in the directory <TEMS Investigation install dir>\XMLSchema. This file lets you compose XML cell files, import and edit existing XML cell files, and export contents in the XML cell file format.
  - Each technology is dealt with in a separate worksheet.
  - In a worksheet, each cell is represented by one row.
  - The worksheet columns hold all definable cell attributes. Neighbor lists are entered in the format [<cell 1>];[<cell 2>];<...>;[<cell n>], where each <cell *i*> = <technology$_i$>:<cell name$_i$>. Example of a neighbor list: [GSM:Bree E];[GSM:Archet S];[WCDMA:Combe N].

A full description of the XML format is found in the Technical Reference, chapter 4.

9.2. Creating a Cell File in CEL Format

The CEL format is a unified version allowing both GSM and WCDMA cells in the same file. It is described exhaustively in the Technical Reference, chapter 3.

If you use a spreadsheet application to edit CEL files, be sure to save them in tab-delimited plain text format. Otherwise, unwanted characters might be inserted which prevent TEMS Investigation from interpreting the file correctly.

9.3. Loading Cell Files

To make a cell file active, it must be loaded in the **General** window. You can have several cell files loaded in the application at the same time.

- From the Navigator’s Menu tab, open the General window.
- In the General window, double-click the item **Cellfile Load**.
- To add a cell file, click the **Add** button and browse to select your file. The cell file is added in the list box.

- To remove a cell file from the list, select it and click **Remove**. To remove all cell files, click **Remove all**.
- When you are done selecting cell files to load, click OK.

The set of loaded cell files can be modified at any time.

If multiple files of the same type (CEL or XML) are loaded, the information in all files is correlated in the presentation. However, if you load both CEL and XML files, no attempt is made to correlate CEL and XML cell information; rather, cell information is presented separately from each type of file.

9.4. Loading Cell Data from Mentum CellPlanner

Mentum CellPlanner uses the XML format for cell data. XML cell files created with Mentum CellPlanner can be loaded into TEMS Investigation.

9.5. Use of Cell Data in Presentations

Once cell data has been loaded, the following functions become available in the application:

- Drawing of cells and indication of neighbor relations and channel usage on the map. See sections 33.2.5.1, 33.2.5.3, and 33.2.5.4.
- Serving cell and handover indication on the map. See section 33.2.5.2.
- Presentation of cell data on the Info tab of a Map window. See section 33.3.
- In logfile reports: Association of statistics with individual cells. Computation of cell ranking based on these statistics. See the Technical Reference, section 10.3.
- Presentation of cell names in status windows, line charts, and bar charts. Configuration of status windows is covered in sections 27.2–27.3. Line charts: section 31.4.3. Bar charts: section 32.4.
- Best server indication on the map, based on scan data. See section 33.2.5.2.
- Indication of distance from current position to current serving cell. See Information Elements and Events, chapter 3 (“Cell Distance” IEs).
- Generation of events detecting (probable) missing neighbors. See Information Elements and Events, chapter 8.

Part II: Configuration and Testing

10. Logfiles

This chapter explains:

- how to log information received from external devices to file (section 10.1)
- how to load a logfile for analysis (section 10.2).

The chapter also describes:

- loading of logfiles from sources outside TEMS Investigation (section 10.3)
- viewing of logfile contents (section 10.4)
- transferring of logfiles via FTP (section 10.5)
- logfile export (section 10.6)
- merging of uplink AQM data into logfiles (section 10.7)
- generation of logfile reports (section 10.8).

Regarding the separate tools RouteFinder and RouteUtility, see sections 10.9 and 10.10.

10.1. Recording Logfiles

Logfile recording can be initiated in the following ways:

- Manually from the **Record** toolbar or **Logfile** menu. Such a logfile will always include all activated devices.
- By starting a **walk**, either along a planned route or unguided, in the **Pinpoint Window**: see section 11.3. Here, too, all activated devices are included.
- By a **script** that is executing. In this case the logfile can record devices selectively, as specified in the script setup. For full instructions on how to configure scripted recording, turn to sections 12.20.1.8–12.20.1.10.

Several logfiles can be recorded concurrently, and each recording is then completely independent of the others. The activities of one device (EQ) can be recorded in multiple logfiles.

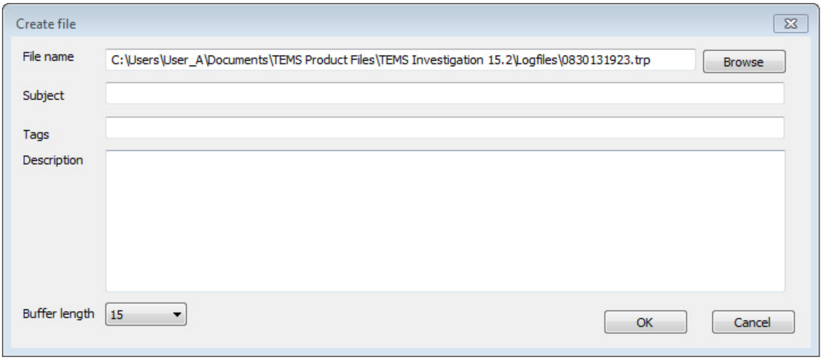
Regardless of the method used to record a logfile, the output is always a single file with extension .trp.

10.1.1. Manual Recording

Manual recording is most conveniently initiated from the Record toolbar.

Click the **Start Recording** button on the Record toolbar.

- If quick recording is turned on (see section 10.1.3), the recording will start immediately. Otherwise, the following configuration dialog will appear:



File name The default naming is in the form of a timestamp: mmddhhmmss.trp (month, day, hours, minutes, seconds).

Subject Here you can enter free text characterizing the logfile.

Tags Use this field to categorize the logfile with suitable keywords. A tag is defined simply by being entered here. Valid keyword separators are comma (,) and semicolon (;).

Description Free-text field for describing the logfile.

Buffer length Length in seconds of buffered content prepended to the logfile. Min.: 0 s. Max.: 40 s. Default: 15 s. See section 10.1.5 for further information.

- Fill out this dialog as desired, then click OK.

Now activate your equipment if you have not already done so. (By starting the recording first you ensure that you capture all relevant measurement data in the logfile.)

- Perform the desired tasks with your external equipment.

After you have completed all of these tasks, click **Stop Recording** to end the current recording and close the logfile. Once you have closed it, you cannot log any more data to the same file.

Alternatively, you can control the recording with the corresponding commands in the **Logfile** menu.

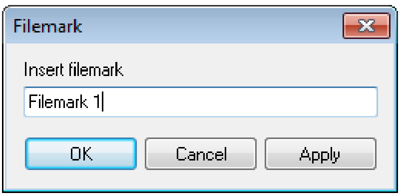
10.1.2. Inserting Filemarks

Filemarks are text strings which can be inserted automatically or manually in a logfile in order to tag interesting segments in the file. They are treated as events and appear as such in presentation windows. Filemarks can be searched for in message windows, as explained in section 29.7.2.

In Service Control scripts, you can use the **Filemark** activity to have filemarks inserted automatically. See section 12.20.1.6.

To add a filemark manually:

Click the **Insert Filemark** button and enter the filemark text (up to 50 characters).

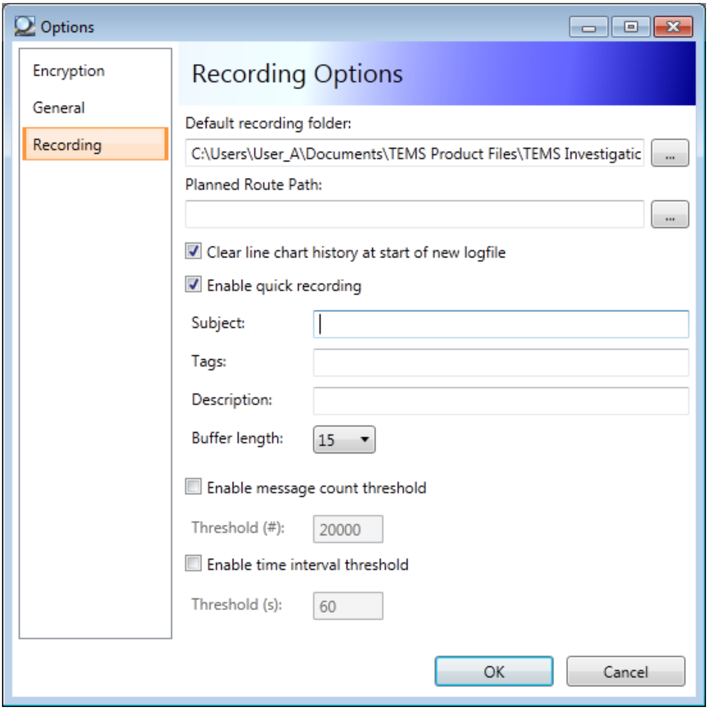


A Filemark event is written to the logfile for each filemark. If multiple logfiles are being recorded, the same filemark will be written to all of these files.

10.1.3. Further Recording Options

Some additional options are available when recording logfiles.

- From the **File** menu, choose **Options**, then choose **Recording** in the left-hand pane.



Default recording folder	Here you can change the default directory where logfiles will be saved.
Planned route path	If you want to display planned routes created in GPX format as an aid in drive testing, point here to the directory where the planned routes (with file extension .gpx) are stored.

Any routes pointed to in this field will be saved with all logfiles that you record. You can in fact proceed to store such logfiles (*.trp), rather than the GPX files themselves, in the **Planned route path** location in order to reuse the planned routes in TEMS Investigation later on.

See also section 8.4.

Clear presentation windows at start of new logfile

If you check this box, an internal history buffer (providing quick access to logfile data for presentation in the user interface) is cleared every time you start recording a new logfile. This reduces the consumption of disk space as well as the CPU load during recording.

To prevent out-of-memory issues, the history buffer in TEMS Investigation is automatically cleared on reaching a size of 410,000 messages. This function is automatic, and you cannot view or edit any settings controlling this behavior.

Enable quick recording

This option allows you to speed up the manual recording procedure so that it starts immediately when you click the **Start Recording** button. In the fields that follow beneath the checkbox, you define **Subject**, **Tags**, **Description**, and **Buffer length** once and for all so that you do not have to specify them for each logfile as detailed in section 10.1.1. The logfile name is automatically generated according to the default format.

Quick recording also comes with options for limiting the logfile size: see below. These options can be combined, and the logfile is then closed as soon as either threshold is reached.

Enable message count threshold

This option is available for quick recording. If checked, the recording will switch to a new file each time a stipulated number of messages have been logged. Enter the desired number in the **Threshold (#)** box. See also the **Note** below.

Enable time interval threshold

This option is available for quick recording. If checked, the recording will switch to a new file whenever a fixed length of time has elapsed. Enter the desired interval in seconds in the **Threshold (s)** box. See also the **Note** below.

> **Note:** Since this option will cause logfiles to end at arbitrary points irrespective of the testing being done, the option must *not* be used when collecting data for KPIs or other statistical reporting that requires consideration of *complete* calls or sessions.

For example, in order to calculate dropped call rates or the percentage of successfully completed data sessions, it is vital that each call or session be contained in a single logfile; otherwise, the accuracy of the statistics cannot be guaranteed.

Note also that information elements presenting average throughputs, byte counts, and the like require a Network Connect activity at the start of the logfile (see Information Elements and Events, section 3.8.2).

Therefore, **always use scripted recording**, governed by the Start Recording and Stop Recording activities as appropriate, when collecting data that is going to serve as input to any form of statistics.

10.1.4. Positioning Logfiles by Pinpointing in the Map Window

This section describes how to use the pinpointing technique for positioning logfile data. Pinpointing is useful in environments where GPS coverage is lacking.

The pinpointing described here is done in the Map window and is *manual*, meaning that you indicate your exact positions as you walk around measuring. TEMS Investigation also has another pinpointing tool, the Pinpoint Window, where you can either pinpoint manually or plan and create your route in advance and then walk it in a simplified fashion. The Pinpoint Window is dealt with in chapter 11.

> **Note:** If you activate a GPS in TEMS Investigation, pinpointing in the Map window is disabled. A GPS can be physically plugged in without disabling the pinpointing function, but it cannot be activated in the TEMS Investigation application. Conversely, while pinpointing is in progress, you cannot activate a GPS in TEMS Investigation.

10.1.4.1. Basic Pinpointing Procedures

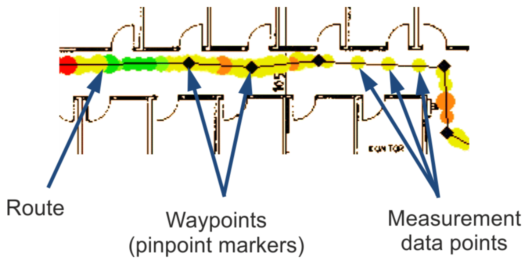
- First, load your floor plan or other image to be used for pinpointing into a Map window. If the image file is unpositioned, you need to position it. See sections 8.3–8.2.

On the Map window toolbar, click the **Pinpoint** button. You must do this before starting the logfile recording.

Now click the **Start Recording** button on the main window toolbar.

To record positions for measurements, you indicate your position by clicking on the map at regular intervals. As long as some device is activated, clicks on the map will be interpreted as pinpointing actions. This is indicated by the cursor changing into an upward arrow whenever it enters the Map window.

Each time you pinpoint, the corresponding position is registered in the logfile as a waypoint along your route. The waypoint is marked with a black diamond, and a new route segment in the form of a straight line is drawn to it from the preceding waypoint. Then, the measurement reports received between the two points are drawn as theme symbols distributed uniformly along the new route segment (and assigned the corresponding positions in the logfile).



The waypoints themselves are stored in the logfile as “Pinpoint” messages which appear by default in the Events window. Therefore the waypoints and connecting lines appear also when the logfile is loaded for analysis later on.

When you are done with your measurement session, finish as follows:

Deactivate the data-collecting device.

- Pinpoint one last time to ensure that all data is accurately positioned.

Click **Stop Recording** to end the recording and close the logfile.

10.1.4.2. Advice on Pinpointing and Recording

From section 10.1.4.1 it is clear that in order for the recorded route to agree well with the actual one, you should pinpoint every time you change direction. Furthermore, to obtain equal data densities in different locations, you should try to maintain approximately the same speed throughout your route. (Note that this is in fact not the case in the figure in section 10.1.4.1, where the tester has increased his speed considerably between waypoints 3 and 4.)

If you pinpoint close to the edge of the Map window, the map will scroll automatically. You cannot manually pan or zoom the map (using the toolbar buttons) while pinpointing.

Do not replace the map while recording is in progress.

To optimize the performance of the Map window, you should remove all unused themes (see section 33.2) and avoid having other presentation windows open at the same time unless you really need them.

10.1.5. Buffering in Connection with Logfile Recording

For each connected device, TEMS Investigation continuously maintains an internal buffer with the latest signaling. When starting a logfile recording (by any of the available methods), you decide how much of this buffered content should be inserted at the start of the logfile. There are pros and cons to including the buffered data, as discussed below.

You may want to use a *large* buffer:

- If you wish to capture as much as possible of the context surrounding a device activity, for example, the signaling leading up to the establishment of the call or data session.
- If, at the start of a new recording, you want to evaluate some condition that depends on previously obtained data. For this to work, you need to have the relevant data available in the buffer so that it is copied into the new logfile.

You may want to use a *small* buffer or no buffer at all:

- If you have no particular interest in what happened before the recording started, or if you want to prevent any possible confusion that might result from unexpected and unrelated data appearing at the start of the logfile.
- If you want to avoid duplication of data, for example in order to prevent skewing of statistics. Consider a script where voice calls are repeated in a while loop and a new logfile is recorded in each turn. If the Start

Recording and Stop Recording activities are put first and last in the loop, then any two consecutive logfiles will overlap. Now if a call fails (e.g. is dropped), the failure will likely be registered in both logfiles, and this duplication will distort any statistics that are computed based on the data. To prevent logfiles from overlapping, decrease the buffer size (possibly to zero). Another way to avoid logfile overlap is to insert Wait activities in your script; see section 12.20.1.10.

10.2. Loading a Logfile for Analysis

> **Note:** To be able to load a logfile, you must deactivate your external equipment. Furthermore, if you have been pinpointing in the Map window, you must also exit Pinpoint mode there, for instance by clicking the **Selection Tool** button on the Map window toolbar (see section 33.6).

Logfile loading is controlled from the **Replay** toolbar or from the **Logfile** menu. The quickest method is to use the toolbar buttons.

One logfile at a time can be loaded in TEMS Investigation. For multi-logfile analysis, TEMS Discovery is used.

10.2.1. Opening a Logfile

Click the **Open Logfile** button to open a logfile.

Alternatively, you can open a logfile by drag-and-drop from Windows Explorer. The file must then be dropped onto the **Logfile** tab of the Navigator.

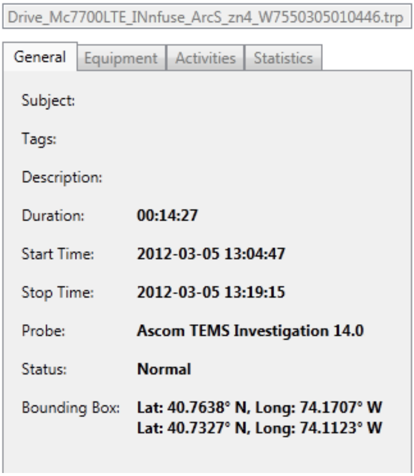
Opening a logfile only loads logfile metadata into the application, not the full contents of the file (that is, the measurement data). Regarding the latter, turn to section 10.2.3.

The metadata is displayed on the Navigator’s **Logfile** tab. This tab shows the logfile name at the top. The name or entire path of the logfile can be copied to the Windows clipboard by right-clicking in the logfile name box and selecting the appropriate command: **Copy filename to clipboard** or **Copy full path to clipboard**.

The remaining space on the Logfile tab is divided into subtabs whose contents are detailed in the subsections that follow.

10.2.2. Logfile Metadata and Statistics

10.2.2.1. “General” Subtab



Subject, Tags, Description Shows the contents of these fields as defined at logfile creation time; see section 10.1.

Start Time Date and time when the recording started.

Stop Time Date and time when the recording concluded.

Probe TEMS product or component used to record the logfile. This can be a version of TEMS Investigation, but it might just as well be, for example, a TEMS Automatic RTU or a TEMS Pocket release.

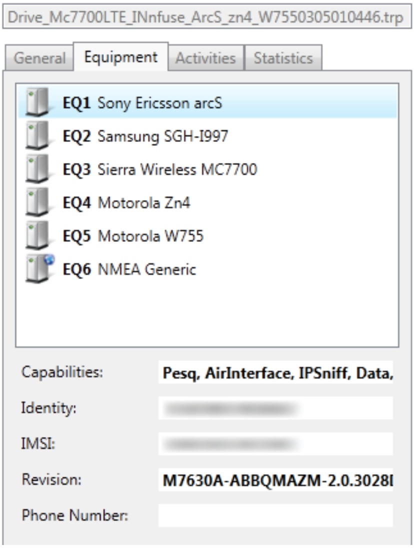
Status *Normal:* The logfile was recorded normally.

Recovered: A failure occurred during recording of this logfile, and an attempt was made to recover the file. Please note that the file may be corrupt.

Unknown: Value displayed for old (pre-14.0) logfiles.

Bounding Box The smallest area (defined by min/max latitude and longitude) that encompasses the route traveled in the logfile.

10.2.2.2. “Equipment” Subtab

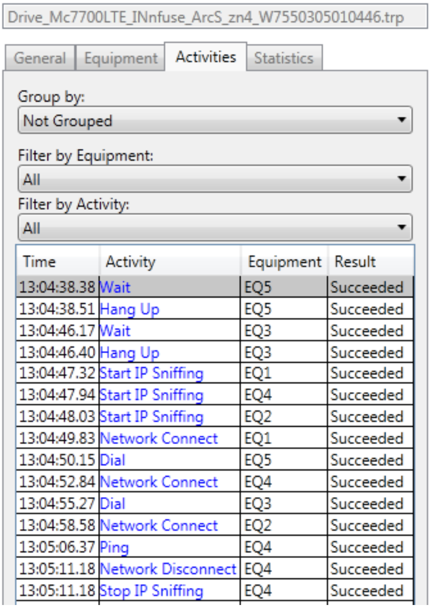


This subtab holds all devices that were activated in TEMS Investigation during recording of the logfile. Each device appears with the same EQ number assigned as it had at the time of recording.

Selecting a device populates the fields at the bottom (**Capabilities**, etc.) just as is done in live mode for active devices on the Navigator’s top-level **Equipment** tab (**Information** subtab: see section 6.3.2.2). The **Revision** field contains miscellaneous device information such as firmware revision.

You can right-click a device and choose **Deactivate** to hide data from that device in the logfile presentation. No data from that device will then be loaded into the presentation windows when you load the full logfile contents.

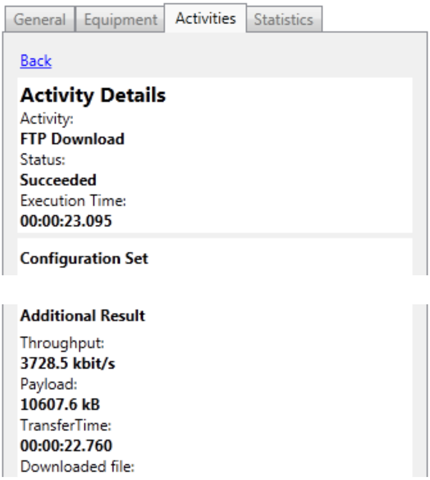
10.2.2.3. “Activities” Subtab



This tab gives a complete chronology of the activities (whether scripted or executed manually) performed by all devices in the course of the logfile recording. You can group and/or filter the contents in various ways:

Group by	*Not Grouped:* The chronology is given in a single table. *Activity:* The chronology is broken into separate tables for each type of activity performed. *Result:* The chronology is broken into separate tables for each possible outcome (Succeeded, Failed, etc.).
Filter by Equipment	You can show all activities or only those of a single EQ.
Filter by Activity	You can show all activities or only those of a particular type.

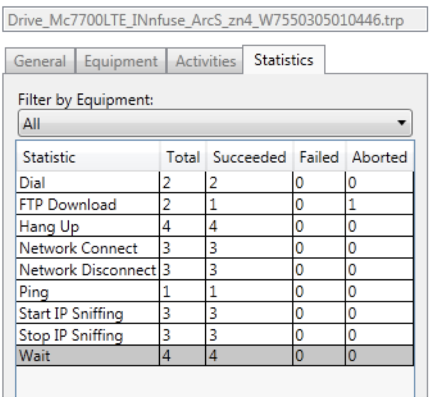
Clicking an activity link opens a detailed description of the configuration, execution, and outcome of the activity. Below are shown a couple of extracts from the description of an FTP Download activity.



- Click the **Back** link to return to the activity listing.

Compare the Service Control Monitor (section 12.15.3.1), which shows equipment status and the outcome of the last activity performed during the execution of a script.

10.2.2.4. “Statistics” Subtab



Statistic	Total	Succeeded	Failed	Aborted
Dial	2	2	0	0
FTP Download	2	1	0	1
Hang Up	4	4	0	0
Network Connect	3	3	0	0
Network Disconnect	3	3	0	0
Ping	1	1	0	0
Start IP Sniffing	3	3	0	0
Stop IP Sniffing	3	3	0	0
Wait	4	4	0	0

This tab provides statistics on the outcomes of activities performed by the devices during recording.

Filter by Equipment	You can show statistics for all devices taken together or for one selected device.

Compare the Service Control Monitor (section 12.15.3.2), which computes similar statistics in testing mode while a script is executing.

10.2.3. Loading Logfile Contents

Click the **Fast Forward** button to load the logfile measurement data into the presentation windows.

You can click the same button again, now labeled **Stop**, to halt the loading of the logfile. The data loaded thus far is then displayed in the presentation windows. Click **Fast Forward** once more to resume logfile loading.

When you are done analyzing a logfile, click the **Close Logfile** button to close it.

10.2.3.1. Play Section of Status Bar

While a logfile is being loaded, the **Play** section of the status bar shows the name of the file and indicates the percentage of the file that has been loaded. See section 3.4.

10.3. Loading Logfiles from Other Sources

TEMS Investigation can load and analyze logfiles from the TEMS products listed below.

- TEMS Investigation 6.x and later
- TEMS Investigation GSM 5.x, 4.x, 3.x
- TEMS Investigation EDGE 1.x
- TEMS Investigation WCDMA 3.x, 2.x
- TEMS Pocket 12.3 and later (*.trp)
- TEMS Pocket 11.0–12.2 (*.tpz)
- TEMS Pocket 10.x[1], 8.x[1], 7.x, 6.x, 5.x [2]

- TEMS Automatic 6.x and later (any RTU/MTU and TEMS Pocket Remote logfiles)
- TEMS Automatic 5.x (any MTU logfiles)
- TEMS Automatic 4.x (MTU logfiles recorded with GSM-only MTUs)
- TEMS Automatic 3.x, 2.5
- TEMS Symphony 7.x
- TEMS DriveTester GSM–TDMA 1.x (GSM logfiles)

TEMS Investigation can also read:

- MDM logfiles from Qualcomm chipset based devices
- Logfiles from Anritsu ML8720 scanners (i.e. files logged by the scanner itself)
- MTR files (GSM; see the Informations Elements and Events volume, section 3.10)

10.4. Viewing Logfile Contents

Everything about data presentation is dealt with in chapters 26–33.

Note especially the search functions in message windows, described in section 29.7.2.

10.5. Logfile Transfer via FTP

You can set up TEMS Investigation to automatically transfer recorded logfiles to a designated FTP server, over the air or via an Ethernet connection. This mechanism serves to simplify ways of working and reduce lead times, always providing quick access to the latest logfiles throughout the organization.

10.5.1. Setting Up Logfile Transfers

- To set up FTP logfile transfers, on the Menu tab of the Navigator, choose **Configuration** → **File Transfer**.

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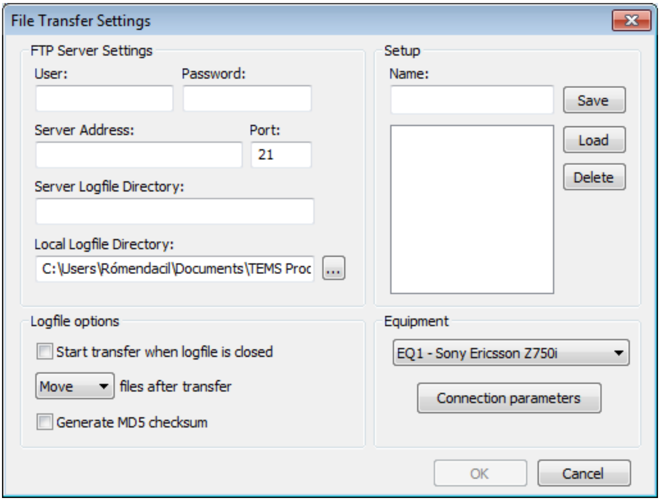
1. Please note that logfiles from these TEMS Pocket versions must first be converted using a PC utility which is delivered with that version.
2. TEMS Pocket 9.x logfiles cannot be loaded in TEMS Investigation.

- In the window that appears, click the **Settings** button.



10.5.1.1. FTP Server Settings

User, Password	User name and password on the FTP server, if required.
Server Address	IP address or host name of FTP server.
Port	The FTP server port to use.
Server Logfile Directory	Path to the directory on the FTP server where the uploaded logfiles will be stored (in a subdirectory named according to the current date). The logfile names are augmented with a timestamp indicating the time of upload: _tfu__hh_mm_ss ("tfu" means "TEMS file upload").
Local Logfile Directory	The local directory on the PC from which logfiles will be uploaded.

10.5.1.2. Logfile Options

Start transfer when logfile is closed	If this is checked, every logfile will be transferred immediately after the recording has ended. If the option is not checked, you initiate transfers manually as described in section 10.5.2.
[...] files after transfer	• **Delete:** After logfiles have been uploaded, they are deleted from the local directory. • **Move:** Within the local directory, logfiles that have been uploaded are moved to a subdirectory Complete that is created automatically for the purpose. If **Start transfer when logfile is closed** is checked, this behavior is preselected and cannot be changed.
Generate MD5 checksum	If checked, TEMS Investigation will generate an MD5 checksum (128-bit hash value) for each logfile to be transferred and send that value as a text file along with the logfile. Using some suitable third-party software, you can then compute the checksum for the uploaded file and confirm that it agrees with that of the original.

10.5.1.3. Equipment

Here you select the device to use for logfile transfer. The transfer can be done over a cellular network, or over an Ethernet or WLAN connection.

Note: Transfer over Ethernet or WLAN requires that detection of network adapters be enabled (it is disabled by default). See section 6.3.3.4.

Note that you *do not* need to have the device activated in TEMS Investigation to be able to transfer files.

For a cellular network device, you need to supply parameters for connecting to the network. Click the **Connection parameters** button to open the dialog for creating a **Network Connect** configuration set. The parameters of this configuration are gone through in section 12.20.3.2.

10.5.1.4. Setup

You can save all settings made in this dialog as a file transfer setup. The setups are maintained in the dialog; there is no explicit handling of setup files.

- To save a setup, type a name for it in the **Name** box and click **Save**. The setup is added in the list box.
- To load a previously saved setup, select it in the list box and click **Load**.
- To delete a setup, select it in the list box and click **Delete**.

10.5.2. Starting Logfile Transfers

This section is applicable only when the option **Start transfer when logfile is closed** described in section 10.5.1.2 is not set. In this case you start the logfile transfer manually on each occasion.

- In the File Transfer Settings dialog, define or select the setup you want to use, then click OK.
- In the File Transfer window, click the **Start** button. (If the file transfer is automatic, this button is named **Auto** and grayed out.)

The progress bar will indicate the progress of the transfer.

10.6. Exporting Logfiles in Other Formats

Logfiles can be exported in the following formats:

- Text file with tab delimited data (suitable for processing in, for example, a spreadsheet application). TEMS Automatic logfiles, too, can be exported in this format. The text export format is described in detail in the Technical Reference, chapter 8.
- MapInfo 3.0 (Interchange or Tab format)
- ArcView Shapefile: about version, see the Technical Reference, section 9.2
- Marconi Planet DMS 3.1
- Ethereal (Wireshark)
- MDM

Some of these formats contain multiple files for each logfile. See the Technical Reference, chapter 9 for details.

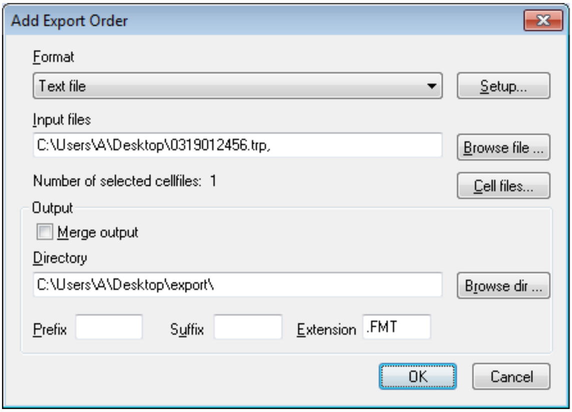
> **Note:** Export in MapInfo, ArcView, or Planet format requires that the data be positioned. If there is no positioning information in the logfile, the export file will contain only a header and no route data.

Logfile export can be done either from the TEMS Investigation user interface or from a Command Prompt. For the latter possibility, see section 10.6.4.

10.6.1. Preparing an Export Order

- First, deactivate any external devices that are currently activated. This is necessary in order for the export to work properly.
- From the Logfile menu, choose **Export Logfile**. A separate window named **TEMS Export** is launched.

In the TEMS Export window, click **Add**. The Add Export Order dialog appears:



Format Select the output format for your logfiles.

Regarding the choice **PESQ merge**, see section 10.7. (This is not a logfile export format in the strict sense.)

Input files Type or select the logfile or logfiles you want to export.

Cell files	Click this button to include one or several cell files in the export. This will have exactly the same effect on information elements and events as having cell files loaded in the TEMS Investigation application itself (populating IEs that require cell file data, etc.).
Merge output	If you are exporting several logfiles and this option is checked, all logfiles will be merged into a single set of export files. (Logfiles are simply concatenated; there is no sorting of messages by timestamps.) The name given to the export files depends on the ordering of logfiles in the **Input files** box. If the **Merge output** option is unchecked, each logfile is exported separately, and the export file set simply retains the name of the logfile.
Directory	The directory where the export files are written.
Prefix	To the export file name you can optionally add a descriptive prefix.
Suffix	To the export file name you can optionally add a descriptive suffix.
Extension	File extension for export file. Editable only for certain formats, including the plain-text format. Export to other formats produces files with fixed extensions, as described in the Technical Reference, chapter 9.

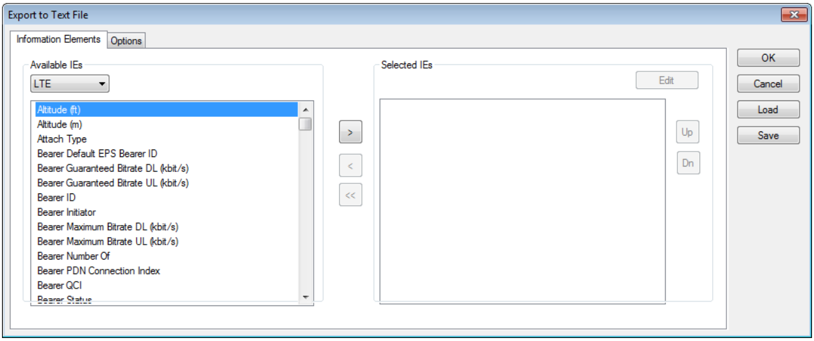
- Now click the **Setup** button to specify details of the export; see section 10.6.2 below.

10.6.2. Specifying the Contents of Export Files

On clicking the **Setup** button, a dialog appears whose contents partly depend on the format chosen.

10.6.2.1. Selecting Information Elements to Export

The **Information Elements** tab is common to many of the formats. Here you select which information elements to include in the export:



You choose each individual element separately. From information elements with arguments you pick one component at a time. By default a chosen item is exported from all devices that report it.

- To export an element, select it in the **Available IEs** list and click the "**>**" button to move it to the **Selected IEs** list. If the element has arguments, you do not get the whole element at once, but only the component with the lowest argument. To select the component with the next higher argument, click "**>**" again. Repeat for all components you want to export.
- By default the items selected are picked from all devices. To export the item only from specified devices, you must edit the item; see Editing the Selected Items below.
- To export an information element from a different category (e.g. the Data category), choose that category in the combo box in the Available IEs section. Elements from different categories can be freely mixed in export files.
- To remove an item from the Selected IEs box, select the item and click "**<**". To clear the entire Selected IEs box, click "**<<**".

Editing the Selected Items

To edit an information element:

- In the **Selected IEs** box, select the desired item and click the **Edit** button above the box. The **Edit IE** dialog appears.

For all export formats, you can restrict the export of a selected IE to a single device, or change the IE argument (where one exists).

For all export formats except tab-delimited text, you can also edit the following settings:

- **NAME** field: This is the IE column heading in the export file. By default, the column heading string consists of the IE name. (You might want to make this string shorter.)
- **NODATA** field: If you enter a string here, it will be written in the export file whenever the IE does not have a valid value. For Planet, any string is accepted, whereas for the remaining formats the string must be numeric (e.g. “999”, “-1”).

As long as these settings have not been edited, the IE name is preceded by an asterisk (*) in the Selected IEs box. Note also that the NAME and NODATA settings are *not* saved along with other logfile export settings, but in different files. See section 10.6.2.8.

Arranging Items in the Export Files

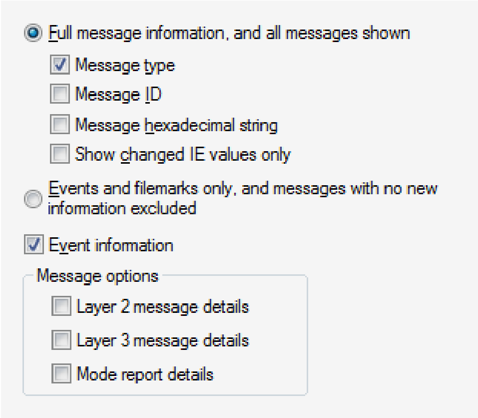
The order of the items in the Selected IEs list will also be the order in which they come in the export files. You can rearrange the items by selecting them and moving them using the **Up** and **Dn** buttons.

10.6.2.2. Text File Specific Settings

Besides your chosen information elements, the text export file always contains data on events, including user-inserted filemarks. There are no user settings relating to the event data.

By default the text export file also contains message information.

Optionally, the export can be reduced in order to decrease the duplication of data and the number of lines in the export file. The choice is made on the **Options** tab:



Full message information...

All messages are kept.

The following columns are optional: Message Type, Message ID, and Hexadecimal String. Check a column to include it. All other standard columns are always included; see the Technical Reference, chapter 8. In addition there will be one column for each selected IE or IE component.

If you check **Show changed IE values only**, IE values are written out only if they have changed since the previous message. This makes for a considerable reduction of the export file size. If the box is not checked, all IE values are written for every message.

Events and filemarks only...

The export file is reduced in two ways:

- The columns Frame Number, Message ID, and Hexadecimal String are excluded from the export file. (The **Event** column is kept, as is the **Event Info** column provided that the **Event information** checkbox below is checked.)
- Messages not triggering an event and containing no changed IE values are wholly excluded.

Event information

Governs whether the **Event Info** column is included in the export.

Message options

Check the relevant boxes in order to have Layer 2 messages, Layer 3 messages, and devices’ mode reports exported as unabridged plain text to a common separate file whose name ends in _textexp.txt.

10.6.2.3. MapInfo Specific Settings

For MapInfo export (whether to Interchange or Tab format), the Options tab looks like this:

Reports to export data from

This setting governs what types of report from the device are included in the export files:

- all reports
- only Layer 3 reports
- only mode reports.

By default all reports are exported.

Export message information...
Check this to include information on Layer 3 and Layer 2 messages in the export files. The following data is added (one column for each item):

- Message direction (internal, uplink, downlink)
- Message name
- Hexadecimal string
- Extension (containing cause values)

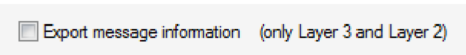
Events
This setting governs the export of events.

- **Do not export events:** No event information is exported.
- **Export events but do not plot...:** Events are exported, but no event-specific symbol is used in MapInfo when plotting on a map.
- **Export events and plot...:** Events are exported, and a unique symbol is used when plotting in MapInfo to distinguish events from other data. Note, however, that there is no differentiation of event types, and that the symbol used is not one of the default TEMS Investigation event symbols.

Include file name in file
Check this to include the file name in the export files.

For details on MapInfo output, see the Technical Reference, section 9.1.

10.6.2.4. ArcView Specific Settings



Export message information...
Check this to include information on Layer 3 and Layer 2 messages in the export files. The following data is added (one column for each item):

- Message direction (internal, uplink, downlink)
- Message name
- Hexadecimal string

For details on ArcView output, see the Technical Reference, section 9.2.

10.6.2.5. Marconi Planet Specific Settings

Export message information...

Check this to include information on Layer 3 and Layer 2 messages in the export file. The following data is added (one column for each item):

- Message direction (internal, uplink, downlink)
- Message name

For details on Marconi Planet output, see the Technical Reference, section 9.3.

10.6.2.6. Ethereal (Wireshark) Specific Settings

The export encompasses all of the logfile content. The **Export message information** checkbox must be checked, otherwise the output file will be empty.

For details on Ethereal output, see the Technical Reference, section 9.4.

10.6.2.7. MDM Specific Settings

MDM export is intended for logfiles recorded with Qualcomm chipset based devices.

The export encompasses all Qualcomm-specific air interface messages in the logfile. The **Export message information** checkbox must be checked, otherwise the output files will be empty.

For details on MDM output, see the Technical Reference, section 9.5.

10.6.2.8. Saving and Loading Export Setups

When you are done specifying the export, you may want to save the setup for future use.

- In the Setup dialog, click **Save** and store the file where appropriate. The file extension will depend on the format (for example, .tex for a text-format export setup).
- To load a previously saved setup in the Setup dialog, click **Load** and locate the setup file.

However, the **NAME** and **NODATA** settings for information elements (see the introduction of section 10.6.2) are *not* saved in the above-mentioned files. They are instead written to DBF files that are found in the Settings directory beneath the TEMS Investigation installation directory.

10.6.3. Executing Export Orders

All the export orders you have defined are listed in the **TEMS Export** window.

- To start executing the export orders, right-click and choose **Start** from the context menu (or click the Start button in the window).
- To abort the execution of the export orders, right-click and choose **Abort** from the context menu.

A summary of the export execution appears in a popup window (“**Export Result**”).

10.6.4. Command Line Controlled Logfile Export

Logfile export can alternatively be initiated from a Command Prompt by running the file TEMS.ExportTool.exe, which is found under <TEMS Investigation install dir>\Application. The command has the following syntax, where optional parts are placed within square brackets [ ]:

TEMS.ExportTool.exe
/IF "<logfile name(s)>" [/OD "<output directory path>"]
[/CFG "<configuration file name>"]
[/CF "<cell file name(s)>"] [/EF "<export format>"]
[/P "<prefix>"] [/S "<suffix>"] [/E "<extension>"] [/MO] [/V]

Each of the command line switches has an abbreviated as well as a full form; for example, /IF and /InputFiles can be used interchangeably.

10.6.4.1. Mandatory Command Line Switches

/IF (or: /InputFiles)

Equivalent to Input files field in logfile export dialog. Wildcards can be used in the file name in regular DOS fashion. Use semicolons (;) to separate files.

Examples:

- /IF "C:\ExpTest\0825_01.trp;C:\ExpTest\0825_02.trp"

  Exports the logfiles listed.
- /IF "C:\ExpTest*;"

  Exports all TEMS Investigation logfiles found in the specified directory.
- /IF "C:\ExpTest1*;C:\ExpTest2*;C:\ExpTest3\0825_*1.trp"

  Exports all TEMS Investigation logfiles found in directories ExpTest1 and ExpTest2 as well as those in directory ExpTest3 matching the given file name pattern.

10.6.4.2. Optional Command Line Switches

/OD (or: /OutputDirectory)

Full path of output directory. Equivalent to Directory field in logfile export dialog. If you do not specify an output directory, the location where the export files are written is indicated in a file batch_result.txt which is found in the Temp directory of your Windows user (for example, under Windows 7: C:\Users\<user name>\AppData\Local\Temp).

/CFG (or: /ConfigurationFile)

Logfile export configuration file, created by saving a setup in the logfile export dialog as described in section 10.6.2.8.

This parameter is optional but strongly recommended for all export formats that have a configuration. Most importantly, a configuration file is required to have any information element values exported; compare section 10.6.2.1.

Here is how configuration file types match up with export formats (/EF):

- /EF "Text file" /CFG "C:\Path\filename.tex"
- /EF "MapInfo Interchange (mif)" /CFG "C:\Path\filename.mex"
- /EF "MapInfo Tab-file" /CFG "C:\Path\filename.mex"
- /EF "ArcView shape-file" /CFG "C:\Path\filename.avx"
- /EF "Marconi Planet-file" /CFG "C:\Path\filename.pex"

No configuration file exists for export to MDM or Ethereal/Wireshark, nor for PESQ uplink data merge.

/CF (or: /CellFiles)

Equivalent to selecting cell files by clicking the Cell files button in the logfile export dialog. If you specify several cell files, use semicolon (;) as delimiter.

/EF (or: /ExportFormat)

Equivalent to Format setting in logfile export dialog. The format string needs to be enclosed within double quotes (" ").

If this parameter is omitted, the export is done in text format.

The possible values are those seen in the Format combo box:

"Text file"
"MapInfo Interchange (mif)"
"MapInfo Tab-file"
"ArcView shape-file"
"Marconi Planet-file"
"Export to Ethereal"
"Export to MDM"
"Pesq Merge"

/P (or: /Prefix)

Equivalent to Prefix field in logfile export dialog.

/S (or: /Suffix)

Equivalent to Suffix field in logfile export dialog.

/E (or: /Extension)

Equivalent to Extension field in logfile export dialog. Note again that for some export formats you cannot override the default extension.

/MO (or: /MergeOutput)

Including this switch is equivalent to checking the Merge output checkbox in the logfile export dialog.

/V (or: /Verbose)

If you include this switch, the name of each exported logfile will be printed in the Command Prompt window.

10.6.4.3. Example

Below is an example of a logfile export command:

> TEMS.ExportTool.exe /IF "C:\ExportTest\0825*" /OD C:\ExportTest\Export /V /CFG "C:\ExportTest\GsmN.tex"

This command exports in text format all logfiles found in C:\ExportTest that were recorded on August 25 (we are assuming here that the default logfile naming has been retained), using the setup described in the configuration file GsmN.tex. The output is stored under C:\ExportTest\Export.

10.7. Merging Uplink AQM Data into Logfiles (UMTS)

When a CallGenerator is used in an audio quality measurement configuration, the CallGenerator computes the uplink AQM data and outputs it in XML files. This uplink data needs to be inserted in each logfile (*.trp) recorded with TEMS Investigation. To perform the data merge, you need to export the TEMS Investigation logfile with **Format** set to **PESQ merge**. The output is a new logfile (still in *.trp format) that includes both uplink and downlink AQM data.

10.7.1. Retrieving Uplink AQM Data

The uplink AQM data is stored as XML files on the CallGenerator PC, by default under C:\TIPESQ in a subfolder named <yyyymmdd><phone number>. The XML files are given random four-digit numbers as names.

No special tool is currently provided in TEMS Investigation for accessing the uplink AQM data; the files must be collected manually from the CallGenerator. This could be done in a number of ways, for example:

- by setting up access to the CallGenerator output directory as a network drive
- by downloading the uplink data files via FTP
- by copying the files onto a USB stick or a CD/DVD.

Note: When downloading the uplink data files it is important to preserve the CallGenerator directory structure, since the merge algorithm relies on this structure to locate the correct files. See the screenshot in section 10.7.2.

10.7.2. Preparing and Performing a Merge

- From the **Logfile** menu, choose **Export Logfile**.

Click **Add**. The Add Export Order dialog appears. Compare section 10.6.1.

- Under **Format**, select **PESQ merge**.
- Click the **Setup** button next to the Format combo box. A dialog appears in which you point out where the uplink AQM data files are located (one XML file for each AQM call). See section 10.7.1. Click the “**...**” button and locate the root directory holding all XML files (the level above the directories named by date). An example is shown below:

- Click OK, then OK once more.
- Back in the Add Export Order dialog, under **Input files**, select the TEMS Investigation logfiles (*.trp) containing the downlink AQM data.
- You also need to specify where the merged output files should be written. To this end, click the **Browse dir** button next to the **Directory** box and navigate to the desired directory.
- Be sure *not* to check the **Merge output** option.
- Click OK to exit the Add Export Order dialog.
- You are now ready to perform the merge. Execute the AQM export order from the Export Logfile window as described in section 10.6.3.

The output files will remain TEMS Investigation logfiles with extension .trp. The name of each output logfile will consist of the original name plus the suffix “-AQM”.

What happens during the merge is that the uplink AQM data is integrated into the logfile, all entries being sorted by their timestamps. The uplink data is inserted into the logfiles at the correct points in time.

For in-depth coverage of the computation of AQM data, including timing issues, see the document “AQM in TEMS Products” which is found in the TEMS Investigation documentation package.

It is possible to perform a merge with an incomplete set of uplink data files, and to repeat the merge procedure later on with further uplink data supplemented. No duplication of data in the output logfile will result from this: the logfile export function processes each AQM call only once.

10.8. Generating Logfile Reports

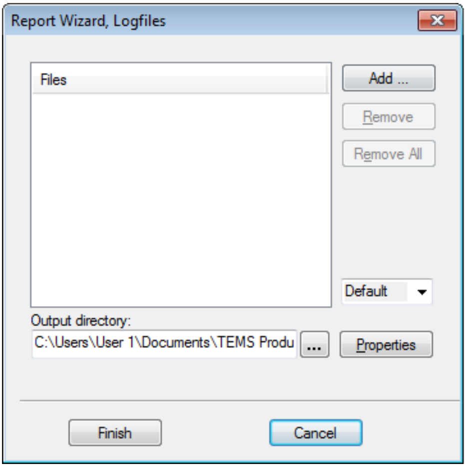
> **Note:** Reporting functions are also available in TEMS Discovery.

From one or several logfiles you can generate a report in HTML format which summarizes the data in the logfiles.

For full details of logfile report contents and format, see the Technical Reference, chapter 10.

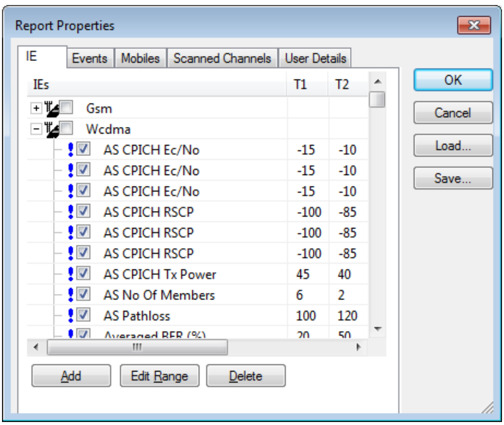
- The logfiles to be included in the report cannot be open while the report is generated. If one of these files is currently open, close it.
- If any external devices are activated, deactivate them. This is necessary in order for the report generation to work properly.

To prepare a logfile report, click the **Generate Report** button on the **Report** toolbar. This dialog appears:



- First, choose the logfile or logfiles on which to base the report. Click **Add** and browse for the files. Those that you choose are listed in the Files box.
- Specify an output directory for the report. Enter a path, or click the button labeled "**...**" to browse your file system.
- Now click **Properties** to assemble the contents of the report. A multi-tab dialog appears.

10.8.1. IE Tab



The report can compare information element values with thresholds. It will contain statistics of the type "Percentage of measurement points with Active Set CPICH Ec/No below –15 dB".

All thresholded information elements listed will also have their distributions visualized in bar charts.

A number of thresholds are predefined in the dialog, as is seen in the above screenshot; you can also define your own thresholds. Check those that you wish to use, and uncheck the others. Check a cellular technology to use all thresholds defined for that technology. Each item in the list represents a set of two thresholds for an information element value:

$$IE[Arg] \le T_1, IE[Arg] \le T_2$$

or

$$IE[Arg] \ge T_1, IE[Arg] \ge T_2$$

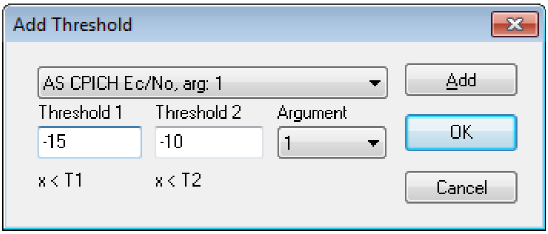
Whether peaks or dips are counted depends on the information element and cannot be changed.

In the report, it is indicated for each threshold

- how many times the value of the information element has crossed the threshold (changed from a more normal value to a more extreme one)
- how long these peaks/dips have lasted on average.

Adding User-defined Thresholds

- To add a pair of thresholds, click the **Add** button.



- Choose an information element.
- Choose an argument (where applicable).

- Specify the two thresholds.
- Click **Add** to add this threshold pair to the list and keep the Add Threshold dialog open.
- Click OK to add this threshold pair to the list and close the Add Threshold dialog.

Editing Thresholds

- To edit a threshold, double-click it and enter the desired new value.

Editing Arguments

- To edit the argument of the information element (where one exists), double-click it and enter the desired new value.

Deleting Thresholds

- To delete a threshold pair, select it and click the **Delete** button.

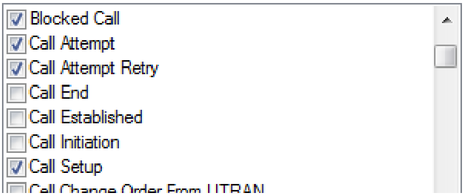
Customizing Value Ranges

The **Ranges** column is used to customize the drawing of distribution charts (see the Technical Reference, section 10.4). By default no ranges are set, and the distribution charts are drawn in a preconfigured manner. If you set up your own value ranges for an IE, the distribution chart will be drawn with one bar for each range:

- Select the desired information element.
- Click the **Edit Range** button.
- Modify the value ranges in the dialog that appears.

10.8.2. Events Tab

The report has a section with event statistics. On this tab you choose what event types to include in these statistics.



- Check the events you want to include, and leave the rest unchecked. Press Ctrl + A to select all events; press Ctrl + A again to deselect all events.

Note: The ranking of cells in the report ("**Worst Cell Indication**") is partially based on the number of events occurring in the cell. The algorithm counts all events, not only those signifying failures. Therefore, in order for the cell ranking to make sense, only failure events should be checked in this step. This is also the default setting.

10.8.3. Mobiles Tab

- Check the external devices whose data you want to include in the report.

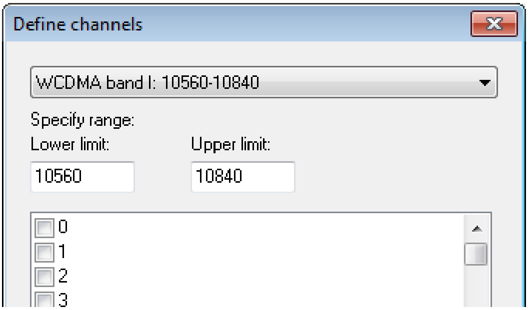
By default all device channels ("MS1", "DC1", "MS2", etc.) used to record the logfile will be checked. GPS data, if available, is included implicitly.

10.8.4. Scanned Channels Tab

Note: The settings on this tab are applicable only if your logfiles contain scan data.

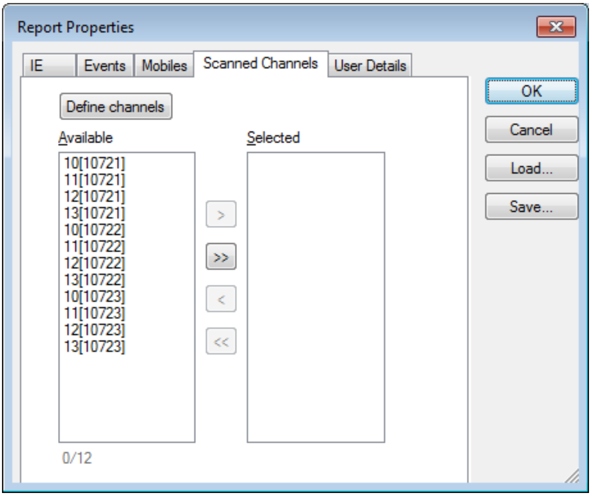
In this step you choose what scan data to present in the report.

- First, click the **Define channels** button in order to populate the "Available" box. This dialog appears:



- In the combo box at the top, select the band of interest.
  - For **LTE**, specify an EARFCN range under “Lower limit” and “Upper limit”, then check the desired Cell Identities in the list box. The cell selection applies to all EARFCNs within the chosen range.
  - For **WCDMA**, specify a UARFCN range under “Lower limit” and “Upper limit”, then check the desired scrambling codes in the list box. The scrambling code selection applies to all UARFCNs within the chosen range.
  - For **GSM**, just check the desired ARFCNs in the list box.
  - For **TD-SCDMA**, specify a UARFCN range under “Lower limit” and “Upper limit”, then check the desired CPIs in the list box. The CPI selection applies to all UARFCNs within the chosen range.
  - For **CDMA**, specify an RF channel range under “Lower limit” and “Upper limit”, then check the desired PNs in the list box. The PN selection applies to all RF channels within the chosen range.

- Click OK to return to the Report Properties dialog. It might look like this:



The “Available” list box now lists the selected channels in the following format:

- **LTE:** m[f] means Cell Identity *m* on EARFCN *f*.
- **WCDMA:** m[f] means scrambling code *m* on UARFCN *f*.
- **GSM:** m[p] means ARFCN *m* on the *p* MHz band.
- **TD-SCDMA:** m[f] means CPI *m* on UARFCN *f*.
- **CDMA:** m[f] means PN *m* on RF channel *f*.

- Move the items that you wish to present from the **Available** box to the **Selected** box.

For each selected item, the report will contain signal strength statistics (mean, median, min, max) and a bar chart. The averaging takes place in the mW domain.

10.8.5. User Details Tab

Here you can type a user name and a report number which will be printed in the report header.

10.8.6. Saving and Loading Report Setups

When you are done specifying the report contents, you may want to save the setup for future use.

- In the Report Properties dialog, click **Save** and store the file where appropriate. The file extension is .rpt.
- To load a previously saved setup into the Report Properties dialog, click **Load** and locate the setup file.

10.8.7. Generating the Report

- In the Report wizard, click **Finish**.

The report will be stored under [My] Documents\TEMS Product Files\TEMS Investigation 15.3\GeneratedReports.

10.8.8. Report Contents

The logfile report has the following main sections (see the Technical Reference, chapter 10 for a complete description):

- Header: Date, Time, Prepared by
- Logfile information: Logfile names and used equipment
- Worst cell indication: Ranking of cells based on thresholds crossed and events triggered
- Thresholds: Detailed statistics on how often and in what cells each threshold has been crossed
- Events: Statistics on events
- Scan data: Statistics on the signal strength of scanned channels (if any)
- Distribution charts for thresholded parameters
- Distribution charts for scan data (if any)

The output involving cell data naturally requires a cell file in order to be generated.

10.9. RouteFinder™

RouteFinder is a stand-alone utility for searching logfiles in TRP format recorded with TEMS products. RouteFinder can be launched from the main window toolbar (see section 3.3.4) or from the **Logfile** menu. The functions of this utility are covered in the RouteFinder User’s Manual.

10.10. RouteUtility™

RouteUtility is another stand-alone tool supplied with TEMS Investigation. It can be used to:

- Extract a selected time interval from a TRP logfile into a new logfile.
- Split a TRP logfile into several self-contained logfiles:
  - One for each participating data-collecting device.
  - One for each area visited, as defined by polygons in GPX-format files.

For full coverage of this utility, see the separate RouteUtility User’s Manual.

11. The Pinpoint Window

11.1. Introduction

The **Pinpoint Window** is designed to further facilitate pinpointing of indoor routes by enabling the construction and use of **pre-planned routes**, similar to those in TEMS Pocket (version 11.x and later). Alternatively, you can also pinpoint **manually** in this window.

Please note that the Pinpoint Window is not a subtype of the **Map** window (see chapter 33) but is distinct from it. Pre-planned routes can be created only in the Pinpoint Window; Map window pinpointing is always manual (see section 10.1.4).

The Pinpoint Window supports loading of map sets in the **iBwave** container format (as does TEMS Pocket) and in a number of other formats. When you save a map set that you have modified in the Pinpoint Window (by defining planned routes in it), the iBwave format is always used.

It is also possible to load **unpositioned images** into the Pinpoint Window and save such images as an unpositioned iBwave container. The pinpointing is then done with reference to image pixel coordinates alone; the images must be georeferenced later on in order to have routes positioned in terms of latitude and longitude.

Logfiles that you record in the Pinpoint Window are created in the regular TEMS Investigation format (*.trp). Such logfiles incorporate the map set used.

A user-selected group of **information elements** (one for each radio access technology, for example, an element denoting signal strength) is presented in the form of markers drawn along the route, both during pinpointing and when loading and studying a pinpointed logfile.

11.2. Creating Planned Routes

11.2.1. Opening a Map Set

- Click the **Open** button and browse to select a map set file.

Map images of arbitrary size can be loaded, but please note that image files larger than 75 MB (pixel width × pixel height × 4 > 7.5×10^7) will be displayed at reduced resolution in the Pinpoint Window.

11.2.1.1. Supported File Formats Holding Map Sets

Some of these file types are pure map set formats, while others may include a map set in addition to their regular contents.

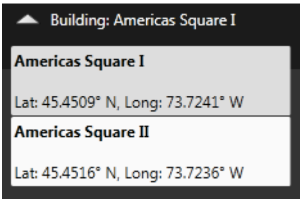
- TEMS Investigation logfile (*.trp, version 14.0 and later) created during a previous route walk or manual pinpointing session in the Pinpoint Window
- iBwave collection (*.ibwc): used as map set format in TEMS Pocket 11.3 and later
- TEMS Pocket 11.0–11.2 map set file (*.pms)
- TEMS Pocket logfile, versions 11.x, 12.x (*.tpz, *.zip)
- TEMS Pocket 7.3 logfile (*.zip)
- MapInfo TAB file (*.tab)

In addition, image files can be loaded and used as unpositioned maps; see section 11.2.1.3.

11.2.1.2. Map Set Metadata Shown in Pop-out Pane

After you have loaded a map set, the pop-out pane on the right is populated with the following metadata:

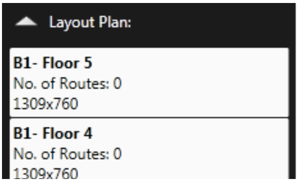
- **Building:** Expand this item to show a list of the buildings contained in the map set. For each building is indicated:
  - **Lat, Long:** Coordinates of the top left corner of the layout plans for each building.



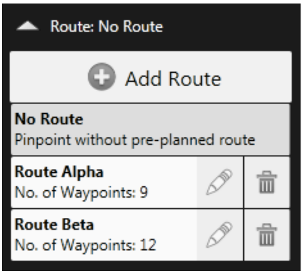
- **Layout Plan:** Expand this item to show the layout plans defined for the selected building. For each layout plan are indicated:
  - The layout plan name

- – The number of routes currently defined for this layout plan
- – The dimensions (in pixels) of the layout plan image.

When you click a layout plan, it is displayed in the map view.



- **Route:** This item holds the routes defined for the plan currently selected under **Layout Plan**.
  - – For each route is stated the number of waypoints it contains.
  - – When you click a route, it is plotted on the map.
  - – Click the  button next to a route to modify the route. See section 11.2.4.
  - – Click the  button next to a route to delete it from the map set.
  - – Click the **Add Route** button to create a new route. See section 11.2.3.
  - – The **No Route** item is used for manual, “freehand” pinpointing without a planned route. See section 11.4.

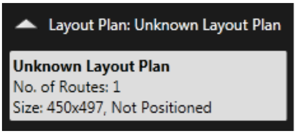


11.2.1.3. Using Unpositioned Images

It is possible to load an unpositioned image (i.e. one without a TAB file accompanying it) into the Pinpoint Window instead of a map set or a file containing a map set. This allows you to put any floor plan image to immediate use for pinpointing without having to position it first. Route waypoints will then be stored simply as image pixel coordinates. Naturally, the image needs to be georeferenced later on to enable geographical positioning of the routes. This can be done for example in TEMS Discovery.

Supported image formats are JPEG, GIF, PNG, and BMP.

When an unpositioned image is loaded into the Pinpoint Window, this is indicated in the pop-out pane as follows:



Pinpointing logfiles (*.trp) are created normally when using an unpositioned image.

An unpositioned image, or a set of images including at least one that is unpositioned, can be saved (along with the associated created routes) as a map set in the regular *.ibwc container format. When you load such a map set back into the Pinpoint Window later on, you will be notified that the map set contains at least one unpositioned image.

Concerning map set related file formats, compare section 11.2.1.1.

11.2.2. Map Handling and Controls

- You can pan the map by dragging.
- The slider on the left is a zoom control. The current zoom level is indicated by the figure below the slider. You can also zoom in and out using the mouse scroll wheel.

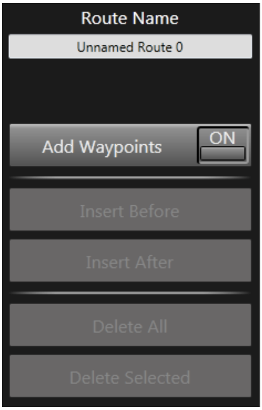
Click the “home” button to set the zoom to native map size (zoom level = 1.0) and place the map image in the top left corner of the Pinpoint Window.

11.2.3. Creating a New Route

- Click the **Add Route** button.

A new route appears in the route list, provisionally named “Unnamed Route <n>”. At the outset, of course, it contains no waypoints.

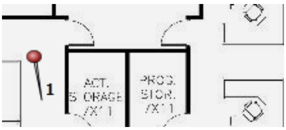
Click this button next to the route to start creating it. The contents of the pop-out pane are replaced.



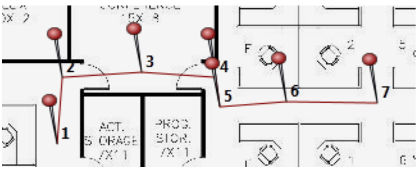
- In the **Route Name** field, enter a name for the new route.

The route is created as a chain of waypoints. The **Add Waypoints** button is toggled “ON” in this situation to indicate that you are currently in “edit route” mode.

- Pan and zoom the map if necessary to locate the spot where you want to place your first pinpoint.
- To add a waypoint, just click in the desired location. The waypoint is marked by a pin symbol and labeled with a sequence number, starting at “1”.



- Keep adding waypoints to trace your planned route. Each time you place a new waypoint, it is joined to the previous one by a connecting straight line.



It is appropriate to place waypoints no further than 10–20 s apart in terms of walking time. Also add a waypoint wherever the walking direction changes. Most importantly, of course, the waypoints should be located in such a way that the entire route (as defined by the connecting line segments) is "walkable". In other words, the planned route should not pass through walls or other impassable obstacles, since measurements will then subsequently be positioned incorrectly along those segments.

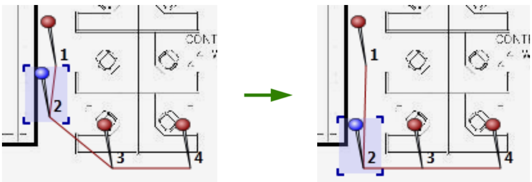
- When you are done creating your planned route, click the **Done** button.
- Click **Save** to save the new route as well as any other changes you have made to the map set. The target format is always *.ibwc (iBwave collection).

How to modify your route in the course of creating it is the topic of the next section.

11.2.4. Editing a Route

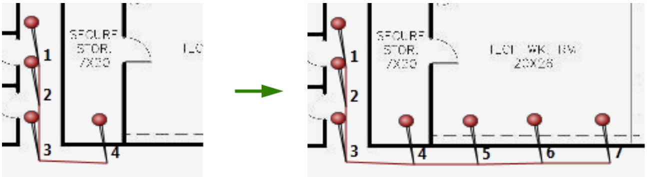
If the route you want to edit is not already loaded in the window, click the "pencil" button next to it in the pop-out pane. The route is then loaded.

- To *move* a waypoint to a new location, just click and drag the pin where you want it. When a pin is selected, it is highlighted by a shaded bounding box, and its head turns blue.



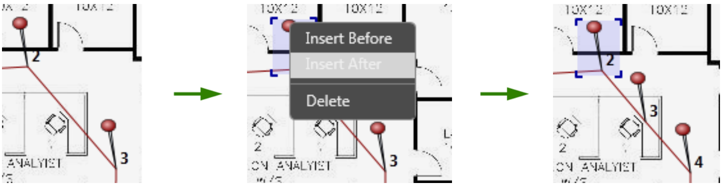
(If **Add Waypoints** is "ON", you must take care not to release the mouse button without dragging, since such an action will add a new waypoint instead. It is most convenient to turn **Add Waypoints** "OFF" before rearranging waypoints.)

- To *add* waypoints at the end of the route, toggle the **Add Waypoints** button "ON". Then click on the map where you wish to place the new waypoints. The first new waypoint is automatically connected to the last waypoint of the existing route. When you have finished, click the **Done** button to exit "edit route" mode.



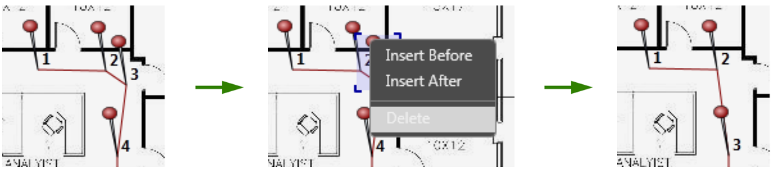
- To *insert* a new waypoint somewhere along the existing route, you can choose between two methods:
  - One method is to right-click the waypoint nearest to the spot of interest, then select **Insert Before** or **Insert After** from the context menu that appears.
  - The other method is to select the relevant waypoint and then click one of the buttons **Insert Before** or **Insert After** in the pop-out pane.

  A new waypoint is now added halfway between the selected one and the one preceding or following it. Adjust the position of the new waypoint by dragging it.



- To *delete* a waypoint, you can again proceed in two ways:
  - Right-click the waypoint and choose **Delete** from the context menu, or:
  - Make sure **Add Waypoints** is toggled “OFF”, then select the waypoint of interest and click the **Delete Selected** button.

  The delete operation removes the pin symbol from the map view, and the waypoints adjacent to the one deleted are joined by a new connecting line.



- To *delete all* waypoints, click the **Delete All** button.
- You can edit the *route name* in the **Route Name** field.

Please note that it is not possible to edit a route in this way while walking it, that is, during recording (see section 11.3.1). However, it is possible during a walk to add further waypoints at the end of the route. How to do this is covered in section 11.3.4.

11.2.5. Deleting a Route

To delete a route from the map set, click the “trash can” button next to the route in the pop-out pane.

11.2.6. Unloading a Map Set

There is no explicit function for unloading a map set. When you load a new map set, the previous one is unloaded automatically.

11.3. Walking Planned Routes

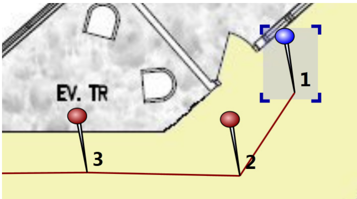
This section tells how to walk a pre-planned route. A recorded walk along a planned route is referred to as a *track* in TEMS Investigation parlance.

It should be pointed out straight away that a track can be less complex, or more complex, than the route it follows. This is because you can skip waypoints or, conversely, visit some waypoints more than once. The logfile of the track records all of your movements as reflected by your commit actions.

11.3.1. Loading and Walking a Route

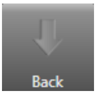
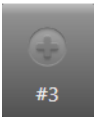
- Load the desired map set by clicking the **Open** button.
- Next, select the planned route of interest among those defined in the map set.

The planned route is drawn in red between waypoints whose pins are likewise colored red. The map is centered around the first waypoint, which is highlighted in blue and enclosed within a shaded bounding box.



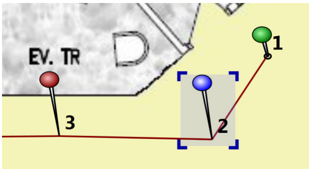
- Go to the physical location marked by the first waypoint.
- Click the **Start** button to start recording your track. You are asked where to save the resulting logfile. This file is created in the regular TEMS Investigation logfile format (*.trp), which also accommodates the auxiliary pinpoint data.

The following controls appear in the pop-out pane:

Control	Function
	**Forward** button: Advance to the next waypoint without committing the current one.
	**Back** button: Retreat to the previous waypoint without committing the current one.
	**Commit** button: Commit the current waypoint (whose sequence number labels the button) to the route walk and move on to the next waypoint. When you perform the commit action, all measurements collected since your last commit are positioned in a straight line between this waypoint and the one you last committed. The first time you commit, all measurements collected so far are positioned at that waypoint. You should therefore always commit the first waypoint immediately on starting logfile recording. If you skip one or several waypoints, they are left out of account when data is positioned; see also section 11.3.3. Clicking the **Commit** button triggers the Pinpoint Added event.

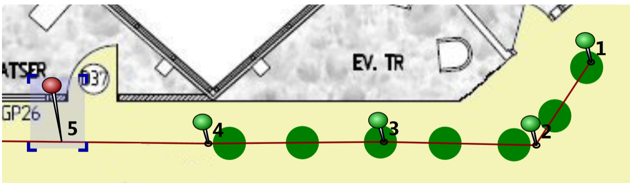
Control	Function
	**Stop** button: Stop the test walk and close the track. If you click **Start** again with the same route still loaded, you will begin a new track which is saved as a distinct logfile (unless you choose to overwrite the previous one).

As soon as you have started recording, click the **Commit** button to indicate that you are currently in the highlighted location (“#1”). The pinhead turns green and the pin is redrawn “pressed down” (shorter) to indicate that you have visited this spot. The highlighting switches to the next waypoint, and the map is re-centered around it.

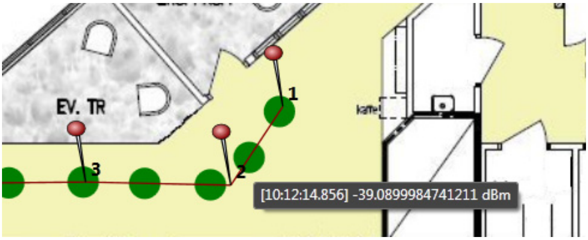


Walk in a straight line and at a steady pace towards the waypoint now highlighted. When you have reached that waypoint, click the **Commit** button again (now labeled “#2”).

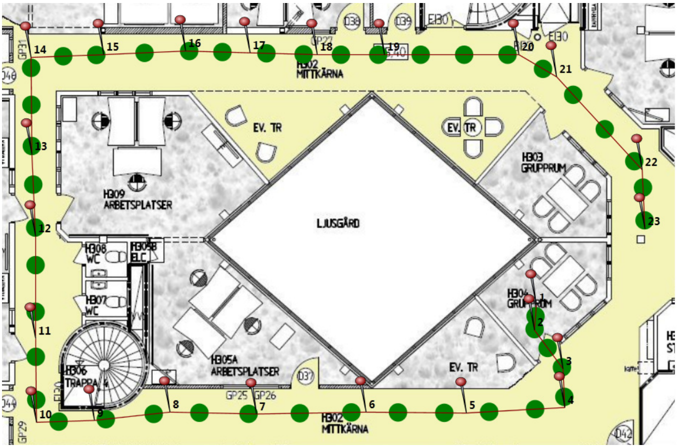
- As you walk the route, dot-shaped markers are filled in along the route segments you have covered. These markers encode the value of an information element, as detailed in the legend in the top left corner of the Pinpoint Window. You can configure the IE presentation as explained in section 11.5.



- When you mouse over an information element marker, a tooltip appears with a timestamp and the IE value at that point:



- Continue walking and committing waypoints until you have completed the route. Below the Commit button in the pop-out pane is a stack of boxed items representing your latest commits. For each commit action is shown at what waypoint it occurred, and when ("hh:mm:ss").



11.3.2. Repeating Parts of a Route

It is possible to backtrack along the route using the **Back** button, and commit the same waypoint multiple times. Doing so simply adds more data to the logfile, and the positioning of measurements is always based on your movements between waypoints (regardless of how you retrace your steps). No previously recorded data is ever deleted from the logfile, and committing a waypoint once again does not in any way override the previous commit action.

If for some reason you need to take a break during a test walk, it is best to proceed as follows:

- Walk up to the next waypoint of the route and commit it before taking your break.
- When resuming your test walk, click **Back** and commit the same waypoint once more before you continue.

This procedure ensures that the measurements collected during the pause and along the next route segment to follow will be positioned accurately.

To avoid these complications, it is advisable not to take extended pauses while walking and recording a track.

11.3.3. Skipping Waypoints of a Route

You can skip waypoints without committing them, using the **Back** and **Forward** buttons. This is useful if you cannot get to a waypoint, for instance because it is behind a locked door. Please bear in mind, however, that this effectively removes the waypoint from the track when it comes to the positioning of the recorded data; the measurements will be positioned along a straight line between the adjacent retained waypoints. A "shortcut" might thus be created that goes through walls or other obstacles – compare the advice given in section 11.2.3 on the preparation of planned routes.

11.3.4. Adding New Waypoints at the End of a Route

It is possible to add waypoints to a route while walking it. This is done simply by clicking the desired spot on the map.

A waypoint added during a test walk is always appended *at the end* of the route and joined to the current last waypoint. For this reason, only use this function after you have reached the final waypoint of the original route – unless you wish to skip part of that route and go somewhere else. When you add a waypoint, the IE marker trail is always drawn from the last waypoint visited to the new one, regardless of whether the trail will bypass part of the route.

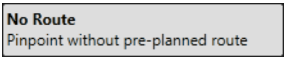
When a waypoint is added, it is automatically committed at the same time.

11.4. Pinpointing Without a Planned Route

In the Pinpoint Window you can alternatively place waypoints manually to indicate your trajectory as you go, without following a planned route. This "freehand" pinpointing is similar to the procedure used in a Map window (described in section 10.1.4), except that it always involves logfile recording.

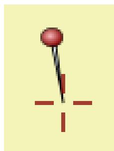
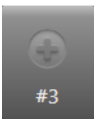
Here is how to do manual pinpointing:

- Load the map set you want to use by clicking the **Open** button.
- Instead of selecting a route, click the "**No Route**" item.



- Click the **Start** button. This initiates recording of a logfile, and you are prompted for a location in which to save it. The logfile is created in the regular TEMS Investigation logfile format (*.trp), which also accommodates the auxiliary pinpoint data.

The following controls appear in the pop-out pane:

Control	Function
 	The **Mouse** and **Crosshair** buttons are used to select pinpointing mode. These modes are just two different methods of placing waypoints; they do not affect the positioning itself or how it is represented in the logfile. You can toggle between the two modes at any time.
	Mouse: In this mode, you simply click a spot on the map to place a waypoint in that spot. The waypoint is automatically committed. You may of course need to pan the map first to bring the relevant part of it into view.
	Crosshair: In this mode, a large red-headed pin with a crosshair appears at a fixed position in the map view. Pan the map so that the pin marks your current position, then click the **Commit** button to place a waypoint there. 
	**Commit** button: Place a waypoint at the current position. This button is used only in Crosshair mode, as explained above. The button is then always labeled with the sequence number of the next waypoint to be added.
	**Stop** button: Stop pinpointing and close the logfile.

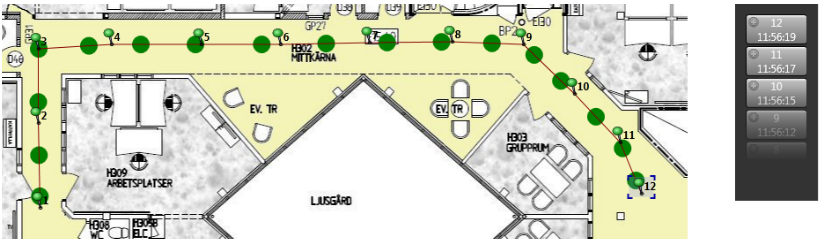
- The default pinpointing mode is Mouse. If you prefer Crosshair mode instead, click the **Crosshair** button.
- As soon as you have started recording, pinpoint once to indicate your starting position. All measurements collected so far are positioned at that waypoint. A pin with a green head is drawn in the map view to mark the spot.
- Continue along your intended trajectory, pinpointing at regular intervals and whenever you change direction. Also keep a steady pace between waypoints. (When you perform a commit, all measurements collected since your previous commit are positioned in a straight line between the two waypoints.)

Each time you place a new waypoint it is highlighted, and the map is re-centered around it.

Each time you place a new waypoint, a Pinpoint Added event is triggered.

Below the Commit button in the pop-out pane is a stack of boxed items representing your latest waypoints. For each waypoint, its sequence number and time of creation (“hh:mm:ss”) are displayed.

IE markers are plotted along the route just as when walking a pre-planned route; compare section 11.3.1.

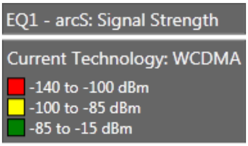


- When you are done with your test, click **Stop**. This closes the logfile. You are also asked whether you want to save the waypoints you have placed as a route in the map set. If you do, the new route will appear in the pop-out pane listing as “Unnamed Route <n>”. Naturally you can change that name if desired.

11.5. Configuring Presentation of Route Data

First off, it should be remarked that when loading a pinpointed logfile, route data is displayed in the same way as during the pinpointing itself.

The *legend* in the top left corner of the Pinpoint Window shows the following for an activated device:



- Equipment designation ("**EQn**") and device model (here, Sony Xperia arc S).
- The family of information elements currently presented for this device: for example, "Signal Strength". When the device switches to a different RAT, the element is by default automatically replaced by its equivalent in the new RAT, as detailed in the tables of section 11.5.1.
- Color coding of information element values.

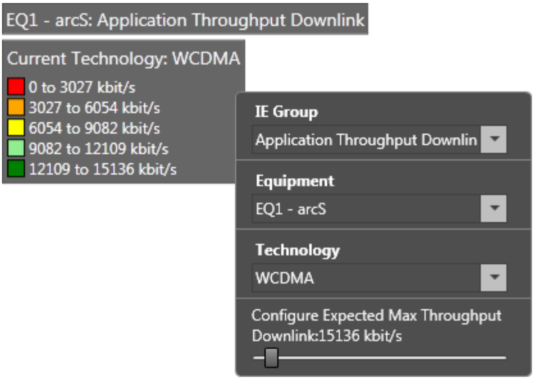
You can configure the appearance of the legend and the presentation of route data by right-clicking the legend. A context menu opens:

IE Group The family of information elements displayed in the Pinpoint Window. See section 11.5.1.

Equipment The device to show in the legend. If multiple devices are present, data can only be displayed from one of them.

Technology The radio access technology from which to display an information element. The default setting "**Auto**" means that the IE presentation adjusts automatically according to what RAT the device is on, as explained above.

For application-level throughput and PHY throughput, a slider appears that allows you to set the expected maximum value and thus obtain color ranges suited to the current technology and radio conditions.



The tables that follow spell out exactly which information elements are spanned by the various IE groups.

From array IEs, the *first* value in the array (lowest argument) is always picked, unless otherwise indicated below.

11.5.1. Members of IE Groups

RAT/ IE Group	Signal Strength	Signal Quality	RSSI
GSM	RxLev Sub (dBm)	RxQual Sub (%)	RxLev Sub (dBm)
WCDMA	Serving CPICH RSCP	Serving CPICH Ec/No	UTRA Carrier RSSI
LTE	Serving Cell RSRP (dBm)	Serving Cell RSRQ (dB)	Serving Cell Channel RSSI (dBm)
TD-SCDMA	Serving P-CCPCH RSCP	Serving P-CCPCH Ec/No	Serving Carrier RSSI
CDMA	Active Set Ec	Active Set Ec/Io	Active Set Serving Io
Wi-Fi	RSSI	–	RSSI

RAT/ IE Group	PHY Throughput DL	PHY Throughput UL
GSM	RLC Throughput DL (kbit/s)	RLC Throughput UL (kbit/s)
WCDMA	RLC/Trsp DL Throughput (Best)	RLC/Trsp UL Throughput (Best)
LTE	PDSCH Phy Throughput	PUSCH Phy Throughput
TD-SCDMA	RLC DL Throughput (kbit/s) – *sum over all arguments*	RLC UL Throughput (kbit/s) – *sum over all arguments*
CDMA	RLP DL Throughput (kbit/s)	RLP UL Throughput (kbit/s)
Wi-Fi	–	–

RAT/ IE Group	Application Throughput DL	Application Throughput UL
GSM	Application Layer Throughput Downlink	Application Layer Throughput Uplink
WCDMA		
LTE		
TD-SCDMA		
CDMA		
Wi-Fi		

RAT/ IE Group	Signal Strength (Scanner)	Signal Quality (Scanner)	RSSI (Scanner)
GSM	Scanned RxLev (dBm)	Scanned C/I	Scanned RxLev (dBm)
WCDMA	Sc 1st Aggr Ec (dBm)	Sc 1st Aggr Ec/Io (dB)	Sc 1st Io
LTE	Sc 1st RSRP (dBm)	Sc 1st RSRQ (dB)	Sc 1st Channel RSSI (dBm)
TD-SCDMA	–	Sc 1st Ec/Io (dB)	Sc 1st Io (dBm)
CDMA	–	Scanned 1st Freq. Ec/Io	Scanned 1st Freq. Io
Wi-Fi	–	–	–

11.6. Adjusting the Waypoint Interpolation Cache

While you are pinpointing a route, an internal cache is maintained which stores the messages accumulating in between pinpoints. After you place a new waypoint, the messages in the cache are positioned along the resulting new route segment, whereupon the cache is flushed.

By default, the cache can hold up to 5,000 messages. This is amply enough in most situations; however, in highly demanding device and service configurations (e.g. with multiple LTE devices connected and running services at high data rates), the default cache size may be insufficient. If the cache does fill up before you place your next waypoint, then all of the cache contents are discarded, and the measurements recorded during this time are neither positioned nor plotted. The cache size can therefore be adjusted as follows:

- From the **File** menu, choose **Options**, then choose **General**.
- Set the size of the interpolation cache. The maximum is 40,000 messages.

Changing the value takes effect immediately (a registry setting is edited).

11.7. Relation to Other TEMS Investigation Functions

11.7.1. Data Presentation

Currently there is no presentation of information elements or other measurement data in the Pinpoint Window. However, you can of course have any presentation windows open side by side with the Pinpoint Window and inspect measurement data there.

Note also that you can have your walked track plotted in a Map window, in live mode as well as during analysis.

11.7.2. Coexistence Issues

While you are recording a logfile in the Pinpoint Window (whether pinpointing manually or walking along a pre-planned route), the following applies:

- You can start recording of other logfiles by other means (using the manual controls or running a script). However, these recordings will automatically be positioned according to the Pinpoint Window waypoints, and not by any other source.

- Clicking **Stop Recording** on the main window toolbar has no effect on the Pinpoint Window.
- Scripts can run independently of what is being done in the Pinpoint Window. A **Start Recording** activity in a script will start a new logfile, but note again that the positioning will be governed by your actions in the Pinpoint Window.
- Having a GPS activated in TEMS Investigation does not affect the Pinpoint Window in any way.

Conversely, while logfile recording initiated by other means is in progress, it is possible to start another recording in the Pinpoint Window. The ongoing recording will not be affected; it will keep the positioning source that was preferred in TEMS Investigation when the recording began. However, starting to record in the Pinpoint Window automatically redefines the preferred positioning source as pinpointing, so that any subsequent recordings initiated while the pinpointing is still active will be positioned according to the pinpointing data.

In summary, all methods of logfile recording can be used independently without restrictions, but the positioning source is not unique to each recording.

11.7.3. Planned Routes

Planned routes created in the Pinpoint Window have no relation whatsoever to planned routes in GPX format, which are associated with outdoor, GPS-based positioning and can be loaded for display in Map windows (see section 8.4.2).

12. Service Control

12.1. Introduction to Service Control

The Service Control tool is used to compose **scripts** that automate service testing – PS as well as CS. Scripting guarantees consistency of measurements, with tests being executed in a uniform and rigorously controlled manner. Scripts also allow you to create advanced testing setups that would be awkward or impossible to manage by operating devices manually.

The range of application of Service Control scripts is as follows:

- Circuit-switched **voice** and **video calls** are supported.
- **Data service testing** encompasses the following services and protocols: ABM, email, FTP, HTTP, MMS, Ping, SMS, TCP, UDP, video streaming, VoIP, and WAP. Which of these are testable for particular cellular technologies is tabulated in section 12.2. With multiple devices activated, multiple data connections can be maintained concurrently.[1]
- **Scanning** can be scripted for all devices indicated in the introduction of chapter 16.

Special activities are available:

- for **recording** data collected while executing the scripts. The recordings will be regular logfiles (extension .trp).
- for applying various **control functions** to devices, such as RAT lock and band lock
- for **AT commands**.

1. Exception: See the Device Configuration Guide, chapter 9 regarding Ericsson Fixed Wireless Terminals.

12.2. Capabilities of Devices

Apart from technology-related restrictions as noted in section 12.3, phone devices *sold* with TEMS Investigation 15.3 (listed in the Device Configuration Guide, section 2.2.1) normally support all types of script activities.

12.3. Supported Services by Cellular Technology

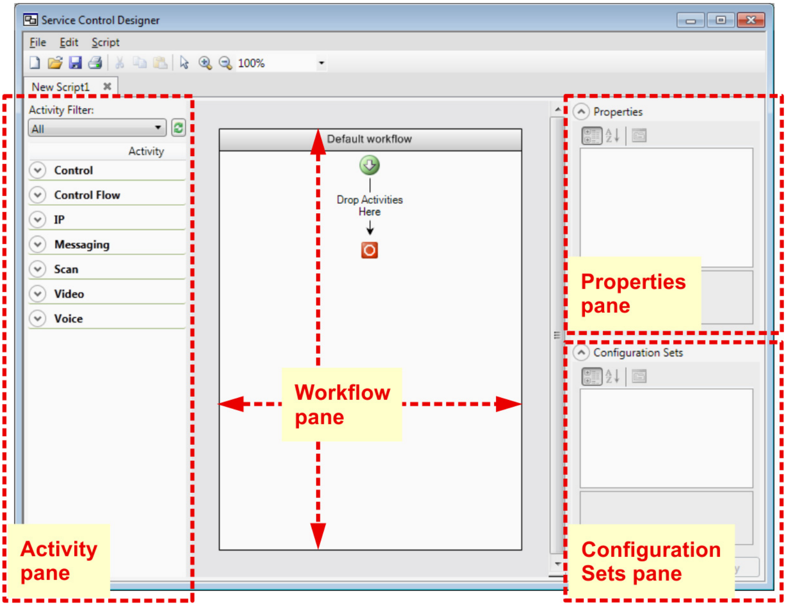
Service/Technology	**UMTS**	**LTE**	**TD-SCDMA**	**CDMA**
CS voice calls	✓		✓	✓
CS video calls	✓		✓	
ABM	✓	✓	✓	✓
Email	✓	✓		✓
FTP	✓	✓	✓	✓
HTTP	✓	✓	✓	✓
MMS	✓	✓		
Ping	✓	✓	✓	✓
SMS[1]	✓	✓		✓
TCP	✓	✓	✓	✓
UDP	✓	✓	✓	✓
Video streaming	✓	✓	✓	✓
VoIP	✓	✓	✓	✓
WAP	✓	✓		✓

1. CDMA: Qualcomm chipset based devices only.

For scanning, there are no technology-related restrictions. What scanning devices can have their actions scripted is stated in chapter 16 (introduction).

12.4. The Service Control Designer

The **Service Control Designer** window is where you compose service control workflows (scripts):



- The **Activity** pane is a palette holding all script building blocks: for running services, for controlling devices, and for execution flow control.
- The **Workflow** pane is the area where you assemble your script graphically in the form of a flowchart.
- The **Properties** pane contains properties of the activity that you are currently working with (the one currently selected in the Workflow pane).
- In the **Configuration Sets** pane you define various entities that can be reused in any script, for example all the details of accessing a particular FTP server.

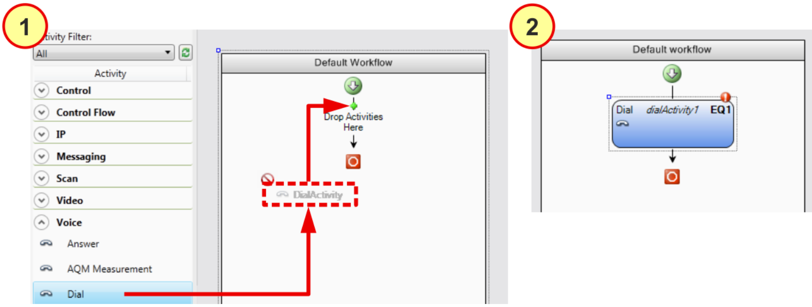
In the Properties and Configuration Sets panes, items can either be grouped into categories or be listed in alphabetical order; use the buttons at the top to toggle between the two display modes. At the bottom of each pane is a box showing an explanation for the item currently selected.

The rest of this chapter is organized as follows. First comes a hands-on tutorial on how to build and run scripts, with numerous screenshots and examples (sections 12.5–12.15). Then follows a reference part cataloging all script activity types with their properties and associated configuration sets (sections 12.16–12.17). Finally some additional features of the Service Control tool are covered, and some reference material is given (sections 12.18–12.19).

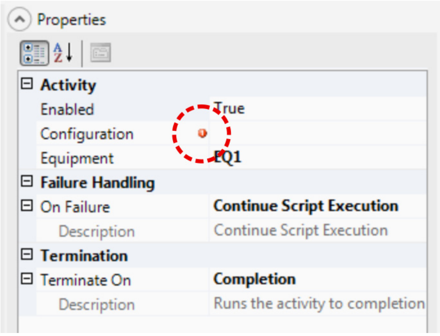
12.5. Basics of Creating Scripts (with Voice)

This section covers the fundamentals of creating a complete and valid script that is ready to be run. For purposes of illustration we will build a very simple script that dials single voice calls. Video calls are handled in similar fashion.

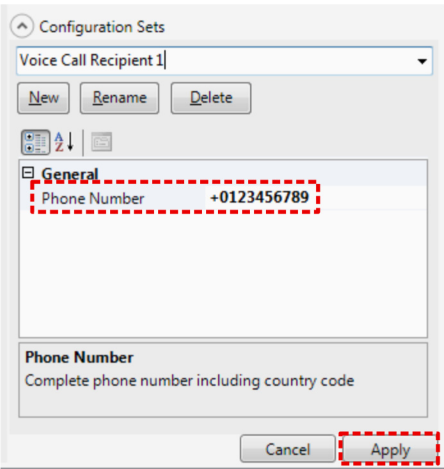
- Add a voice dial activity to the script. To this end, expand the **Voice** node in the **Activity** pane and drag the Dial item to the empty workflow. (The cross-reference here, just like others that follow, points to the reference section 12.16.)



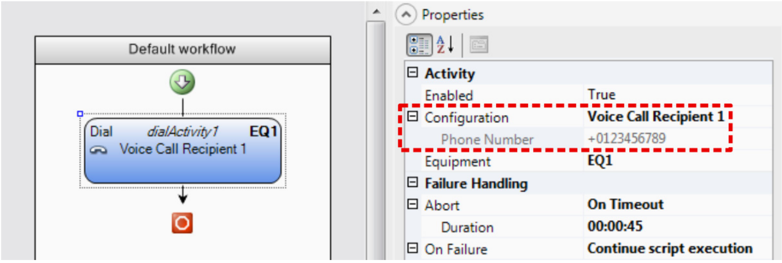
- The Dial box is tagged by an *exclamation mark*. This means that the activity is not yet properly configured. A similar exclamation mark in the **Properties** pane indicates the property that is undefined: “Configuration”.



- What we need to do is to define a configuration set for the Dial activity. This is done in the **Configuration Sets** pane. For a voice dial, the configuration consists simply of the phone number to call. (In other cases it can be more complex, as will be seen later.)
- Give the configuration a suitable name, such as one identifying the subscription having this number. The example below uses a neutral designation “Voice Call Recipient 1”, for which you will probably want to substitute something more specific.
- Finish by clicking the **Apply** button.

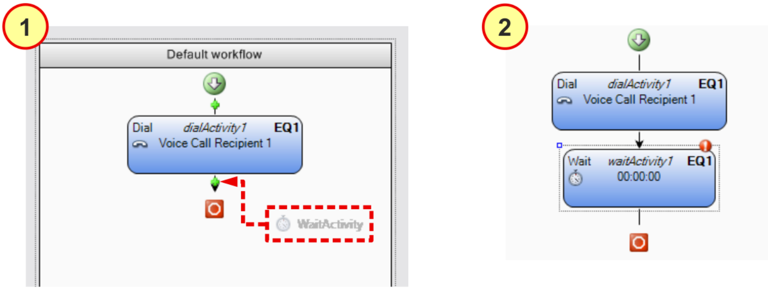


- The Properties and Workflow panes are now updated with the configuration data.

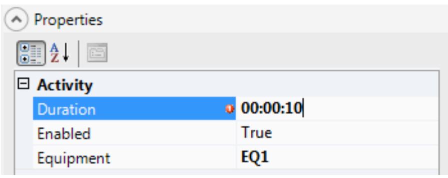


When just dialing a call like this, it will not have a duration. The call will be established and then immediately hung up (since the script has run to completion). To give duration to a call, use the Wait activity: compare section 12.10.5.

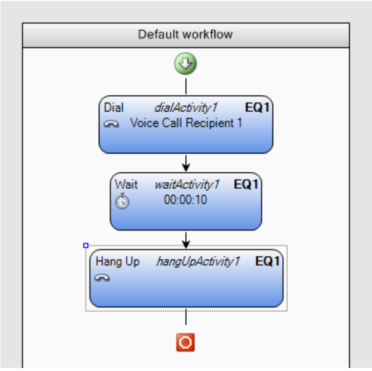
- Drag the **Wait** activity to a position just below the voice dial box. The graphical user interface helps you position the Wait box correctly by means of guiding symbols and text.



- Set the duration of the wait in the Properties pane:



- Finally, add a Hang Up activity after the wait.

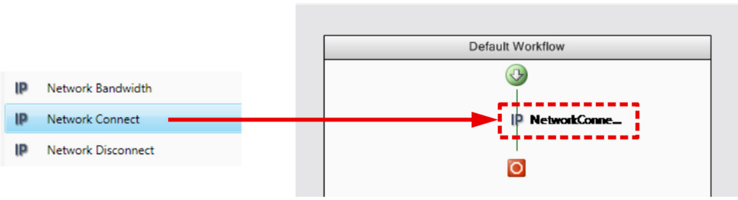


If you want the script to control both caller and receiver, turn to section 12.10.4 for guidance.

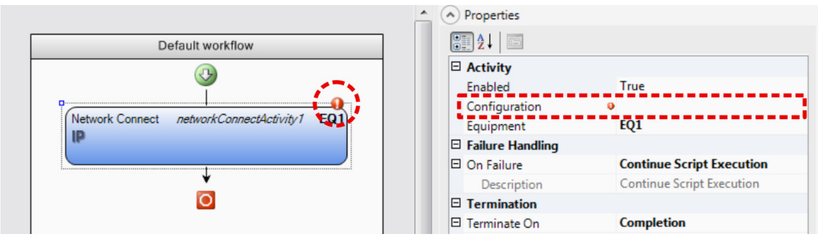
12.6. Setting Up a Network Connection

This section shows how to set up a network connection, which is a necessary preparation for running data services.

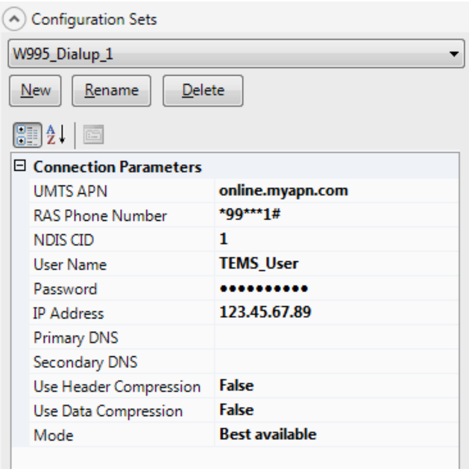
- Expand the **IP** node in the Activity pane and add a Network Connect activity to the script.



- Again you will be notified that a matching configuration is missing:



- A configuration for a data connection is created in the same way as one for voice, only it contains many more parameters. In particular, you need to specify whether to use RAS or NDIS. See section 12.20.3.2 for full details.



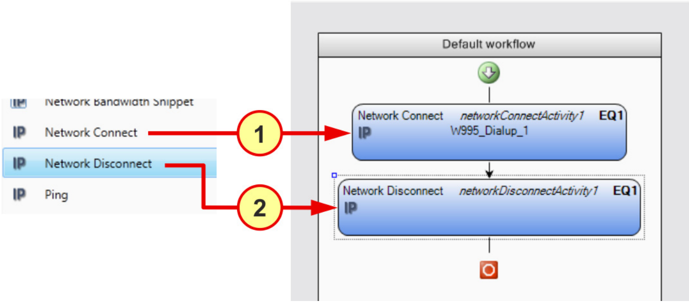
- Once you have the configuration down, point to it from the **Configuration** field in the activity properties. Later on, if you have multiple network connect configurations defined, you can pick and choose among them.

12.7. Setting Up a Data Service Activity

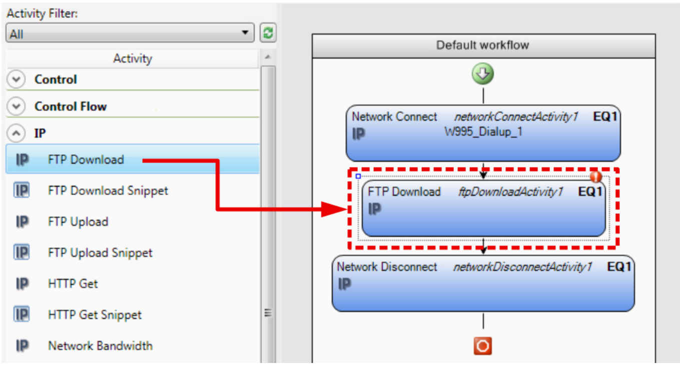
In this section, we will set up an FTP download as an example of a data service activity. We will use the data connection configuration created in section 12.6.

- First add a Network Connect activity. Associate it with the “W995_Dialup_1” configuration set created in section 12.6.

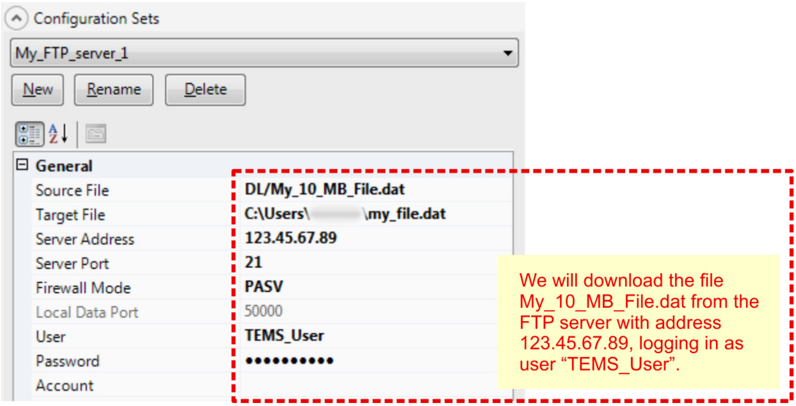
- Then add a Network Disconnect activity at the bottom of the workflow. The disconnect operation will take down the network connection. This activity needs no particular configuration, so you do not need to associate it with a configuration set.



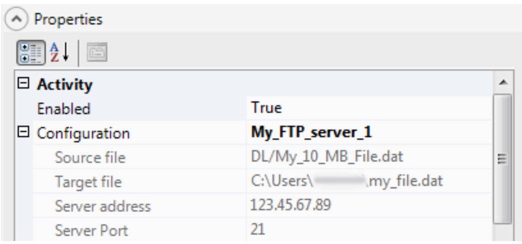
- The FTP session itself is handled by the FTP Download activity. Insert an activity of this type between network connect and disconnect:



- For the FTP Download activity, you need to create a configuration set representing the FTP server and how to access it. Again this is done in similar fashion as for previously created configurations.



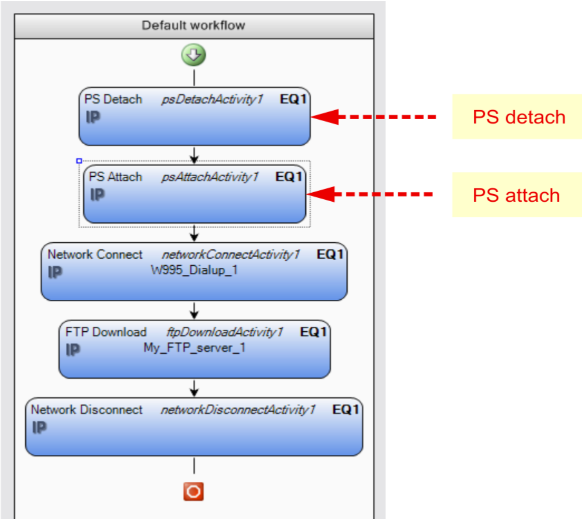
- After completing the definition of the FTP server configuration, reference it from the FTP Download activity in the same manner as before.



12.8. Stand-alone PS Attach and Detach

In this section we will perform explicit PS attach and detach operations in isolation. One reason for doing this could be to measure the time taken by these operations, particularly for the purpose of computing KPIs. We will reuse the configuration sets and activities from sections 12.6 and 12.7.

- We begin with the FTP download workflow from section 12.7.
- At the start of this workflow, add a PS Detach and a PS Attach activity, in that order (they are found in the **IP** category). This will detach the device from the PS network and then reattach the device.



See also section 12.9.

12.9. Snippets

A *snippet* is a fixed sequence of activities that is defined as a building block and can be reused as such, saving time and effort when creating new scripts.

Predefined snippets for all supported services are provided in the Activity pane. For an example of such a predefined snippet in use, see section 12.10.4.

The predefined snippets are also tailored to produce all data required to compute *KPIs*. (The KPI computation itself is done in TEMS Discovery.) Compare chapter 36.

You can also save an arbitrary activity sequence as a user-defined snippet:

- Select all of the activities by dragging the mouse pointer, then enter the **File** menu and select **Save as Snippet**. You are prompted to name and describe the snippet.

Example: The detach-and-attach procedure in section 12.8 could be a good candidate for a user-defined snippet, since it will recur in any script where you want to detach and then reattach to the PS network.

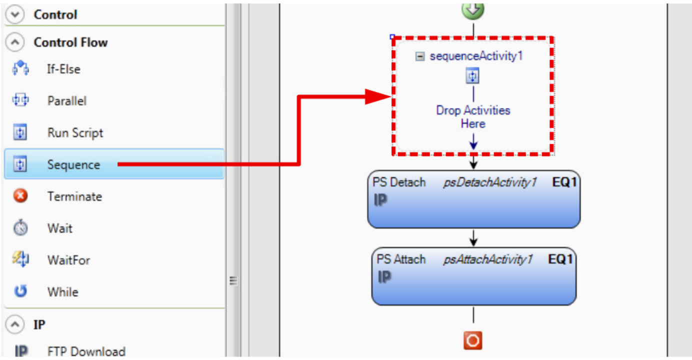
12.10. Workflow Control Structures

The **Control Flow** node in the Activity pane contains a number of logical constructs and timers for controlling the script execution flow.

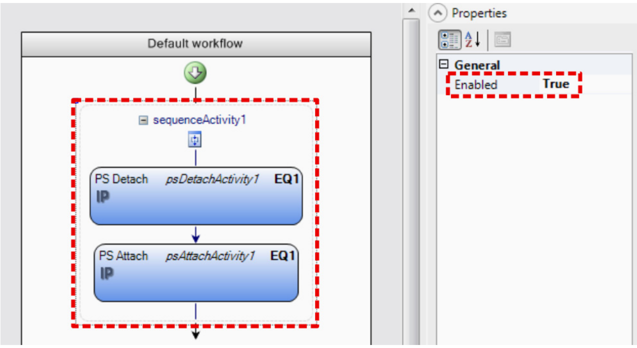
12.10.1. Sequences

You can formally define a group of activities in a script as a *sequence*. This is handy if you want to apply some operation to all of these activities – for example, to enable or disable them.

- Suppose your script includes PS detach followed by PS attach as described in section 12.8. Suppose further that you want a convenient means of turning the detach/attach activities on and off. You can then encapsulate the PS Detach and PS Attach activities within a sequence.
- Expand the **Control Flow** node and from it drag a Sequence activity to a position immediately above the PS Detach activity:



- Select the PS Detach and PS Attach activities by holding Ctrl and clicking each activity, then drag them both (using the PS Detach box as handle) into the sequenceActivity1 box. You can now enable and disable the detach–attach sequence as a whole:



Compare section 12.15.5. For full details on the Sequence activity, see section 12.20.2.5.

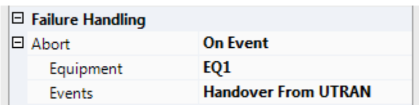
12.10.2. If–Else Constructs

An if–else construct is used to split the execution flow into several branches based on the outcome of a previous activity.

Here is an example. Suppose the device is on a WCDMA network and is instructed to do an FTP download. Now if the device is handed over to GSM, so that the throughput is sharply reduced, then we want to abandon the download, i.e. the activity should terminate. (This is accomplished by imposing a “terminate on event” condition on the activity; see section 12.12.) After a handover to GSM has occurred, we want to proceed with a voice call (which does not require a large bandwidth). If on the other hand the device remains on WCDMA, then after the FTP download has completed we want to continue with a video streaming session.

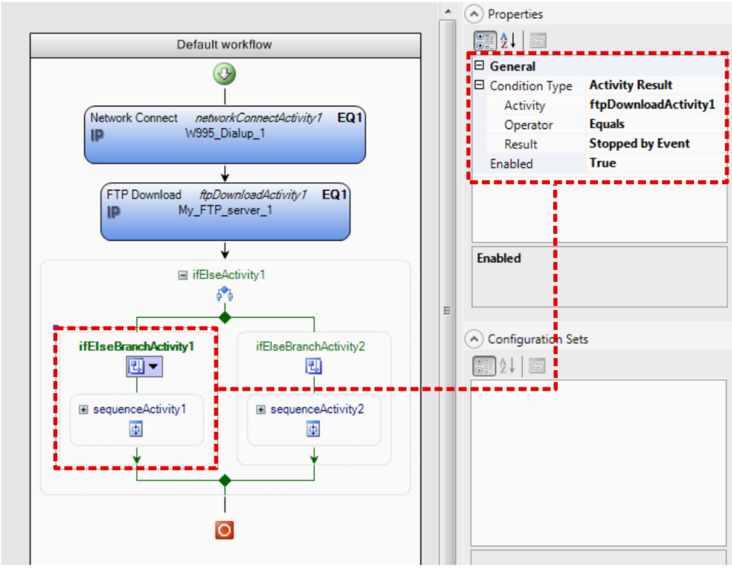
To this end we use an if–else construct in the following manner:

- First add a Network Connect activity, and then an FTP Download activity with the **Abort** property set to **On Event** and “Handover from UTRAN” selected as event type:



- Then add an If–Else activity below the FTP download:

- For the left-hand branch ("ifElseBranchActivity1"), set **Condition Type** to Activity Result, and set the associated attributes as follows: **Activity** = the name of the FTP download activity, by default "ftpDownloadActivity1", **Operator** = Equals, **Result** = Stopped by Event. See next screenshot.
- For the right-hand branch ("ifElseBranchActivity2"), set **Condition Type** to Any. This always evaluates to true, so that the right-hand branch will be executed whenever the condition in the left-hand branch is false. (Not shown in the screenshot below.)



- Add a voice dial activity on the left (to the node "sequenceActivity1") and a streaming activity on the right (to the node "sequenceActivity2"), as described in the introduction of this subsection. This is done just as in sections 12.5 and 12.7 and is not detailed here.

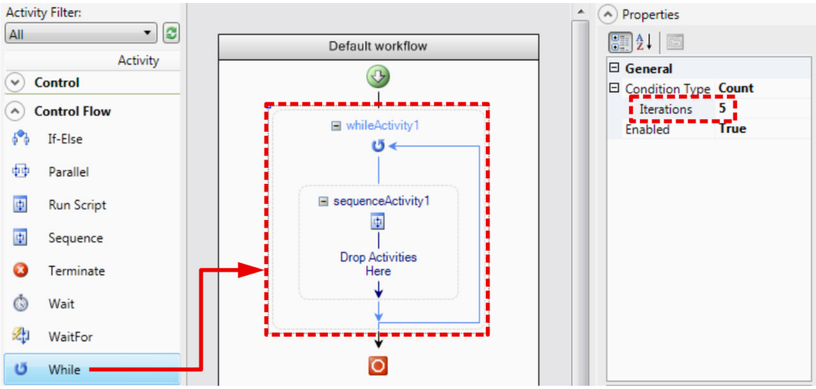
See section 12.20.2.1 for full details on the If–Else activity.

12.10.3. While Loops

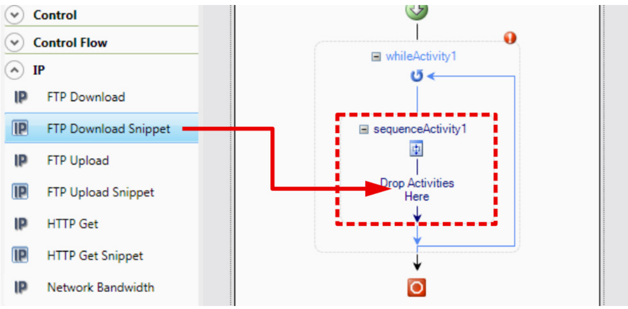
While loops are used to repeat a sequence of activities a predetermined number of times.

- Suppose we want to execute an FTP download five times over.

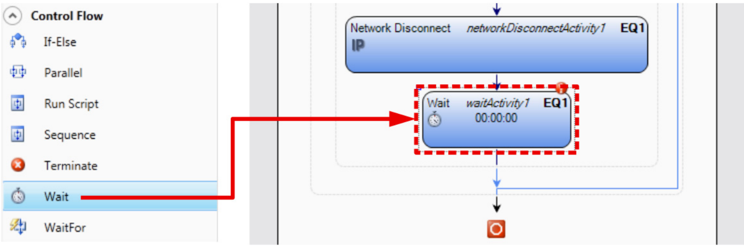
- Begin by dragging While activity to the start of the workflow. (Just as with sequences – compare section 12.10.1 –, you first add the empty While construct to the workflow, then fill it with the desired contents.)
- In the Properties pane, set the number of times you want to iterate the while loop. Below, by entering the value 5, we stipulate that the loop should be run five times in total.



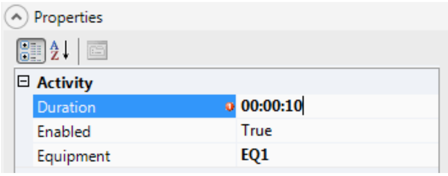
- Now drag the predefined FTP download snippet into the while loop, dropping it onto “sequenceActivity1” in the indicated spot (“**Drop Activities Here**”):



- It may be desirable to insert a brief *pause* after each pass through the while loop. You can accomplish this by appending a Wait activity at the end of the FTP snippet:



- Set the duration of the wait in the Properties pane:



For example, if you set Duration to 10 s, the script will perform five FTP downloads in succession with a 10 s idle interval between downloads.

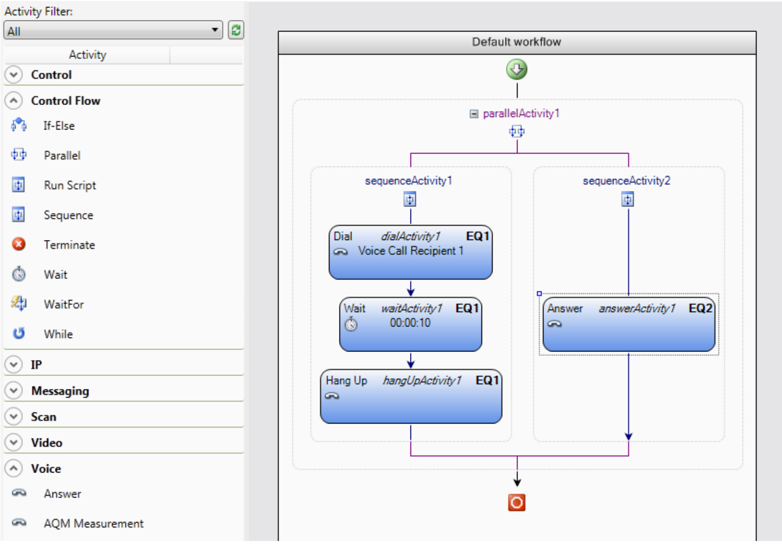
See section 12.20.2.2 for full details on the While activity.

12.10.4. Parallel Activities

All scripts so far have been written for a single device engaged in one activity at a time. However, a script can also control the activities of multiple devices, or assign multiple parallel activities to the same device.

12.10.4.1. Example 1: CS Voice/Video – Caller and Receiver

For example, if one phone is to place a voice or video call to another, caller and receiver must be put in parallel, one dialing and the other answering. To create a branching structure for these concurrent tasks, we use the Parallel activity from the Control Flow category. See the screenshot below, where EQ1 calls EQ2:

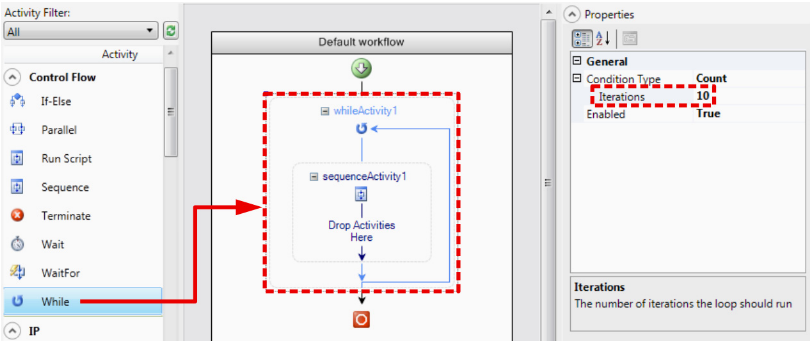


A parallel structure is also recommended for MMS send/receive.

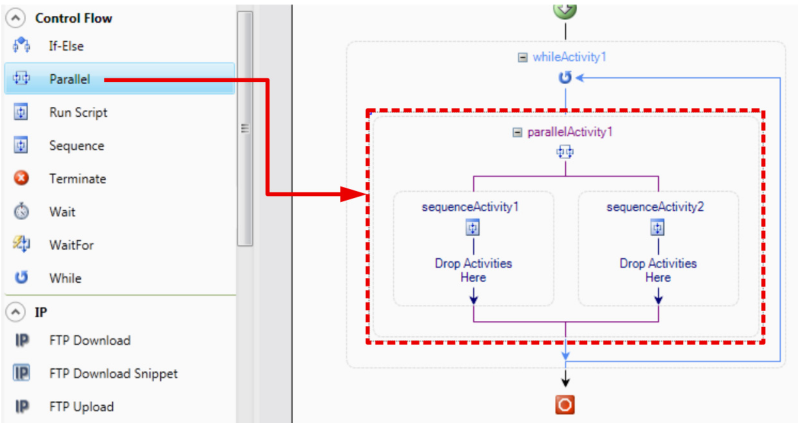
12.10.4.2. Example 2: Concurrent Activities on Different Devices

Next is a slightly more complicated example. Suppose that we want to control three UEs in parallel, one performing downloads over FTP and the other two looping short voice calls. For this purpose we need to build a somewhat more complicated workflow, as detailed in this section.

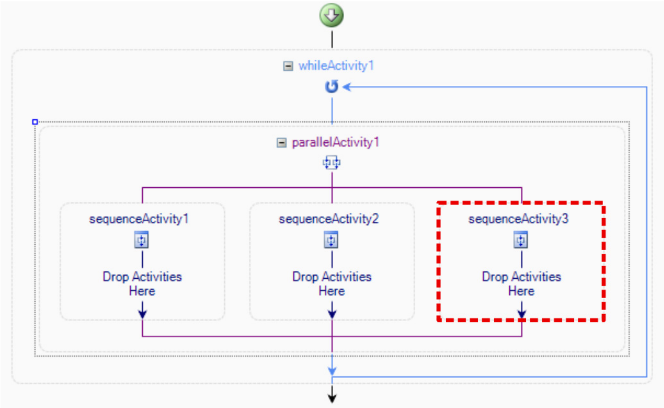
- First add a While activity and set it to run 10 times. This will become an outer loop repeating the various activities that will be included in it.



- Remove “sequenceActivity1” by selecting it and pressing Delete. (The Sequence activity is created automatically, but in this case we do not need it at the topmost level – compare the steps that follow.)
- Drop a Parallel activity inside the while loop.



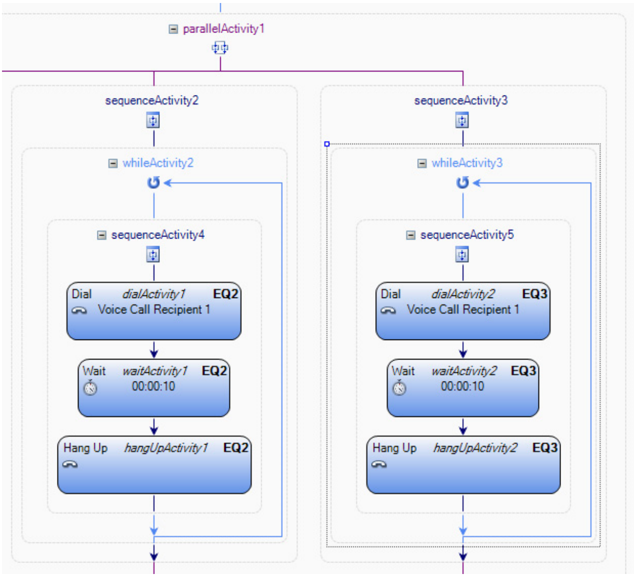
- Since the Parallel construct by default provides only two branches, we need to add one more. To this end, right-click the “parallelActivity1” box and choose **Add Branch** from the context menu. The structure is now expanded with a third branch:



It is now time to define the service-related activities. Let us begin with the voice calls:

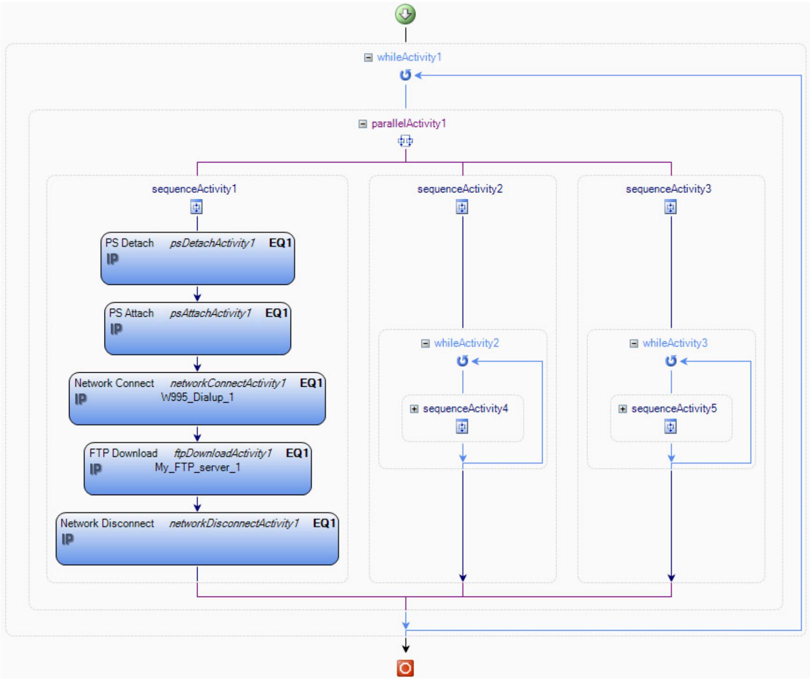
- Add while loops to branches 2 and 3 and set each to execute 5 times.
- Add a voice call snippet (a predefined one is found in the **Activity** pane) to each while loop. Set the wait time to 10 seconds.
- To assign the activities to the correct devices, we need to change the equipment (**EQ**) parameter to EQ2 and EQ3 in branch 2 and branch 3 respectively. This is done in the **Properties** pane or from the context menu for each activity.

After these steps, branches 2 and 3 of the workflow should have the following structure:



- Next, define the FTP task for device no. 1. All you need to do here is to add an FTP download snippet to branch 1 and associate it with a functional configuration.

In the screenshot that follows, the voice sequences have been collapsed to clarify the overall structure of the workflow.



This script will conduct a total of 10 FTP downloads and 2 × 5 × 10 = 100 voice calls.

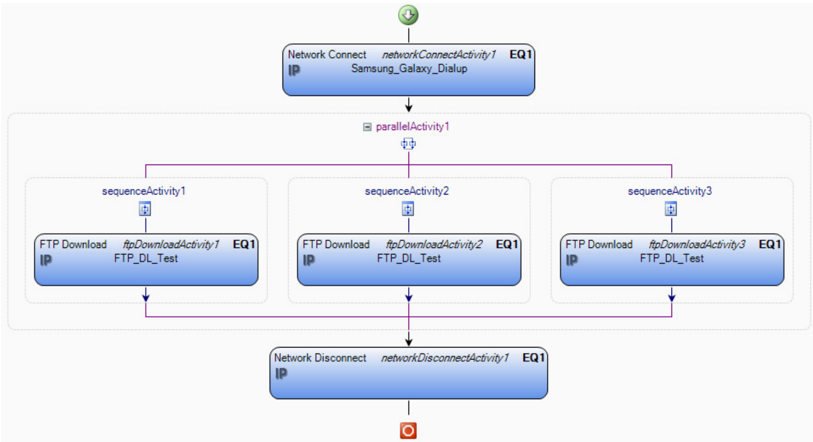
See section 12.20.2.3 for full details on the Parallel activity.

Note: When composing a script for multiple concurrent data service sessions using multiple devices, it is wise to make sure that these sessions are not all initiated simultaneously. It is better to let the sessions start one at a time, allowing at least a few seconds between successive initiations. Insert Wait activities as appropriate to achieve this. (No such Waits are present in the above example, which contains only one data service session.)

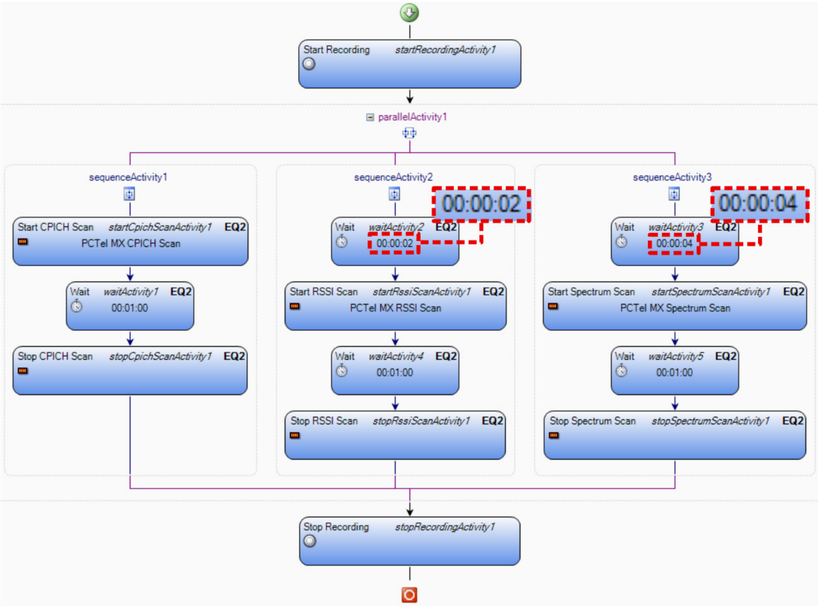
12.10.4.3. Example 3: Concurrent Activities on the Same Device

The Parallel structure can also be used to run multiple activities concurrently on the same device, even multiple activities of the same type, provided that the device supports it. The activities concerned are those for FTP download/upload, HTTP, email, and Ping.

The script shown below lets one device perform two concurrent FTP downloads. All instances of the FTP Download activity use the same configuration set; however, to prevent file write conflicts, each activity adds a unique prefix to the target file name (refer to section 12.20.3.11 for details).



When assigning multiple scanning activities to the same device, it is best not to start all of the scans at the exact same time. Insert short waits as appropriate to stagger the start times, as exemplified in the following screenshot (branch 1: no Wait; branch 2: Wait with duration 2 s; branch 3: Wait with duration 4 s). Compare the similar advice in section 12.10.4.2.



12.10.5. Wait

The Wait activity basically does nothing, and it temporarily halts the execution of the workflow branch it is located in – for *all* devices, not just the device the Wait is assigned to. After the wait time has expired, the execution proceeds to the next activity.

When following a (voice) **Dial**, **Video Dial**, or **Start ... Scan** activity, the Wait has the apparent effect of giving duration to that activity, and this construction is the most convenient method of controlling the duration. The Wait activity also comes in useful whenever some tasks need to be cleanly separated in time for one reason or other.

For some usage examples, see sections 12.5, 12.10.3, 12.10.4.2, and 12.20.1.10.

See section 12.20.2.8 for full details on this activity.

12.10.6. Wait For

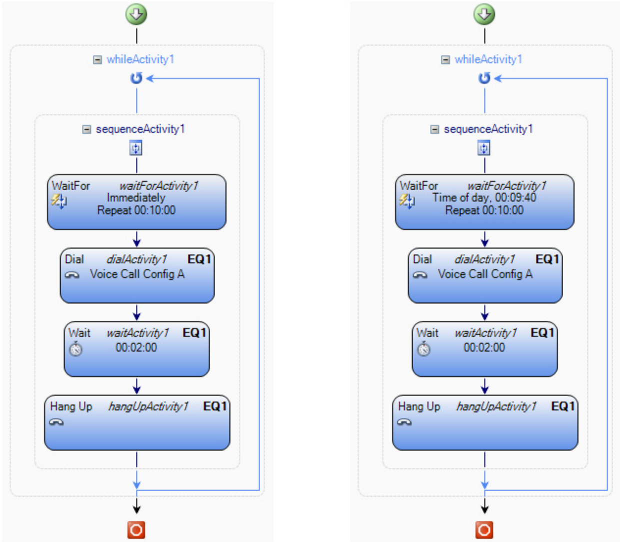
The Wait For activity can be used to:

- Wait for a *scheduled point in time*. The schedule can be set up in a number of ways. See section 12.10.6.1 below.
- Wait for another *activity* to finish with a predetermined *outcome*. See section 12.10.6.2.
- Wait for a particular kind of *event* to occur. This is straightforward; see the reference section 12.20.2.9 for the fine points. A special case is Wait For with *periodic* events: see section 12.10.6.3.

12.10.6.1. Waiting For a Scheduled Point in Time

Suppose we want a device to dial a short voice call once every 10 minutes. This can be accomplished by putting the voice call inside a while loop which also contains a Wait For activity, providing a timing mechanism.

- Create a While loop and set its termination condition to whatever you like.
- At the top of the loop, put a Wait For with **Trigger** = Schedule.
  - If you just want to start the dialing as soon as the script starts, set **Start** to Immediately.
  - Alternatively, you can specify that the calls should begin at the turn of the hour ("On the Hour") or at an arbitrary time ("Time of Day").
- To make the loop execute with the desired frequency, continue by setting **Repeat** to Yes and **Repeat Interval** to 10 minutes. The loop will then pause at the Wait For activity each time until 10 minutes have passed since the previous turn. This pattern will repeat until the while loop terminates.
- Add activities for the voice call (Dial, Wait, Hang Up) just as in section 12.5. In the screenshots below, the call duration has been set to 2 minutes.



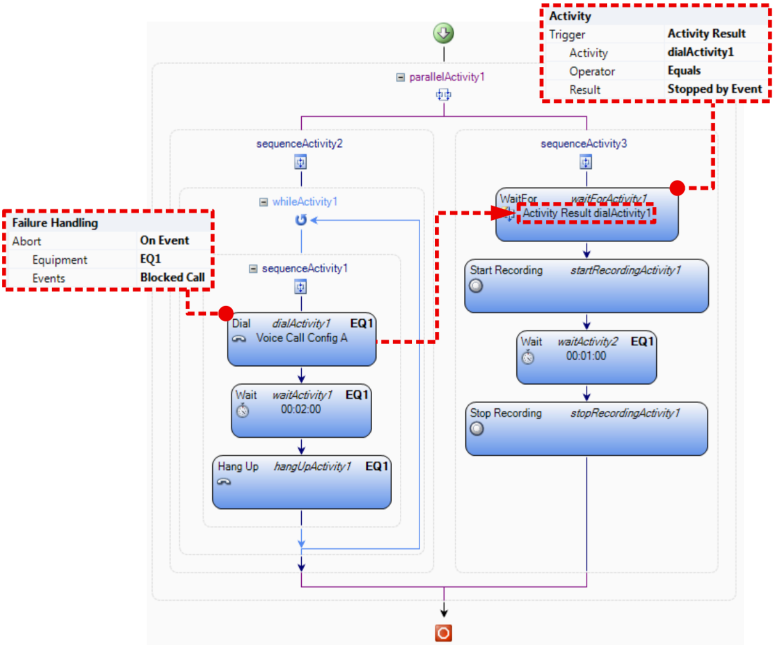
Left: While loop controlled by Wait For with Start = Immediately.
Right: While loop controlled by Wait For with Start = Time of Day.

12.10.6.2. Waiting For a Given Outcome of an Activity

Instead of collecting data continuously, an alternative (“event-driven”) approach to data collection is to wait until something interesting happens and trigger recording only then.

Again taking CS voice as a simple use case, suppose that the voice service is tested by dialing one call after another. If a call proceeds normally, we do not log any data, but if a call is blocked, we want to start a logfile recording to capture what happens over the following one-minute period.

- Create a Parallel structure with two branches.
- In the left-hand branch, insert a While loop repeating voice calls. Configure the Dial activity to abort if the call is blocked (**Abort** property set to **On Event** with “Blocked Call” selected as trigger).
- In the right-hand branch, put a Wait For activity at the top monitoring the voice calls. Set the **Trigger** property to **Activity Result** and stipulate that it should equal “Stopped by Event”. Then add activities for logfile recording beneath the Wait For: Start Recording followed by a Wait with Duration = 1 min and finally Stop Recording.



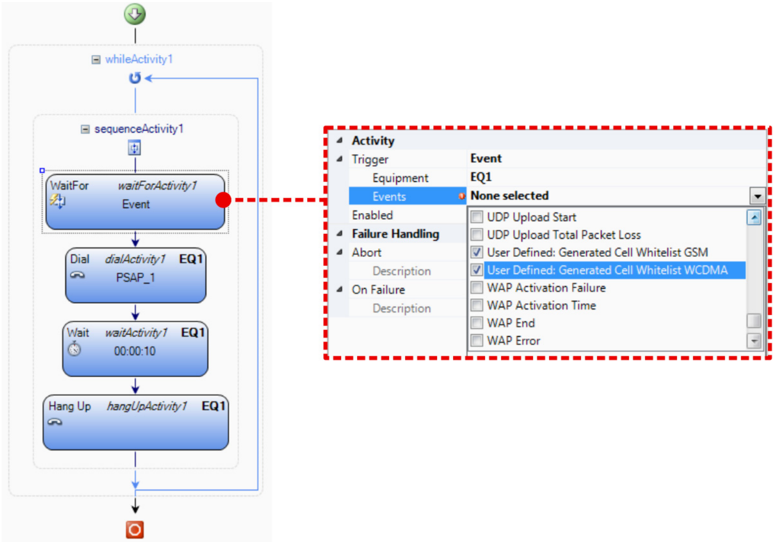
If any call failures are of interest, and not only blocks, then set **Activity Result** to the catch-all value “Failed” instead. Recording will then be triggered by any voice call that does not complete normally.

12.10.6.3. Wait For with Periodic Events

Suppose we want to perform some kind of task whenever a given condition is satisfied. We can then construct a user-defined event for the condition and make that event periodic, which means that it is generated *repeatedly* at fixed intervals as long as the condition is true (see section 24.3). Next, a script is written containing a while loop, at the start of which a Wait For activity listens for the periodic event. The rest of the loop contains the task to be performed.

One natural application of this construction is to cell whitelists. See section 24.4. In this case, the Wait For activity waits for a whitelist event, signifying that the user is currently camping on an allowed cell. If such an event is generated, the script proceeds through the rest of the while loop, so that the device performs its task once. Then a new whitelist check is done, etc.

Note that user-defined events are prefixed with the string “User Defined:” in the **Events** drop-down box. See the image below.



Left: While loop with Wait For having event as trigger.
Right: Selection of whitelist events (one for each RAT) as Wait For triggers.[1]

12.10.7. Run Script

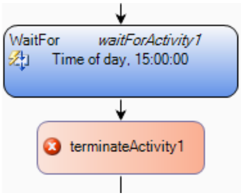
The Run Script activity is a reference to another script and consists in executing the whole of that script at the given point in the workflow. Using Run Script can be regarded as an alternative to saving and reusing *snippets* (see section 12.9), and it may be preferable if you want to organize your scripts in modular fashion, keeping down the complexity of each individual script.

---

1. Please note in this connection that for the user-defined events to appear in the **Events** drop-down list, they must exist when you add the Wait For activity to the script. If you add the Wait For first and create the user-defined events only later, the events will not show in the drop-down list for that particular Wait For instance. To resolve, simply drag a new Wait For activity into the script flowchart and use that one instead.

12.10.8. Terminate

The Terminate activity simply kills the whole script immediately and unconditionally. One possible application of this activity is to combine it with Wait For to stop a script at a fixed time of day. The Wait For should then have **Trigger** = **Schedule** and **Start** = “Time of Day”. For example, suppose the script contains a while loop; the sequence depicted below might then be inserted in the while loop to stop execution at 3 p.m.



12.11. Editing Workflows and Script Settings

You can move activities around in the workflow by clicking and dragging.

You can also edit workflows using the **Cut**, **Copy**, and **Paste** commands found in the **Edit** menu of the Service Control Designer window. The same operations can be performed from the window toolbar or from the context menu that appears when right-clicking a workflow item. The editing commands work in standard Windows fashion.

A few points merit special comment:

- You can select multiple activities to move, cut, or copy by holding Ctrl and clicking. The activities do not have to be adjacent in the workflow but can be picked arbitrarily.
- If you are selecting a number of consecutive activities and wish to preserve their ordering after they are moved or pasted, Ctrl-click the activities from top to bottom in the same order as they come in the workflow.
- When dragging a selection to a new position in the sequence, use the *topmost* activity as handle to preserve the ordering of activities. (Whatever activity you use as handle will end up on top.)
- The destination of a pasted item depends on what, if anything, is currently selected in the workflow:

Item(s) Selected in Workflow	Paste Destination
None	Bottom of workflow
One or more arrows, no activity	Above arrow first selected
One or more activities[1]	Below activity first selected
Sequence activity	Bottom of sequence
If–Else, While, or Parallel activity	– (cannot paste)

1. Any except the ones mentioned in subsequent table rows.

12.12. Activity Properties That Control Execution

All activities have some general properties governing their execution:

- If an activity *fails*, you can choose to skip that activity, retry the activity, or terminate the entire script (**On Failure** property).
- You can have an activity *aborted* after a fixed length of time, or if a specific event occurs (**Abort** property).

For full details, see section 12.16.2.

12.13. UE Control Functionality

A number of control functions accessible from the Navigator (**Equipment** tab, bottom part, **Activities** tab: see section 7.1) can also be applied in a script in the form of activities.

For the RAT lock and band lock functions, it must be noted that the script activities are inevitably more generic in nature than the manual control functions, since when composing a script it is not known what devices the activities will apply to. Therefore, the Band Lock activity has bands from every supported technology selectable, whereas the manual band lock function in the Navigator (acting as it does on a specific device of a well-defined make and model) can only lock on the bands supported by the device. In conclusion, a UE control activity in a script can be executed only if the target device is capable of the operation in question. You will be notified if this is not the case (see section 12.14 on validation).

The same applies to the Channel Lock script activity as compared to the manually applied Cell Lock control function.

See section 12.20.1 for full details on the UE control activities.

12.14. Validating Scripts

Before a script is run, it needs to be *validated* to ensure that it is syntactically correct and does not assign tasks that your devices do not support. For uncomplicated scripts like our first example in section 12.5, this may seem trivial. However, when building more complex scripts involving multiple devices and control logic, the validation becomes a non-trivial issue. Validation is also crucial for UE control functionality (see section 12.13).

A script is automatically validated when you start it. You can also explicitly have a script validated in advance:

- Enter the **Script** menu and choose **Validate**. You will be presented with the results.
- If the script passes validation, you will receive a notification "Script validation succeeded". The script is then ready to be run. See section 12.15.

12.15. Running Scripts

You can run a script either from the **Service Control Monitor** or from the **Service Control Designer**.

12.15.1. General Aspects of Script Execution

- The devices involved in a script will execute their assigned activities independently of one another, except when the devices engage in a service where they interact, and when devices are involved in different workflow branches that converge. In the latter case, all branches are synchronized before the execution proceeds past the point of convergence.
- How to run only parts of a script is described in section 12.15.5.
- It is possible in the application to run several scripts at the same time; however, this is *not* recommended. (The script validation does not extend to such usage.)
- When executing a script, the keylock function must not be activated in any of the participating devices. If it is, the script will not work properly.

- If you stop a script while an SMS or MMS message is being transferred, you should wait until the receiving device has received the message before restarting the script. Otherwise, unpredictable behavior may result.

12.15.2. Preparations

12.15.3. Running Scripts from the Service Control Monitor

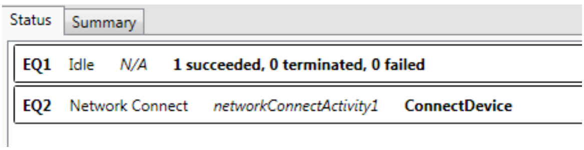
Click the **Open Script** button and select your script (file extension .tsc).

Click the **Run Script** button to start the script.

Click the **Stop Script** button to stop script execution.

12.15.3.1. Monitoring Equipment Status

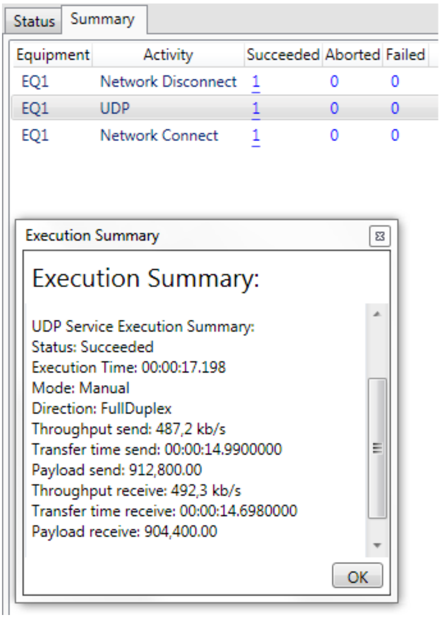
On the **Status** tab of the Service Control Monitor, the current status for each device is displayed. If a device is engaged in multiple concurrent service sessions, one line is printed for each session.



12.15.3.2. Viewing Statistics on Script Execution

On the **Summary** tab of the Service Control Monitor, statistics are given on the outcome of each activity type (number of succeeded, aborted, and failed activities). Clicking an underlined number in this table brings up a summary of each activity that has been run.

Below is an example (UDP with full duplex tested):



12.15.4. Running Scripts from the Service Control Designer

- Enter the **Script** menu and choose **Run**.

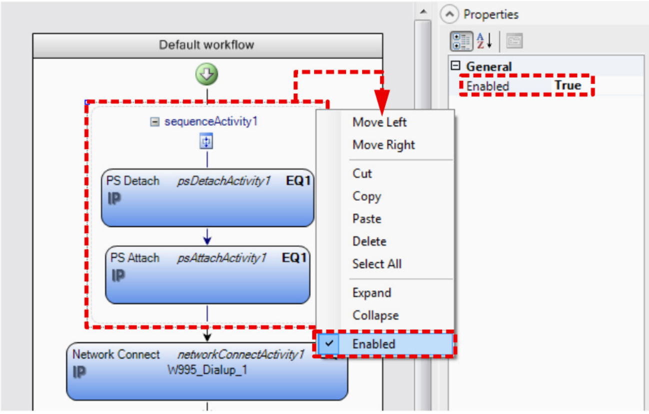
The tab holding the usual contents of the window is now hidden and replaced by **Status** and **Summary** tabs which are identical with those in the Service Control Monitor (see section 12.15.3).

 Click the **Stop Script** button to stop script execution.

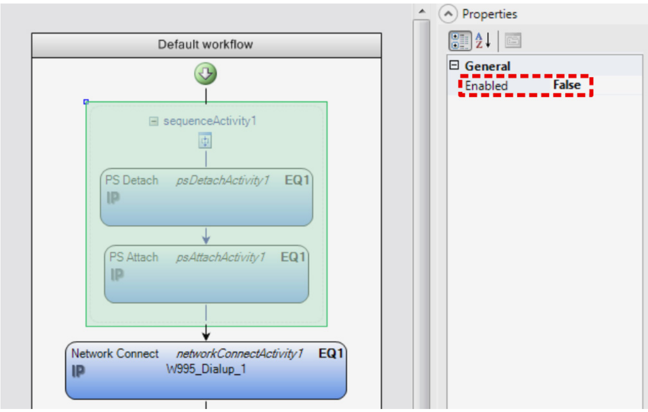
 Click the **Return to Designer** button to return to the Service Control Designer window.

12.15.5. Suppressing Parts of a Script

It may happen that you want to run only certain parts of a script and exclude others. You can easily disable any individual activity by right-clicking it or by changing the **Enabled** flag in the Properties pane, as shown below.



An activity that is currently disabled appears *dimmed* in the workflow pane. For example, suppose we want to skip the initial detach/attach procedure. After disabling the sequence comprising the first two activities, the flowchart looks like this:



Note: Be sure not to disable an activity that another activity is dependent on. For example, do not suppress an activity whose outcome is used to evaluate a subsequent If–Else condition (see section 12.10.2).

To re-enable a disabled activity, just set the **Enable** property to **True** again.

12.15.6. Presentation of Data Service Testing

See section 7.3.1.

12.16. General Activity Properties

These properties are common to all or many activity types.

Activity-specific properties are covered in section 12.16 in connection with their respective activities.

12.16.1. Activity Section

- **Name:** Name given to the activity. (Only appears for certain non-editable activities such as the “root” activity at the bottom of the workflow.)
- **Configuration:** Reference to a configuration set of the type associated with this activity. For example, for FTP Download, an FTP server configuration set needs to be selected here. The combo box is populated with all existing configuration sets that fit the activity; if no such configuration set exists, you need to create one in the Configuration Sets pane.
- **Equipment:** The EQ to which the activity is assigned.
- **Enabled:** True or False. If set to False, the activity is disabled and will not be performed when the script is run. This is indicated by the activity being dimmed by a semi-transparent greenish box in the flowchart.

12.16.2. Failure Handling Section

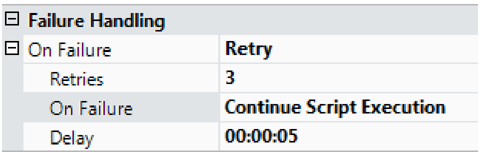
- **Abort:** This property determines under what conditions the activity will be aborted.
  - **Disabled:** The activity will execute as long as it takes to complete.
  - **On Timeout:** The activity will be aborted after a fixed period of time, unless it has already completed before that time. What you indicate here is thus a maximum duration for the activity.
  - **On Event:** The activity will be aborted if and when one of the specified events occurs; otherwise it will run to completion.
  - **On Timeout and/or Event:** Select this to create a more complex abort condition in the form of a boolean expression combining **On Timeout** and **On Event** criteria as defined above. Additional fields **Condition 1**,

Operator (AND/OR), and **Condition 2** appear for defining the boolean expression, which can be expanded recursively.

Note that this property is also possessed by the root activity, in which case it applies to the entire script.

Compare the Terminate activity, which aborts the whole script with immediate effect.

- **On Failure:** This property determines what will happen if an activity fails (when first attempted).
  - **Continue Script Execution:** If an activity fails, the activity is abandoned, and the execution proceeds to the next activity in the workflow branch in question.
  - **Stop Script Execution:** If an activity fails, the activity is abandoned, and the whole script is terminated.
  - **Retry:** If an activity fails, it will be retried. When you choose this option, a set of further parameters appear: **Retries** – the number of retries; **Delay** – the time to wait before each retry; **On Failure** – what action to take if all retries fail (continue or stop script).



12.17. Configuration Sets

12.17.1. Descriptions of Configuration Sets

All types of configuration set are associated with a particular service. For that reason, each configuration set is described in section 12.16 in conjunction with the activity or activities that use it.

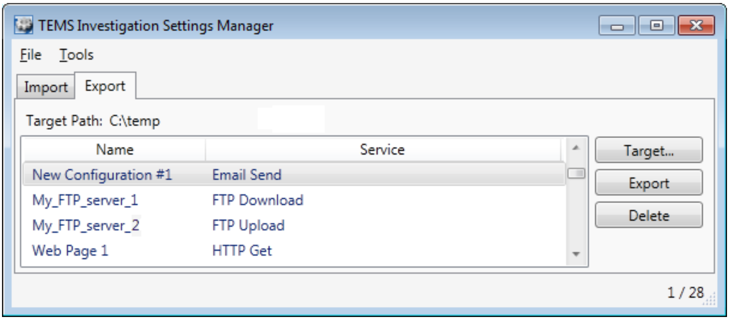
12.17.2. Managing Configuration Sets

You can manage configuration sets using the Settings Manager utility. For a tutorial on how to use these functions in conjunction with script saving/loading in order to port scripts between PCs, see section 12.18.1.1.

- To launch the Settings Manager utility, choose **File** → **Manage Settings**.

Alternatively, in Windows, choose **Start** → **All Programs** → **Ascom** → **TEMS Products** → **Utilities** → **TEMS Investigation 15.3 Service Settings**.

This window appears:



12.17.2.1. Exporting Configuration Sets

To export configuration sets you use the **Export** tab. All configuration sets currently known to the application are listed in the window.

- Select the configuration sets you want to export by clicking them in the list. Shift + click and Ctrl + click can also be used, in standard Windows fashion. To select/deselect all sets, right-click in the list and choose **Select All**/**Unselect All**.
- Now select where to export the configuration sets. Click the **Target** button and point to the desired directory.
- To perform the export, click the **Export** button. Each configuration set is now exported as a file named according to the format TEMS.Services.Settings.<service name>Settings.<...>.config.

Any user names and passwords (e.g. for FTP or HTTP servers) contained in configuration sets are encrypted in the *.config file. Be aware that anyone making use of the configuration set will be accessing servers with the same credentials.

12.17.2.2. Importing Configuration Sets

To import previously exported configuration sets, you use the **Import** tab.

- Click the **Source** button and browse to the directory you want to import from. The window is populated with all configuration sets found in that directory.
- Select the configuration sets you want to import by clicking them in the list. Shift + click and Ctrl + click can also be used. To select/unselect all sets, right-click in the list and choose **Select All**/**Unselect All**.
- To perform the import, click the **Import** button.

Please note that it is not possible to import obsolete configuration sets from older TEMS Investigation versions, for example:

- Configuration sets for the VoIP Dial, VoIP Answer, and VoIP Hangup activities found in TEMS Investigation 14.x.
- Configuration sets for scanning from TEMS Investigation 14.0 or older versions.

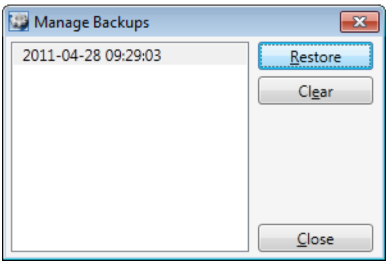
12.17.2.3. Deleting Configuration Sets

You can delete a configuration set from TEMS Investigation by selecting it on the Export tab and clicking the **Delete** button.

From the Tools menu you can delete all configuration sets by choosing **Clear Settings**.

If the **Enable Backup** option is selected, a backup of the configuration sets will be created whenever you use the Clear Settings command.

- To restore configuration sets from a backup, choose Tools → **Manage Backups**, select the backup of interest from the list, and click the **Restore** button.
- To delete a backup, select it and click **Clear**.



12.18. Saving and Loading Scripts

12.18.1. Saving a Script to File

To save a script to file, click the **Save** button on the Service Control Designer toolbar.

The file will receive the extension .tsc (for “TEMS Service Control”).

The Save Script dialog contains the following options:

- **Description:** Free-text field where you can optionally enter a description of the script.
- **Format:** You can save the script either with or without the configuration sets it uses. Note that configuration sets can also be saved separately: see section 12.17.2.
  - **Standard:** No configuration sets are saved with the script. This means that changes to a configuration set will automatically propagate to all scripts that reference it. Choose this option if you are going to use the script on one PC only. (This is the default setting.)
  - **Redistributable:** All configuration sets referenced in a script are saved with the script, making the TSC file a self-contained and independent entity that can be immediately reused on a different PC. Choose this option if you are going to use the script on several PCs.

To open an existing script stored on file, click the **Load** button on the Service Control Designer toolbar.

12.18.1.1. Tutorial on Porting Scripts between PCs

Follow these steps to share a script and its related configuration sets between two computers:

- On the “sender” PC:
  - Save your workspace.
  - Save your script with **Format** set to **Redistributable**.
  - Export your configuration sets.
- On the “receiver” PC (with the above data from the sender available on some suitable storage medium):
  - Import the configuration sets exported from the sender.

- Start TEMS Investigation.
- Open the sender’s workspace.
- Open the sender’s script. The script can now be not only run but also freely modified on the receiver PC.

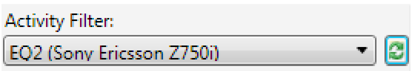
12.18.2. Saving a Workflow as an Image

- You can also save the contents of the workflow pane as an *image*. To this end, choose **File** → **Save As Image** in the Service Control window and select the desired image file format.

12.19. Further Functionality in the Service Control Designer Window

12.19.1. Activity Filter

The **Activity Filter** combo box at the top of the Activity pane can be used to filter the list of activities so that it shows only the activity types supported by a particular device. By default all activities are shown (“**All**”).



The **Refresh** button to the right of the Activity Filter combo box updates the activity list with any new user-defined snippets that have been created since the list was last refreshed.

12.19.2. Context Menu in Workflow Pane

The context menu that appears when you right-click in the workflow pane has functionality that is mostly mirrored in other places: in the regular window menu and in the Properties pane. The rest is standard Windows functionality, except the **Move Left** and **Move Right** commands which you can use to change the ordering of activities in a workflow.

The context menu is especially useful for changing properties (EQ assignment, on-failure behavior) of several activities at once. This is most conveniently done from the context menu:

- Select all of the activities you want to modify by dragging the mouse pointer or by Ctrl + click, then right-click the selection and choose the desired command from the context menu.

12.19.3. Zooming the Workflow Pane

In the workflow pane, the mouse pointer by default has the usual point-and-click function. You can however switch the mouse to zoom mode, where mouse pointing actions have the effect of zooming the workflow pane in or out.

After you click the **Zoom In** button on the window toolbar, mouse clicks in the workflow pane will magnify its contents in predefined steps. You can also click and drag to select a portion of the workflow pane that you want to enlarge.

To reverse the mouse-click zoom function, click the **Zoom Out** button on the window toolbar.

To return the mouse to pointing mode, click the **Pointer** button.

12.20. Activities (Reference Section)

This section also explains all activity-specific properties found in the Properties pane: that is, those not covered in section 12.16. Not all activities have unique properties.

12.20.1. Control Activities

12.20.1.1. Activate

Activates the device so that it can be used in TEMS Investigation. This has the same effect as manual device activation, described in section 6.4.1.

This activity has no unique properties.

12.20.1.2. AT

Sends an AT command.

- **AT Timeout** property: Time (“hh:mm:ss”) to wait for an AT response from the device.

- **AT Command** property: AT command string. (Define a configuration for each AT command you want to send.)

Known Limitations

- Certain devices respond to very few AT commands. One example is the Samsung SPH-M320.

12.20.1.3. Band Lock

Locks the device to a subset of frequency bands.

- **Bands** property: Specify band or bands to lock on. The details are analogous to the manual band lock function on the Navigator's Equipment tab; see section 13.6.

12.20.1.4. Channel Lock

Locks the device to one or several radio channels.

This activity corresponds to the radio channel oriented parts of the manual Cell Lock control function, which is applied from the Navigator (see section 13.9). Note, however, that the Channel Lock activity is more generic in that it covers many more technologies.

The Channel Lock activity does *not* control BSIC or scrambling code selection, like the manual Cell Lock function does.

- **Channels** property: Specify the channel or channels to lock on for each technology of interest. A channel lock takes effect only after the device has entered the associated RAT.

The Channel Lock activity is supported for the following devices:

- Sony Xperia V LT25i (GSM only)
- Sony Xperia T LT30a (GSM only)
- Sony Ericsson Xperia arc S
- Samsung Galaxy S 4G
- Samsung Infuse 4G
- Sony Ericsson W995

12.20.1.5. Deactivate

Deactivates the device so that it can no longer be used in TEMS Investigation until it is activated again; equivalent to manual deactivation as described in section 6.4.2. Compare Activate.

This activity has no unique properties.

12.20.1.6. Filemark

Enables automatic filemarks. See section 10.1.2.

- **Filemark** property: Filemark text string.

12.20.1.7. Radio Access Technology Lock

Locks the device to a particular radio access technology (RAT).

- **Technology** property: Specify the RAT to lock on. The choice “Not locked” releases a lock that has been previously applied.

Please note that if the measurements will be performed on LTE (**Technology** property set to LTE), or if they *might* be performed on such a network (no RAT lock set, but an LTE network is present), then the PS Attach activity at the beginning of the script should be preceded by a specification of the APN to be used. Do this by means of an AT activity containing the following string in the **AT Command** property:

AT+CGDCONT=1,"IP","<yourAPN.com>"

Locking to a particular RAT might take a while, depending on the network configuration, so consider adding a Wait activity before a subsequent measurement activity to ensure that the RAT lock takes effect before the measurement begins.

12.20.1.8. Start Recording

Starts recording of a logfile. A Start Recording activity must be paired with a Stop Recording activity that concludes the recording and closes the logfile.

- **Equipment** property: Here you select which devices to include in the recording. The selection is made at the EQ level; device channels cannot be distinguished (for example, recording MS but not DC for a particular device). By default all EQs are selected. **Note:** Positioning data from the currently preferred GPS, if one exists, will be included in the logfile even if the GPS EQ is not selected here.

- **Prefix** property: You can add a descriptive prefix to the default logfile name. The following characters are ignored if entered in this field: \ / : * ? ' < > |

Note: Start Recording activities in different branches of a Parallel activity must not have the same logfile prefix.

- **Directory** property: The directory where logfiles produced by the script will be stored.
- **Buffer length** property: Length in seconds of buffered content prepended to the logfile. Min.: 0 s. Max.: 40 s. Default: 0 s (**Note:** This is different from manual recording). See section 10.1.5 for further information.
- **Subject**, **Description**, and **Tags** properties: These correspond to the identically named metadata fields that you can define when recording a logfile manually; see section 10.1.

12.20.1.9. Stop Recording

Concludes the recording of a logfile initiated by a Start Recording activity and closes the logfile.

- **Recording Activity** property: Here you select which Start Recording activity to stop, identified by its name (e.g. “startRecordingActivity1”).

12.20.1.10. Notes on Script-controlled Logfile Recording

Note that logfiles always record data from **all activated devices** (among those selected for inclusion in the recording), not only the devices that participate in the script (i.e. those that have some device-specific activity assigned to them).

The automatic **data buffering** in TEMS Investigation may result in overlap between logfiles, as explained in section 10.1.5. If you want to avoid this, set the buffer length lower or to zero. Alternatively, you can insert Wait activities of suitable duration in your script to separate Stop Recording activities from Start Recording activities that will follow immediately in the execution flow. For example, in a loop that begins with Start Recording and ends with Stop Recording, insert a Wait at the end.

Other methods of recording are independent of scripted recording and do not affect a script that is executing. See section 10.1.

12.20.2. Control Flow Activities

For a hands-on tutorial on how to use these activities, please turn to section 12.10.

12.20.2.1. If–Else

This activity splits the workflow into two or more branches, with a condition attached to each branch. Each condition (except the catch-all “Any”: see below) is based on the outcome of a previous activity. Evaluation of conditions proceeds from left to right.

At the top level, the If–Else activity does not have any unique properties. Each branch of the construct, however, is constituted by an “if–else branch” activity which has the following property:

- **Condition Type** property:

  To define a non-trivial, yet simple condition, set Condition Type to **Activity Result**. The following attributes then become visible:

  > **Activity:** The activity (identified by its name in the script) whose outcome will determine the truth value of the condition.
  >
  > **Operator:** Relational operator: “Equals” or “NotEquals”.
  >
  > **Result:** The activity result that you want to match. One of: Succeeded, Failed, Stopped by User, Stopped by Duration, Stopped by Event, Stopped due to Equipment Restart, Stopped due to Application Restart.

  You can also set up a more complex condition in the form of a boolean expression involving multiple activity result conditions, each composed as described above. To this end, set Condition Type to **Combined**. The following attributes then appear (the structure can be expanded recursively):

  > - **Condition 1:** A subcondition of type **Activity Result**, or another **Combined** condition.
  > - **Operator:** Boolean operator: **And** or **Or**.
  > - **Condition 2:** A subcondition of type **Activity Result**, or another **Combined** condition.

Finally, setting Condition Type to **Any** creates a trivial condition that always evaluates to true. This value should always be used as a catch-all condition for the rightmost if–else branch. (The If–Else construct is set up in that way by default.)

For an example of usage, see section 12.10.2.

12.20.2.2. While

This activity constitutes a while loop.

- **Condition Type** property:

Count: Fixed number of iterations.

Time: Fixed execution time. When this duration expires, the while loop does not terminate immediately; rather, the current turn is completed first. (The running time is compared to the limit *before* a new turn begins.)

Event: The while loop is terminated when any of the selected events is reported by the selected equipment.

Combined: Select this to define a more complex termination condition in the form of a boolean expression combining instances of the other available criteria. Additional fields appear as follows; the structure can be expanded recursively:

- **Condition 1:** A subcondition of type **Count**, **Time** or **Event**, or another **Combined** condition.
- **Operator:** Boolean operator: **And** or **Or**.
- **Condition 2:** A subcondition of type **Count**, **Time** or **Event**, or another **Combined** condition.

While loops can be nested arbitrarily.

For an example of usage, see section 12.10.3.

12.20.2.3. Parallel

This activity splits the workflow unconditionally into two or more branches. There is no hard limit on the number of branches. A device can participate in more than one branch, provided that the device supports concurrent execution of the services involved (or several sessions using the same service).

Each of the parallel branches is encapsulated within a Sequence activity.

This activity has no unique properties.

For usage examples, see section 12.10.4.

12.20.2.4. Run Script

This activity calls another script and is equivalent to inserting the whole of that script in its place.

- **Script to Run** property: Browse for the script file (*.tsc) that you want to call. It should be stored in the same directory as the calling script.

See also section 12.10.7.

12.20.2.5. Sequence

This control structure formally defines a sequence of activities as a unit, allowing it to be treated as such. (For example, the entire sequence can be enabled or disabled in a single action, as exemplified in section 12.10.1.)

This activity has no unique properties.

12.20.2.6. Synchronized Call Sequence

This activity is intended solely for use in the snippet bearing the same name. See section 12.20.7.8.

12.20.2.7. Terminate

This activity terminates the entire script immediately. It has no unique properties.

For an example of usage, see section 12.10.8.

12.20.2.8. Wait

The Wait activity basically does nothing at all, and in effect it temporarily halts the execution of the workflow branch where it is located. After the wait time has expired, the execution proceeds to the next activity.

When following a (voice) Dial or Video Dial activity, the Wait has the apparent effect of giving duration to the call, and this construction is the most convenient method of controlling the call length. The situation with **Start ... Scan** activities is similar. Furthermore, the Wait activity comes in useful whenever some other tasks need to be separated in time.

- **Duration** property: This property governs how long to wait.

For usage examples, see sections 12.5, 12.10.3, 12.10.4.2, and 12.20.1.10.

12.20.2.9. Wait For

This is a conditional wait which lasts until a given condition is satisfied.

- **Trigger** property: This property determines what to wait for.

Event: Wait for an event to occur. Additional fields named **Equipment** and **Events** appear where you specify the desired event(s) and the device(s) that should report it. An implicit OR relationship holds among devices as well as among events. That is, if you specify multiple devices and/or multiple events, the wait will end as soon as any of the devices reports any of the events.
Schedule: Wait for a point in time determined by a schedule (which is unrelated to any device activity). Additional fields **Start**, **Time**, **Repeat**, and **Repeat Interval** appear where you set up the schedule. • **Start** = *Immediately*: No wait. This option is intended to be used in while loops together with the **Repeat** option. Its use is best illustrated by an example; see section 12.10.6.1. • **Start** = *On The Hour*: Wait for a new hour to begin. Equivalent to Time of Day with **Time** = hh:00:00; see below. • **Start** = *Time of Day*: Wait for a specified time of day (**Time**), stated in the format hh:mm:ss. An example is given in section 12.10.6.1. • **Repeat:** This option is intended to be used in while loops and has an effect only within such a structure. What it does is to reiterate the “wait for” procedure at regular intervals whose length is defined by **Repeat Interval**. See the example in section 12.10.6.2. If Repeat is set to No, there will be no repetitions.

Activity Result: Wait for a particular outcome of another activity in the script. Additional fields **Activity**, **Operator**, **Result** appear where you detail the required outcome: for example, “ftpDownloadActivity1 Equals Failed”. • **Result** = *Succeeded*: The activity completed normally. • **Result** = *Failed*: The activity failed for whatever reason (other than termination by the TEMS Investigation user). • **Result** = *Stopped by User*: The activity was stopped by the user clicking the **Stop Script** button.[1] • **Result** = *Stopped by Duration*: The activity was aborted because its maximum duration expired. This can happen only if the activity has its **Abort** property set to **On Timeout**: see section 12.16.2. • **Result** = *Stopped by Event*: The activity was aborted because a specific event occurred (**Abort** property set to **On Event**; again, see section 12.16.2). You must yourself ensure that the monitored activity has a position in the work flow where it will in fact complete to terminate the Wait For activity. This is not considered during validation. For usage examples, see section 12.10.6.
Combined: Select this to define a more complex trigger in the form of a boolean expression combining instances of the other available criteria. Additional fields appear as follows; the structure can be expanded recursively: • **Condition 1:** A subcondition of type **Event**, **Schedule** or **Activity Result**, or another **Combined** condition. • **Operator:** Boolean operator: **And** or **Or**. • **Condition 2:** A subcondition of type **Event**, **Schedule** or **Activity Result**, or another **Combined** condition.

1. If the activity is executed manually from the Navigator as described in chapter 7, “Stopped by User” equates to the user right-clicking the activity in the Navigator and choosing **Stop**.

12.20.3. IP Activities

12.20.3.1. Notes on IPv4 vs. IPv6

TEMS Investigation fully supports the IPv6 address space.

The file <TEMS Investigation install dir>\Application\Investigation.exe.config contains these flags governing address space usage:

<dataServicesConfiguration supportsIPv6="true" preferIPv6="false" />

- To enable testing with IPv6-capable devices in IPv6 networks, just leave these settings as they are. No other preparations are needed.
- To disable IPv6 in TEMS Investigation, change supportsIPv6 to false. Only IPv4 will then be used in testing.
- To test IPv6 networks exclusively whenever possible, change preferIPv6 to true.

TEMS Investigation must be restarted for changes to take effect.

12.20.3.2. Network Connect

Establishes a data service connection. In the packet-switched case, a PDP context is activated (LTE, UMTS) or a PPP session established (CDMA); in the circuit-switched case, the device works like an ordinary modem and performs a dial-up.

Whether NDIS or RAS is used is governed by the **Mode** parameter, as detailed under **Configuration** below. NDIS can be chosen for packet-switched only, whereas RAS can be used with both PS and CS. Ericsson Fixed Wireless Terminals *must* use an NDIS data connection.

Note: For certain devices, setting up an NDIS connection requires prior configuration using a software application delivered with the device. – Some LTE devices must be connected to the network manually, using their connection manager applications, rather than automatically in the Service Control script. Be aware that in these cases, you must still include a Network Connect activity in your script. – For other LTE devices, the connection manager must be started to enable the Network Connect activity in scripts.

See the Device Configuration Guide, section 4.1 for specifics in this regard on various devices and device categories.

A side-effect of the Network Connect activity is to start a restricted form of IP sniffing that is performed continuously for the sake of collecting input to KPI calculations. (This IP sniffing collects only data needed for KPIs and is distinct from the full-scale variety which is initiated by the Start IP Sniffing activity.) If your data collecting device is unable to perform the IP sniffing, you can work around that problem by editing a line in the file <TEMS Investigation install dir>\Application\Investigation.exe.config, which by default reads:

<dataIpSnifferConfiguration ipSniffEnabled="true" ignoreIPSniff-Error="false" [...] />

You can either disable IP sniffing by setting ipSniffEnabled="false", or you can ignore failure to start IP sniffing and go ahead with the execution anyway: ignoreIPSniffError="true". Please note that in either case, no KPI data can be collected. TEMS Investigation must be restarted for any changes to take effect.

If an Network Connect has previously succeeded but the connection goes down later on, a Network Connection Lost event is generated. (NDIS only.)

- **Configuration** property:

Mode: Technology to use for connecting to the network: NDIS or RAS. If “Best available” is chosen, NDIS is first and RAS is second priority. For an NDIS connection to be establishable, the device must of course support NDIS.
Succeed If Already Connected: This parameter governs what will happen if the device already has a network connection (a valid IP address) set up by other means when the Network Connect activity is run, for example using an external connection manager. • If set to True, the Network Connect activity will count as successful anyway, and on the Summary tab of the Service Control Monitor it will be noted that a connection was already available. This setting is useful if you want to be able to run Network Connect without full knowledge of the device’s previous activities, and you wish to avoid triggering a failure just because the device was already connected. • If set to False, the Network Connect activity will count as a failure.

UMTS/LTE APN: The Access Point Name to use for UMTS and LTE networks. The parameter is not applicable to other cellular technologies. Leave this field empty if an APN is specified in the device (always needed for NDIS) or for the modem in Windows. Regarding devices for which the APN must be configured differently, see the Device Configuration Guide, sections 4.2, 4.7, 4.11. **RAS Phone Number:** Phone number to use when performing a RAS dial. For UMTS this is usually *99#; however, if a CID “n” other than 1 is to be used you need to specify that value, as follows: *99****n*#. For TD-SCDMA, enter *98*1#. For CDMA/EV-DO, enter #777. **NDIS CID:** The CID (Connection Identifier) to connect with when NDIS is used.
User Name, Password: Certain operators require authentication in order to establish a data service connection. If this is the case for you, enter user and password here. **IP Address:** Local IP address. Leave blank if the IP address is provided automatically by the operator. **Primary DNS:** IP address of the primary domain name server. Leave blank if this is provided automatically by the operator. **Secondary DNS:** IP address of the secondary domain name server. Leave blank if this is provided automatically by the operator.
Use Header Compression: Use of header compression for packet-switched. (Property of PS bearer.) Not applicable to circuit-switched. **Use Data Compression:** Use of data compression for packet-switched. (Property of PS bearer.) Not applicable to circuit-switched.

List of network connect events.

12.20.3.3. Network Disconnect

Terminates a data service connection. In the packet-switched case a PDP context is deactivated (LTE, UMTS) or a PPP session ended (CDMA); in the circuit-switched case the device performs a hang-up.

For certain NDIS-capable devices, an NDIS connection must be terminated using the PC application accompanying the device (compare the Network Connect activity). Note that in such cases, it is still necessary to include a Network Disconnect activity in the script.

If the device is already disconnected, this activity has no effect, but it still counts as successful on the Summary tab of the Service Control Monitor. (Same behavior as for Network Connect with **Succeed If Already Connected** set to True.)

This activity has no unique properties.

12.20.3.4. PS Attach

Performs a packet service attach.

Note that this activity may not be needed for those devices that may have automatically attached to a PS network when powered on. If you are uncertain as to whether or not the device performs such an automatic attach, simply insert a PS Attach activity at the beginning of the script. This ensures that the device will attach and that logging of Layer 3 messages will be initiated.

After the measurements, at the end of the script, insert a PS Detach activity to detach from the PS network.

Please note that in case the measurements will be performed on LTE (RAT lock set with **Technology** = “LTE”), or if they *might* be performed on such a network (no RAT lock set, but an LTE network is present), then the PS Attach should be preceded by a specification of the APN to be used. Do this by means of an AT activity containing the following string in the **AT Command** property:

AT+CGDCONT=1,"IP","<yourAPN.com>"

This activity has no unique properties.

12.20.3.5. PS Detach

Performs a packet service detach.

This activity should take place at the end of the script if PS Attach has been done earlier.

PS Detach may also be useful as an initial operation to make sure that the phone is not attached to the packet service when starting a measurement (for example, if it has attached automatically at power-on).

This activity has no unique properties.

12.20.3.6. SIP Register

Causes the device to register with a SIP or IMS server. This is a necessary preparation for a VoIP call; see also section 12.20.7.5. A user account must exist on the server.

- **Configuration** property:

Client: • *PJSIP:* The PJSIP VoIP client is used. This is the default setting. • *ODM:* An on-device measurement VoIP client is used.
Registration Setting: • *Client-based:* The VoIP (IMS) client will register with the server according to settings stored in the client. This option is used for on-device clients. • *User-defined:* The VoIP (IMS) client will register with the server using the parameters that follow below. This option must be used for PC-based VoIP clients to enable them to identify themselves.
Proxy: The proxy server to use. May be omitted. **Domain:** The domain to register with. If **Proxy** is not used, a valid server name must be entered here. **User Name:** User name of account on the server. **Password:** Password for the server account.

12.20.3.7. SIP Unregister

Causes the device to unregister from a SIP or IMS server used for VoIP.

- **Configuration** property:

Client: • *PJSIP:* The PJSIP VoIP client is used. This is the default setting. • *ODM:* An on-device measurement VoIP client is used.

12.20.3.8. Start IP Sniffing

Starts capture of IP packets.

Note that you *do not* have to use this command to obtain the data required for KPIs; such data is collected automatically. Compare chapter 36.

IP sniffing data is presented in the IP Protocol Reports message window. A large number of protocols are supported, as detailed in the description of the window just linked to.

IP sniffing requires administrator rights on the PC: see the Device Configuration Guide, section 13.2.1.

- **Configuration** property:

Client: • *PC:* The TEMS Investigation built-in IP sniffer is used. • *ODM:* An on-device IP sniffing service is used.
Packet Size: Determines how many bytes of each message will be presented. If you choose a fixed packet size, any further bytes in the message will be truncated. If you choose **Full packet size**, all messages are presented in full and the entire header is always decoded. (For ODM, 1500 bytes is regarded as “full packet size”, and any bytes in excess of that number are truncated.)
Filter: Type of filtering to apply to IP packets. • *Optimized Performance:* Capture of IP packets is reduced to the minimum needed to compute KPIs. (Packets are filtered with respect to IP address, protocol [TCP/UDP], and port.) Not supported for ODM. • *Headers Only:* The first 54 bytes of every IP packet are captured. This is frequently the preferable setting. • *None:* No filtering of IP packets. **Note:** This means that all packets belonging to any service used by the PC will be captured; packets are filtered with respect to IP address only. At throughputs above about 25 Mbit/s, this option *cannot* be used since it will overload and crash the application. The information element TCP Packet Loss and the event IP Interruption Time require that the Filter parameter *not* be set to “Optimized Performance”.

12.20.3.9. Stop IP Sniffing

Stops capture of IP packets initiated by the Start IP Sniffing activity.

- **Configuration** property:

> **Client:**
> - *PC:* The TEMS Investigation built-in IP sniffer is used.
> - *ODM:* An on-device IP sniffing service is used.

12.20.3.10. Available Bandwidth Measurement

Calculates the available bandwidth in the cellular network at successive moments in time.

This activity is performed by means of data transmissions between the TEMS Investigation device and one or several ABM servers (which are hosted by Ascom). Measurement can be performed against up to four ABM servers concurrently. All ABM servers are addressed with a single script activity.

Available ABM servers:

- 162.13.38.90, port 15001 (London, UK: EMEA)
- 119.9.67.138, port 15001 (Hong Kong, China: APAC)
- 192.237.128.240, port 15001 (Chicago, IL, US: AM/CALA)

For a description of the ABM algorithm, please consult chapter 48.

The devices supporting available bandwidth measurement are listed in the Device Configuration Guide, section 2.6.

- **Configuration** property:

> **Duration:** Duration of available bandwidth measurement.
>
> For each of ABM servers 1, ..., 4, the following needs specifying:
>
> **Server** <*n*> **Enabled:** Governs whether or not this ABM server is used.
>
> **Server Address:** IP address to the ABM server (cannot be given as an URL).
>
> **Server Port:** The port on which the ABM server listens for requests.

Lists of ABM information elements and events.

12.20.3.11. FTP Download

Downloads a file from an FTP server.

Please be aware that paths and file names must have correct case throughout.

Note also that you can conduct TCP load tests with the **Network Bandwidth** activity (see section 12.20.3.19).

- **Configuration** property:

Source File: The path and name of the file residing on the FTP server, e.g. srcdir/srcfile.dat. No explicit root symbol is used (no leading slash); if the file is in the root directory, type the file name only. Note that the correct orientation of the slashes is dependent on the FTP server operating system. **Target File:** Drive letter, path, and file name describing where to store the file on your computer, e.g. C:\targdir\targfile.dat. The drive letter must be included. A session ID (integer) is prefixed to the file name. If multiple FTP Download activities execute in parallel, multiple files are created, each with a unique session ID prefixed to prevent conflicts, e.g.: 0targfile.dat, 1targfile.dat. If the Target File field is left blank, no files are stored; this is the default setting.
Server Address: The IP address or host name of the FTP server. No ftp:// prefix is to be used. The address may not contain a path to a subdirectory. **Server Port:** The port on which the FTP server listens for requests. The default port number is 21 (for SFTP, 22). **Firewall Mode:** PASV or PORT, enabling or disabling passive FTP as defined in ► IETF RFC 959. Note that it is essential to set this correctly. For SFTP, this setting is not applicable. **Local Data Port:** The data port the client will use for FTP download. Valid only when **Firewall Mode** = PORT.

Use SFTP: If set to Yes, file transfer will be done over SFTP (SSH File Transfer Protocol, "Secure FTP") rather than FTP proper.

Note that no KPI data is logged for SFTP. Also be aware that the throughput may be reduced compared to regular FTP. Therefore, do not use SFTP in stress tests aimed at determining the maximum data throughput.

Regarding necessary SFTP server configuration, see the Installation Guide, section 4.2.5.

User: User name on the FTP server, if required.

Password: User password on the FTP server, if required.

Account: Account name on the FTP server, if applicable.

End Session After Time: If set to True, the FTP session is ended automatically after a user-specified length of time. Enter the desired session duration in the **Time** field. The duration is counted from the moment the first FTP packet is received from the server.

Lists of FTP download information elements and events.

Configuration of TCP Receive Buffer Size

The size of the TCP receive buffer can be changed in the file <TEMS Investigation install dir>\Application\Investigation.exe.config by editing the following line:

<dataServicesConfiguration [...] ftpReceiveBufferSize="4194304" />

TEMS Investigation must be restarted for changes to take effect.

Be aware that drastic changes to this value will have similarly drastic effects on the data throughput. The default value is suitable for high-speed networks.

This setting is applicable to regular FTP only, not to SFTP.

12.20.3.12. FTP Upload

Uploads a file to an FTP server.

Please be aware that paths and file names must have correct case throughout.

- **Configuration** property:

Target File: Path and file name describing where and how to store the file on the FTP server, e.g. targdir/targfile.dat. No explicit root symbol is used; if you type a file name only, the file will be written to the root directory. Note that the correct orientation of the slashes is dependent on the FTP server operating system. A session ID (integer) is prefixed to the file name. If multiple FTP Upload activities execute in parallel, multiple files are created, each with a unique session ID prefixed to prevent conflicts, e.g.: 0targfile.dat, 1targfile.dat. **Note**, however, that if multiple instances of TEMS Investigation installed on different PCs are uploading to the same server, each instance must use a unique target file name. **Source File:** Drive letter, path, and file name identifying the file to be uploaded, e.g. C:\srcdir\srcfile.dat. The drive letter must be included.
Size to Upload: Size of the file to upload (only valid if **Use Temporary File** = True). It is possible to specify the unit as follows: B = byte, K = kilobyte, M = megabyte, G = gigabyte, T = terabyte. Alternatively, lowercase letters can be used with no difference in meaning. If you do not specify a unit, the number you enter is interpreted as a byte count. **Use Temporary File:** If set to True, a temporary file is created holding the data to upload. If set to False, no such file is created. **Delete Uploaded File:** If set to True, the target file is deleted after successful upload. If set to False, the target file is not deleted.
Server Address: The IP address or host name of the FTP server. No ftp:// prefix is to be used. The address may not contain a path to a subdirectory. **Server Port:** The port on which the FTP server listens for requests. The default port number is 21 (for SFTP, 22). **Firewall Mode:** PASV or PORT, enabling or disabling passive FTP as defined in ► IETF RFC 959. Note that it is essential to set this correctly. For SFTP, this setting is not applicable. **Local Data Port:** The data port the client will use for FTP upload. Valid only when **Firewall Mode** = PORT.

Use SFTP: If set to Yes, file transfer will be done over SFTP (SSH File Transfer Protocol, "Secure FTP") rather than FTP proper.

Note that no KPI data is logged for SFTP. Also be aware that the throughput may be reduced compared to regular FTP. Therefore, do not use SFTP in stress tests aimed at determining the maximum data throughput.

Regarding necessary SFTP server configuration, see the Installation Guide, section 4.2.5.

User: User name on the FTP server, if required.

Password: User password on the FTP server, if required.

Account: Account name on the FTP server, if applicable.

End Session After Time: If set to True, the FTP session is ended automatically after a user-specified length of time. Enter the desired session duration in the **Time** field. The duration is counted from the moment the first FTP packet is received from the server.

Lists of FTP upload information elements and events.

Configuration of TCP Send Buffer Size

The size of the TCP send buffer can be changed in the file <TEMS Investigation install dir>\Application\Investigation.exe.config by editing the following line:

<dataServicesConfiguration [...] ftpSendBufferSize="262144" [...] />

TEMS Investigation must be restarted for changes to take effect.

Be aware that drastic changes to this value will have similarly drastic effects on the data throughput. The default value is suitable for high-speed networks.

This setting is applicable to regular FTP only, not to SFTP.

12.20.3.13. HTTP Get

Downloads a URL from an HTTP server.

- **Configuration** property:

Browser Client: Web browser used to conduct HTTP Get sessions. • *TEMS Browser:* The internal Web browser in TEMS Investigation is used. • *Internet Explorer:* Internet Explorer 9 is used. **Note:** This is the only version currently supported; in particular, be aware that Internet Explorer 11 cannot be used. Regarding concurrency limitations, see below.
Client Threads: Number of concurrent threads to be used by the client in handling the HTTP session. Note that the main URL (specified under **URL**) is downloaded only once, regardless of the number of threads.
URL: Main URL to download. – In post-processing, the HTTP Get session will be classified as “File Transfer” if the downloaded file has one of the following extensions: .7z, .avi, .bmp, .jpg, .mp3, .mpg, .png, .rar, .txt, .wav, or .zip. If the file has some other extension, the session will count as “Web Browsing”.
Terminate All Internet Explorer Processes: If set to True, all Internet Explorer processes will be killed whenever no HTTP Get activity is executing. This ensures that no ghost processes are left running and consuming resources; on the other hand, it also prevents you from doing Web browsing with Internet Explorer while HTTP testing is in progress. If you turn this option on, use some other browser for Web browsing.
Use Proxy Server: Select whether to use a proxy server for this connection. **Proxy Server Address:** Proxy server address. **Proxy Server Port:** Proxy server port.

> **End Session After Time:** If set to True, the HTTP session is ended automatically after a user-specified length of time, indicated in the **Time** field. The duration is counted from the moment the first HTTP packet is received from the server.
>
> **End Session After Payload Size:** If set to True, the HTTP session is ended automatically after a user-specified amount of data has been downloaded. Enter the number of bytes to download in the **Payload Size** field.

Lists of HTTP Get information elements and events.

Limitations on HTTP Session Concurrency

Internet Explorer and the TEMS browser cannot run concurrently on the same device.

On the other hand, when either Internet Explorer alone or the TEMS browser alone is used, there are no restrictions on HTTP session concurrency, neither for a single device nor for multiple devices.

12.20.3.14. HTTP Post

Uploads a file via HTTP to a URL.

The HTTP Post activity does not support HTTPS.

> **Note:** This activity requires a script (*.aspx) to be present on the HTTP server. For details, including sample scripts, please see the document “HTTP Upload Server Installation Guide” which is included in the TEMS Investigation documentation package.

- **Configuration** property:

> **Browser Client:** Web browser used to conduct HTTP Post sessions.
>
> - *TEMS Browser:* The internal Web browser in TEMS Investigation is used.
> - *Internet Explorer:* Internet Explorer 9 is used. **Note:** This is the only version currently supported; in particular, be aware that Internet Explorer 11 cannot be used.
>
> No particular concurrency limitations apply to the HTTP Post activity.

URL: The URL of the web page to which the file will be uploaded. **Use Proxy Server:** Select whether to use a proxy server for this connection. **Proxy Server Address:** Proxy server address. **Proxy Server Port:** Proxy server port.
Block Size: Size of blocks in which the file is written to the stream. Min.: 4 kB. Max.: 256 kB. The larger the block size, the higher the maximum possible throughput, whereas the actual throughput will depend on the available bandwidth. The default block size is 8192 bytes, which is the value used internally by Internet Explorer. **Set Transfer Time:** If set to True, the HTTP file transfer is ended automatically after a user-specified length of time. Enter the desired transfer duration in the **File Transfer Time Out** field. The time is counted from the moment the first HTTP packet is received by the server. **Size to Upload:** Size of the file to upload to the URL. A temporary data file of the specified size will be created. It is possible to indicate the unit as follows: B = byte, K = kilobyte, M = megabyte, G = gigabyte, T = terabyte. Alternatively, lowercase letters can be used with no difference in meaning. If you do not specify a unit, the number you enter is interpreted as a byte count.

Lists of HTTP Post information elements and events.

12.20.3.15. WAP Get

Downloads a page from a WAP server.

Note that WAP pages that redirect the user to a different page cannot be downloaded.

- **Configuration** property:

URL: URL of WAP page to download. The WAP server can be specified as an IP address or host name; the http:// prefix is optional.

Connection Mode: One of CO (Connection-oriented), CL (Connectionless), or WP-HTTP (Wireless Profiled HTTP). • CO and CL are used by WAP 1.x and require a WAP gateway. The difference between the modes is essentially this: With CO, the device first contacts and performs a handshake with the WAP gateway before starting to request WAP pages, whereas with CL this is not done. • WP-HTTP is used by WAP 2.0. This WAP version may use a WAP proxy, but this is optional.
Gateway Address: *(Appears when Connection Mode = CO or CL)* The IP address of the operator’s WAP gateway. **Gateway Port:** *(Appears when Connection Mode = CO or CL)* The WSP port on the server. The default port numbers are 9201 (CO), 9200 (CL). **Proxy Address:** *(Appears when Connection Mode = WP-HTTP; optional)* The IP address of the WAP proxy. **Proxy Port:** *(Appears when Connection Mode = WP-HTTP; optional)* The WAP proxy port number. The default is 8080.
User Agent: This is a string indicating, among other things, the make and model of the device and what WAP software it has installed. (Some WAP portals adapt their contents to the devices accessing them.) Example of User Agent string (for Sony Ericsson W995): User-Agent: SonyEricssonW995/R1DB Browser/NetFront/3.4 Profile/MIDP-2.1 Configuration/CLDC-1.1 JavaPlatform/JP-8.4.1

Lists of WAP information elements and events.

12.20.3.16. Ping

Initiates a sequence of pings.

- **Configuration** property:

Remote Address: The IP address or host name of the server to be pinged.
Packet Size: Size in bytes of each ICMP packet sent with the Ping activity. The maximum size is 2000 bytes.
Interval Time: Time between consecutive pings. Given in the format hh:mm:ss.ddd... .
Number of Pings: The number of pings to send. There is no upper limit.
Max Response Time: Maximum time to wait for each ping response. Given in the format hh:mm:ss.ddd... .

List of Ping events.

12.20.3.17. Trace Route

Traces the route taken by IP packets through the Internet to reach a given server.

- **Configuration** property:

Remote Address: The IP address or host name of the server you want to trace a route to.
Maximum Number of Hops: The maximum number of hops between routers that the path to the destination server may contain. If this number is exceeded, the activity will terminate.
Hop Timeout: Time limit for each hop between routers. Given in the format hh:mm:ss.ddddddd. If this time limit is exceeded for some hop, the activity will terminate.

List of Trace Route events.

12.20.3.18. UDP

Data transfer tests using the UDP protocol is a good way to determine the optimum data throughput rate for services that tolerate a given degree of data loss. UDP is more suitable than TCP for this purpose, since the rigorous acknowledgement and retransmission mechanisms of TCP (designed to guarantee full data integrity) will always slow down data throughput, even if the service does not require these safeguards.

You can let TEMS Investigation run the UDP test in an automated fashion. The application will then start out at a low throughput rate and gradually increase the throughput until the packet loss becomes excessive.

UDP testing is done against a PC that is running the application TEMS UDP Server. How to install and configure this software is described in the document "TEMS UDP Server User's Manual", found in the TEMS Investigation documentation package. The TEMS Investigation application has a UDP client built into it which interacts with this server.

- **Configuration** property:

Remote Address: The IP address or host name of the UDP server. **TCP Control Port:** The TCP protocol is used in setting up the UDP session and also to communicate the test results after the session has concluded. Specify the TCP control port to use here.
UDP Mode: • *Automatic:* The TEMS Investigation UDP client will automatically determine the optimum data rate; see the introductory text above. In this case, the parameters from **Packets Per Second** onward (see below) are set automatically and are not editable. Please note that you cannot test Full Duplex in automatic mode. • *Manual:* You specify the data rate and packet rate yourself, using the parameters below.
Direction: • *Send:* The client sends UDP data to the server. • *Receive:* The server sends UDP data to the client. • *Full Duplex:* Data is sent in both directions concurrently.

Packet Size: The UDP packet size (in bytes) that will be used. **Packets per Second:** Number of UDP packets to send or receive per second. For Full Duplex mode, this is the packet rate in each direction. **Throughput (kbit/s):** The UDP throughput rate that will be used. The packet and throughput parameters work as follows. If you select automatic mode, all parameters are set by the application and cannot be edited. If you select manual mode, you specify the parameter values yourself. However, since the parameters are constrained by the relation (packets per second) × (packet size) = throughput, when you change one parameter the others will be adjusted so that the above equation still holds true.
Duration: The duration of the UDP session ("hh:mm:ss").

Lists of UDP information elements: download/upload.

List of UDP events.

Further Notes on UDP Testing

Statistics on completed UDP sessions are output on the **Summary** tab of the Service Control Monitor, just as for other service sessions. See section 12.15.3.

It must be kept in mind that the uplink UDP information elements in the category **Data**, which are updated continuously in the course of the UDP session (see Information Elements and Events, section 3.8) only indicate the amount of data *sent*. They do not indicate the amount successfully transferred to the server. Therefore, when the packet loss rate becomes non-negligible, the UDP Upload Throughput information element is no longer reliable. To find out what percentage of packets was actually received by the UDP server, you need to check the summary statistics in the Service Control Monitor. The client uses TCP to obtain this information from the server after the UDP session has concluded.

By contrast, the UDP Download Throughput is always accurate.

> **Note:** UDP upload testing tends to cause very high CPU load, especially when multiple users are running UDP concurrently.

12.20.3.19. Network Bandwidth (Iperf Testing)

This activity measures maximum TCP or UDP bandwidth performance by interacting with an Iperf server.

Before you can use this activity, you must install the Iperf software on the machine that is to act as Iperf server. Either version 2 or 3 of Iperf can be used. Both are included in the TEMS Investigation software package. See also the Installation Guide, section 4.2.4.

UDP testing with the Network Bandwidth activity is similar to the UDP activity; see section 12.20.3.18. Measuring over TCP, on the other hand, is comparable to assigning multiple concurrent FTP activities to a device; see the example in section 12.10.4.3.

- **Configuration** property:

  General section

Iperf Version: Iperf software version: 2 or 3. **Remote Address:** The IP address or host name of the Iperf server.
Direction: • *Send:* The client sends data to the server. • *Receive:* The server sends data to the client. • *Full Duplex:* Data is sent in both directions concurrently.
Port 1: Iperf server port number to use for **Direction** = Send (also used for **Direction** = Full Duplex). **Port 2:** Iperf server port number to use for **Direction** = Receive (also used for **Direction** = Full Duplex). For Full Duplex, different port numbers should be assigned to **Port 1** and **Port 2**.
Protocol: The protocol to use for Iperf testing: TCP or UDP. **Duration:** The duration of the Iperf testing session (hh:mm:ss). **Retry count:** Maximum number of times to retry the Network Bandwidth activity if the Iperf server is busy. **Retry interval:** Time interval between retries.

Telnet/SSH2 section

> **Connection Client:** For Iperf 2, either Telnet or SSH2 can be used as protocol. Please note that SSH2 requires a special TEMS Investigation license option; see the Installation Guide, section 4.2.4. For Iperf 3, only Telnet can be used.
>
> **Port:** Port on the remote server.
>
> **User:** User name on the remote server.
>
> **Password:** Password on the remote server.
>
> **Path:** Path to Iperf on the remote server. For a Windows machine this must be an absolute path, e.g. C:\Iperf\. For a Unix or Linux machine a relative path must be given, e.g. /usr/local/bin/.

UDP section (used for UDP only)

> **Bandwidth:** Estimated available UDP bandwidth (throughput). It is possible to specify the unit as follows: B = bit/s, K = kbit/s, M = Mbit/s, G = Gbit/s, T = Tbit/s. Alternatively, lowercase letters can be used with no difference in meaning. If you do not specify a unit, the number you enter is interpreted as bit/s. **Note:** Setting this value too high for a slow network connection will lead to failures.
>
> **Buffer Size:** UDP buffer size in kilobytes.
>
> **Packet Size:** UDP packet size in bytes.

Lists of information elements: TCP download/upload; UDP download/upload.

Lists of events: TCP; UDP.

Recommendations for Iperf Testing

- The Iperf server does not support multiple concurrent connections. For this reason, observe the following:
  - The IperfWatcher monitoring tool should have one Iperf server per device and data transfer direction.
  - Do not run the same script on all devices; rather, you need to use different port numbers for different devices in order to prevent spurious failures.
  - For **Direction** = Full Duplex, two different port numbers should be assigned (as noted above).

How to set up multiple Iperf 3 server instances on the server machine is explained in the Installation Guide, section 4.2.4.3.

- The value of **Duration** in the Iperf activity should correspond to the RetryCount and RetryInterval settings on the Iperf server.

  Example: Suppose that IperfWatcher is configured with RetryCount = 3 s and RetryInterval = 10 s. You should then set **Duration** to less than 3 × 10 = 30 s to prevent the Iperf server from being restarted by IperfWatcher while the activity is still running, something which would cause spurious failures.

- For best measurement accuracy, Iperf activities with different **Bandwidth** values should be run.

- It is advisable to set the **Abort** failure handling property (see section 12.16.2) to **On Timeout** with some suitable time period specified.

12.20.3.20. Social Network

This activity is used to test the general user experience of an Internet-based social network. At present, the activity supports only the Chinese micro-blogging service Weibo (Mandarin: 新浪微博 , *Xīnlàng Wēibó*).

Two devices are required for this kind of testing, each using a different user account on the social network. The test begins with the two users logging in to their accounts. Then the following cycle is repeated a predetermined number of times: one device (the “master”) posts a status update on the network and shares it with the other device (the “slave”); the slave responds by making a comment on the status update.

The two users must be friends/followers of each other so that when one user communicates, the other will be notified. The two devices must be connected to the same PC and the same instance of TEMS Investigation.

For the recommended script setup, see below.

- **Configuration** property:

Target Service: The social network service to test. Currently, Weibo is supported. **User Name:** User name on the targeted social network. **Password:** User password on the targeted social network.

Use Proxy Server: Select whether to use a proxy server for this connection. **Proxy Server Address:** Proxy server address. **Proxy Server Port:** Proxy server port.
Behavior: • *Master:* Select this for the device that should initiate the test by making a status update on the social network. All of the test results will be reported for this device. • *Slave:* Select this for the other party, which responds to the master's status update by making a comment.
Number of Cycles: The number of "status update + comment" cycles that should be completed with success during a testing session.
Target User: The display name/nick of the social network user addressed. That is, for the master device, enter the slave's nick, and for the slave device, enter the master's nick.
Status String: Text to be sent in status update posting. **Status Image:** Image to be sent in status update posting. **Error Comment String:** Text used by the slave to comment on the status update if the attached image failed to download. This string must be set identically for both master and slave.

Lists of social network information elements and events.

Recommended Script Structure

See chapter 50.

Weibo Limitations

The license for the API used to communicate through Weibo places certain limits on the frequency of user interactions. The following limitations are directly relevant to the Weibo testing performed in TEMS Investigation:

- Status updates/shares: Max. 30/hour
- Comments: Max. 60/hour

12.20.3.21. Predefined Snippets for IP

One snippet is provided for each data service related activity; all with the following structure: **Network Connect** → <data service activity> → **Network Disconnect**.

12.20.4. Messaging Activities

12.20.4.1. Email Send

Sends an email to an SMTP server.

When composing an email script controlling both sender and receiver, it is best to use a sequence structure with a waiting period: **Email Send** → **Wait** → **Email Receive**.

- **Configuration** property:

From: Email address of sender. **To:** Email address of recipient. **Subject:** Content of email Subject field. **Body Text File:** Name of file containing email body text. **Attachment:** *(Optional)* Name of file to enclose with the email as attachment.
Server Address: The IP address or host name of the SMTP server. **Server Port:** The port on which the SMTP server listens for requests. **User:** User name of email account. **Password:** Password for email account.
Security: • *None:* No security is applied. • *SSL/TLS:* SSL or TLS is used during the whole email session. • *STARTTLS:* The initial communication is not encrypted, but a STARTTLS command is issued later on to set up a secure session.

Lists of email send information elements and events.

12.20.4.2. Email Receive

Receives an email from an IMAP or POP3 server.

When composing an email script controlling both sender and receiver, it is best to use a sequence structure with a waiting period: **Email Send** → **Wait** → **Email Receive**.

- **Configuration** property:

Email Protocol: The email retrieval protocol to use: IMAP4 or POP3. **Server Address:** The IP address or host name of the IMAP or POP3 server. **Server Port:** The port on which the IMAP or POP3 server listens for requests. **User:** User name of email account. **Password:** Password for email account.
Storage Location: Full path to directory in which to store emails. For POP3, all email contents are written to a single file: header fields, body text, and attachments (if any). For IMAP, the header and body are stored together in one file, while each attachment is stored separately in a file of its own. **Delete Retrieved Files:** If set to True, all files are deleted from the **Storage Location** directory immediately on being downloaded there.
Security: • *None:* No security is applied. • *SSL/TLS:* SSL or TLS is used during the whole email session. • *STARTTLS:* The initial communication is not encrypted, but a STARTTLS command is issued later on to set up a secure session.

Lists of email receive information elements and events.

12.20.4.3. MMS Send

Sends an MMS.

When composing an MMS script controlling both sender and receiver, it is best to use a **Parallel** structure. See sections 12.10.4 and 12.20.2.3.

- **Configuration** property:

Connection and **Gateway** sections

These are WAP settings, the same as for the WAP Get activity; see section 12.20.3.15.

MMS Content section

To: The phone number(s) or email address(es) to send the MMS to. Multiple recipients can be specified, separated by semicolons. The receiving device can be identical with the sender. **Text of MMS Message:** Free text field containing the text message of the MMS (if any). **File to Attach to the MMS:** The file to send. A wide variety of file types, including plain-text files and frequently used image file formats, is supported. A file with an extension unknown to TEMS Investigation will be sent as an attachment to the MMS (content type “application/octet-stream”). Please note that operators generally impose a limit on the MMS file size. If you encounter problems sending MMS messages, try sending very small files to find out whether the size limit is causing the problem.

MMS Message Center section

URL: The URL of the MMS Center (usually beginning with http://). **User, Password:** Login credentials for MMS Center, if required.

Proxy section: WAP proxy, optionally used for Connection Mode = WP-HTTP; see the WAP Get activity.

Lists of MMS send information elements and events.

12.20.4.4. MMS Receive

Receives an MMS.

Note that the device acting as recipient must *not* have automatic MMS download turned on (where the device retrieves the MMS message from the MMS Center automatically as soon as it receives a notification).

- **Configuration** property:

Connection Parameters section: Same as for Network Connect. The MMS Receive activity needs its own connection parameters since logging in to the MMS Center frequently requires connecting to a different APN.

Connection Settings and **Gateway** sections: These are WAP settings, the same as for the WAP Get activity.

Proxy section: WAP proxy, optionally used for Connection Mode = WP-HTTP; see the WAP Get activity.

Lists of MMS receive information elements and events.

12.20.4.5. SMS Send

Sends an SMS.

The SMS service is implemented with AT commands. For SMS Send activities to work, the device must therefore be equipped with an AT port and support the following AT commands:

- UMTS: AT+CMGF with format 0 or 1 and AT-CMGS.
- CDMA: AT+MODE, AT+CMGW, and AT+CMSS.

- **Configuration** property:

> **Receiving Device:** The phone number or email address to send the SMS to. The receiving device may be identical with the sender.
>
> **SMS Message:** SMS message string.
>
> **Request Delivery Report:** Set this to True if you want the device to request a delivery report from the SMS Center.
>
> **Delivery Report Timeout:** Time to wait for the delivery report.
>
> **Use Custom SMS Center:** Set this to True if you want to make use of an SMS Center other than the one specified on the SIM. To stick with the SMS Center indicated on the SIM, set this parameter to False.
>
> **SMS Center:** Phone number to the SMS Center.

List of SMS events.

12.20.4.6. SMS Receive

Receives an SMS.

This activity is not supported by devices that lack an AT port or that do not support the AT commands listed under SMS Send.

- **Configuration** property:

Match Type: • *Regular expression:* Enter regular expression under **Message Match Pattern** to match whole message text. The syntax is that of .NET Framework regular expressions. Reference: ▶ msdn.microsoft.com/en-us/library/hs600312(v=VS.90).aspx • *Starts with:* Enter string under Message Match Pattern to match beginning of message text. • *Ends with:* Enter string under Message Match Pattern to match end of message text. **Message Match Pattern:** The pattern to use for matching incoming or stored messages. If the field is left empty, any message will match.
Search Text Messages: • *Radio only:* The device is not searched for matching SMS messages. Instead, the activity immediately starts waiting for a matching message to be received. • *Device first – then radio:* SMS messages stored on the device are searched for matching messages. The point of doing this is to catch a message already received by the device before it performs the SMS Receive activity. If no match is found, the activity subsequently waits for a matching message to arrive. • *Device only:* SMS messages stored on the device are searched for matching messages. If no match is found, the activity terminates without waiting for a matching message. • *Device only – then clear SMS inbox:* Same as “Device only”, except that once the search is done, the device’s SMS inbox is cleared.

List of SMS events.

12.20.4.7. Predefined Snippets for Messaging

One snippet is provided for each messaging activity; all with the following structure: **Network Connect** → <data service activity> → **Network Disconnect**.

12.20.5. Scan Activities

A scan activity starts or stops a scan task of a specified type. Use a Wait activity between Start and Stop to specify the duration of the scan.

- **Scanner** property: Here you select the type of scanner to use. The choice made here determines the contents of the **Configuration** property. Please note that if you add a scan activity to the workflow, and no configurations have yet been defined for that activity type, then you need to make a selection in the Scanner drop-down box to enable the Configuration Sets pane.
- **Configuration** property: Scan configuration, identical to that for a manually initiated scan.[1] These are all described in chapters 17–22. Below is a full list of the scan activities, keyed to their configuration descriptions:

Scan Activity	Technology	Ref. to Config. Descr.
Start/Stop Code Domain Scan	CDMA	21.4
Start/Stop CPICH Scan	WCDMA	18.2
Start/Stop Enhanced Power Scan	LTE	19.5
Start/Stop Narrowband Interference Scan	CDMA	21.6
Start/Stop Network Scan	WCDMA	18.6
Start/Stop Pilot Scan	TD-SCDMA	20.3
Start/Stop PN Scan	CDMA	21.3
Start/Stop Preamble Scan	WiMAX	22.3
Start/Stop RS Scan	LTE	19.2

1. Except that remaining measurement capacity in the scanner cannot of course be stated in the absence of a physical scanner to refer to.

Scan Activity	Technology	Ref. to Config. Descr.
Start/Stop RSSI Scan	GSM	17.2
	WCDMA	18.4
	LTE	19.3
	TD-SCDMA	20.4
	CDMA	21.5
	WiMAX	22.4
Start/Stop Spectrum Scan	GSM	17.3
	WCDMA	18.5
	LTE	19.4
	CDMA	21.7
	WiMAX	22.5
Start/Stop Timeslot Scan	WCDMA	18.3

12.20.5.1. Predefined Snippets for Scanning

One snippet is provided for each scan type. All of these have the following structure: **Start ... Scan** → **Wait** → **Stop ... Scan**.

12.20.6. Video Activities

12.20.6.1. Video Dial

Dials a phone number and sets up a video telephony call.

After dialing, the device waits for the event Call Established. If this event does not occur, the device may *retry* the call. The retry behavior is governed by the **On Failure** property; see section 12.16.2.

The call *duration* is most conveniently specified by means of a subsequent Wait activity.

Devices engaged in a video call should preferably be locked on WCDMA.

- **Configuration** property:

Phone Number: The complete phone number (including country code) to call. Valid characters are: +, #, *, 0, ..., 9, and p (for pause).

12.20.6.2. Answer

Waits for an incoming video call to arrive and answers it when it arrives.

Devices engaged in a video call should preferably be locked on WCDMA.

This activity has no unique properties.

12.20.6.3. Hang Up

Hangs up a video call.

This activity has no unique properties.

12.20.6.4. Streaming

Downloads streaming video from a streaming server and plays it in TEMS Investigation or in an external video player.

Streaming over HTTP requires administrator rights on the PC: see the Installation Guide, section 13.2.1.

Streaming over RTP is not supported by devices that are tethered to the PC. (This limitation does not apply to streaming over HTTP.)

For software requirements, see the Installation Guide, section 4.1.3.

For a general discussion of testing video streaming over RTP, see chapter 30.

- **Configuration** property:

Use URL: If set to True, a full URL will be used for streaming (“HTTP streaming”). Enter that URL under **Streaming URL**. **Video Quality:** This field is enabled if **Use URL** = True. It is used to specify the quality of the streamed video to the VQmon quality measurement algorithm: “Normal” or “High Definition”. **Use Proxy Server:** If set to True, the streaming server will be accessed through a proxy server. Enter its IP address or host name under **Proxy Address**.

This field is enabled if **Use URL** and **Use Proxy Server** are both True: **HTTP Port:** The HTTP port on the streaming server. The default port number is 8080.
The four parameters that follow are for RTP streaming only (**Use URL** = False). **RTSP Port:** The RTSP port on the streaming server. The default port number is 554. **RTP Port:** Here you specify ports to use for RTP on your PC. The port entered and the three following ports will be allocated to RTP data. By default, ports 5004–5007 are used. **Prebuffer Length:** Length (in seconds) of segment to buffer during initial buffering. Min: 1 s. Max: 20 s. **Rebuffer Length:** Length (in seconds) of segment to buffer during rebuffering. Min: 1 s. Max: 20 s.
Streaming Duration: • RTP streaming: For **Streaming Mode** = “Live”, specify the duration of the streaming session here. When this time has expired, the activity terminates. • HTTP streaming: The maximum duration of the streaming session. When this time has expired, the activity will terminate, even if the whole stream has not yet been played.
The four parameters that follow are for RTP streaming only (**Use URL** = False). **Target File:** Name and storage location for received streaming file. The format is .3gp. **Streaming Mode:** “Normal” means downloading a video clip of known length (on-demand streaming). “Live” means tapping into a live stream or repeating playlist delivered by a streaming server. **Streaming Server:** The IP address or host name of the streaming server. **File To Stream:** The file name of the video clip or streaming session description to be downloaded from the streaming server.

Max Interruption Count: Maximum number of interruptions allowed during the streaming session. If this number is exceeded, the session is aborted.

Max Single Interruption Length: Maximum duration (in seconds) of a single interruption. If this duration is exceeded, the session is aborted.

Max Total Interruption Length: Maximum total duration (in seconds) of all interruptions. If this duration is exceeded, the session is aborted.

Consider Interruption Abort as Failed Measurement: This flag governs whether a Streaming activity will count as failed if aborted because of excessive interruption, according to any of the criteria above. Compare section 12.15.3.2 on script execution statistics.

Lists of streaming information elements and events.

12.20.6.5. WAP Streaming

This activity is used to do streaming via a WAP page.

- **Configuration** property:

Streaming Link: The text string of the WAP page RTSP link to the stream that is to be downloaded.

URL ... User Agent: See the WAP Get activity.

RTSP Port ... Streaming Mode: See the Streaming activity.

12.20.6.6. Predefined Snippets for Video

- Video Call snippet: **Video Dial** → **Wait** → **Hang Up**.
- Streaming snippets: **Network Connect** → <streaming activity> → **Network Disconnect**.

12.20.7. Voice Activities

12.20.7.1. Dial

Dials a phone number and sets up a voice call (circuit-switched or VoIP).

You may instruct the device to *retry* the call if the call setup fails. The retry behavior is governed by the **On Failure** property; see section 12.16.2.

The call *duration* is specified:

- in a subsequent Voice Quality or AQM Measurement activity, if voice quality is measured;
- otherwise, most conveniently by means of a subsequent Wait activity.

- **Configuration** property:

Call Type: • **Default:** The type of call the device will make (CS or VoIP) is determined by a setting in the device, or by its capabilities. • **VoIP UE:** VoIP call using an on-device VoIP client. • **VoIP PC:** VoIP call using the VoIP client built into TEMS Investigation. Regarding this, see also section 12.20.7.5.
Phone Number: The complete phone number to call, including country code. For audio quality measurement, enter the number to the other call party; see chapters 38–41. Valid characters are: +, #, *, 0, ..., 9, and p (for pause). **Codec:** *(Appears for certain VoIP clients)* Voice codec, one of: G.711 A-law, G.711 µ-law, AMR-WB, AMR-NB, or EVRC-B. "Default" is the client's default codec, which means the one last used. If the VoIP client does not support Zcodec selection, it always uses the default codec. For certain codecs, this additional field appears: **Codec Rate:** Voice codec rate.

12.20.7.2. Answer

Waits for an incoming voice call (circuit-switched or VoIP) to arrive and answers it when it arrives.

- **Configuration** property:

Call Type: • **Default:** The type of voice call (CS or VoIP) is determined by a setting in the device, or by its capabilities. • **VoIP UE:** VoIP call using an on-device VoIP client. • **VoIP PC:** VoIP call using the VoIP client built into TEMS Investigation.

> **Codec:** *(Appears for certain VoIP clients)* Voice codec, one of: G.711 A-law, G.711 μ-law, AMR-WB, AMR-NB, or EVRC-B. “Default” is the client’s default codec, which means the one last used. If the VoIP client does not support codec selection, it always uses the default codec.
>
> For certain codecs, this additional field appears:
>
> **Codec Rate:** Voice codec rate.

12.20.7.3. Hang Up

Hangs up a voice call (circuit-switched or VoIP).

- **Configuration** property:

> **Call Type:**
>
> - **Default:** The type of voice call (CS or VoIP) is determined by a setting in the device, or by its capabilities.
> - **VoIP UE:** VoIP call using an on-device VoIP client.
> - **VoIP PC:** VoIP call using the VoIP client built into TEMS Investigation.

12.20.7.4. Voice Quality

Performs audio quality measurement (AQM) including PESQ/POLQA:

- for CS voice in an ACU R2 configuration (see chapter 38)
- for CS voice or VoIP in an on-device measurement configuration (see sections 15.6.1, 15.6.2, 41.2)
- for VoIP in a PC client based configuration (see section 41.1).

CS voice quality measurement in other configurations is handled with the AQM Measurement activity.

Note that the measurements collected are found in the Media Quality information element category: see Information Elements and Events, section 3.9.

- **Configuration** property:

Algorithm: The algorithm to use for audio quality measurement. • **Nonintrusive:** (This option loads the channel with speech, but currently does not produce any unique measurements.) • **PESQ P862.1:** PESQ. • **POLQA P863 Narrowband:** POLQA for narrowband speech. • **POLQA P863 Super Wideband:** POLQA for super wideband speech.
Audio Source: The source of the audio whose quality is to be measured. When this source is external to the PC, the device physically connected to the PC is meant. • **On Device Measurement:** On-device client. • **VoIP (PC):** PC-based VoIP client. • **Ascom ACU R2:** Audio Capturing Unit ACU R2. This option is used whenever an ACU R2 is present (i.e. also when one is used in a VoIP configuration). The remaining options are not used in TEMS Investigation.
Call Type: • **M2M:** Mobile to mobile. • **M2F:** Mobile to fixed. This option is available only in the ACU R2 configuration.
Duration: The length of time ("hh:mm:ss") for which to collect voice quality measurements. **Store AQM Files:** The purpose of this option is to allow you to save audio files that have received poor MOS scores. Enter the threshold value under **MOS Limit**. If the MOS score is lower than or equal to this threshold, the audio file will be saved under [My] Documents\TEMS Product Files\TEMS Investigation 15.3\PESQ. In the case of ODM POLQA, the files are stored on the internal memory card of the AQM-computing device under odm\polqa\saved.

12.20.7.5. How to Set Up PC Client Based VoIP Testing

This section applies to VoIP testing with PC-based clients.

A number of things must be observed when setting up and running VoIP scripts. For a full tutorial on testing VoIP, see the technical paper “VoIP Testing with TEMS Investigation PC-based Clients”, found in the TEMS Investigation documentation package. Below is a summary of the salient points.

- The calling device and called device must be connected to different PCs, each running an instance of TEMS Investigation. This setup is necessary to enable audio quality measurement for VoIP.
- You must not have any other measurement devices plugged into either PC when doing VoIP testing. You cannot have an Ethernet cable connected either, nor any other internet connections in parallel. All network interfaces except the testing device must be disabled, both fixed and wireless.
- Two scripts must be prepared, one for the caller and one for the callee. Predefined VoIP snippets are provided; see section 12.20.7.7.
- Caller and callee must use the same speech codec.
- Both caller and callee must register with the SIP or IMS server to be used for VoIP. Furthermore, the callee must be registered *before* the caller places the call. The callee script must therefore complete its SIP Register activity before the caller script reaches Dial.
- The **Duration** parameter should be set differently for caller and callee, so that it can be controlled which side hangs up the call.

12.20.7.6. AQM Measurement

Performs audio quality measurement (AQM), including PESQ/POLQA, during a CS voice call. See chapters 39 and 40.

Please note that in certain CS voice AQM setups, you do not use this activity but rather the Voice Quality activity. Details are given under the latter.

- **Configuration** property:

Algorithm: One of PESQ, POLQA NB, and POLQA SWB. Please note that POLQA can be measured only in the ACU TerraTec configuration (**Measurement Type** = “M2M DL + UL”).

Measurement Type: • **M2F DL + UL:** Mobile-to-fixed audio quality measurement using CallGenerator. • **M2M DL:** Mobile-to-mobile audio quality measurement using Mobile Receiving Unit (MRU). • **M2M DL + UL:** Mobile-to-mobile audio quality measurement using Audio Capturing Unit (ACU TerraTec).
AQM Duration: The length of time for which to collect audio quality measurements ("hh:mm:ss").
Audio Channel *(only used for M2M DL + UL, otherwise has the value* "None"*)*: • **Channel1:** Choose this channel for the phone connected to **LINE IN 1**/**LINE OUT 1** on the ACU (TerraTec). • **Channel2:** Channel for phone connected to **LINE IN 2**/ **LINE OUT 2**. • **Channel3:** Channel for phone connected to **LINE IN 3**/ **LINE OUT 3**. • **Channel4:** Channel for phone connected to **LINE IN 4**/ **LINE OUT 4**.
Recording Threshold *(only used for M2M DL + UL)*: All audio files (*.pcm) with an AQM value worse than this threshold value will be stored under My Documents\TEMS Product Files\TEMS Investigation 15.3\PESQ\Recordings. The point of this mechanism is to have files with poor audio quality automatically saved for further study.

12.20.7.7. Predefined Snippets for Voice

- Voice Call snippet: **Dial** → **Wait** → **Hang Up**.
- Voice Answer snippet: **Answer** → **Wait**.
- VoIP PC Dial snippet: **Network Connect** → **SIP Register** → **Dial** → **Voice Quality** → **Hang Up** → **SIP Unregister** → **Network Disconnect**.
- VoIP PC Answer snippet: **Network Connect** → **SIP Register** → **Answer** → **Voice Quality** → **SIP Unregister** → **Network Disconnect**.
- Synchronized Voice Call Sequence snippet: This is a special case; see section 12.20.7.8.

12.20.7.8. Synchronized Voice Call Sequence Snippet

This snippet conducts a sequence of voice calls, alternatingly mobile-terminated (MT) and mobile-originated (MO), between a TEMS Investigation data-collecting device and a CallGenerator.

At the top level this snippet consists of a sole Synchronized Call Sequence activity, which in turn encloses the voice call sequence structure. The Synchronized Call Sequence activity differs from a regular Sequence in that it imposes various constraints on its contents, as dictated by the requirements of the voice call sequence.

Sequence Order Call

The snippet starts with a Dial activity making a Sequence Order (SO) call to the CallGenerator. The function of the SO call is to order MT calls from the CallGenerator and to inform it about the requested call sequence structure as embodied in the rest of the snippet. These parameters are sent by DTMF signaling and include:

- Device phone number (**Note:** This must be defined for the device in the Navigator: **Equipment** tab → **Information** subtab → **Phone Number** field. See section 6.3.2.2.)
- Number of MT calls
- Number of MO calls
- Duration of voice quality measurements
- Interval between voice calls

Voice quality is measured during the SO call itself.

Outer While Loop

The SO call hang-up is followed by an outer while loop which contains two further while loops inside it: one for MT calls and one for MO calls.

MT Call Loop

The device picks up each MT call by means of the Answer activity, then runs a Voice Quality activity, which also determines the duration of the call.

MO Call Loop

The device places each MO call by means of the Dial activity and measures voice quality just as for MT calls.

Termination of Call Sequence

When the snippet terminates, for example when the script is stopped, a Sequence Cancel call is placed to the CallGenerator so that it stops calling. Unlike the Sequence Order (SO) call, the Sequence Cancel call requires no configuration of any kind and is not visible in the user interface.

> **Note:** Do not manually abort the Sequence Cancel call; if you do, the device will keep receiving calls from the CallGenerator.

Constraints on Syntax and Configuration

It is strongly recommended to stick to the Synchronized Voice Call Sequence snippet and its associated container activity in setting up voice call sequences, since the setup is somewhat complex and the framework provided takes care of all necessary validation. The following constraints apply:

- The Dial activities must (obviously) have the same recipient phone number, namely, that of the CallGenerator.
- All Voice Quality activities must have identical parameter setups.
- The SO call must come first, then the MT loop, and finally the MO loop. The MT loop is mandatory; the MO loop, on the other hand, is optional and can be omitted.
- The MT and MO call loops must take the same total amount of time. Specifically, MT Voice Quality **Duration** + MT Wait **Duration** + 10 s (estimated time taken by Answer activity) must be equal to MO Voice Quality **Duration** + MT Wait **Duration**.

The preconfigured snippet is naturally set up in such a way as to satisfy these requirements. The default Wait time is set shorter for MT than for MO in order to ensure that the device is ready to answer the MT call when it arrives. Since the time taken by Dial, Answer, Hang Up, and the DTMF signaling will vary from one call to another, the timing is continuously adjusted during execution so that the call parties stay in sync.

What you may want to do in terms of modification, however, is to add activities for device control and logfile recording to the snippet. Besides the activity types found in the predefined snippet, the following further activities are allowed within the Synchronized Call Sequence activity:

- Activate, Deactivate

- Start Recording, Stop Recording

Failure Cases

- If the SO call fails, it is retried practically indefinitely (**On Failure** → **Retries** is set to 10000).
- If an expected MT call from the CallGenerator does not arrive, the snippet keeps running until the Answer activity has timed out three times, and then terminates. If the script has the snippet enclosed within a further while loop, the snippet will start over with a new SO call.

If the snippet terminates because of some error condition, a Sequence Cancel call is made to the CallGenerator to inhibit MT calls.

13. Control Functions

This chapter deals with control functions that are applied from the Navigator as described in chapter 7. Some of these can also be applied by a script that is running: see sections 12.13 and 12.20.1.

Regarding the configurable **device properties**, which largely serve the same purpose as control functions, see chapter 14.

13.1. What Are Control Functions Good For?

TEMS Investigation control functions allow you to perform tests within minutes which would otherwise take hours or even days to perform. Running such **quick and non-intrusive** tests with TEMS Investigation does away with cumbersome altering of settings on the network side and eliminates the risk of inconveniencing commercial users or introducing errors in the network configuration.

TEMS Investigation control functions are **real-time**, which means that you can apply them immediately any time you wish, either manually or automatically through scripting, perhaps interleaved with other testing or use of other TEMS Investigation features. In no circumstances is it necessary to reboot the connected device for a control function to take effect.

See section 13.17 for examples of tangible efficiency gains that are achievable through the use of control functions.

13.2. Control Function Support by Device

The following control functions are independent of cellular technology:

Control Function	Supported By
AT commands	Supported for all connectable devices.
Nonvolatile item read/write	Supported for Qualcomm chipset based devices.

Control Function	Supported By
PESQ device pairing	Supported for devices capable of audio quality measurement using CallGenerator or MRU. See the Device Configuration Guide, section 2.4.3.
Wi-Fi Hotspot Pairing	Supported for certain devices capable of sharing a Wi-Fi hotspot.

Regarding other control functions, see the tables below. The devices are split into two tables based on the range of control functions they support. **Note** that for the devices in the second table, these functions are in certain instances implemented as **device properties** instead. A “D” appears in the table to signify this. See chapter 14.

Over and above what is shown in the tables that follow, RAT lock and band lock are supported generally for a large class of Qualcomm chipset based devices.

Table 1: Older Devices

Control Function	Sony Ericsson				N.
	W760i, C905*, C702	TM506, Z750i	K800i, K600i	K790*, W600i	Nokia NTM3
Band lock, GSM	✓	✓	✓	✓	✓
Band lock, WCDMA	✓	✓			✓
RAT lock, GSM/WCDMA	✓	✓	✓		✓

Table 2: Newer Devices

Control Function[1]	Sony [Er.]			Samsung			
	Xperia V LT25i, T LT30a (QC)	Xperia arc S LT18a/i (QC)	W995*	Galaxy S4 GT-I9505 (QC)	Galaxy S III GT-I9305 (QC)	Galaxy S 4G	Infuse 4G
Access class control	✓	✓	D			D	D
Band lock, GSM	✓	✓	✓	✓	✓	✓	✓
Band lock, WCDMA	✓	✓	✓	✓	✓	✓	✓
Band lock, LTE	✓			✓	✓		
Barred cells, access control	✓	✓	D			D	D
BLER target control (WCDMA)		✓	D			D	D
Cell lock: GSM, ARFCN	✓	✓	✓			✓	✓
Cell lock: GSM, ARFCN + BSIC						✓	✓
Cell prevent: GSM	✓	✓	✓			✓	✓
Cell lock: WCDMA, UARFCN[2]	✓	✓	✓			✓	✓
Cell lock: WCDMA, UARFCN + SC[2]	✓	✓	✓			✓	✓
Cell prevent: WCDMA		✓				✓	✓
Cell lock: LTE, EARFCN	✓						
PLMN control		✓					
RAT lock, GSM/WCDMA	✓	✓	✓	✓	✓	✓	✓
RAT lock, LTE	✓			✓	✓		
Reserved cells, access control	✓	✓	D			D	D
RRC WCDMA capability control		✓	D			D	D
Speech codec control	✓	✓	D			D	D

1. For non-QC devices, see also **device properties** ("D") in chapter 14.
2. Regarding the behavior of this function on the Sony LT25i and LT30a phones, see section 13.9.2.1.

13.3. Functions of Dialog Buttons

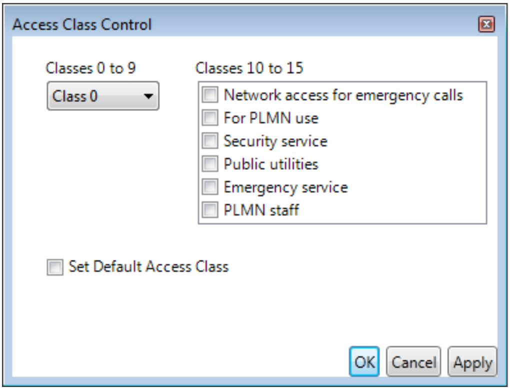
Besides OK and Cancel, the control function dialogs contain an **Apply** button. The latter transfers the current dialog settings to the device, just like OK, but without exiting the dialog.

13.4. Access Class Control

Here you can manipulate access class settings (▶ 3GPP 22.011, chapter 4). They are explained in section 14.3.2.1.

The **Set Default Access Class** option causes the device to revert to its default access class settings.

See also section 13.17.4.

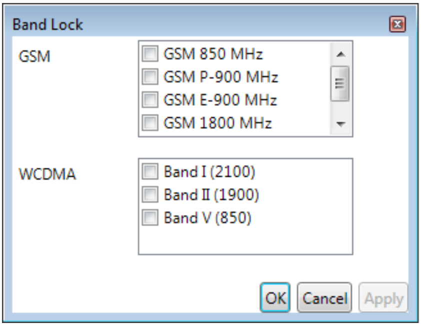


13.5. AT Commands

The **AT** item is used to issue AT commands manually. Each AT command is specified in a configuration set which is identical to that referenced by an **AT** activity in a Service Control script. If no AT configuration set exists, you need to create one. See section 12.20.1.2 for details.

13.6. Band Lock

You can restrict the device's use of frequency bands. What frequency bands appear here depends on what the device has support for.



- Check the bands that the device should be allowed to use.
- Click either **OK** or **Apply**. Clicking OK will close the dialog, whereas Apply keeps it open.

See also section 13.17.1.

Sony Ericsson Specific Limitations

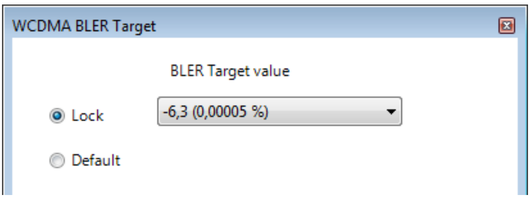
If you make selections under **GSM**, you need to be aware of the following limitations:

- If the 850 band is selected, the P-900 band cannot be selected.
- Only one 900 band at a time can be selected.

13.7. BLER Target (WCDMA)

This function overrides the BLER target set for the device by the network. For details, see section 14.3.2.12. Use the **Lock** option to change the BLER target to the value selected in the combo box. The **Default** option causes the device to revert to its default BLER target.

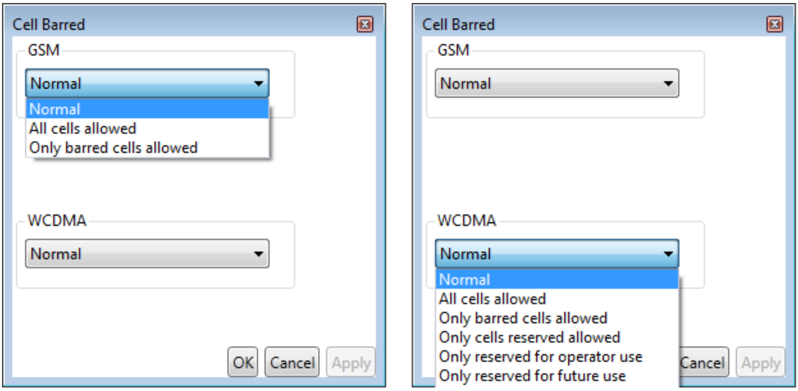
See also section 13.17.4.



13.8. Cell Barred

Here you can modify the device’s behavior with respect to accessing of barred, reserved, and other cells. The options are the same as in sections 14.3.2.5 (GSM) and 14.3.2.11 (WCDMA).

See also section 13.17.3.



13.9. Cell Lock

The Cell Lock function spans both GSM, WCDMA and LTE. It encompasses locking on cells as well as on channels/carriers.

- In GSM and WCDMA, the function has an effect in idle as well as dedicated (connected) mode. In other words, it can be used to control both cell selection and handover behavior.
- In LTE, the function itself has an effect in idle mode only; however, combined with a phone app that disables inter-frequency handover, the lock can be maintained in connected mode also. See section 13.9.3 for full details.

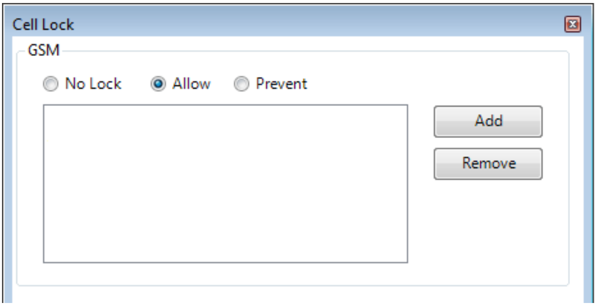
If you attempt to lock a device on cells/channels/carriers that it does not support, the following will happen:

- In GSM and WCDMA, the device will go into no service mode.
- In LTE, the application of the control function will fail, thus not affecting the device’s behavior.

13.9.1. Cell Lock in GSM

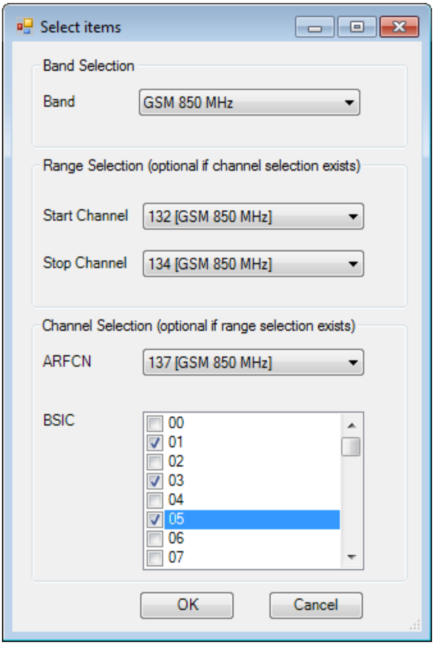
For GSM you can do the following:

- *Lock* the device on one or several cells[1]. The device is then restricted to using only these cells. This is the **Allow** option in the Cell Lock dialog.
- *Prevent* one or several cells. The device is then prevented from using these cells. This is the **Prevent** option in the Cell Lock dialog.



- To configure the set of cells to which the lock or prevent function should apply, click the **Add** button:

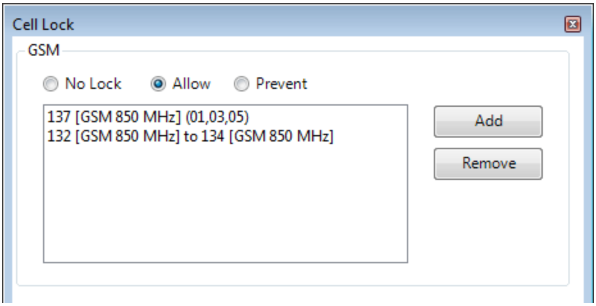
1. The word “cell” is used somewhat loosely here to mean either an ARFCN or an ARFCN + BSIC combination. See below.



- **Band selection:** Here you specify a GSM band from which to select ARFCNs.
- **Range selection** and **Channel selection**: You can define either of these, or both.
- Under **Range selection**, you specify a range of ARFCNs as extending from **Start Channel** to **Stop Channel**.
- Under **Channel selection**, you pick a single ARFCN and one or several BSICs. The ARFCN and the BSIC set are joined by an implicit AND.

You can define additional items as shown above to extend the ARFCN set, clicking the **Add** button each time.

Below is an example of a GSM Cell Lock setup. Here, the device is locked to cells on the GSM 850 MHz band having ARFCN 132, 133, or 134 with arbitrary BSIC, or ARFCN 137 with BSIC in the subset {01, 03, 05}.



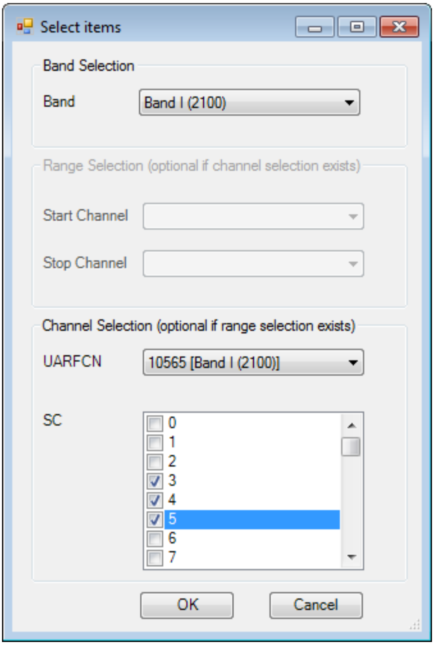
- To remove an item from the list box, select it and click **Remove**.

13.9.2. Cell Lock in WCDMA

For WCDMA you can do one of the following:

- *Lock* the device to one or several cells and/or UARFCNs. The device is then restricted to using only these cells/UARFCNs.
- *Prevent* one or several cells and/or UARFCNs. The device is then prevented from using these cells/UARFCNs.

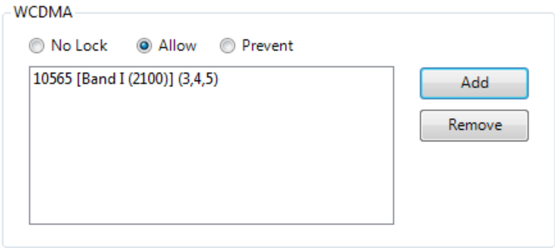
- To configure the set of cells/UARFCNs to which the lock or prevent function should apply, click the **Add** button:



- **Band selection:** Here you specify a WCDMA band from which to select UARFCNs.
- **Range selection** is not used for WCDMA.
- Under **Channel selection**, you pick one UARFCN and one or several SCs. The UARFCN and the SC set are joined by an implicit AND.

You can define additional items as shown above to extend the cell/UARFCN set, clicking the **Add** button each time.

Below is an example of a WCDMA Cell Lock setup. Here, the device is locked on the UTRA Band I (2100 MHz) cells having UARFCN 10565 and SC in the subset {3, 4, 5}.



- To remove an item from the list box, select it and click **Remove**.

13.9.2.1. Notes on Sony Xperia V LT25i and Xperia T LT30a

For certain devices, identified in the table in section 13.2, the Cell Lock function behaves somewhat differently when applied to WCDMA. Rather than applying a lock in absolute terms, you single out one cell (UARFCN + scrambling code combination), or simply one UARFCN, that the device should use. You cannot select multiple SCs here.

- In **idle mode**, the function forces the device to camp on the selected cell or some cell on the selected UARFCN.
- In **connected mode**, the function has the following effect:
  – The device encourages the network to include the selected cell (or any cell on the selected UARFCN, if no scrambling code has been specified) in the active set when the device comes close enough to measure on the cell.
  – Once a desired cell has entered the active set, the device keeps it there until the connection drops. That is, no further soft or softer handovers are performed adding cells to the active set.
  – Nothing in particular is done to have unwanted cells removed from the active set; this only happens naturally as the device reaches the boundary of a cell.

A good way to use this function is as follows: Apply the function while the device is in idle mode to lock it to the cell or UARFCN you want to test. Then run your service testing. Only the desired cell, or cells on the desired UARFCN, will then be admitted to the active set.

Technical Notes on Idle Mode

After the function has been applied, the device will still search on all UARFCNs, but will accept only the selected UARFCN or UARFCN + SC combination. It may therefore take some time from the moment the control function is applied until the device finds an acceptable cell.

Technical Notes on Dedicated Mode

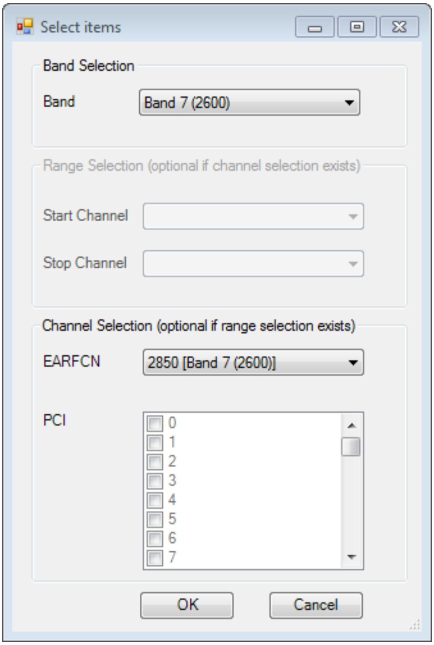
The “encouraging” referred to is accomplished by TEMS Investigation by filtering the Measurement Reports sent to the network. Only the Measurement Reports signaling intra- and inter-frequency events are filtered. Further, the reports are only filtered if the target cell has been measured and found acceptable, which the network controls through the Measurement Control messages it sends to the device.

13.9.3. Cell Lock in LTE

For LTE you can lock the device on one EARFCN. It is not possible to specify a PCI, nor can this function be toggled to “prevent” mode.

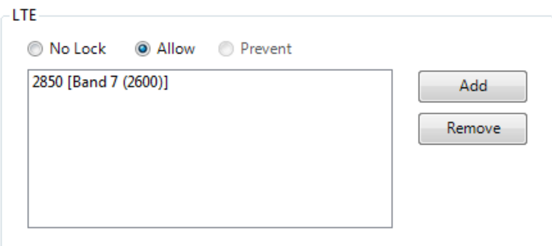
The LTE Cell Lock function has a permanent effect in idle mode only. When the device goes into connected mode and engages in data transfer, it will switch to a different EARFCN if ordered to do so by the network. However, devices supporting this function come equipped with an app called “TEMS Capability Control”, which lets you disable LTE inter-frequency (that is, inter-EARFCN) handover. This disabling must be done before you connect the device in TEMS Investigation. See section 13.9.3.1.

- To pick an EARFCN to lock on, click the **Add** button:



- **Band selection:** Here you specify an LTE band on which the EARFCN resides.
- **Range selection** is not used for LTE.
- Under **Channel selection**, select the EARFCN you wish to lock on. The PCI box is currently disabled.

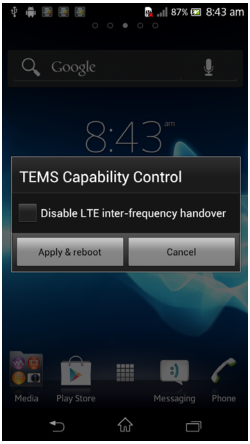
Below is an example of an LTE Cell Lock setup. Here, the device is locked on EARFCN 2850 on E-UTRA Band 7 (2600 MHz).



- To remove the item from the list box, select it and click **Remove**.

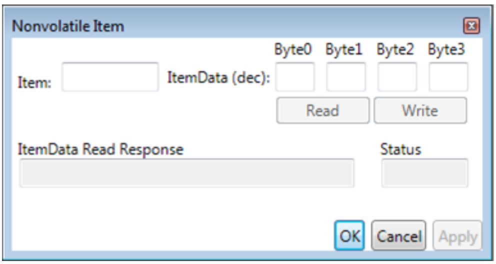
13.9.3.1. The TEMS Capability Control App

The TEMS Capability Control app has a checkbox that reads "**Disable LTE inter-frequency handover**". The TEMS Investigation device needs to be rebooted for a change in handover behavior to take effect; this is done automatically when you tap the **Apply & reboot** button. Note that once LTE inter-frequency handover has been disabled, no further reboot is required on any occasion when you apply an LTE EARFCN lock.



13.10. Nonvolatile Item Read/Write

The Nonvolatile Item functions allow you to inspect and modify settings for Qualcomm chipset based devices by reading and writing items over the Qualcomm NV interface.



The dialog is limited to 4 bytes; this is however sufficient to cover most basic NV items.

Specifics on the NV interface are vendor proprietary and must be obtained from the vendor.

> **WARNING:** It is possible to corrupt the device’s calibration parameters or otherwise damage the device by writing the wrong value to the wrong address. You are always prompted to confirm an NV command before it is executed.

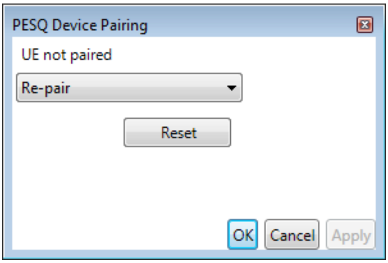
Before an NV write, a read is always performed at the same address. All traffic over the NV interface is logged in internal protocol reports, so if you are recording a logfile in TEMS Investigation it should be possible to recover the previous values of parameters by studying these reports.

After an NV write the device is always automatically reset, and consequently it is deactivated in TEMS Investigation.

13.11. PESQ Device Pairing

If you are going to do audio quality measurement with a CallGenerator or MRU, this is how you select the AQM module with which a given EQ should interact. The PESQ Device Pairing item is selectable only for devices supporting audio quality measurements (these are listed in the Device Configuration Guide, section 2.4.3). AQM modules do *not* themselves appear as EQs on the Equipment tab.

Selecting this item opens the **PESQ Device Pairing** dialog:



- At the outset, the string “**UE not paired**” is displayed, indicating that the device has not yet been paired with an AQM module.
- To accomplish pairing, select the appropriate AQM module in the combo box, which holds all available AQM modules, identified by their serial numbers.

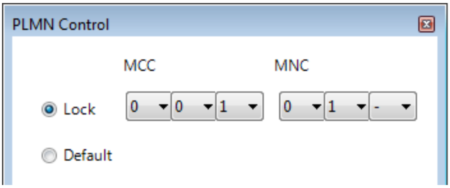
- Click either **OK** or **Apply**. Clicking OK will close the dialog, whereas Apply keeps it open.

You need to pair off your EQs and AQM modules manually like this the first time around. On later occasions, you can use the re-pairing function (see section 6.6.2) to recreate the same pairing automatically, provided that the physical connections between devices and AQM modules are unchanged.

- If you want to undo the pairing so that the device is no longer associated with any AQM module, click the **Reset** button. **Note** that if you unpair the devices in this way, you can no longer use the re-pairing function.

13.12. PLMN Control

This function locks the device on a PLMN, specified by an MCC and MNC combination just as in section 14.3.2.2.



There is however one difference compared to the device property setting: The control function allows you to distinguish two-digit and three-digit MNCs. Two-digit MNC are entered in the first two combo boxes, with the third box set to “-”.

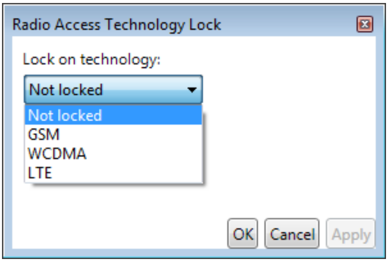
For example, the two-digit MNC “01” is entered like this:

On the other hand, the three-digit MNC “001” (formally distinct from the preceding!) is entered as follows:

See also section 13.17.4.

13.13. Radio Access Technology Lock ("Lock on RAT")

Certain devices can be locked to a particular radio access technology. The RAT lock function works only in idle mode.



The **Lock on technology** combo box shows the device's current RAT lock *state*.

You also use the same combo box to perform RAT lock *actions* by selecting a new RAT lock state to be applied and then clicking the **OK** or the **Apply** button. Clicking OK will close the dialog, whereas Apply keeps it open. Note that the lock on RAT procedure may take some time to complete.

The items in the "Lock on technology" combo box have the following meanings:

- **Not locked**
  - *State:* No forcing of UE network selection will occur.
  - *Action:* Releases a previously applied RAT lock.
- **GSM**
  - *State:* The device is locked to GSM, that is, the device is forced to camp on a GSM network whenever one is available.
  - *Action:* Locks the device to GSM.
- **WCDMA**
  - *State:* The device is locked to WCDMA, that is, the device is forced to camp on a WCDMA network whenever one is available.
  - *Action:* Locks the device to WCDMA.

- **LTE**
  - *State:* The device is locked to LTE, that is, the device is forced to camp on a LTE network whenever one is available.
  - *Action:* Locks the device to LTE.

See also section 13.17.1.

13.13.1. RAT Lock vs. Technology-specific Control Functions: Sony/Sony Ericsson

This section also applies to the Qualcomm chipset based Sony/Sony Ericsson Xperia phones.

The RAT lock setting takes priority over all intra-technology locking functions (channel, cell, and band lock) covered in sections 13.6, 13.8, 14.3.2.6, and 14.3.2.13.

On the assumption that multiple networks (GSM, WCDMA, LTE) are available to the device, this has the following implications:

- If the RAT lock is set, the device will be locked to the selected technology indefinitely[1]; applying an intra-technology lock for a different technology will *not* by itself force the device to that technology. For example, if the device is RAT-locked to WCDMA, applying a GSM band lock does not force the device to GSM. You can apply the lock, but it will have no effect at the time.
- In order to force immediate use of a different RAT, you must set the RAT lock to that technology; the device will then be switched to the selected RAT and locked to it indefinitely, *and* any control functions you have applied which are specific to that RAT will take effect. In the example given in the preceding paragraph, after the device RAT lock is changed to GSM and the device has switched to that technology, a previously applied GSM band lock will come into effect.

Note again that the RAT lock function has an effect in idle mode only.

If no RAT lock is applied, the device will camp on whatever network the fixed side prescribes (as it normally does). Whatever technology-specific settings you have made will be in force while the device is using that technology;

1. Except if you put the device in scanning mode, in which case it ceases to behave like a UE at all.

however, these settings will not interfere with the choice of RAT made by the fixed side.

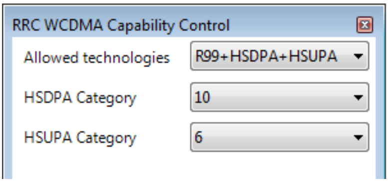
13.13.2. RAT Lock vs. Technology-specific Control Functions: Nokia

If you lock a Nokia device on a RAT, then try to apply a locking function for a different RAT, the device will go into no service mode. For example, this will be the result if you lock the device to GSM, then attempt to lock on a WCDMA cell.

However, the technology-specific setting is remembered and will come into effect after the RAT lock has been released. In the above example, when you release the GSM RAT lock, the device will immediately switch to WCDMA and lock on the WCDMA cell you selected.

13.14. RRC WCDMA Capability Control

This function lets you modify the device's reported HSPA capabilities. The options are the same as in the device properties described in section 14.3.2.14.



13.15. Speech Codec Control

This function lets you redefine the set of speech codecs that should be enabled in the device and change the default order of priority between these codecs. The user interface is the same as in section 14.3.2.3.

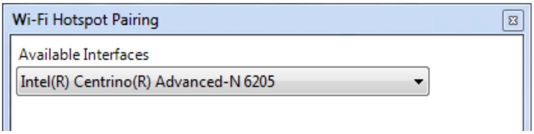
The **Set Default Speech Codecs** option causes the device to revert to its default speech codec settings.

See also section 13.17.2.

13.16. Wi-Fi Hotspot Pairing

This function is used to inform TEMS Investigation about a tethered data connection that has been set up between the PC and a connected device by pairing the PC’s Wi-Fi adapter to a Wi-Fi hotspot shared from the device.

In the dialog, under **Available Interfaces**, select the PC’s Wi-Fi adapter. It is represented by the same string as in the Control Panel (Windows 7: **Network and Internet** → **Network Connections**).



13.17. Saving Time and Effort with Control Functions

13.17.1. Example 1: RAT Lock and Band Lock

The RAT lock and band lock functions enable reliable and cost-efficient testing of all technologies and frequency bands in multi-technology networks. One highly relevant application is to testing new frequency bands as they are introduced in networks to increase capacity.

Without non-intrusive control functions like these at their disposal, operators can accomplish this kind of testing only by laborious means, such as making temporary changes to network or cell site configurations. These procedures may disturb subscribers; they could also introduce errors in the network, and they certainly take considerable time. The table below sums up how TEMS Investigation allows a tester to perform these tasks much more simply and incomparably faster:

Task	Time Taken	
	By traditional methods	With TEMS Investigation
Locking on band	~30 min (requires network reconfiguration)	~1 min (simple user interface operation)
Locking on RAT	several days (requires multiple, pre-ordered SIMs with distinct PLMN settings)	

Network reconfiguration is not really an option in the RAT case, since shutting down commercial network components (even briefly) would have an intolerable impact on subscribers. For band lock, on the other hand, network reconfiguration is the only "traditional" method available.

With its ability to lock phones to RAT and band at a moment's notice, TEMS Investigation saves engineers all of the hassle just described, thus also eliminating the risk of network changes being made incorrectly or remaining by accident after the testing is done.

Note especially how TEMS Investigation control functions differ from solutions which require the device to reboot whenever a control function is to be applied. Such behavior means several minutes of lost time for the user on each occasion: waiting for the phone to reboot, starting the test application, and finally resuming tests. Limitations of this kind also prevent scripting of control functions, so that they cannot execute unsupervised in the background. With TEMS Investigation, no such limitations apply.

13.17.2. Example 2: Speech Codec Control

The Speech codec control function lets the TEMS Investigation user select which speech codecs the device should report as supported to the network. The network will then pick a codec to use for speech coding from this subset alone. Each codec provides a different trade-off between audio quality and robustness to channel errors. Speech codec selection in TEMS Investigation can be controlled in real time before setting up each voice call.

Again, the alternative to this non-intrusive solution is to change the configuration in the mobile network. This procedure is both time-consuming and costly, and moreover it may give rise to errors in the network or in measurement results. Speech codec control as supported by TEMS Investigation is the only practical way to test individual speech codecs.

Task	Time Taken	
	By traditional methods	**With TEMS Investigation**
Forcing use of speech codec	~30 min (requires network reconfiguration)	~1 min (simple user interface operation)

13.17.3. Example 3: Cell Barred

By barring a cell, the operator can prevent commercial users from camping on that cell. Certain TEMS Investigation devices, however, have the ability to ignore the access restriction and use the cell anyway. Tests can then be conducted in a controlled environment without interruptions (using an "**Only barred**" or "**Only reserved**" option, as exhibited in section 13.8). This increases the reliability of tests and promotes testing efficiency, as alternative methods can be costly and error-prone. Furthermore, the testing can be done with minimum impact on paying subscribers.

13.17.4. Further Examples

Similar efficiency gains can be obtained with all other control functions that TEMS Investigation offers. Here are some further use cases:

- **Simulating a different mobile device access class.** By modifying these settings, you can quickly and easily simulate different access class privileges for devices, with a view to performance verification.
- **Changing the BLER target in a WCDMA cell.** Changing the network's assigned BLER target lets you study how this setting impacts transmit power control in a cell.
- **Locking on a PLMN (MCC + MNC combination).** This function overrides the device's regular PLMN selection, which is a slow procedure. You can use the function to inhibit unwanted roaming, or (in the course of

emergency service testing) to make the device reattach more quickly to its home network.

Task	Time Taken	
	By traditional methods	**With TEMS Investigation**
Simulating different access class	several days (requires SIM modification)	~1 min See section 13.4
Changing BLER target	~30 min (requires network reconfiguration)	~1 min See section 13.7
Locking on PLMN	several days (requires multiple, pre-ordered SIMs with distinct PLMN settings)	~1 min See section 13.12

14. Device Properties

You can view and modify certain properties of devices that are connected in TEMS Investigation. Such operations mostly serve the same kind of purposes as control functions, which are covered in chapter 13.

14.1. Accessing Device Properties

To access the property dialog of a device, do as follows:

- Right-click on the device on the Navigator's Equipment tab.
- Choose **Properties** from the context menu.

14.2. Overview of Properties by Device

This overview covers certain Sony/Sony Ericsson, Nokia, and Samsung devices. Other supported devices share little or none of the control functionality listed here.

Some devices have Navigator control functions that correspond, wholly or partially, to device properties for other devices. For clarity, these instances are marked with an "N" (for "Navigator") in the table below.

Device properties that correspond to aspects of the Cell Lock control function in the Navigator (described in section 13.9) are labeled "**CL**" in the table.

The GSM channel verification function, too, is included in the table for convenience. This function is the topic of chapter 51.

Device Property	Sony/Sony Ericsson								Sams.		No.
	Xperia V LT25i, T LT30a (QC)	Xperia arc S LT18a/i (QC)	W995*, W760i, C905*, C702	TM506, Z750i	K800i	K790*	K600i	W600i	Galaxy S 4G	Infuse 4G	Nokia NTM3
Access class control	N	N	✓	✓	✓	✓	✓	✓	✓	✓	
Barred cells, access control	N	N	✓	✓	✓	✓	✓	✓	✓	✓	✓
BLER target control (WCDMA)		N	✓	✓	✓				✓	✓	
C/A measurements (GSM)			✓	✓	✓	✓	✓	✓			
Channel verification (GSM)[1]			✓	✓	✓	✓	✓	✓			
Disable handover **CL**	N	N	✓						N	N	
EDGE capability control			✓	✓		✓			✓	✓	
L3 messages, discard/ignore			✓	✓	✓	✓					
Lock on ARFCN **CL**	N	N	✓	✓	✓	✓	✓	✓	N	N	✓
Lock on BSIC **CL**									N	N	
Lock on PLMN		N	✓	✓	✓	✓	✓	✓		✓	
Lock on SC **CL**	N	N	✓	✓	✓		✓		N	N	✓
Lock on UARFCN **CL**	N	N	✓	✓	✓		✓		N	N	
Prevent handover[2] **CL**	N	N	✓	✓	✓	✓	✓	✓	N	N	
Reserved cells, access control	N	N	✓	✓					✓	✓	
RRC WCDMA capability control		N	✓	✓					✓	✓	
Speech codec control[3]	N	N	✓	✓	✓	✓	✓	✓	✓	✓	
TxPower control (GSM)			✓	✓	✓	✓	✓		✓		

1. See chapter 51.
2. That is, prevent handover to specified cells.
3. Changing order of priority between codecs is supported for C905*/W995* only.

14.3. Properties of ST-Ericsson Chipset Based Devices

This section deals with viewable and editable properties of ST-Ericsson chipset based devices: Sony Ericsson phones except Xperia arc S, and the Samsung Galaxy S 4G and Infuse 4G models.

When you activate the device in the application, the device retrieves all settings you have specified for it. Any changes to the properties will apply as long as the device remains activated in TEMS Investigation.

Functions of Dialog Buttons

Besides OK and Cancel, the Properties dialog contains the buttons **Restore Defaults** and **Apply**. These buttons have the following functions:

- **Apply** saves all changes made to settings, like OK, but without exiting the dialog.
- **Restore Defaults** resets all settings to their defaults, without exiting the dialog.

14.3.1. Extended Reports

This item appears for certain Sony Ericsson phones, listing messages and mode reports delivered by the phone. You can turn the reporting on and off for each item listed.

Note the following:

- “Path Searcher Report (A2)” must be checked for the WCDMA category Finger Info information elements to be valid.
- “Downlink DPCCH Report” and “Uplink DPCCH Report” must be checked for the WCDMA information elements Power Control Indication DL and Power Control Indication UL (respectively) to be valid. These high bit rate reports are by default disabled.
- Regarding “TPC Info Per Cell”, see Information Elements and Events, section 7.1.

14.3.2. Common Controls

Each of the nodes in the property grid contains a field **Default/Modified**. At the outset this field has the value Default everywhere, which means no alteration of regular device behavior. To activate a control function, you must switch the corresponding "Default/Modified" field to Modified (can be done by double-clicking the value), then proceed to set the other parameters as desired according to the subsections below.

14.3.2.1. CAS Access Class

Here you can manipulate access class settings (▶ 3GPP 22.011, chapter 4).

Classes 0 ... 9	Every device is by default allocated randomly to one of these classes. You can change the default allocation here.
Classes 10 ... 15	Membership of these classes entitles a device to make access attempts in various special situations. Check the classes that you want the device to be a member of.

14.3.2.2. CAS Lock on PLMN

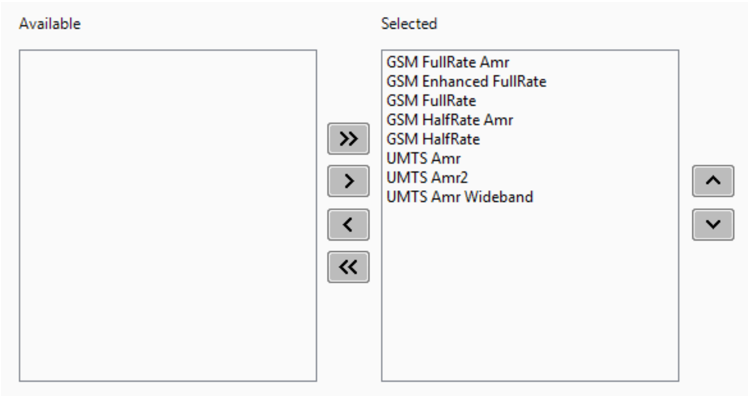
You can lock the device on a PLMN, specified by an MCC and MNC combination. Note that this function can be meaningfully applied only if the SIM supports multiple PLMNs. If you lock on a PLMN that is not available, the device will go into limited service mode.

MCC, MNC	Define the target PLMN here.

14.3.2.3. CAS Speech Codec

For certain device models (indicated in section 14.2) you can both define a subset of codecs that should be enabled and change the default order of priority between the selected codecs.

Speech codecs	When you click the "**...**" button in the right-hand field listing codecs, the user interface shown below appears.



- Use the arrow buttons in the middle to move any codecs you want to disable from the Selected box to the **Available** box. Those that you leave in the Selected box will remain enabled.
- Then use the arrow buttons on the right to adjust the order of priority for the selected codecs.

For other device models you can only select which codecs should be enabled; this is done in a regular property grid. By default all codecs are enabled.

14.3.2.4. GSM Adjacent Scan

Devices capable of C/A measurements on hopping channels can be set to measure either one channel or two channels on each side of the carrier.

Number of adjacent channels	Specify one or two channels; see above.

14.3.2.5. GSM Barred Cells

Here you can alter the device’s behavior in GSM idle mode with respect to barred cells. If the “barred” flag is set for a cell, this normally prevents the device from accessing it.

Mode	**Normal:** The device will not camp on barred cells. **All cells allowed:** The device will camp on any cell, ignoring cell barring. **Only barred cells allowed:** The device will camp *only* on barred cells.

14.3.2.6. GSM Cell Selection

When the device is in idle mode, it can be locked to one channel or to a set of channels. This inhibits all reselections to other channels, regardless of the signal strength and quality of neighboring cells. The inverted operation is also possible, namely to prevent reselection to a specified channel set.

ARFCNs	Check the channels you want to lock on or exclude.
Control mode	**Normal:** No effect on default behavior. **Lock:** The device will be locked to the set of channels checked under **ARFCNs**. **Prevent:** The device will be prevented from camping on the channels checked under **ARFCNs**.

Note: To apply this kind of lock, you must first lock the device to the GSM RAT (see section 13.13) and to a GSM band (see section 13.6).

14.3.2.7. GSM EDGE Capability

For EDGE-capable devices you can choose to disable the EDGE capability. This function can be used to force data transfer over GPRS rather than EDGE.

EDGE allowed	**Yes:** EDGE enabled. **No:** EDGE disabled.

14.3.2.8. GSM Handover

When the device is in dedicated mode, you can manipulate its handover behavior. Specifically, you can do one of the following:

- *Prevent* handover to specified channels. The device will then report no RxLev for these channels.
- *Force* handover to a specified channel, or restrict handovers to a chosen channel set. The device will then report a very high RxLev for any such cell, a very low RxLev for the serving cell, and no RxLev for other neighboring cells.
- *Disable* handover altogether.

ARFCNs	Check the channels you want to prevent handover to or restrict handover to.
Control mode	**Normal:** No effect on default behavior. **Lock:** The device will be able perform handover only to the set of channels checked under **ARFCNs**. Selecting a single channel forces handover to that channel. **Prevent:** The device will be prevented from performing handover to the channels checked under **ARFCNs**. **Disable handover:** The device will be prevented from performing any handovers at all.

14.3.2.9. GSM Tx Power

For each GSM frequency band you can specify a Tx Power value which will override the network allocated Tx Power. Regarding the latter, see ▶ 3GPP 45.005, section 4.1.

Tx Power GSM 850 (dBm) (etc.)	Enter the desired new Tx Power in dBm for the GSM 850 MHz band.

14.3.2.10. Layer 3 Messages

For certain Sony Ericsson UEs you can discard Layer 3 messages of specified types.

Note: The UE must have been activated at least once for the full tree of Layer 3 message types to appear here.

Default/Discard	To enable the function, select **Discard** here.
Loaded	Number of Layer 3 message types selected under **Message types**.
Message types	Click the browse button (marked “**...**”). In the dialog that appears, check the types of Layer 3 message that you want to discard. The device can store up to 10 message types in its memory.

Discarded messages are colored red in the Layer 3 Messages window and tagged with a special note in the plain-text decoding; see section 29.3.

14.3.2.11. WCDMA Barred Cells

Here you can modify the device’s behavior with respect to accessing of barred, reserved, and other cells:

Normal	No change from normal cell barring behavior.
Mode	**All cells allowed:** The device will access any cell, also barred and reserved ones. **Only barred:** The device will only access barred cells. **Only reserved:** The device will only access reserved cells. **Only reserved for operator use:** The device will only access cells that are reserved for operator use. **Only reserved for future use:** The device will only access cells that are reserved for future use. **Only barred or reserved:** The device will only access cells that are barred or reserved.

14.3.2.12. WCDMA BLER Target

For certain Sony Ericsson UEs you can override the BLER target set for the UE by the network.

BLER Target value	The BLER target for the UE will change to the value you set here. Regarding the format of this value, see ▶ 3GPP 25.331.

14.3.2.13. WCDMA Cell Selection

Here you can lock the UE to selected UARFCNs or scrambling codes in WCDMA, in idle mode as well as connected mode.

Control mode	**Normal:** No effect on default behavior. **Lock:** The device will be locked to the set of UARFCNs/scrambling codes that you select in the **UARFCNs** and **Scrambling codes** fields.
Scrambling codes	Lists the scrambling codes to lock on. To be able to specify target SCs, you must first have selected a single target UARFCN. Up to 32 SCs can then be listed as targets. If you have specified multiple target UARFCNs, you cannot add any target SCs (the Scrambling codes field is grayed).
UARFCNs	Check the UARFCN you want to lock to. Up to 32 target UARFCNs can be specified. However, note that if you list more than one UARFCN, you cannot also select scrambling codes as targets.

Note: To apply this kind of lock, you must first lock the device to the WCDMA RAT (see section 13.13) and to a WCDMA band (see section 13.6).

14.3.2.14. WCDMA RRC Radio Capability

For devices supporting HSDPA, or all of HSPA, you can enable or disable these capabilities.

Allowed technologies	**R99 only:** Only WCDMA R99 is enabled. **HSDPA:** HSDPA is enabled (but not HSUPA, even if the device supports it). **HSDPA + HSUPA:** Both HSDPA and HSUPA are enabled.
HSDPA category	If HSDPA is enabled, you can set here what HSDPA (HS-DSCH) category the device should report. These categories are defined in ► 3GPP 25.306, table 5.1a.
HSUPA category	If HSUPA is enabled, you can set here what HSUPA (E-DCH) category the device should report. These categories are defined in ► 3GPP 25.306, table 5.1g.

14.4. Properties of Nokia Phones (NTM3)

14.4.1. Channel Lock Control (GSM)

In GSM mode, you can lock the phone to a single ARFCN. The channel lock function works in idle mode only.

Enable channel lock	Set this to Yes to enable the channel lock function.
Band	Specify the band containing the channel you want to lock on.
ARFCN	Specify the ARFCN of the channel to lock on.

14.4.2. GSM Cell Barring Control

This setting governs how the phone behaves with respect to barred GSM cells.

Cell barring	**Normal:** The phone will not camp on barred cells. **Reversed:** The phone will camp *only* on barred cells. **Ignored:** The phone will camp on any cell, ignoring cell barring.

14.4.3. Sector Lock Control (WCDMA)

These settings apply in WCDMA mode. The phone will be locked to the chosen UARFCN and scrambling code.

Enable sector lock	Set this to Yes to enable the sector lock function.
UARFCN	Specify the UARFCN to lock on.
Scrambling code	Specify the scrambling code to lock on.

14.5. Properties of Qualcomm Chipset Based Devices

Properties of Qualcomm chipset based devices are mostly limited to enabling and disabling of various logs. This is true for the Sony Ericsson Xperia arc S and later Xperia models as well; for these devices all control functions are applied from the Navigator, as explained in section 7.1.

However, for many Qualcomm chipset based devices, RAT lock and band lock functions are available.

Please note that if you turn on all “extended” logs (without turning off something else), the data volume logged will be huge, and it may be necessary to start recording of a new logfile once every hour or at even shorter intervals to prevent RAM usage from becoming excessive.

Notes on specific information elements:

- For speech codec information elements to be populated, you must enable all logs with “Vocoder Packet” in their names.

- For the LTE element Serving Cell Tx1-Tx2 Per Rx Antenna to be calculated, the log "LL1 CRS TXRX Power Report" (version 4 or later) must be turned on. This log is by default turned off.

Regarding the NV (Nonvolatile) interface, see section 13.10.

14.5.1. Properties Specific to Certain Xperia Phones

The Sony Ericsson Xperia arc S LT18a/i, Sony Xperia V LT25i, and Sony Xperia T LT30a phones have a log category "TEMS" containing some logs that affect the population of information elements:

- The "WCDMA RRC State" log must be turned on for the WCDMA RRC State element to receive a value at device connect/start of logfile. If the log is turned off, no RRC State is presented until the state changes.
- The "WCDMA SIR Target" log must be turned on for the WCDMA SIR Target element to be populated.
- *(Xperia arc S only)* The "GSM C/I" log must be turned on for the "C/I" family of elements in the GSM category to be populated. Please note that with this device, C/I is obtained only for circuit-switched, not for packet-switched data.

14.6. Properties of Samsung LTE Modems

For Samsung LTE modems, various message categories can be enabled and disabled.

Common; **LTE**	For each of these top-level message categories, the following options exist: **All enabled:** All messages are enabled. **All disabled:** All messages are disabled. **Select messages:** When this option is chosen, further fields appear which allow you to enable or disable various subcategories of messages. (The settings you make here do *not* affect the scope of **All enabled**, which always means all messages without restriction.)

Please note that if you disable everything here, no reports from the **MS** device channel will be displayed in TEMS Investigation.

14.7. Properties of GPS Units

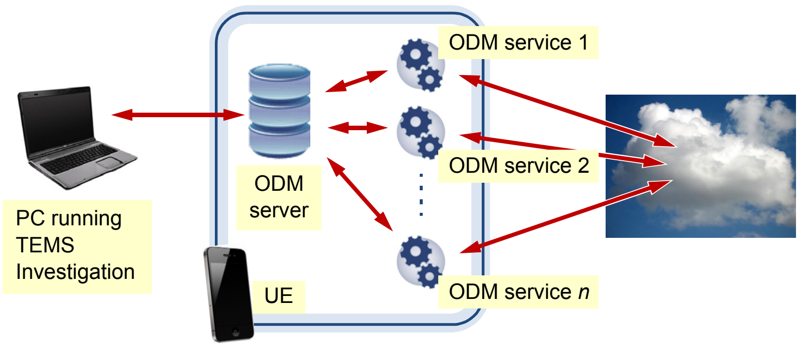
You can inspect and change some properties of a GPS unit. What properties are editable depends on what product you are using.

15. On-device Measurement

On-device measurement, ODM for short, is a testing methodology that differs from other testing performed with TEMS Investigation. The essential difference is that the software performing the measurement resides on a connected device rather than being part of the TEMS Investigation PC software. This chapter explains how ODM works, how to set it up, and what data is obtained when doing this kind of testing.

15.1. On-device Measurement Configuration

See the diagram below. The TEMS Investigation PC software communicates with a software component in the UE called the ODM server. This component in turn manages ODM services, which are client applications in the UE, each handling a particular kind of service and running sessions in the cellular network.



15.2. Available On-device Services

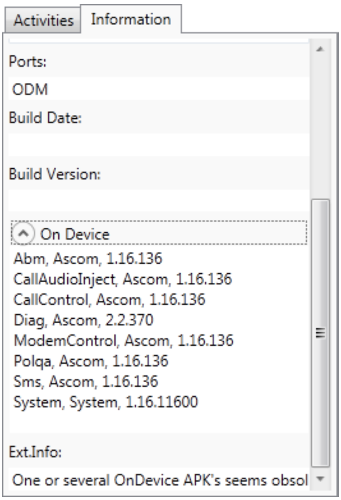
- **ODM MTSI.** This service is used for VoIP alone.
- **ODM Call Control.** This service handles voice calls over *either* circuit-switched *or* IP, depending on the settings in the device.

- **ODM POLQA.** This service conducts audio quality measurements, using the POLQA algorithm, for voice calls over either CS or VoIP.
- **ODM IP Sniffing.** This service performs IP sniffing.

ODM MTSI and ODM Call Control are not distinguished in the TEMS Investigation user interface (no device supports both).

In addition, certain devices internally use other ODM services, which are not user-configurable and are not discussed further in this chapter. However, be aware that these devices must always have the ODM software installed to be able to function as data-collecting devices with TEMS Investigation.

The full list of ODM services installed on a device can be viewed in the Navigator, as indicated in section 6.3.2.2: **Equipment** tab → **Information** subtab → **On Device** node (expand this node). Below is an example.



15.3. Devices Supporting On-device Testing

All of these are listed in the Device Configuration Guide, section 2.7.

15.4. Preparations for On-device Testing

Before you can start ODM testing, besides possessing the general TEMS Investigation ODM license option (see the Installation Guide, section 3.3.3.5), you need to get the ODM software on your devices licensed by Ascom. To this end, Ascom needs to know the equipment identities (IMEIs or MEIDs) of your ODM devices. These will usually have been stated in the product order, but if not, they need to be provided to Ascom by some other means – for example, by email – before ODM can be licensed on the devices.

To place a request for licensing of the ODM software:

- Make sure the device has an Internet connection (over a cellular network, Wi-Fi, or other).
- Connect the device in TEMS Investigation.
- Right-click the device in the Navigator and select the **Install ODM on UE** command. See section 6.3.1.1 for further details.

After issuing this request, keep the device turned on for at least two minutes so as to fully ensure that the ODM request is sent successfully.

You will be notified by Ascom when the ODM software has been licensed. Please note that this may take 1–2 days, although the procedure will usually be faster. Following this, you need to reboot the device twice to make it ready for on-device measurement.

The software for all of the various ODM services is included in the same download package; there is no need for any separate downloads to obtain software for specific services.

15.5. Checking for On-device Software Updates

A special utility exists for checking whether new on-device software is available. It is run when you issue the **Install ODM on UE** command in the Navigator, and also in conjunction with each automatic check for TEMS Investigation software updates (see section 2.4).

Furthermore, checking for on-device software updates can be done manually in one of the following ways:

- Run the application **Start** → **All Programs** → **Ascom** → **TEMS Products** → **Utilities** → **Check for On Device Measurements Updates**, or:
- Under Documents, browse to TEMS Product Files\TEMS Investigation 15.3\Update\ODM and run the file ODMUpdate.exe. The outcome of the update check is recorded in ODM Server Update Log.txt.

If TEMS Investigation has detected that some on-device software is out of date, the icon of a device using this software is tagged with a yellow triangle (as shown in section 6.3.1). Run the **Install ODM on UE** command to get the latest software.

You can always inspect on the Navigator's **Equipment** tab what ODM software a device has installed, as described in section 15.2.

15.6. Setting Up On-device Testing in TEMS Investigation

On-device testing is configured using Service Control scripts and associated configuration sets, just like other testing in TEMS Investigation.

15.6.1. Setup for VoIP

In on-device VoIP testing, two devices connected to the PC call each other using their built-in VoIP clients, which are controlled by TEMS Investigation.

On-device VoIP testing always uses the following Service Control activities:

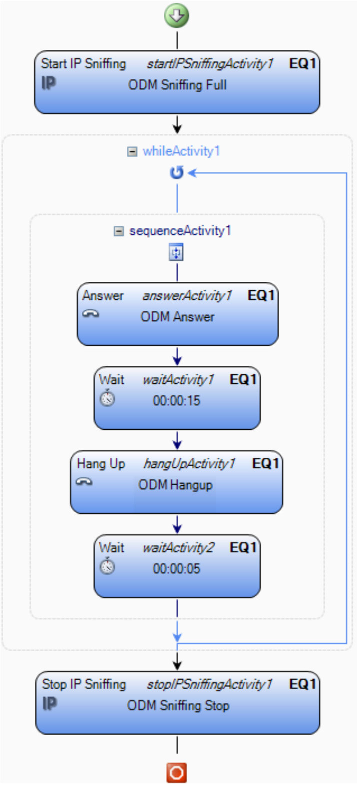
- Dial, Answer, and Hang Up. See section 12.20.7. **Client** must be set explicitly to "VoIP UE", or it can be set to "Default" for a device that will by default conduct voice calls over IP.
- SIP Register/Unregister: See sections 12.20.3.6, 12.20.3.7.

15.6.1.1. Notes on Devices Using ODM Call Control

This section applies to devices that use the ODM Call Control service for VoIP. They are listed in the Device Configuration Guide, section 2.7.1.

- To obtain adequate VoIP measurement data with ODM Call Control, it is necessary to also use the ODM IP Sniffing service in conjunction with it. In your script, enclose everything to do with VoIP within Start IP Sniffing and Stop IP Sniffing activities, both with **Client** set to "ODM".
- Insert a Wait of at least 3 seconds after each dial, answer, and hangup activity. This is to allow slower phones enough time to execute.

An example is shown below (answering side).



> **Note:** No screen saver must be enabled on a device running ODM Call Control. If a screen saver is activated during a call, the hangup will fail.

15.6.2. Setup for CS Voice

For any device equipped with an ODM service that is configured to make voice calls over circuit-switched, you just have to assign Dial, Answer, and Hang Up activities to it with **Client** set to “Default”. See section 12.20.7.

For devices that use the ODM Call Control service, insert a Wait of at least 3 seconds after each dial, answer, and hangup activity. Compare section 15.6.1.1.

15.6.3. Setup for AQM

To measure audio quality for VoIP using ODM MTSI, you use the Voice Quality activity. See section 12.20.7.4.

To measure audio quality using ODM POLQA, whether during a CS voice or a VoIP call, you likewise use the Voice Quality activity. The script should then be structured in the same way as for the AQM configuration using an ACU R2 unit. See section 38.2.3.1, "Mobile-to-mobile (M2M): All Devices Connected to the Same PC".

15.6.4. Setup for IP Sniffing

For ODM IP Sniffing, the connected device uses the regular Service Control activities Start IP Sniffing and Stop IP Sniffing with **Client** set to "ODM". See sections 12.20.3.8, 12.20.3.9. Note the limitations regarding the **Filter** options; to ensure that IP-based KPIs can be computed, set **Packet Size** to at least 128 bytes (with **Filter** = None).

15.7. Output from On-device Testing

Generally speaking, the same range of information elements, events, and KPIs are obtained with ODM as when testing with PC-based clients. Deviations are noted below.

15.7.1. Output for VoIP

15.7.1.1. VoIP with ODM MTSI

Output from ODM MTSI VoIP is similar to that from VoIP testing with a PC-based client. Specifics are as follows:

- *"Data" category IEs:* VoIP* (all elements). See Information Elements and Events, section 3.8.
- *"Media Quality" category IEs:* A subset of the AQM*, PESQ*, and POLQA* elements. See Information Elements and Events, section 3.8 and chapter 5 (extent of support).
- *MTSI KPIs:* See the Technical Reference, section 11.2.8; these are based on events as detailed in Information Elements and Events, section 8.4.

15.7.1.2. VoIP with ODM Call Control

- *"Data" category IEs:* VoIP* (all elements).
- *"Media Quality" category IEs:* A subset of the AQM* and POLQA* elements (provided that the device supports ODM POLQA). See Information Elements and Events, chapter 5.
- *MTSI KPIs* (provided that ODM IP Sniffing has also been used).

15.7.2. Output for CS Voice

This is similar to regular CS voice testing.

Media Quality IEs can be obtained with devices that support ODM POLQA. See Information Elements and Events, chapter 5.

15.7.3. Output for IP Sniffing

The output from IP sniffing is presented in the IP Protocol Report window as usual. You can also export the logfile in Wireshark format (*.eth file extension) as described in section 10.6.2.6.

15.8. Benefits of On-device Testing

This section hints at some of the benefits that can be reaped with an on-device test setup as opposed to a more traditional one with PC-based service testing software.

- On-device testing infuses the old slogan **"Test like a user"** with fresh meaning. Picking the VoLTE service as an example, we can state that a terminal-based VoLTE client will **cope better in the LTE network**. When running VoLTE over a PC client, the voice call will not be prioritized in the network as would be appropriate for a real-time service, but dealt with on a "best effort" basis only. A device-based VoLTE client, on the other hand, is sure to be assigned a VoLTE logical channel with high priority (QoS class). What this means is that the service performance will not suffer from any limitations inherent in the test setup, and it will therefore reflect real-world subscriber experience in a way that cannot be fully achieved with a PC-based VoLTE client.
- A client embedded in device firmware will have been adapted to and **optimized for that particular device**. This too gives a performance edge over PC-based clients (independently of channel assignment/traffic

prioritization as described in the preceding bullet), even a PC-based client from the same vendor.

- For certain measurement tasks, an on-device client implementation is desirable or even indispensable in order to obtain sufficient **accuracy**: communicating with a PC client would cause excessive delay.
- Yet another advantage of on-device service testing is that it **offloads the PC** by distributing the processing across multiple devices.

16. Scanning: General

Scanning can be done either

- manually from the Navigator’s **Equipment** tab, or
- as an activity in a Service Control script.

The configuration dialogs are the same in both cases, and they are gone through in chapters 17–22.

Note, however, that scripted scanning is currently available for a subset of supported scanning devices:

Scanning Type/ Scanning Device	Andrew	Anritsu	DRT	PCTel	R&S TSMW	Sony Ericsson	SRU	Transcom
Manual	✓	✓	✓	✓	✓	✓	✓	✓
Scripted				✓		✓	✓	✓

16.1. Connectable Scanners

For an overview of scanners connectable in TEMS Investigation for various cellular technologies, see the Device Configuration Guide, section 2.2.4.

16.2. Scripted Scanning

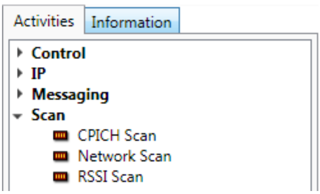
Scripted scanning works just like scripting of other activities and does not require special comment; please refer to chapter 12 (the scan activities are listed in section 12.20.5).

16.3. Manual Scanning

16.3.1. Setting Up a Scan Manually

Scanning tasks can be set up manually on the Navigator's **Equipment** tab; specifically, from the **Activities** subtab in the bottom pane.

- First, to be able to access the scanning configuration dialogs, you need to *activate* the device you want to scan with (if it is not already activated). See chapter 6.
- Once the device has been activated, the Activities subtab is populated. For a scanning-capable device, the available activities will include ones collected under a **Scan** node. Expand this node to view a list of the scanning methods that this device supports.



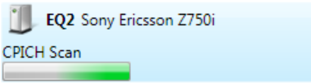
- Right-click the scanning method you want to use, and select **Configuration Sets** from the context menu. This opens a dialog where you define a setup for the selected scanning method. The dialog contents depend on the technology and scanning method chosen as well as on the make and model of the scanning device. All details are covered in subsequent chapters (17–22).

16.3.2. Starting a Scan Manually

With suitable configuration sets already defined, you can initiate a scan manually as follows:

- On the Navigator's **Equipment** tab, select the device to scan with.
- On the **Activities** subtab, expand the **Scan** node.
- Right-click the scanning method you want to use, and from the context menu select the desired configuration set among those in existence.
- Right-click the scanning method item again, and from the context menu select **Start**.

While the scan is ongoing, it will be indicated in the top pane of the Equipment tab for the device that is busy scanning.



It is possible to scan with several devices simultaneously.

When running multiple scan tasks on the same device (e.g. one pilot scan and one RSSI scan), it is best not to start all of these tasks in very rapid succession. To prevent malfunctions, it is preferable to wait until one scan starts returning data before starting another. Compare the similar advice on scripting of parallel tasks which is given in section 12.10.4.3.

16.3.3. Recording Scan Data Manually

To record data from a manually initiated scan, create a new logfile as described in section 10.1.

16.3.4. Stopping a Scan Manually

To stop a scan that is in progress:

- Go to the Navigator’s **Equipment** tab, **Activities** subtab.
- Under the **Scan** node, right-click the scanning method being executed, and select **Stop**.

16.4. Presenting Scan Data

The output of scans is primarily intended to be displayed in a suite of ready-made bar charts and other windows. The scanning presentation windows are fully synchronized with the rest of the application, and the output from all of these can be displayed in parallel.

However, since all scan data is available in information elements, you are free to present it in any presentation window. For example, scan data can be displayed in status windows of your own design. How to build a status window is covered in chapter 27. The information elements of interest are all found in the Information Elements and Events volume; the most important ones are referenced in chapters 17–22.

16.5. Technical Data on Scanning Devices

- A Sony Ericsson phone cannot act as a regular phone while it is scanning. It cannot engage in voice/video calls or data services during this time.
- Frequency band support is determined by the scanning device and by the antennas. For band support in connectable scanning devices, see the Device Configuration Guide, section 2.2.4.
- Detailed data on the scanning capabilities and performance of Sony Ericsson phones is provided in the technical paper “Scanning with Sony Ericsson TEMS Devices”, included in the TEMS Investigation documentation package.
- Some technical data on PCTel scanners and antennas used with them is provided in the Device Configuration Guide, section 10.2.2.

For further information on third-party scanning devices, please consult documentation from the respective suppliers.

16.6. Notes on Scanner Multitasking

16.6.1. PCTel Scanners

Within a cellular technology, scanning methods are conceptually independent, and they can be run concurrently by PCTel scanners. Only the scanner measurement capacity places a limit on the possibilities of handling several scanning tasks in parallel. For example, a WCDMA SCH timeslot scan at maximum resolution may require the full resources of the PCTel scanner, so that it cannot perform any other tasks at the same time.

A PCTel scanner’s measurement capacity is indicated as a number of measurement points. As you set up the scanning tasks, you are continuously notified in the setup dialog of how many measurement points that remain.

With some PCTel scanners only 2,560 measurement points can be allocated for spectrum scanning, even though the scanner in fact has more measurement points available.

16.6.2. DRT Scanners

For a DRT scanner, TEMS Investigation sets a limit on the amount of scan data it will accept. (The DRT scanner can produce more data than this, but the data volume would then become unmanageably large.) Again the limit is expressed in terms of measurement points, and the setup dialog keeps track of the number of measurement points that remain to be allocated.

16.6.3. Rohde & Schwarz TSMW

The TSMW scanner uses a form of automatic load balancing to make the best possible use of the scanner’s measurement capacity. If the scan tasks that are running have a combined resource allocation of less than 100% in their setups, then the actual resource use will be raised automatically if the scan tasks require it.

The resource percentage selected is the minimum that the scan task is guaranteed to get when executed. It is therefore not possible when setting up scan tasks to allocate more than 100% of resources in total. (There is no inverse mechanism treating the selected resource percentages as “opening bids” that can be pared down at execution time.)

R&S recommends that each scan task should be allocated at least 20% of resources in the setup dialog.

16.6.4. Sony Ericsson Phones and SRUs

Sony Ericsson phones and SRUs do not handle concurrent execution of multiple scanning methods.

16.7. Notes on GPS Units in Scanners

The internal GPS in a scanner equipped with such a device will deliver data only if it is selected as **Preferred GPS** and activated in TEMS Investigation. See section 6.5.

17. GSM Scanning

TEMS Investigation supports scanning of GSM radio frequency carriers with the following kinds of device:

- Sony Ericsson phones[1]
- SRUs (Scanning Receiver Units)[2]
- PCTel scanners
- Rohde & Schwarz TSMW scanner.

How to configure the R&S scanner (and the PC along with it) for use with TEMS Investigation is covered in the Device Configuration Guide, section 10.3.2.

A note on terminology: GSM radio frequency carriers are sometimes referred to below as *channels* for simplicity, although this is a slight abuse of the term.

17.1. Scanning Methods and Capabilities

TEMS Investigation offers these GSM scanning methods, supported using the various devices as indicated. Please note that for a scanning method to be actually available in TEMS Investigation, the device must have been purchased with the relevant option (wherever applicable).

1. For specifics, see Information Elements and Events, section 4.1.
2. Built on Ericsson hardware.

GSM Scanning Capability/ Scanning Device	Sony Ericsson	SRU	PCTel SeeGull	R&S TSMW	Section Ref.
RSSI scanning, static ARFCN set	✓	✓	✓	✓	17.2
RSSI scanning: BSIC decoding	✓	✓	✓	✓	17.2
RSSI scanning: C/I measurement			✓	✓	17.2.3
RSSI scanning: System Info decoding			✓		17.2.3
Spectrum analysis			✓		17.3

17.2. RSSI Scanning

17.2.1. Setup of RSSI Scan: General Settings

Technology	Set this to “GSM” for GSM scanning.
Band	GSM frequency band or bands to scan.
Channels	ARFCNs to scan on the selected band. Select all channels to scan the entire band. There is no limit to the selectable number of channels.

17.2.2. Setup of RSSI Scan: Sony Ericsson, SRU

BSIC	Setting this to Yes causes the phone to decode the Base Station Identity Code whenever possible. It should be noted that BSIC decoding is computationally costly and considerably reduces the sample rate of the scan.

When composing a script for RSSI scanning with a Sony Ericsson phone, it is necessary to add a Wait of duration 30 seconds after the Stop RSSI Scan activity if the device is to proceed with some other activity. The reason is that the device must be given sufficient time to reset.

17.2.3. Setup of RSSI Scan: PCTel SeeGull

Bandwidth	Select whether to perform a regular GSM signal scan (“Normal”) or a Continuous Wave scan (“CW”). This setting applies to all channels you select for scanning. It is not possible to specify the type of scan for each channel separately. • **Normal:** Bandwidth 200 kHz. • **CW:** Bandwidth 30 kHz. Regardless of the choice made here, the measurements are extracted to the same information elements (Scanned RxLev, etc. in the “GSM” category).
Remaining Measurement Points	See section 16.6.1.
BSIC	Setting this to Yes causes the scanner to decode the Base Station Identity Code whenever possible. It should be noted that BSIC decoding is computationally costly and considerably reduces the sample rate of the scan. PCTel scanners supplied with older versions of TEMS Investigation may lack BSIC decoding capability. Check the Device Inquiry mode report from the scanner to find out whether it is capable of decoding BSIC.
C/I Measurements	Setting this to Yes causes a subset of the “C/I” information elements to be updated, as described in Information Elements and Events, section 3.1. PCTel scanners can be purchased with or without the C/I scanning function enabled; check the Device Inquiry mode report from the scanner to find out whether it has this capability (“GSM BCCH C/I”). If available, the function can be turned on and off in the dialog.

System Information	Setting this to Yes causes the scanner to decode System Information messages for the strongest cell. The scanner must suspend the regular scan in order to read System Information, and this is therefore done only once each time the strongest cell changes. Whenever System Information is read, the information element Neighbor (SI) ARFCN is updated.
Dwelling Time	The length of time the scanner dwells on each BCCH trying to decode System Information blocks, before moving on to the next BCCH. Given as a multiple of 12 GSM frames, which translates to 12 × 120 / 26 ≈ 55.38 ms. The default is 17 ≈ 941.5 ms.

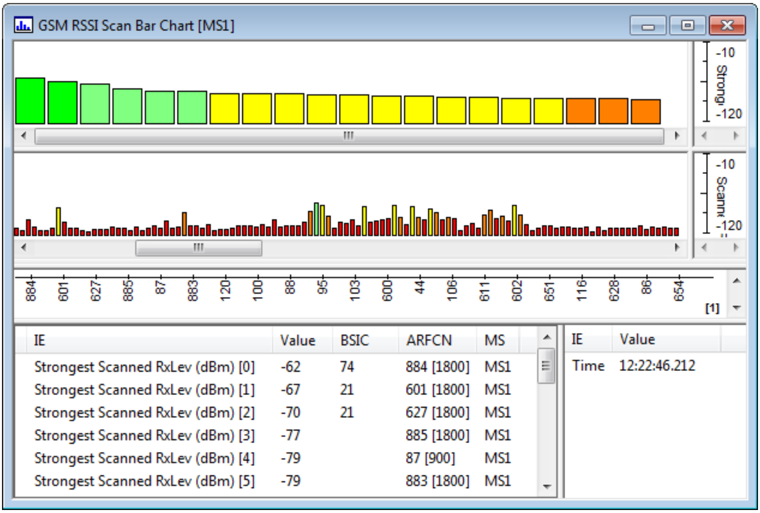
17.2.4. Setup of RSSI Scan: Rohde & Schwarz TSMW

Measurement Rate (mHz)	Average measurement rate (in millihertz) shared between all selected channels.
Measurement Details	• **Channels:** Channels to scan. • **SCH Power (DL):** Enables SCH-related measurements such as SCH power, ETS power, BSIC, and GSM frame number. • **C/I (DL):** Enables carrier-to-interference measurement. This is only valid for SCH-related measurements. • **Dummy Burst Removal (DL):** Enables detection of dummy bursts and removal of dummy bursts from the GSM signal before further analysis. • **Dummy Burst Power (DL):** Enables power measurement for dummy bursts. This can produce many more power results for C_0 carriers than the SCH measurement.
RF Front-end	Front-end on which to schedule measurements. The measurement tasks are manually distributed on the built-in front-ends.

Resource Allocation (%)	Resources allocated on the specified front-end. See also section 16.6.3.

17.2.5. Presentation of RSSI Scanning

The main vehicle for presenting GSM RSSI scan data is the GSM RSSI Scan Bar Chart:



The top chart by default shows the strongest scanned channels sorted by decreasing signal strength. The bottom chart by default shows all scanned channels in order of ascending ARFCN.

Regarding the bar chart window itself, see chapter 32.

Principal information elements: Scanned RxLev, Scanned C/I, Scanned Cell Name, Scanned ARFCN, Scanned BSIC, Neighbor (SI) ARFCN.

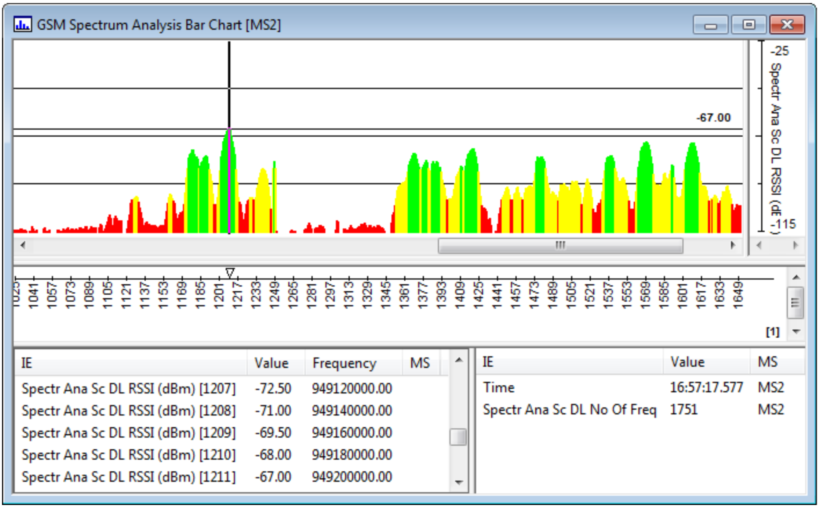
17.3. Spectrum Analysis

17.3.1. Setup of Spectrum Analysis Scan

The setup for spectrum analysis is the same as for WCDMA (except that Technology = GSM). See section 18.5.1.

17.3.2. Presentation of Spectrum Analysis Scan

A GSM Spectrum Analysis Bar Chart is provided:



Principal information element: Spectr Ana Sc DL RSSI (dBm).

18. WCDMA Scanning

TEMS Investigation supports scanning of WCDMA carriers with the following kinds of device:

- Certain Sony Ericsson phones operating in scan mode
- SRU (Scanning Receiver Unit)
- PCTel scanner
- Rohde & Schwarz TSMW scanner
- Anritsu scanner.

How to configure the R&S scanner (and the PC along with it) for use with TEMS Investigation is covered in the Device Configuration Guide, section 10.3.2.

18.1. Scanning Methods and Capabilities

TEMS Investigation offers these WCDMA scanning methods, supported using the various devices as indicated. Please note that for a scanning method to be actually available in TEMS Investigation, the device must have been purchased with the relevant option (wherever applicable).

WCDMA Scanning Capability/ Scanning Device	Sony Ericsson, SRU	Anritsu ML8720	Anritsu ML8780A	PCTel PCT	PCTel SeeGull LX	PCTel SeeGull EX	PCTel SeeGull MX	R&S TSMW	Section Ref.
Pilot scanning, static SC set	✓	✓			✓				18.2
Pilot scanning, Top *N*	✓	✓	✓	✓	✓	✓	✓	✓	18.2
Pilot: SIB decoding (continuous)	✓					✓	✓		18.2
Pilot: SIB decoding (snapshot)	✓								18.2.2
Pilot: High Speed/High Dynamic						✓	✓	✓	18.2.3
Pilot: P-SCH + S-SCH		✓	✓		✓	✓	✓	✓	18.2
Pilot: Max. no. of UARFCNs	12	[1]	8	4	12	12	12	12	18.2
SCH timeslot scanning					✓				18.3
RSSI scanning				✓	✓	✓	✓		18.4
Spectrum analysis				✓	✓	✓	✓		18.5
Network scanning	✓								18.6

1. Anritsu ML8720: 1 or 2 depending on physical configuration.

18.2. Pilot Scanning (with SCH Scanning)

This method scans CPICH control channels, scrambled with cell-specific scrambling codes. Several UARFCNs can be scanned at a time. UARFCNs and scrambling codes are selected independently of one another.

Where supported, the same method also scans primary and secondary synchronization channels (P-SCH, S-SCH).

18.2.1. Setup of Pilot Scan: General

Technology	Always "WCDMA" for WCDMA scanning.
Band	WCDMA frequency band or bands to scan.

Channels	Here you set the UARFCNs of the frequencies on which to scan the CPICH. The allowed range is dependent on the frequency band.

18.2.2. Setup of Pilot Scan: Sony Ericsson, SRU

Setup options are as follows:

- **Scan selected:** A user-defined, static set of scrambling codes (common to all UARFCNs) is scanned. Optional snapshot SIB decoding.
- **BCH scanning:** User-defined, static set of scrambling codes (common to all UARFCNs) scanned. Unconditional and continuous SIB decoding.
- **Scan strongest:** Strongest scrambling codes scanned ("Top *N*"). Optional snapshot SIB decoding.

The choice is made under **Type of Scanning** in the setup dialog.

Type of Scanning	See also the introduction of this section. • **Scan selected:** Choose this to scan a static set of scrambling codes on all frequencies defined under **Channels**. • **BCH scanning:** If you choose this option, you select scrambling codes in the same way as for Scan selected, and the same scan data will be collected. However, the updating frequency will be considerably lower, and the sensitivity of the scrambling code detection may be lower as well. The processing time freed up in this way is instead used to continuously decode System Information Blocks (SIBs). This decoding is furthermore *continuous*, unlike that governed by the System Information option (which see). • **Scan strongest:** Choose this to have the *N* strongest scrambling codes reported from the chosen UARFCNs. The scanner automatically finds the strongest scrambling codes.

Cell Noise Floor	Ec/Io threshold for accepting a signal on the CPICH as a detected cell. The threshold should be adjusted to ensure detection of cells actually present while keeping the false detection rate down. The default is –26 dB.
Scan Strongest	This field is enabled if you have chosen “Scan strongest” under **Type of Scanning**. To scan the *N* strongest scrambling codes, enter the value *N* here ($N \leq 40$).
Scrambling Codes	This field is enabled if you have chosen “Scan selected” or “BCH scanning” under **Type of Scanning**. Enter the scrambling codes you want to scan.
System Information	If this option is set to Yes for Scan selected or Scan strongest, a “snapshot” SIB decoding will be done once every time a new cell has become the strongest (unless that cell has previously appeared as the strongest during the last two minutes). On completing the SIB decoding, the phone reverts to regular pilot scanning. If the strongest cell does not change within two minutes, SIBs will be decoded again for that cell. For BCH scanning, this option is always set to Yes. It then refers not to snapshot SIB decoding but to the continuous SIB decoding performed by that method.

18.2.3. Setup of Pilot Scan: PCTel

The set of scrambling codes to scan on each UARFCN is composed in one of two ways:

- user-defined, static set of scrambling codes, common to all UARFCNs
- strongest scrambling codes (“Top *N*”)

What settings are supported by the various PCTel SeeGull models appears from the table in section 18.1. Only settings supported by the connected scanner are displayed in the dialog.

Type of Scanning	See also the introduction of this section. • **Scan selected:** Choose this to scan a static set of scrambling codes on all frequencies defined under **Channels**. The same scrambling codes will be scanned on the CPICH and on the P-SCH and S-SCH. Up to 128 scrambling codes can be selected. • **Scan strongest:** Choose this to have the *N* strongest scrambling codes reported from the chosen UARFCNs. The scanner automatically finds the strongest scrambling codes.
Number of Pilots	This field appears if **Type of Scanning** is set to "Scan strongest". To scan the *N* strongest scrambling codes, enter the value *N* here ($N \leq 32$).
Selected Numbers	This field appears if **Type of Scanning** is set to "Scan selected". Enter the scrambling codes you want to scan.
PN Threshold	This is a signal code power threshold (in dB) used for the Aggregate Ec/Io and Delay Spread measurements (see section 18.2.7). If the PN threshold is set too low, the Aggregate Ec/Io and Delay Spread values will be affected by random noise more than may be desired. By raising the threshold you reduce the influence of random noise correlations, and you will thus be able to discern multipath and fading effects more accurately. The setting –20 dB is recommended.
Remaining Measurement Points	See section 16.6.1.

Data Mode	It is possible to reduce the amount of data that is presented and recorded: • **Full** means no reduction. • **Sub** means that some data is not presented or recorded (compare sections 18.2.8 and 18.2.11). It should be noted that choosing “Sub” results in a much faster updating of scan presentations. The precise meaning of “Sub” depends on the scope of the scan: • For “Scan selected”, Time Offset, P-SCH Ec/Io, S-SCH Ec/Io, and Rake Finger Count are excluded, as is SIR. (The “SIR” field is disabled in this case.) • For “Scan strongest”, only P-SCH Ec/Io and S-SCH Ec/Io are excluded.
SIR	Setting this to Yes causes the scanner to deliver the information elements “Sc ... SIR”.
System Information	Set this to Yes to decode System Information blocks (continuously). With this option selected, a maximum of 16 scrambling codes can be scanned. From the SIB decoding are extracted the information elements “Sc 1st (2nd, 3rd, 4th) Intra-freq Cells”.
Measurement Mode	There are two choices, High Speed and High Dynamic. These are two algorithms with different priorities: • **High Dynamic** puts the emphasis on accuracy. Each sample reported by the scanner is typically based on a measurement 20 ms in length. • **High Speed** is faster and accordingly less accurate. Each reported sample is typically based on a 10 ms measurement.
Dwelling Time	The length of time the scanner dwells on each scrambling code (cell) trying to decode System Information blocks, before moving on to the next cell. Given as a multiple of 40 ms. The default is 50 = 2000 ms.

18.2.4. Setup of Pilot Scan: Rohde & Schwarz TSMW

Measurement Mode	High Speed or High Dynamic. These are two algorithms with different priorities. High Dynamic puts the emphasis on accuracy, whereas High Speed is faster and accordingly less accurate.
Measurement Rate (mHz)	Average measurement rate (in millihertz) shared between all selected channels.
RF Front-end	Front-end (processor) on which to schedule measurement. The measurement tasks are manually distributed on the two built-in front-ends.
Resource Allocation (%)	Resources allocated on the specified front-end. See also section 16.6.3.
Resource Available (%)	Read-only field indicating the remaining available resources on the processor selected under RF Front-end.

18.2.5. Setup of Pilot Scan: Anritsu

The set of scrambling codes to scan on a UARFCN is composed in one of two ways:

- user-defined, static set of scrambling codes, common to all UARFCNs, or
- strongest scrambling codes (“Top N”)

Type of Scanning	See also the introduction of this section. • **Scan selected:** Choose this to scan a static set of scrambling codes on all frequencies defined under “UARFCN” below. The same scrambling codes will be scanned on the CPICH and on the P-SCH and S-SCH. Up to 32 scrambling codes can be selected. *(ML8720 only)* • **Scan strongest:** Choose this to have the *N* strongest scrambling codes reported from the chosen UARFCNs (“Top N”). The scanner automatically finds the strongest scrambling codes.
Number of Pilots	This field appears if **Type of scanning** is set to “Scan strongest”. To scan the *N* strongest scrambling codes, enter the value *N* here. The maximum number of pilots that can be scanned is equal to floor(40/N_{ch}), where N_{ch} is the number of UARFCNs entered under **Channels**. For example, if 3 UARFCNs are selected, up to 13 SCs can be scanned on each.
Selective Level	This threshold (value in dB) determines how high above the noise floor a scrambling code must reach in order to be accepted as valid by the scanner. The default is 4 dB.
Rake Threshold	This threshold (value in dB) determines, for a given scrambling code, how strong a signal path must be (in relation to the strongest signal path for that scrambling code) in order to be accepted as valid. Setting the threshold at *n* dB means that a signal path must not be more than *n* dB weaker than the strongest one. In other words, this threshold governs how many Rake fingers will contribute to the signal. The default is 20 dB.

Search Method *(ML8720)*	This setting governs the choice of cell search method in Top N scan mode (“Scan strongest” option). • If **P-CPICH** is selected, only CPICH channels will be scanned to find scrambling codes. (For all scrambling codes detected in this way, however, the scanner will measure and report on the P-SCH and S-SCH as well.) This mode is useful especially for troubleshooting of transmitters. The P-CPICH mode cannot be used if two UARFCNs are to be scanned. If you select two UARFCNs, the P-CPICH radio button is grayed. • If **SCH** is selected, the scanner will search for scrambling codes that use P-SCH and S-SCH. This is more suitable for drive testing and is the default setting in TEMS Investigation. If you are scanning two UARFCNs it is the only option, as explained above.
BCH Scan *(ML8780A)*	If selected, the scanner will perform continuous SIB decoding. This can only be done on one UARFCN at a time (only one is selectable under **Channels** when the BCH Scan option is set).

18.2.6. Presentation: General

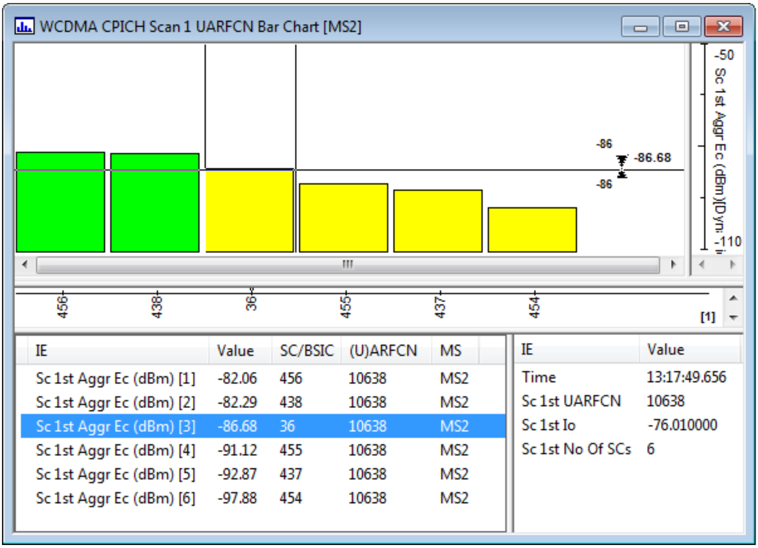
Pilot scan data is presented in

- the CPICH Scan bar charts (section 18.2.7)
- the CPICH Scan Data status window (section 18.2.8)
- the CPICH Scan line charts (section 18.2.9)

Synchronization channels are presented in the Synch Channels window (section 18.2.11).

18.2.7. Presentation: “CPICH Scan” Bar Charts

The CPICH Scan bar charts present CPICH scan data. One predefined bar chart is provided for each UMTS frequency scanned.



Each bar chart by default presents aggregate Ec (see section 18.2.8) for each scrambling code found. Regarding data sorting, see section 18.2.14.1.

The updating rate is chiefly dependent on the number of live signals encountered in the network. For a manually selected set of scrambling codes, the updating rate is also greatly affected by the size of this set, whereas for the “Top *N*” scan the number *N* is only marginally important (since all scrambling codes have to be searched regardless of *N*).

18.2.8. Presentation: “CPICH Data” Status Windows

The CPICH Data and CPICH Best UARFCN Data status windows both contain a large number of columns with scan data. They differ only with respect to sorting: CPICH Data is sorted first by UARFCN, whereas CPICH Best UARFCN Data is sorted by Aggr Ec/Io regardless of UARFCN. The columns have the following meanings:

SC	Scrambling code number.
Peak Ec/Io	The peak code power of the scrambling code (Ec) relative to the total signal power in the channel (Io), i.e. the difference between them in dB.

Peak Ec	The peak code power of the scrambling code in dBm.
Ag Ec/Io	The aggregate code power of the scrambling code relative to the total signal power in the channel (Io), i.e. the difference between them in dB.
Ag Ec	The aggregate code power of the scrambling code in dBm. The aggregate code power is a measure of the total signal power (distributed around the main peak due to multipath propagation) that is above the PN threshold (settable in the PCTel scanner: see section 18.2.3).
Aggr–Peak Ec	Difference in dB between the aggregate code power (Ag Ec) and peak code power (Peak Ec), i.e. Rake receiver gain.
Delay Spread	Time in chips from the first to the last Ec/Io peak that is above the PN threshold. This is a measure of the signal spreading due to multipath propagation.
RFC	Rake finger count, i.e. the number of Ec/Io peaks (multipath components) that are above the PN threshold.
Time Offset	The time offset of the radio frame on the CPICH, given in chips from a 1/100th second time mark aligned with GPS time. Ranges from 0 to 38399.
SIR	Signal-to-interference ratio of the scrambling code in dB. Measured on DPCCH.

All of these are identical with information elements having similar names but beginning with “Sc”. See Information Elements and Events, section 3.2.

18.2.9. Presentation: “CPICH Scan” Line Charts

The default configuration of this window is as follows:

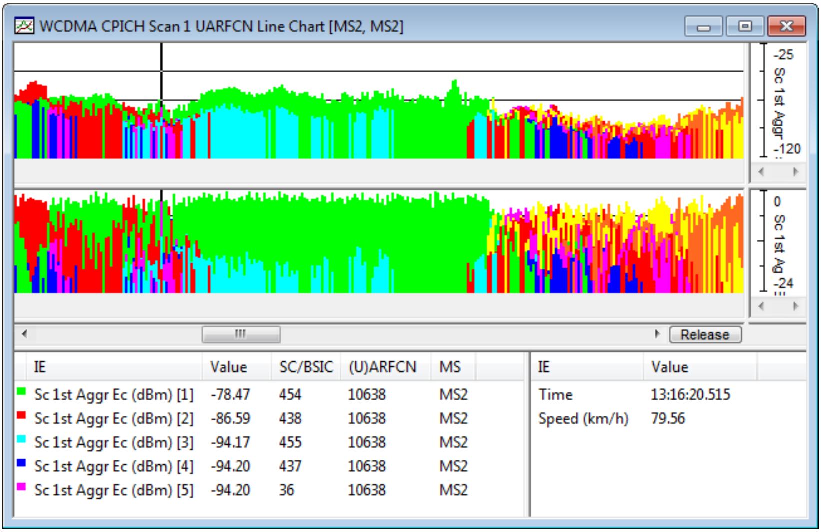


Chart Panes

The charts present the five strongest scrambling codes. The top chart shows Aggr Ec (in dBm) and the bottom chart shows Aggr Ec/Io (in dB).

Legend Pane

The Legend pane (bottom left) glosses either of the two charts. To switch to the other chart, right-click and choose the desired chart from the context menu.

18.2.10. Presentation: “Poss No Of AS Members” and “Other/Own” Information Elements

These information elements are diagnostic of the CPICH pilot pollution situation.[1]

- **Poss No Of AS Members:**

1. Please note that the IEs described here are no longer present by default in any presentation window; you need to add them manually. See also the IE descriptions: Poss No of AS Members; Other/Own.

The *active set* (AS) is defined as the set of scrambling codes (SCs) associated with channels that are assigned to a particular subscriber unit. Here an SC is regarded as a possible active set member if it is sufficiently strong compared to the strongest SC. The relative code power threshold is determined by the argument within square brackets []. Note that one cannot know for sure (on the basis of the scan data alone) whether the possible members actually do belong to the active set.

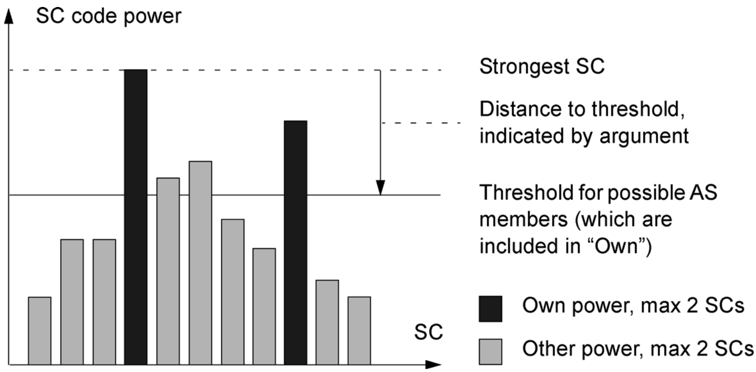
Example: If the argument is 3 (default value), all SCs with a code power not more than 3 dB below that of the strongest SC will be counted. In the above figure, there are three such SCs, so the active set is judged to have a total of four possible members.

- **Other/Own ... :**

  These are estimated ratios between polluting signal power and desired signal power, based on the power threshold described above (again given as argument to each information element) and on different assumptions about the number of possible active set members. The four "Other/Own" elements represent the assumptions that there is desired signal power on 1, 2, 3, and 4 SCs respectively.

  For "Max *N* SCs", "Own" is the sum of the code powers of the *N* strongest possible active set members, if the number of possible members is at least *N*; otherwise it is simply the sum of the code powers of all possible active set members. "Other" is the sum of the code powers of all remaining SCs.

  In the example below, there are three other SCs reaching above the threshold which is set relative to the strongest SC. However, for "Max 2 SCs", only the strongest of the three is included in "Own".

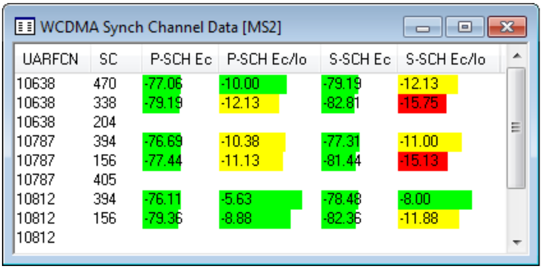


The “Other/Own” ratios are of course calculated from absolute code power values (i.e. Ec values in mW).

> **Note:** The arguments should be kept the same for all five information elements. It is of course possible to set each argument to any of the permissible values, but with different arguments for different elements you cannot really draw any useful conclusions.

18.2.11. Presentation: Synch Channel Data Window

This window presents scan data on the synchronization channels P-SCH and S-SCH, obtained with the Pilot scanning method.



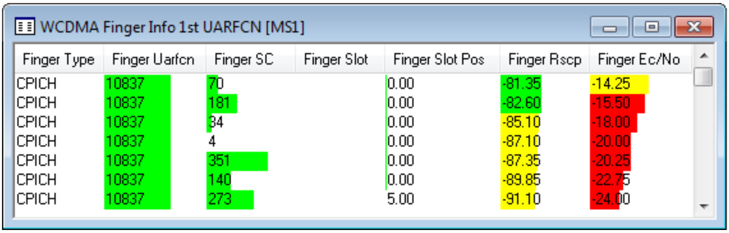
UARFCN	SC	P-SCH Ec	P-SCH Ec/Io	S-SCH Ec	S-SCH Ec/Io
10638	470	-77.06	-10.00	-79.19	-12.13
10638	338	-79.19	-12.13	-82.81	-15.75
10638	204				
10787	394	-76.69	-10.38	-77.31	-11.00
10787	156	-77.44	-11.13	-81.44	-15.13
10787	405				
10812	394	-76.11	-5.63	-78.48	-8.00
10812	156	-79.36	-8.88	-82.36	-11.88
10812					

Information elements: P-SCH Ec, P-SCH Ec/Io, S-SCH Ec, S-SCH Ec/Io.

By default the scrambling codes are sorted by signal power with the strongest on top. The presented data can be freely rearranged, as described in section 27.3, “Changing Status Window Properties”.

18.2.12. Presentation: “Finger Info” Status Windows

These windows present Rake finger information obtained during Pilot scanning. For definitions of the information elements, see Information Elements and Events (“Finger” IEs).



18.2.13. Presentation: BCH Scanning

All scan data collected using the options Scan selected and Scan strongest are obtained for BCH scanning also (though less frequently); see sections 18.2.7–18.2.12 above regarding the presentation of this data.

No special presentation windows are provided for BCH scanning. However, decoded System Information Blocks are output in the Layer 3 Messages window at a greatly enhanced rate.

One form of refined TEMS Investigation output that can be based on SIBs is the Missing WCDMA Neighbor event which warns about missing neighbors in WCDMA. See Information Elements and Events, section 8.2.

Another piece of data found in SIBs is an uplink interference measurement. This is particularly interesting for HSUPA, where the guiding principle of scheduling is to provide (as far as possible) all UEs with all the resources they need while also making sure that the total uplink interference does not exceed the accepted maximum. The uplink interference measurements can of course be inspected in the plain-text SIB decoding, but they are also extracted as an information element (Sc Best UL Interference).

18.2.14. Customizing the Presentation

18.2.14.1. Sorting of Scrambling Codes

You can sort scrambling codes in scanning information elements in a number of different ways. The sorting order is set in the **General** window.

- Open the General window from the Navigator.
- Double-click the item “WCDMA”.

A dialog appears with these sorting options:

- Sort by decreasing Aggr Ec/Io (default)

- Sort by increasing Aggr Ec/Io
- Sort by fixed position: Scrambling codes are sorted by index and are always assigned the same argument indices, that is, scrambling code *n* is always found at argument index *n* + 1.
- Sort by scrambling code: Scrambling codes are sorted by index; the code with the lowest index appears at argument index 1, the code with the next higher index appears at argument index 2, etc.

> **Note:** The sorting order of the "Sc Best" elements (see Information Elements and Events, section 3.2) is fixed and is *not* affected by the General window settings.

18.2.14.2. Presenting Scrambling Codes from Multiple UARFCNs

In the "Sc Best" information elements, all scrambling codes found on all UMTS frequencies are collected in a single array. These elements are sorted by signal strength (Aggr Ec/Io) in descending order, and this sorting order is unchangeable.

Use these elements in order to view scan data from several UARFCNs in one window.

18.3. SCH Timeslot Scanning

This method scans timeslot-length intervals, i.e. intervals 2560 chips long, on a Primary Synchronization Channel (P-SCH). It is useful for monitoring synchronization reference signals sent on this channel.

It should be pointed out that this scan is wholly separate from the P-SCH and S-SCH scans included in the Pilot scanning method (section 18.2).

18.3.1. Setup of SCH Timeslot Scan

18.3.1.1. General Settings

Technology	Always "WCDMA" for WCDMA scanning.
Band	WCDMA frequency band to scan.

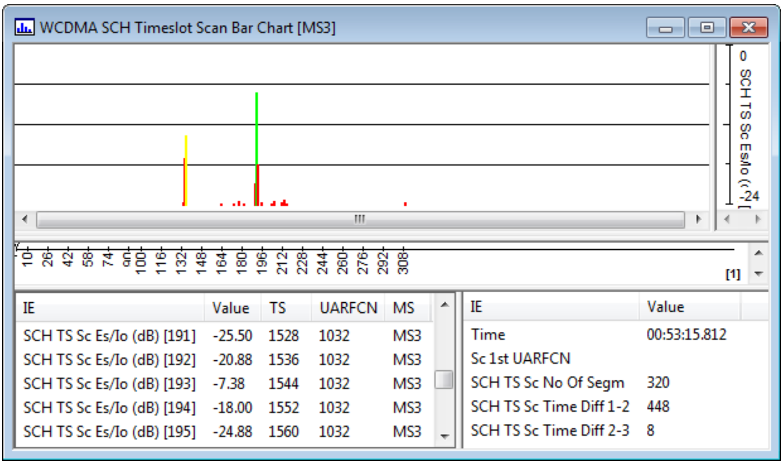
Channels	UARFCN to scan.
Center Frequency	The center frequency of the UARFCN chosen.

18.3.1.2. Context Settings

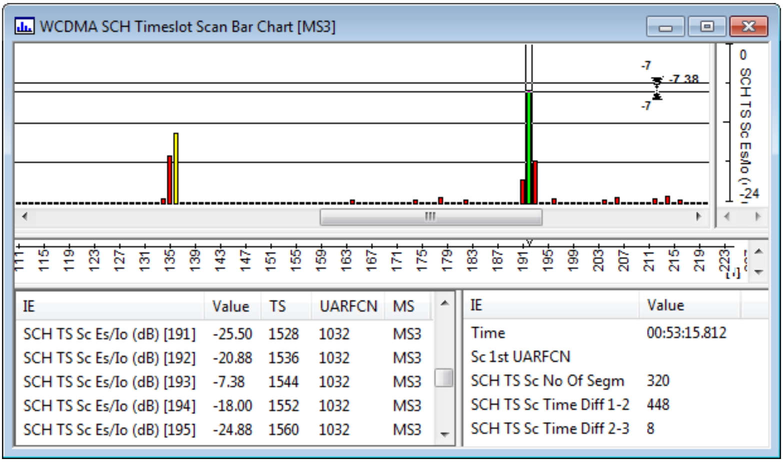
Compression Rate	The time resolution of the scan: • **Every** means that a power value is reported for every chip in the timeslot. • **Every 2**, etc. means that the *peak* (not average) power is reported for successive segments 2, 4, or 8 chips in length.
Remaining Measurement Points	See section 16.6.1.

18.3.2. Presentation: SCH Timeslot Scan Bar Chart

The bar chart displays an Es/Io trace for the latest timeslot scanned (2560 chips).



Whole-timeslot view



Zoomed-in view

Each SCH signal will show up as a spike on the trace, the height of the spike reflecting the strength of the signal in terms of Es/Io. The legend pane gives Es/Io for each chip, or peak Es/Io for every 2, 4, or 8 chips, depending on the setup; see section 18.3.1. Since the SCH signals are repeated every timeslot, the spikes will normally remain in the same positions as the trace is updated.

Principal information element: SCH TS Sc Es/Io (dB).

The updating rate is dependent on the compression rate and on network conditions. However, if the compression rate is set to “Every 4”, the updating interval will be on the order of 1 s.

The position of a spike shows at what point a new timeslot begins in the current transmission. Provided that the base station clock is synchronized with GPS time, the T_Cell parameter can be determined: the spike will be positioned approximately at T_Cell + 140 chips, the offset being due to delay in the scanner. If the base station is not synchronized with GPS time, however, no conclusions can be drawn about the value of T_Cell.

In a WCDMA cell with multiple sectors, each sector will transmit/receive at a different time offset (e.g. 0, 256, and 512 chips). The SCH timeslot scan will then display multiple spikes within a timeslot, one for each sector. From this the time separation between the sectors can be determined. In the lower right pane, the parameters “Time diff 1-2” and “Time diff 2-3” are given:

- “Time diff 1-2” indicates the time separation in chips between the strongest peak and the second strongest.

- “Time diff 2-3” indicates the time separation in chips between the second strongest peak and the third strongest.

These parameters are identical with the information elements SCH TS Sc Time Diff 1-2 and SCH TS Sc Time Diff 2-3; see Information Elements and Events, section 3.2. Determining the time separation naturally does not require synchronization of the base station with GPS time.

18.4. RSSI Scanning

18.4.1. Setup of RSSI Scan

18.4.1.1. General Settings

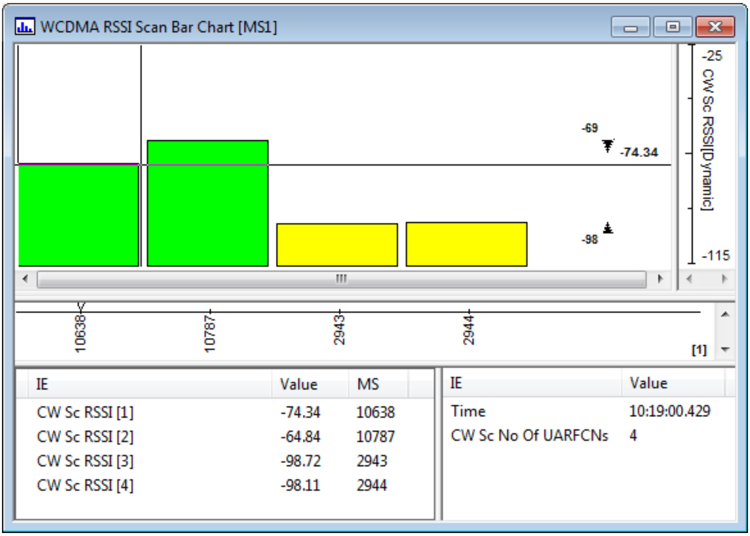
Technology	Always “WCDMA” for WCDMA scanning.
Band	WCDMA frequency band to scan.
Channels	UARFCNs to scan (up to 255). The allowed UARFCN range is dependent on the band.

18.4.1.2. Context Settings

Bandwidth	Select whether to perform a regular WCDMA signal scan (“Normal”) or a Continuous Wave scan (“CW”). This setting applies to all channels you select for scanning. • **Normal:** Bandwidth 3.84 MHz. • **CW:** Bandwidth 200 kHz. Regardless of the choice made here, the measurements are extracted to the same information elements (CW Sc RSSI, etc. in the “WCDMA” category).
Remaining Measurement Points	See section 16.6.1.

18.4.2. Presentation: RSSI Scan Bar Chart

This bar chart displays RSSI for each UARFCN scanned.



Principal information element: CW Sc RSSI.

18.5. Spectrum Analysis

This scanning method shows downlink signal strength as a function of frequency.

18.5.1. Setup of Spectrum Analysis Scan

18.5.1.1. General Settings

Technology	Choose "WCDMA" for WCDMA scanning.
Band	WCDMA frequency band to scan.
Start Frequency	Low end of the frequency range to be swept by the scan. Given in MHz.

Stop Frequency	High end of the frequency range to be swept by the scan. Given in MHz.
Resolution Bandwidth	Interval between successive scan samples in Hz, the highest selectable resolution being 5000 Hz. In the presentation window, the legend pane will list all samples; the chart, on the other hand, can of course only distinguish the samples as far as the screen resolution permits.

18.5.1.2. Context Settings

Number of Sweeps	The number of sweeps on which to base the presented averaged measurements. The minimum number is 1, and the maximum is 16.
Remaining Measurement Points	See section 16.6.1. Note that the spectrum analysis is prone to consume a large number of measurement points. Adapt the resolution to the width of the frequency range.

18.5.2. Presentation: Spectrum Analysis Bar Charts

Two charts are provided, one for the downlink (Spectrum Analysis Bar Chart) and one for the uplink (Spectrum Analysis Uplink Bar Chart).[1] They both display RSSI as a function of frequency.

Principal information elements: Spectr Ana Sc DL RSSI (dBm), Spectr Ana Sc UL RSSI (dBm).

18.6. Network Scanning

This function is highly useful for obtaining a bird’s-eye view of an unfamiliar WCDMA radio environment. It will detect WCDMA carriers (UARFCNs) that are in use on each of the WCDMA bands 2100 MHz, 1900 MHz, 850 MHz. On each carrier, one cell (scrambling code) is detected and presented.

1. Uplink spectrum analysis is currently not supported by any currently connectable devices, but the chart is retained to allow displaying of such data from old logfiles.

In network scanning mode it is also possible to detect inappropriate allocation of UARFCNs resulting in carrier overlap. A mobile phone in regular phone mode, once it has found a WCDMA carrier, automatically assumes that there are no further UARFCNs within ±3 MHz of the detected carrier and is therefore unable to spot overlapping carriers. By contrast, a Sony Ericsson phone in scan mode is usually able to identify all carriers, overlapping or not, thus allowing faulty frequency allocations to be easily found and rectified.

18.6.1. Setup of Network Scan

18.6.1.1. General Settings

Technology	Choose “WCDMA” for WCDMA scanning.

18.6.1.2. UARFCN Ranges (“Interval 1, 2, 3”)

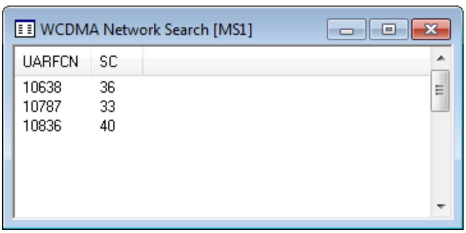
You can set up three separate UARFCN ranges (Interval 1, 2, 3) to scan in the network. Each range can be located on any of the supported frequency bands.

Interval <n> enabled	Set the flag to Yes if you want to define this UARFCN range.
Band	If you want the UARFCN range to be identical to an entire WCDMA frequency band, select that band here.
Custom range; From, To	If you want the UARFCN range to consist of a portion of a band, set Custom range to Yes. Additional fields “From” and “To” appear, in which you specify the endpoints of the UARFCN range.

18.6.1.3. Context Settings

Include additional channels	Check this to include additional channels on the 1900 or 850 MHz band. Additional channels have UARFCNs that are completely different from the general channels. (See ▶ 3GPP 25.101, sections 5.4.3–5.4.4 for details on the two kinds of channel.) If this option is checked, all additional channels that lie within the frequency range you have specified in the dialog (whole band or UARFCN range) will be included in the scan.
Cell Ec/No threshold	Ec/No threshold for cell detection within a detected carrier. This threshold should be high enough to minimize the false detection rate, yet not so high that cells actually present may go undetected. The risk of the latter is particularly pronounced in the case of overlapping carriers, where all cells will be significantly disturbed. The default setting is –26 dB, which should be suitable in most situations.
RSSI threshold	RSSI threshold for detecting carriers. The default setting is –94 dBm, reflecting a trade-off between the desire to detect all networks in operation and the wish to avoid spurious “hits”. Setting the threshold too low results in a very long search time (e.g. several minutes at –100 dBm).

18.6.2. Presentation: Network Search Window



The result of the network scan is output in the Network Search window. It lists all UARFCNs found, that is, the center frequency of each detected WCDMA carrier. UARFCNs from all WCDMA frequency bands are listed in the same column. One scrambling code (cell) is displayed for each UARFCN.

Principal information elements: Network Search UARFCN, Network Search SC.

19. LTE Scanning

TEMS Investigation supports scanning of LTE carriers with the following kinds of device:

- DRT scanner
- PCTel scanner
- Rohde & Schwarz TSMW scanner
- Transcom scanner
- Andrew scanner.

Certain scanners require special configuration of the device itself as well as the PC to prepare them for use with TEMS Investigation. What needs doing is covered in the Device Configuration Guide, sections 10.1.2–10.3.2.

19.1. Scanning Methods and Capabilities

TEMS Investigation offers these LTE scanning methods, supported using the various devices as indicated. Please note that for a scanning method to be actually available in TEMS Investigation, the device must have been purchased with the relevant option (wherever applicable).

It is possible to run several of these scanning methods concurrently.

LTE Scanning Capability/ Scanning Device	DRT	PCTel SeeGull EX	PCTel SeeGull MX	R&S TSMW	Transcom	Andrew i.Scan	Section Ref.
Signal scanning	✓	✓	✓	✓	✓	✓	19.2
Signal scan, MIMO multiple Tx	✓	✓	✓		✓	✓	19.2
Signal scan, MIMO multiple Rx			✓				19.2
RSSI scanning	✓	✓	✓		✓		19.3
Spectrum scanning	✓	✓	✓		✓	✓	19.4
Enhanced power scanning		✓	✓				19.5

19.1.1. Notes on Scanned Bandwidth

For all LTE scanning methods, the set of channel numbers available for scanning is dependent on the bandwidth selected, and some bandwidths may not be at all applicable to the band in question. Example (E-UTRA Band 7):

RSSI scan:

- 100 kHz bandwidth: available channels 2750–3449

Signal scan:

- 1.4 MHz bandwidth: N/A
- 3 MHz bandwidth: N/A
- 5 MHz bandwidth: available channels 2772–3428
- 10 MHz bandwidth: available channels 2795–3405
- 15 MHz bandwidth: available channels 2817–3383
- 20 MHz bandwidth: available channels 2840–3360

19.2. LTE Signal Scanning

The LTE air interface uses OFDM as modulation method on the downlink. Synchronization Channels are used for service detection and synchronization, and Reference Signals (RS's) are used for channel estimation purposes.

The LTE signal scan provides the following metrics:

- SCH (PCI, PCIG, P-SCH RSSI, S-SCH RSSI, SCHRQ)
- RS (RSRP, RSRQ)
- CINR (SCH CINR, RS CINR)
- CFO
- Time Offset

19.2.1. Setup of LTE Signal Scan: General

Technology	Always "LTE".
Band	LTE band or bands to scan.
Channels	EARFCNs to scan within the selected LTE band. Each EARFCN is specified as a number representing the center frequency of the channel. Up to 12 EARFCNs can be selected.

19.2.2. Setup of LTE Signal Scan: DRT

Scan Type	• **Targeted Scan:** Select this if you wish to scan a fixed set of cells. Specify the cells under Cell Index List. • **Top N:** Select this if you wish to scan the strongest cells. Set the number of cells the scanner should report under Top N.

Logging Mode	When using a DRT scanner purchased with TEMS Investigation, the scan data is always recorded in regular TEMS Investigation logfiles (*.trp), regardless of how this parameter is set. If you are using a DRT scanner with the optional multimedia card (MMC), you can optionally record a logfile with scan data on the MMC as well. (This logging has got nothing to do with TEMS Investigation.) The MMC must have been formatted and inserted into the scanner before the scanner is powered on. • **MMC:** Log to MMC. • **None:** Do not log to MMC.
Top N	This field is editable if you have set Scan Type to “Top N”. Here you specify how many cells the scanner should report; setting the field to *N* causes the scanner to return the *N* strongest cells ($N \leq 16$).
Cell Index List	This field is editable if you have set Scan Type to “Targeted”. Here you specify the indices of the cells to scan (up to 16 cells for each EARFCN, i.e. up to 16 × 12 = 192 cells in total).
Primary Detection Threshold (dB)	Threshold (in negative dB) for detection of Primary Synchronization Channel. Min: –30 dB. Max: 0 dB.
Secondary Detection Threshold (dB)	Threshold (in negative dB) for detection of Secondary Synchronization Channel. Min: –30 dB. Max: 0 dB.
Decoding Threshold (dB)	CINR threshold for attempting to decode the MIB/ SIB. Min: –30 dB. Max: 50 dB.
Enable SCH	Measurement of Synchronization Channels: P-SCH RSSI, S-SCH RSSI, and SCHRQ.
Enable BCH RP	Measurement of BCH received power. *Not supported by currently connectable scanners.*
Enable RS	Measurement of Reference Signal (RSRP, RSRQ).

Enable CINR	Calculation of CINR, Carrier to Interference-plus-Noise Ratio for SCH and RS. The carrier is the desired signal, and the interference can be either noise or co-channel interference or both.
Enable CFO	Measurement of Center Frequency Offset. *Not supported by currently connectable scanners.*
Bandwidth	The bandwidth to scan. • If you choose **Auto-select**, the scanner will itself detect the bandwidth in use. For this to work, a valid LTE signal with strength greater than the detection thresholds is required. • If you choose a *fixed bandwidth* (1.4, 3, 5, 10, 15, or 20 MHz), that bandwidth will always be scanned. If you know what the implemented bandwidth is, simply select it. See also section 19.1.1.
Enable AGC	Use of AGC (Automatic Gain Control) scanning parameter. It should normally be enabled, since otherwise high-level signals may saturate the receiver and cause errors.
Cyclic Prefix Detection Mode	• **Automatic:** Cyclic prefix used by detected cells is automatically detected. • **Normal:** Normal prefix assumed. • **Extended:** Extended prefix assumed.
Duplexing Detection Mode	• **Automatic:** Duplexing method used by detected cells is automatically detected. • **FDD:** Frequency Division Duplexing assumed. • **TDD:** Time Division Duplexing assumed.
Enable ECP	This should be turned on if the network uses Extended Cyclic Prefixes. ▶ 3GPP 36.211, table 6.2.3-1
Observations Average	Number of LTE frames over which to average scan measurements.

Detection Mode	• **Fast mode:** This mode offers reasonable sensitivity with a fast scan rate. • **Robust mode:** This mode uses lower detection thresholds and increased averaging to detect lower-level signals. It is a slower scan mode.
Number of Tx	The number of Tx signals to be detected by the scanner. If the eNodeB is using MIMO transmission, with separate RS symbols per Tx port, the scanner can detect each of the different RS’s and is then able to measure each Tx signal separately.

19.2.3. Setup of LTE Signal Scan: PCTel

With PCTel only Top-N scanning is supported, not scanning of a fixed cell list.

Bandwidth	The bandwidth to scan. The bandwidth must be selected manually. See also section 19.1.1.
Carrier RSSI Threshold	The RS and SS measurements will be performed only if measured Carrier RSSI is above this threshold.
Top N	Here you specify how many cells the scanner should report; setting the field to *N* causes the scanner to return the *N* strongest cells.
Number of Tx Antennas	The number of Tx antenna ports to measure on (multiple ports for MIMO). The scanner is capable of detecting this automatically (“Auto Detect”).
Number of Rx Antennas	The number of Rx antennas on the scanner (multiple antennas for MIMO).
Cyclic Prefix	The type of cyclic prefix used in OFDM, e.g. “Normal 15 kHz”. The scanner is capable of detecting this automatically (“Auto Detect”).
Sync Signal Measurement Threshold	Only Synchronization Signal (SS) measurements above this threshold (in dBm) will be reported. Setting this value to zero means the threshold will be selected automatically by the scanner.

Reference Signal Measurement Threshold	Only Reference Signal (RS) measurements above this threshold (in dBm) will be reported. Setting this value to zero means the threshold will be selected automatically by the scanner.
Measurement Mode	Signal scan measurement mode. For FDD, the following modes are available: • **Wideband** • **Wideband + Subband** • **Wideband + RF Path** • **Wideband + Subband + RF Path** For TDD, the same set of modes exist; these options are prefixed with “**TD**”. Note, however, that the bandwidths 15 MHz and 20 MHz are not supported for TDD. The **RF Path** option means multipath (MIMO) scanning. It populates the MIMO scanning information elements with “Rx*i* Tx*j*” in their names. The **Subband** option refers to subband scanning, which does not populate any special information elements. However, all subband measurements appear in the plain-text decoded scan reports. If this option is included, the subband settings that follow become visible in the property grid. The RF Path and Subband options are referred to collectively as “Enhanced signal scanning” in section 19.1.
Subband Start	Subband start index within the measurement bandwidth. Must be in the range 0 ... Number of Subbands – 1.
Number of Subbands	Number of subbands to divide the measurement bandwidth into.

With PCTel SeeGull MX scanners, multiple concurrent LTE signal scans can be performed, for example on different bands. The output to information elements remains exactly the same with this setup: All scanned EARFCNs are presented within the information element range “1st” … “12th”. If a total of more than 12 EARFCNs are scanned, only the first 12 selected for scanning will be presented.

19.2.4. Setup of LTE Signal Scan: Rohde & Schwarz TSMW

Cyclic Prefix	The type of cyclic prefix used in OFDM. Seven (7) OFDM symbols (15 kHz) can be transmitted per slot if normal prefix length is used and 6 OFDM symbols per slot if extended prefix length is used. The scanner is capable of detecting this automatically (“Auto Detect”).
Frame Structure	Channel frame structure. With FDD, uplink and downlink transmitters use separate frequency bands, whereas with TDD, a single frequency band is shared between uplink and downlink. It is possible to run FDD and TDD signal scan tasks concurrently. The output to information elements remains exactly the same with this setup: All scanned EARFCNs are presented within the information element range “1st” … “12th”. If a total of more than 12 EARFCNs are scanned, only the first 12 selected for scanning are presented.
Measurement Rate (Hz)	Average number of 100 ms blocks to measure per second.
RS-CINR Carrier Sections	Enables RS-CINR measurement within the innermost 1080 kHz around the center frequency of the LTE channel. Each selected value corresponds to a measurement where the 1080 kHz segment is divided into the specified number of equal-sized sections, RS-CINR being measured for each such section separately. You can select several values, which will then give rise to multiple instances of the RS-CINR measurement, each dividing the 1080 kHz into a different number of sections. The final output is a single RS-CINR value, which is what is presented in TEMS Investigation.

RS-CINR Noise Reduction	Specifies the type of LTE signal to assume for RS-CINR measurements. A signal matching filter reducing scanner-internal interference will be applied if this parameter is set.
TDD Frame Configurations	Specifies uplink–downlink configurations to try when performing reference signal measurements on TDD channels.
S-SCH to P-SCH Ratio Settings	
Ratio Type	Specifies either a list of ratios or a range in which the power ratio between the primary and secondary synchronization channel must reside.
Lower Ratio Limit (dB)	Lower limit for ratio between primary and secondary synchronization channel.
Upper Ratio Limit (dB)	Upper limit for ratio between primary and secondary synchronization channel.
Fixed Ratios (dB)	List of power ratios between the primary and secondary synchronization channels.
RF Front-end	Front-end (processor) on which to schedule measurement. The measurement tasks are manually distributed on the two built-in front-ends.
Resource Allocation (%)	Resources allocated on the specified front-end. See also section 16.6.3.
Resource Available (%)	Read-only field indicating the remaining available resources on the processor selected under RF Front-end.

19.2.5. Setup of LTE Signal Scan: Transcom

Please note that the Transcom scanner is not capable of scanning more than one band at a time.

LTE Signal Scan Type	• **Full Band Scan:** Scan the full band selected under Band. • **Cell Coverage Scan:** Scan only the EARFCNs selected under Channels.
Top Number	Number of cells to include in the presentation (up to 32). What cells will appear depends on the selected sorting order (Sort Cells By parameter).
Sort Cells By	Parameter by which to sort cells in presentation windows. One of RSSI, RP, RQ, Timing, or CINR for one of the signals PSS, SSS, or RS. "Unsorted" means that the cells will be listed in the order they are scanned.
Frame Structure Type	Channel frame structure. If FDD, uplink and downlink transmitters use separate frequency bands. If TDD, a single frequency band is shared between uplink and downlink.
Subframe Configuration	TDD special subframe configuration: ▶ 3GPP 36.211, table 4.2-1. Does not exist for FDD.
PSS Measurement	Use of Primary Synchronization Signal measurement.
SSS Measurement	Use of Secondary Synchronization Signal measurement.
RS0 Measurement	Use of Reference Signal measurement with Rx1 antenna.
RS1 Measurement	Use of Reference Signal measurement with Rx2 antenna.
Timeslot Measurement	Use of timeslot measurement.

BCH Measurement	Use of BCH measurement.
Co-Channel Detection Measurement	Use of co-channel detection.
Bandwidth	Bandwidth to scan. See also section 19.1.1.

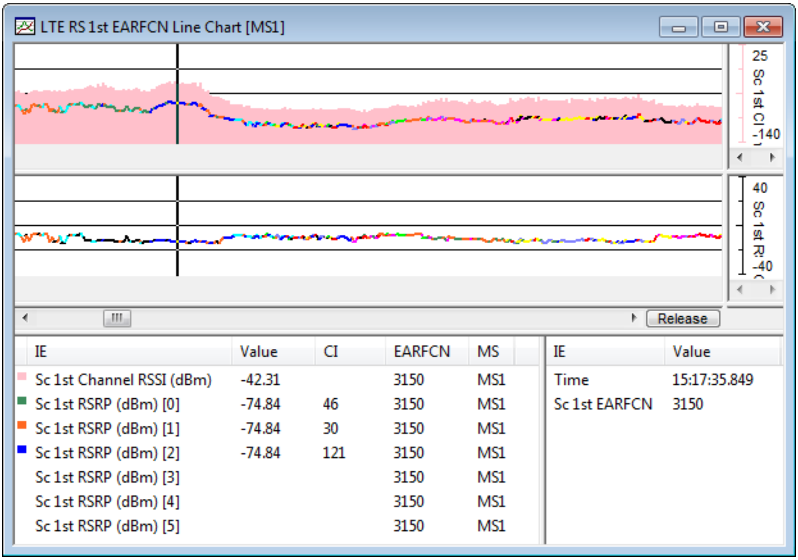
19.2.6. Setup of LTE Signal Scan: Andrew

Scan Rate	Minimum time for scan in ms.
Report Threshold	Epss/Io detection threshold (i.e. for Primary Synchronization Channel), given in 0.1 dB increments. For example, –6.5 dB is indicated as –65. Min: –240 = –24 dB. Max: 0 = 0 dB.

19.2.7. Presentation of LTE Signal Scan

LTE signal scans are presented in a suite of predefined charts and status windows. See Information Elements and Events, section 10.3.3.

The information elements include RSRP, RSRQ, RS CINR, BCH RSSI, P-SCH RP, S-SCH RP, SCH RQ, SCH CINR.



Example of LTE signal scan presentation: bar chart showing RSRP and RSRQ.

19.2.8. Customizing the Presentation

19.2.8.1. Sorting of Cells

You can sort LTE cells in scanning information elements in a number of different ways. The sorting order is set in the **General** window.

- Open the General window from the Navigator.
- Double-click the item “LTE”.

A dialog appears with these sorting options:

- Sort by decreasing RSRP, RSRQ, or RS CINR; this is the default setting.
- Sort by increasing RSRP, RSRQ, or RS CINR.
- Sort by fixed position: Cells are sorted by Cell Identity and are always assigned the same argument indices, that is, a cell with Cell Identity *n* is always found at argument index *n*.

- Sort by Cell Identity: Cells are sorted by Cell Identity; the cell with the lowest Cell Identity appears at argument index 1, the cell with the next higher Cell Identity appears at argument index 2, etc.

Note: The sorting order of the "Sc Best" elements (see Information Elements and Events, section 3.3) is fixed and is *not* affected by the General window settings.

19.3. RSSI Scanning

19.3.1. Setup of RSSI Scan: General

Technology	Always "LTE".
Band	LTE band to scan.
Channels	EARFCNs to scan within the selected LTE band. Each EARFCN is specified as a number representing the center frequency of the channel. Up to 255 EARFCNs can be scanned.

19.3.2. Setup of RSSI Scan: DRT

Logging Mode	See section 19.2.2.
Bandwidth	Bandwidth to scan; fixed at 100 kHz.

19.3.3. Setup of RSSI Scan: PCTel

Bandwidth	Bandwidth to scan; select a bandwidth from the list.
Remaining Measurement Points	See section 16.6.1.

19.3.4. Setup of RSSI Scan: Transcom

RSSI Scan Type	• **Full Band Scan:** Scan the whole LTE band selected under Band. • **Channel Scan:** Scan only the EARFCNs selected under Channels.
Measured Bandwidth	Bandwidth to scan; select a bandwidth from the list.

19.3.5. Presentation of RSSI Scan

RSSI scans are presented in a suite of predefined charts. See Information Elements and Events, section 10.3.3.

Principal information elements: Sc RSSI (dBm), Sc RSSI (dBm) [EARFCN].

19.4. Spectrum Scanning

A spectrum scan shows downlink signal strength as a function of frequency.

19.4.1. Setup of Spectrum Scan: General

Technology	Always "LTE".
Band	Select the LTE frequency band to scan.
Start Frequency	Low end of the frequency range to be swept by the scan. Given in MHz.
Stop Frequency	High end of the frequency range to be swept by the scan. Given in MHz.
Resolution Bandwidth	Interval between successive scan samples in Hz, the highest selectable resolution being 5000 Hz. In the presentation window, the legend pane will list all samples; the chart, on the other hand, can of course only distinguish the samples as far as the screen resolution permits.

19.4.2. Setup of Spectrum Scan: DRT

The DRT-specific settings are the same as for WiMAX; see section 22.5. Note, however, that the Triggered Scan option is still associated with WiMAX frames; that is, it will come into play only if you are using the LTE scanner to search for WiMAX presence.

19.4.3. Setup of Spectrum Scan: PCTel

The PCTel-specific settings are the same as for WCDMA. See section 18.5.1.

19.4.4. Setup of Spectrum Scan: Transcom

Number of Sweeps	The number of sweeps on which to base the presented average RSSI. Currently, the only value supported is 1.

19.4.5. Setup of Spectrum Scan: Andrew

Scan Rate	Minimum time for scan in ms.

19.4.6. Spectrum Scan Presentation

Spectrum scans are presented in a predefined bar chart. See Information Elements and Events, section 10.3.3.

Principal information element: Spectr Ana Sc RSSI (dBm).

19.5. Enhanced Power Scanning

Compared to the spectrum scan, the enhanced power scan is a higher-performance scan that provides selective power measurements in the time and frequency domains.

19.5.1. Setup of Enhanced Power Scan: General

Technology	Always “LTE”.

Band	LTE band to scan.
Channel	EARFCN to scan within the selected LTE band.

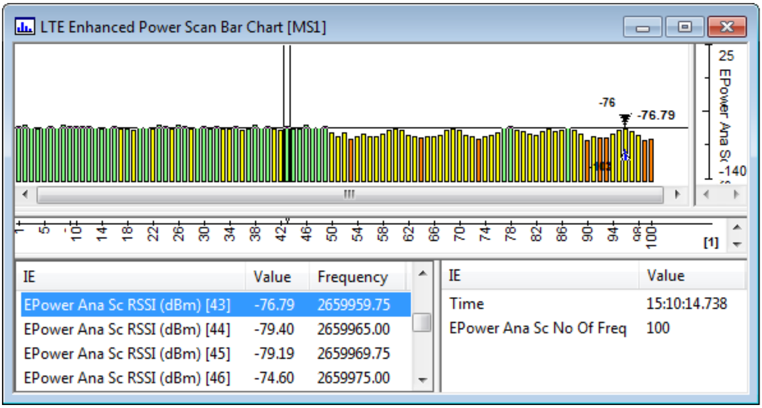
19.5.2. Setup of Enhanced Power Scan

Bandwidth	Bandwidth to scan. One of: CW: 100 kHz Normal: 1.4 MHz Wide Type 2: 3 MHz Wide Type 3: 5 MHz Wide Type 4: 10 MHz Wide Type 5: 15 MHz Wide Type 6: 20 MHz See also section 19.1.1.
Time Period Reference	Specifies whether the EARFCN given under Channel is the minimum, center, or maximum frequency of the band to be scanned.
Timing Period Mark	The scan will start on the nearest Timing Period Mark with the Timing Period Mark Offset specified. Given in units of 50 µs. Max: 20000.
Timing Period Mark Offset	Time offset in units of 50 µs. Must be less than or equal to Timing Period Mark.
Measurement Window	Measurement window size in units of 50 µs. Must be larger than 100, or else set to zero which means that the choice of window size is made by the scanner for optimal measurement performance.
Number of Bins	The number of measurements to make within the specified band. If Time Period Reference is set to Center, then the number of bins must be odd.
Resolution Bandwidth	Resolution bandwidth.

Frequency Step Size	Frequency step size.
Remaining Measurement Points	See section 16.6.1.

19.5.3. Presentation of Enhanced Power Scan

Enhanced power scans are presented in a predefined bar chart.



Principal information element: EPower Ana Sc DL RSSI (dBm).

20. TD-SCDMA Scanning

TEMS Investigation supports scanning of TD-SCDMA UARFCNs.

As for other cellular technologies, TEMS Investigation can make use of GPS data from the scanner's internal GPS.

> **Note:** You must have GPS coverage to obtain TD-SCDMA scan data. This is because a GPS signal is needed for time synchronization, which is indispensable for the TD (Time Division) component of the TD-SCDMA technology.

20.1. Scanning Methods

- **Pilot scanning** (section 20.3): Top *N*
- **RSSI scanning** (section 20.4)

20.2. General Scan Settings

Regardless of scanning method, you need to set the following:

Technology	Always "TD-SCDMA" for TD-SCDMA scanning.
Band	TD-SCDMA band or bands to scan.
Channels	TD-SCDMA UARFCNs to scan within the selected band. Each UARFCN is specified as a number representing the center frequency of the channel. Up to 12 UARFCNs can be selected for pilot scanning, and up to 255 UARFCNs for RSSI scanning.

20.3. Pilot Scanning

TD-SCDMA pilot scanning can be done in two different modes:

- Midamble Top N mode
- Sync DL Top N mode

Depending on the mode, different parts of the TD-SCDMA frame are measured, as explained further below.

Midamble Top N Pilot Scanning

This mode measures the Primary Common Control Physical Channel (P-CCPCH), which is transmitted in Timeslot 0 (TS0). To this end it scans the TS0 midamble (144 chips), located between the two data sections. The midamble is used as a training sequence for channel estimation, power measurements, and synchronization.

The mapping between Cell Parameter Identity (CPI) and the Basic Midamble Code used is given in ▶ 3GPP 25.223-840, table 6, section 7.3.

SyncDL Top N Pilot Scanning

This mode measures the Downlink Pilot Timeslot (DwPTS), which is located just before the first switching point in the Guard Period (GP) and after Timeslot 0. The switching points are used to manage the transition between uplink and downlink (since TD-SCDMA utilizes TDD to separate uplink and downlink).

The DwPTS is used for downlink synchronization. During the cell search procedure, the UE acquires the timing of the DwPTS by correlating with the SYNC-DL code transmitted in the DwPTS.

20.3.1. Setup of Pilot Scan

Type of Scanning	• **Scan strongest:** The *N* strongest CPIs will be reported from the chosen UARFCNs. The value *N* is determined by the Number of Pilots parameter. The scanner automatically finds the strongest CPIs.
Number of Pilots	To scan the *N* strongest CPIs, enter the value *N* here ($N \leq 32$).

PN Threshold	If the Ec/Io value is below the PN threshold, Ec/Io will not be reported.
Remaining Measurement Points	See section 16.6.1.
Measurement Mode	Select "Midamble Top N" or "SyncDL Top N". The modes are described in the introduction of section 20.3.

20.3.2. Presentation of Pilot Scan

Pilot scans are presented in a suite of predefined charts and status windows. See Information Elements and Events, section 10.4.3.

Principal information elements: Sc ... Ec/Io (dB), Sc ... Eps/Io (dB), Sc ... SIR (dB).

20.3.2.1. Sorting of Cells

You can sort TD-SCDMA cells in scanning information elements in a number of different ways. The sorting order is set in the **General** window.

- Open the General window from the Navigator.
- Double-click the item "TD-SCDMA".

A dialog appears with these sorting options:

- Sort by decreasing Midamble Ec/Io (default)
- Sort by increasing Midamble Ec/Io
- Sort by fixed position: To each cell is assigned the argument that corresponds to its CPI, so that a cell with CPI *n* is always found at argument index *n* + 1.
- Sort by Cell Parameter Id: Cells are sorted in order of ascending CPI, so that the cell with the lowest CPI appears at argument index 1, the cell with the next higher CPI appears at argument index 2, etc.

> **Note:** The sorting order of the "Sc Best" elements (see Information Elements and Events, section 3.4) is fixed and is *not* affected by the General window settings.

20.4. RSSI Scanning

The RSSI scan returns narrowband or wideband channel aggregate power.

Scanners with both TD-SCDMA and GSM capability can do an RSSI scan on either of these technologies. You make the selection under **General settings** → **Technology**. The GSM RSSI scan is configured in the usual manner as described in section 17.2.

20.4.1. Setup of RSSI Scan

What UARFCNs to scan is set in the General settings; see section 20.2.

Bandwidth	Bandwidth to scan: either “Normal” (wideband) or “CW” (narrowband).
Remaining Measurement Points	See section 16.6.1.

20.4.2. Presentation of RSSI Scan

RSSI scans are presented in a suite of predefined charts. See Information Elements and Events, section 10.4.3.

Principal information elements: Sc RSSI (dBm), Sc RSSI (dBm) [UARFCN].

21. CDMA Scanning

TEMS Investigation supports scanning of CDMA (IS-2000, IS-856, IS-95) RF channels.

How to configure the Andrew i.Scan scanner (and the PC along with it) for use with TEMS Investigation is covered in the Device Configuration Guide, section 10.6.1.

21.1. Scanning Methods

TEMS Investigation offers these CDMA scanning methods, supported using the various devices as indicated. Please note that for a scanning method to be actually available in TEMS Investigation, the device must have been purchased with the relevant option (wherever applicable).

CDMA Scanning Capability/ Scanning Device	**PCTel SeeGull LX, EX**	**PCTel SeeGull MX**	**Andrew i.Scan**	**Section Ref.**
Pilot scanning[1]	✓	✓	✓	21.3
Code domain scanning	✓			21.4
RSSI scanning	✓	✓		21.5
Narrowband interference scanning	✓			21.6
Spectrum analysis	✓		✓	21.7

1. PCTel MX: Follow UE option not supported.

21.2. General Scan Settings

The following settings are common to all or most of the scanning methods:

Technology	One of: • CDMA One (IS-95) • CDMA2000 • EV-DO
Band	CDMA band or bands to scan.
Channels	CDMA RF channels to scan within the selected band. Each channel is specified as a number representing the center frequency of the channel. Up to 12 RF channels can be selected.

21.3. Pilot Scanning

This method scans pilots, scrambled with cell-specific PN sequence offsets.

21.3.1. Setup of Pilot Scan: PCTel

With PCTel SeeGull MX and EX scanners, multiple concurrent PN scans can be performed: for example, one PN scan on a CDMA2000 frequency and one on an EV-DO frequency. The output to information elements remains exactly the same with this setup: All scanned frequencies, regardless of technology, are presented within the information element range “1st” … “12th”. If a total of more than 12 frequencies are scanned, only the first 12 selected for scanning are presented.

General Settings (Not Technology-dependent)

Type of Scanning	The set of pilots (PNs) to scan on each RF channel is composed in one of the following ways: • **Scan selected:** User-defined, static set of pilots (up to 512, i.e. no restriction on number of pilots), common to all selected RF channels. • **Scan strongest:** The strongest pilots ("Top *N*"; up to *N* = 32) on each RF channel, or the 32 strongest pilots on the RF channel currently used by a CDMA phone that is also activated in the application. The latter option is activated by setting "Follow UE" to Yes. In either case, the scanner automatically finds the strongest pilots.
Selected Numbers	This field is visible if Type of Scanning is set to "Scan selected". Here you pick the pilots you want to scan.
Number of Pilots	This field is visible if Type of Scanning is set to "Scan strongest". Entering the number *N* means scan the *N* strongest pilots. Min: 1. Max: 32.
PN Threshold	This is a signal code power threshold (in dB) used for the Delay Spread measurements. If the PN threshold is set too low, the Delay Spread values will be affected by random noise more than may be desired. By raising the threshold you reduce the influence of random noise correlations, and you will thus be able to discern multipath and fading effects more accurately. The setting –20 dB is recommended.
Remaining Measurement Points	See section 16.6.1.

Settings Specific to CDMA One (IS-95) and CDMA2000 (IS-2000)

Use Pilot Increment	This refers to the inter-sector pilot PN increment used by the access network in assigning PN offsets to sectors. This parameter, along with Start Pilot and Pilot Increment, are applicable only in “Scan selected” mode. If a pilot increment is used, TEMS Investigation will filter the list of selectable PNs: for example, if Start Pilot = 0 and Pilot Increment = 3, only the PNs 0, 3, 6, ... will appear in the list.
Start Pilot	The index of the first PN allocated.
Pilot Increment	The PN increment.
Max Cell Radius	The maximum radius within which to detect pilots.

Settings Specific to EV-DO (IS-856)

Pilot Window Length	This parameter indicates the length, in chips, of the time window in which the pilot is searched. The maximum pilot window length supported by the scanning receiver is 64. This is also the default and recommended setting.
Search Window Size	Normal (64 chips), Wide (128 chips), or Wider (256 chips).

Selection of Measurements to Perform

On the rows that follow you specify whether to measure each of the following (at least one item must be set to Yes):

Ec/Io	The peak pilot Ec/Io value.
Pilot Delay	The number of chips between the expected arrival time and the actual arrival time of the signal.
Aggregate Ec/Io	The sum of all peak pilot Ec/Io values above the PN threshold.[1]

Delay Spread	The number of chips between the first and last pilot Ec/Io peak above the PN threshold.

1. This measurement does not appear as an information element; it is only found in scanner reports.

Remaining Options

Measurement Mode *(EX only)*	There are two choices, High Speed and High Dynamic. These are two algorithms with different priorities. High Dynamic puts the emphasis on accuracy. Each sample reported by the scanner is typically based on a measurement 20 ms in length. High Speed is faster and accordingly less accurate. Each reported sample is typically based on a 10 ms measurement.
Timing Mode	Here you select by what method the scanner should synchronize to the base station's transmissions. • **GPS Only:** The scanner will rely exclusively on its internal GPS for timing. • **Pilot Sync Only:** The scanner will rely exclusively on the Pilot and Sync channels for timing. • **GPS Preferred:** The scanner will use its internal GPS for timing whenever possible and resort to the Pilot and Sync channels in other cases. This setting is enabled only if the scanner has been purchased with the Sync Channel Timing option. Pilot synchronization allows the scanner to operate in indoor environments where GPS coverage is lacking. Without the Sync Channel Timing option, the scanner can only use its GPS for timing. The Timing mode setting is applicable for IS-95 and IS-2000 only, not for IS-856.

Integration (Chips)	This is the number of chips over which each signal energy value is integrated. Setting this parameter high improves the accuracy and reliability of the output but also slows the scan down. The default and recommended value is 2048 for IS-2000 and IS-95, and 3072 for IS-856.
Follow UE, Selected UE	If this is set to On, a further field "Selected UE" appears where you select which CDMA phone the scanner should follow. The scan will then cover the 32 strongest pilots on the RF channel that the selected phone is currently using. When the phone switches to a different RF channel, the scanner follows along automatically. If you choose this option, all other controls in the dialog are disabled. The band, protocol, and RF channel information is taken from the phone.

Note: When setting up a Follow UE scan, all fields in the setup dialog must have some value set. Enter dummy values in the dialog as needed.

21.3.2. Setup of Pilot Scan: Andrew

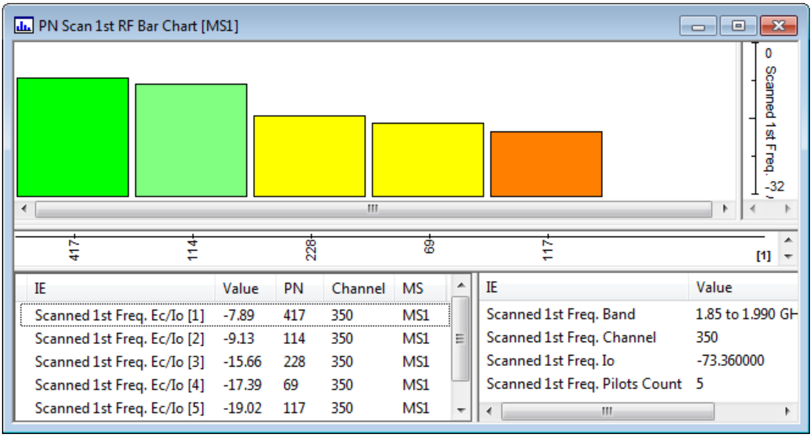
Scan Rate	Minimum time for scan in ms.
Report Threshold	Ec/Io detection threshold in dB. Min: –24. Max: 0.
Number of Top N	Entering the number *N* means scan the *N* strongest pilots. Min: 1. Max: 32.
PN Increment	The PN increment. Compare the discussion of the corresponding parameters in section 21.3.1.
Correlation Length	CDMA: Scan correlation length in chips. Must be divisible by 128. Min: 512. Max: 2048. EV-DO: Scan correlation length in slots. Min: 1. Max: 16.

21.3.3. Presentation: "PN Scan" Bar Charts

The PN Scan bar charts present pilot scan data. One predefined bar chart is provided for each RF channel scanned.

Each bar chart by default presents peak Ec/Io for each pilot found. Pilots are sorted by ascending PN offset.

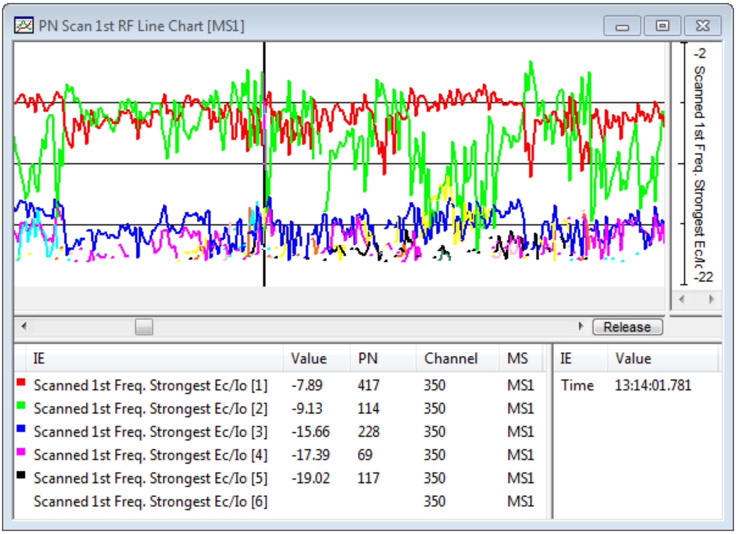
The updating rate is chiefly dependent on the number of live signals encountered in the network. For a manually selected set of pilots, the updating rate is also greatly affected by the size of this set, whereas for the "Top *N*" scan the number *N* is only marginally important (since all pilots have to be searched regardless of *N*).



Principal information elements: Scanned 1st Freq. Ec/Io, Scanned 1st Freq. Ec.

21.3.4. Presentation: "PN Scan" Line Charts

The PN Scan line charts track scanned pilots over time. One predefined line chart is provided for each RF channel scanned.



21.3.5. Presentation: Strongest Scanned PN Bar Chart

This bar chart shows the strongest pilots scanned, regardless of RF channel.

21.3.6. Customizing the Presentation

21.3.6.1. Sorting of Pilots

You can sort pilots in scanning information elements in a number of different ways. The sorting order is set in the **General** window.

- Open the General window from the Navigator.
- Double-click the item “CDMA”.

A dialog appears with these sorting options:

- Sort by decreasing Ec/Io (default).
- Sort by increasing Ec/Io.
- Sort by fixed position: Pilot PNs are sorted by index and are always assigned the same argument indices, that is, pilot PN *n* is always found at argument index *n* + 1.

- Sort by Pilot PN: Pilot PNs are sorted by index; the pilot with the lowest index appears at argument index 1, the pilot with the next higher index appears at argument index 2, etc.

Note: The sorting order of the "Sc Best" elements (see Information Elements and Events, section 3.2) is fixed and is *not* affected by the General window settings.

21.4. Code Domain Scanning

Code domain scanning consists in measuring the power of individual Walsh codes, used in CDMA to provide orthogonality among all the users in a cell. Each user traffic channel is assigned a different Walsh code by the base station.

Code domain scanning is supported on IS-95 and IS-2000 networks.

21.4.1. Setup of Code Domain Scan

21.4.1.1. General Settings

With regard to the general settings covered in section 21.2, please note that only one band and only one RF channel are selectable.

Further general settings are as follows:

Pilot number/PN code	Select the pilot PNs for which you want to scan Walsh codes. Up to 12 pilot PNs can be selected.
Walsh Code Length (chips)	Length of Walsh codes used in the network: 64 or 128. The latter exists in IS-2000 only.
Walsh Codes	Select the Walsh codes you wish to scan. There is no restriction on the number of Walsh codes that can be scanned.

21.4.1.2. Context Settings

Chip Window Size	Size in chips of the time window in which Walsh codes are searched. Min: 1. Max: 64.
Timing Mode	Same as Timing Mode for pilot scanning.
Bandwidth	Select Normal or Continuous Wave (“CW”). This setting applies to all channels you select for scanning. • **Normal:** CDMA band, bandwidth 1.2288 MHz. • **CW:** “Condensed” or CW band. For the cellular (800) band, the bandwidth is 30 kHz. For the PCS (1900) band, the bandwidth is 50 kHz.

21.4.2. Presentation: Code Domain Scan Line Charts and Bar Charts

One line chart and one bar chart are provided to visualize the range of scanned Walsh codes for each selected pilot PN.

Principal information elements: Scanned Code Domain <nth> Pilot Code, Scanned Code Domain <nth> Pilot Code Ec, Scanned Code Domain <nth> Pilot Code Ec/Io.

21.5. RSSI Scanning

21.5.1. Setup of RSSI Scan

Follow UE	Choose Yes to scan the RF channel that the CDMA phone in the combo box is currently using (plus a number of adjacent RF channels).[1] When the phone switches to a different RF channel, the scanner follows along automatically. If you choose this option, all other controls in the dialog are disabled. The band, protocol and RF channel information are taken from the phone. This option is not available for EV-DO.

Bandwidth	Select Normal or Continuous Wave ("CW"). This setting applies to all channels you select for scanning. • **Normal:** CDMA band, bandwidth 1.2288 MHz. • **CW:** "Condensed" or CW band. For the cellular (800) band, the bandwidth is 30 kHz. For the PCS (1900) band, the bandwidth is 50 kHz. Regardless of the choice made here, the measurements are extracted to the same information elements (Scanned RSSI, etc. in the "CDMA" category).
Remaining Measurement Points	See section 16.6.1.

1. Specifically (*n* = phone's RF channel number):
   on the 800 MHz band, RF channels [*n* – 21 ... *n* + 21];
   on the 1900 MHz band, RF channels [*n* – 13 ... *n* + 13];
   on the 450 MHz band, RF channels [*n* – 26 ... *n* + 26] if 79 ≤ *n* ≤ 275, otherwise [*n* – 33 ... *n* + 33].

21.5.2. Presentation: RSSI Scan Bar Chart

This bar chart displays RSSI for each RF channel scanned.

Principal information element: Scanned RSSI, Scanned RSSI Average (dBm).

21.6. Narrowband Interference Scanning

In this mode the scanner scans a narrow band centered around a specific RF channel, identifying other sufficiently strong RF channels as interferers. For the cellular (800) band the scanned bandwidth is 30 kHz, and for the PCS (1900) band it is 50 kHz.

The narrowband interference scan has lower resolution than the spectrum analysis scan (see section 21.7) but is considerably faster. Once you have done a narrowband interference scan to identify interferers, you can proceed to perform a spectrum analysis in the relevant frequency range, thereby obtaining an even clearer view of the problematic signals.

21.6.1. Setup of Narrowband Interference Scan

21.6.1.1. General Settings

Under Channels, you select a single RF channel around which to scan. As regards the rest, see section 21.2.

21.6.1.2. Context Settings

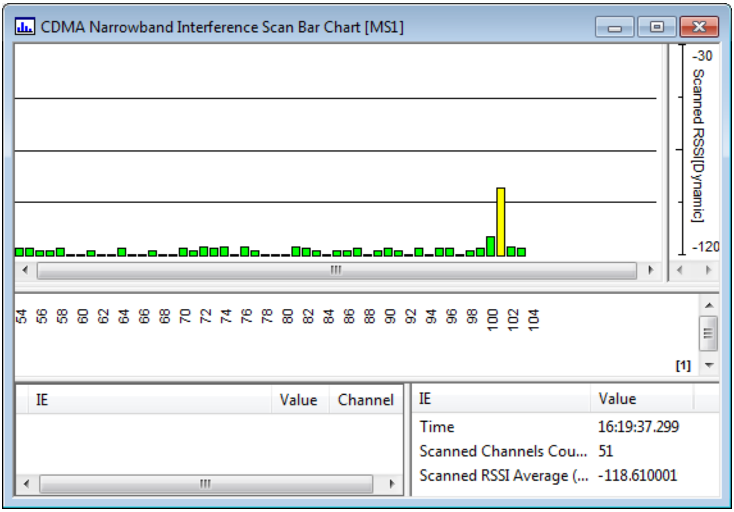
Remaining Measurement Points	See section 16.6.1.

21.6.1.3. Interference Offset

- Open the **General** window and double-click the CDMA item.
- In the dialog that appears, enter the Interference Offset in dB. This is a threshold governing how strong an RF channel must be in order to be regarded as an interferer. Specifically, an in-band RF channel is considered to be an interferer if its strength exceeds the average in-band RSSI by an amount at least equal to Interference Offset.

21.6.2. Presentation: Narrowband Interference Scan Bar Chart

The results from this scanning method are presented in the CDMA Narrowband Interference Scan Bar Chart:



Each bar in this chart represents an RF channel. This chart uses a special, predefined color coding:

- **Yellow:** The RF channel is an interferer according to the Interference Offset threshold criterion entered (see section 21.6.1).
- **Green:** The RF channel is not an interferer according to the Interference Offset criterion.

An event “Narrowband Interference” is reported when an in-band interferer is detected. See Information Elements and Events, section 8.3.

No special information element is associated with this scanning method.

21.7. Spectrum Analysis

This scanning method shows downlink signal strength as a function of frequency.

21.7.1. Setup of Spectrum Analysis Scan

21.7.1.1. General Settings

Technology	Choose the relevant CDMA technology.
Band	CDMA frequency band to scan.
Start Frequency	Low end of the frequency range to be swept by the scan. Given in MHz.
Stop Frequency	High end of the frequency range to be swept by the scan. Given in MHz.
Resolution Bandwidth	Interval between successive scan samples in Hz, the highest selectable resolution being 5000 Hz. In the presentation window, the legend pane will list all samples; the chart, on the other hand, can of course only distinguish the samples as far as the screen resolution permits.

21.7.1.2. Context Settings

- The PCTel-specific settings are the same as for WCDMA. See section 18.5.1.
- The Andrew-specific settings are the same as for LTE. See section 19.4.5.

21.7.2. Presentation of Spectrum Analysis Scan

Spectrum scans are presented in a predefined bar chart. See Information Elements and Events, section 10.5.3.

Principal information element: Spectr Ana Sc DL RSSI.

22. WiMAX Scanning

TEMS Investigation has the ability to scan WiMAX carriers.

How to configure a DRT scanner (and the PC along with it) for use with TEMS Investigation is covered in the Device Configuration Guide, section 10.1.2.

22.1. Scanning Methods

WiMAX scanning methods are as follows:

- WiMAX preamble scan
- RSSI scan
- Spectrum analysis

22.2. General Scan Settings

Regardless of scanning method, you need to set the following:

Band	WiMAX band to scan: one of the bands (WiMAX RF Profiles) supported by the scanner, and the associated OFDMA bandwidth. Regarding band support, see section 22.1.
Channels	WiMAX channels to scan within the selected band. Each channel is specified as a number representing the center frequency of the channel. Up to 1500 channels can be selected.
Technology	Always “WiMAX” at present.

22.3. Preamble Scanning

The WiMAX air interface uses OFDM as modulation method. Within an OFDM frame, each subframe is preceded by a preamble. The preamble is used for synchronization and channel estimation purposes.

The bandwidth scanned during preamble scanning is that of the selected band (i.e. WiMAX RF Profile; currently either 5 or 10 MHz). Up to 100 preambles can be tracked simultaneously.

22.3.1. Setup of Preamble Scan

Scan Type	• **Targeted:** Select this if you wish to scan a fixed set of preambles. Specify the preambles under Preamble Index List. • **Top N:** Select this if you wish to scan the strongest preambles. Set the number of preambles to report under Top N.
Logging Mode	When using a DRT scanner purchased with TEMS Investigation, the scan data is always recorded in regular TEMS Investigation logfiles (*.trp), regardless of how this parameter is set. If you are using a DRT scanner with the optional multimedia card (MMC), you can optionally record a logfile with scan data on the MMC as well. (This logging has got nothing to do with TEMS Investigation.) The MMC must have been formatted and inserted into the scanner before the scanner is powered on. • **MMC:** Log to MMC. • **None:** Do not log to MMC.
Enable Preamble Power	Calculation of preamble power.
Enable Preamble CINR	Calculation of CINR, Carrier to Interference-plus-Noise Ratio. The carrier is the desired signal, and the interference can be either noise or co-channel interference or both.

Enable CFO	Measurement of Carrier Frequency Offset.
Enable Delay Spread	Measurement of multipath delay spread.
Enable Absolute Delay	Measurement of delay relative to GPS.
Enable DL-MAP Pilot CINR	Measurement of downlink MAP pilot CINR.
Enable DL-MAP Pilot Power	Measurement of downlink MAP pilot power.
Enable DL-MAP Data Power	Measurement of downlink MAP data power.
Use N=3 for CINR Measurements	If set to True, cluster size *N* = 3 will be used for CINR measurement, that is, CINR will be measured for each segment. If set to False, cluster size *N* = 1 will be used for CINR measurement, that is, CINR will be measured over all segments.
Enable AGC	Use of AGC (Automatic Gain Control) scanning parameter. It should normally be enabled, since otherwise high level signals may saturate the receiver and cause errors.
Measurement Mode	One of Fast mode, Robust mode, or Rogue mode.
Enable Channel Response: Time Domain	Measurement of channel response in time domain.
Enable Channel Response: Frequency Domain	Measurement of channel response in frequency domain.

Top N	This field is editable if you have set Scan Type to "Top N". Here you specify how many preambles the scanner should report; setting the field to *N* causes the scanner to return the *N* strongest preambles.
Preamble Index List	This field is editable if you have set Scan Type to "Targeted". Here you specify the indices of the preambles to scan.
Detect Threshold	Threshold (in negative dB) below which no preamble detection is reported.
Decode Threshold	Threshold (in dB) below which data is not decoded.
Enable Statistical Information	This must be set on for measurement statistics (mean and standard deviation for RSSI, CINR) to be computed.
Number of Samples for Stats	The number of samples on which to base each computation of measurement statistics. However, the actual number of samples used may be smaller, as reported in the "Samples Taken" information elements (see Information Elements and Events, section 3.6).
Enable Frame Prefix Decoding	Decoding of downlink Frame Prefix (DLFP). The Frame Prefix specifies the modulation type and number of symbols associated with one or several downlink bursts that follow the FCH.
Enable Downlink Map Decoding	Decoding of downlink MAP messages. These include the burst profile for each user, which defines the modulation and coding scheme used on the downlink.
Enable Uplink Map Decoding	Decoding of uplink MAP messages. Compare Enable Downlink Map Decoding.
Enable DCD Decoding	Decoding of Downlink Channel Descriptor (a message containing information about downlink characteristics).

Enable UCD Decoding	Decoding of Uplink Channel Descriptor (a message containing information about uplink characteristics).

22.4. RSSI Scanning

22.4.1. Setup of RSSI Scan

Logging Mode	See section 22.3.
Bandwidth	Bandwidth to scan; select a bandwidth from the list.

22.5. Spectrum Analysis

A spectrum scan shows downlink signal strength as a function of frequency.

22.5.1. Setup of Spectrum Analysis Scan

Logging Mode	See section 22.3.
Average Time	Length of time for total averaging in µs.
Triggered Scan	Setting this to Yes means that the scanning will be triggered at the start of a new WiMAX frame.
Offset Time (µs)	Offset from start of frame in µs. Valid for triggered scan only.
Block Time (µs)	Length of time for block averaging in µs. Valid for triggered scan only.
Measurement Points	The number of measurement points left to allocate.

22.6. Presentation

WiMAX scans are presented in a suite of predefined charts and status windows. See Information Elements and Events, section 10.6.1.

The purpose of having views that are grouped by preamble index, rather than by RSSI or CINR, is to provide information about all the sectors of a site. This can help identify improperly aimed antennas, or find crossed feeders.

The purpose of having views sorted by RSSI or CINR, without any grouping by segment, is to provide information that is helpful in determining coverage, best server, and handover targets for neighbor lists.

For the IEs, see the Information Elements and Events volume, section 3.6.

23. Wi-Fi Measurements

TEMS Investigation is capable of collecting Wi-Fi measurements using the PC’s built-in Wi-Fi network card or an external Wi-Fi adapter plugged into the PC.

For TEMS Investigation to detect such a device, you need to check the “Wi-Fi Network Card” item in Device Detection Properties dialog (see section 6.6.3) and then restart TEMS Investigation. The Wi-Fi device will then appear as an “**EQ**” of its own in the application.

There are no script activities or manual control commands for starting and stopping Wi-Fi measurements. Rather, as soon as you activate the Wi-Fi device, TEMS Investigation will start presenting data from it, populating the Wi-Fi information elements listed in IEs and Events, section 3.11. These elements appear in Wi-Fi presentation windows as indicated in IEs and Events, section 10.7.

Please note that activating a Wi-Fi device in TEMS Investigation is independent of whether the device is connected to a Wi-Fi access point, or indeed whether it has its radio switched on at all. An event Wi-Fi Scan State with extra information “On” is always generated when you activate a Wi-Fi device in TEMS Investigation. Naturally, in order to actually obtain Wi-Fi measurements, the device must be in an operational state and detect a Wi-Fi network.

24. Events

TEMS Investigation generates events to indicate noteworthy occurrences in the cellular network. A number of events are predefined; in addition to these, you can define events of your own.

24.1. Presentation of Events

Events that occur are listed in the **Events** window. Regarding this window, see Information Elements and Events, section 10.9.

Events can also be presented:

- as symbols on the map (see section 33.2.4)
- as symbols and vertical lines in line charts (see section 31.4)
- as audio signals (see section 24.5).

24.2. Predefined and User-defined Events

Definitions of all predefined events are found in Information Elements and Events, chapter 8.

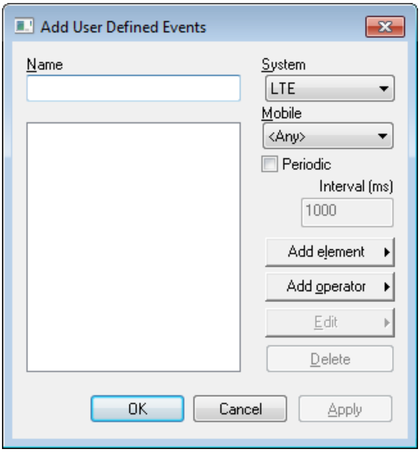
User-defined events are specified by logical expressions, which trigger the event when they evaluate to true. These expressions can contain:

- Layer 3 messages
- other events
- conditions involving information elements.

24.3. Setting Up a User-defined Event

- Open the **Event Definition** window.

Click **Add**.



Name

Enter a name for your user-defined event.

System

The choice in this combo box governs what will be selectable when you click the **Add Element** button.

Mobile

If you choose a specific external device in this combo box, the event is triggered only when the event expression is true for this particular device. If you choose “Any”, the event can be triggered by any device.

Periodic, Interval

If **Periodic** is checked, the event is generated *repeatedly* as long as its condition is true, at intervals governed by the **Interval** parameter. This is especially useful for cell whitelist events: see section 24.4.

If **Periodic** is not checked, the event is generated only once when its condition becomes true.

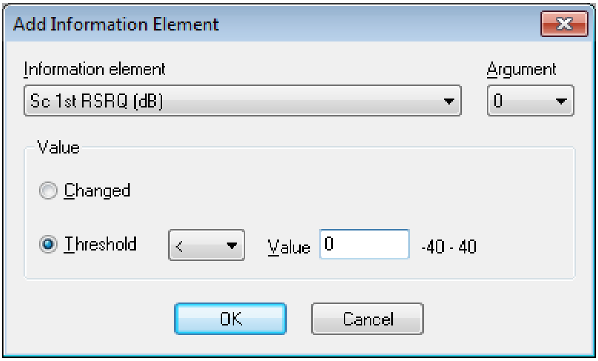
You build up the event expression by using the add buttons on the right. The structure of the expression is displayed in the box beneath the **Name** field.

24.3.1. Adding a Layer 3 Message to the Event Expression

- Click **Add Element** and choose **Layer 3** from the context menu. Choose the desired message from the dialog that appears.

24.3.2. Adding an Information Element Criterion to the Event Expression

- Click **Add Element** and choose **Information Element** from the context menu.



Information element	Choose an information element.
Argument	If the information element has an argument, specify it here.
Value: Changed	Choose this to trigger the event whenever the value of the selected information element changes.
Value: Threshold	Choose this to trigger the event when the selected information element assumes, exceeds, or drops below a certain value. Choose a threshold operator (“=”, “>”, or “<”), and set the threshold value.

24.3.3. Adding an Event to the Event Expression

- In the Add User Defined Events dialog, click **Add Element** and choose **Event** from the context menu.
- In the new dialog that appears, choose an event from the combo box.

24.3.4. Adding an Operator/Delimiter to the Event Expression

To build a composite logical expression, you will need logical operators and possibly delimiters (brackets). Available operators are AND, OR, XOR, and NOT.

- In the Add User Defined Events dialog, click **Add Operator** and select an operator or delimiter from the context menu.

> **Note:** Events used in the expression for a user-defined event can be combined with the OR operator only (not with AND, NOT, or XOR).

Keep adding items to the event expression until it is complete. Then click OK to exit the Add User Defined Events dialog. The new event is now added to the list in the Event Definition window.

See section 24.3.7 below for an example of a logical expression.

> **Note:** If a user-defined event is added or modified after a logfile is loaded, the logfile must be reloaded for the events to become visible.

24.3.5. Editing User-defined Events

- Select the event you want to edit in the Event Definition window.
- Click **Edit** and make the desired changes.

24.3.6. Deleting User-defined Events

- Select the event you want to delete in the Event Definition window.

- Click **Delete**.

24.3.7. Example of User-defined Event

This example is taken from GSM.

There are many possible causes of poor C/I values. Two common ones are co-channel and adjacent channel interference. In certain circumstances, however, the main problem is not interference from other callers, but the fact that the signal is overwhelmed by assorted random disturbances – i.e. what is usually called “noise”. This means thermal noise generated within the circuits of the phone as well as external background noise from a plethora of sources, including other man-made signals so faint that they merely add up to a quasi-random disturbance.

The following event gives a rough indication that the poor C/I is probably due to a noise problem: the poor C/I coincides with a very low signal strength.

1. From the Configuration folder in the Navigator, open the Event Definition window.
2.  Click Add.
3. Name the event “Noise Indication” (or whatever you like).
4. Click Add Element and choose “Information Element” from the context menu.
5. From the Add Information Element combo box, choose “C/I Worst”.
6. Choose “Threshold”, and choose “<” from the combo box.
7. Set Value to 10.
8. Click OK.
9. Click Add Operator and choose “AND”.
10. Click Add Element and choose “Information Element”.
11. Under “Information Element” choose “RxLev Sub (dBm)”.
12. Choose “Threshold” and choose “<” from the combo box.
13. Set Value to –99.
14. Click OK. The event expression should now look as follows:

```
C/I Worst < 10
AND
RxLev Sub (dBm) < –99
```

15 Click OK to finish.

The event is now added to the event list and can be used in the Map window and in other presentation windows.

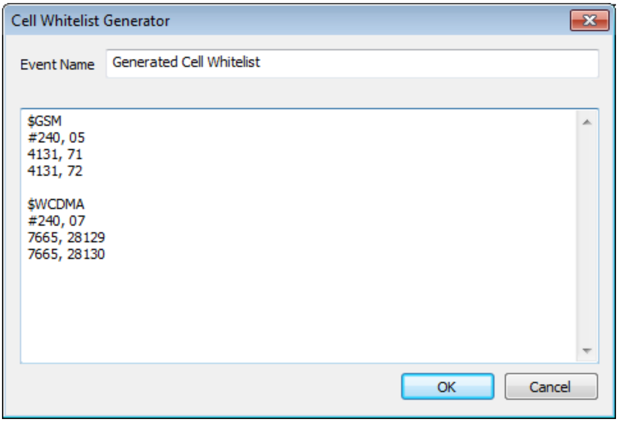
24.4. Generating Cell Whitelist Events

The Event Definition window has a special function for generating user-defined events based on *cell lists*. The purpose of this function is to provide a convenient means of alerting the user when entering a cell that belongs to a specified set. This is useful in any scenario where testing is restricted to certain cells. For example, testing of an emergency service might be performed in cells which have been temporarily reconfigured to divert emergency calls to a different number (so that they do not interfere with genuine emergency calls). Outside of these cells, emergency calls would be put through normally and are therefore forbidden.

A list of allowed cells is referred to in TEMS Investigation as a “whitelist”. To construct your whitelist, proceed as follows:

Click the **Cell Whitelist** button.

In the dialog that appears, enter your list of cells according to the format description given in the Technical Reference, chapter 6. The input might look something like this:

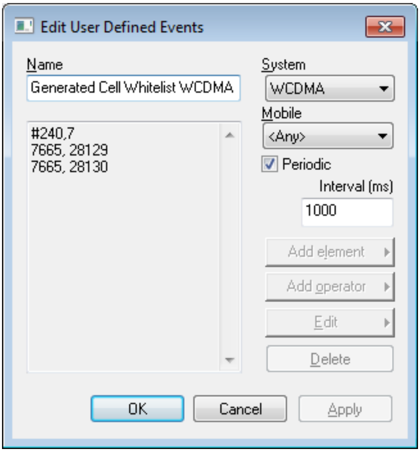


- You can change the event name if you wish. To the **Event Name** string, a RAT designation will be appended (see below).
- When you are done, click OK.

From the cell whitelist TEMS Investigation now constructs a set of user-defined events: one for each RAT occurring in the whitelist. Whenever a connected device enters one of the cells on the list, the appropriate event will be triggered.

The resulting event expression is not reproduced explicitly in the Event Definition window; it is represented there by the string “<Compiled Whitelist Expression>”. However, if you select the event and click the **Edit** button, you can view the event expression in the same format as in the Cell Whitelist Generator dialog. Please note that the whitelist event expression cannot be modified from here.[1]

1. The name and the periodicity (**Interval** setting) of a previously defined whitelist event can be changed when the event is inspected.



Whitelist events are automatically made *periodic* (**Periodic** option checked), so that they can provide continuous updates on whether or not the user is camping on a white cell. This information can be utilized by a script to perform a certain task if the device is in a white cell, but skip the task otherwise. See section 12.10.6.3 for further guidance on how to compose such scripts.

Please keep in mind that the Cell Whitelist Generator functions as a “one-way” editing aid. After you click OK in the Cell Whitelist Generator dialog, its contents are converted to an event and cannot subsequently be reverted to the whitelist format. (However, when opened, the Cell Whitelist Generator dialog does retain the contents it held when last closed.)

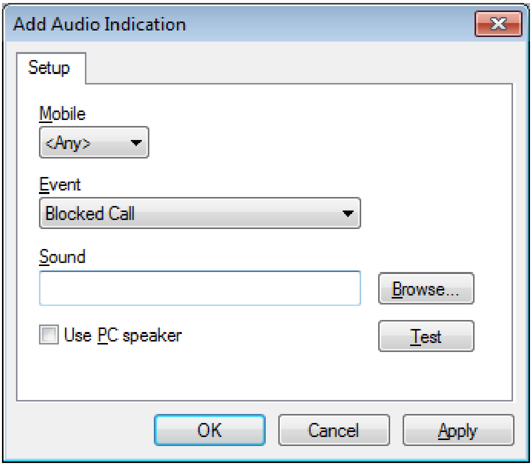
24.5. Audio Indications for Events

For each event you can specify an audio signal to be played when the event occurs. This is useful if you are performing a drive test on your own and need to keep your eyes on the road.

To associate events with audio signals, you use the **Audio Indications** window found in the Configuration folder in the Navigator.

24.5.1. Adding Audio Indications

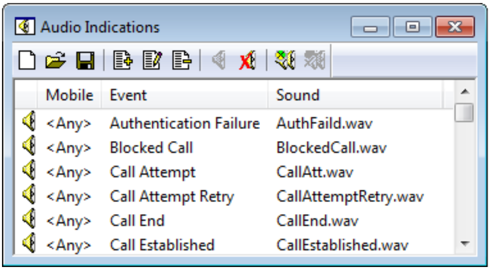
Click **Add** in the Audio Indications window.



Mobile	Choose an external device.
Event	Choose an event.
Sound	Enter the path to the WAV file you want to use, or click Browse and select the file.
Use PC speaker	Check to use the internal speaker of your PC.
Test	Listen to the selected sound file.

- Click **Apply** to add the current audio indication and keep the dialog open.
- Click OK when you are done adding audio indications.

The events that are now associated with sounds are listed in the Audio Indications window.



24.5.2. Editing Audio Indications

- Select the audio indication to be edited.

Click **Edit** and make the desired changes.

24.5.3. Activating and Deactivating Audio Indications

Audio indications are by default active.

To deactivate an audio indication, select it and click **Deactivate Sound**.

To re-activate an audio indication that has been previously deactivated, select it and click **Activate Sound**.

24.5.4. Muting All Audio Indications

To disable all audio indications, independently of their status (active or deactivated):

Click **Mute All**.

You might find this attractive when doing post-processing.

To re-enable all audio indications:

Click **Undo Mute All**.

The status of the audio indications will remain the same as before you clicked Mute All: active audio indications will start playing again, and deactivated ones will remain deactivated.

24.5.5. Saving and Loading Audio Indications

- Select the audio indication you want to save.

 Click **Save** and enter a file name (extension .svt).

 Click **Open** to load an *.svt file in the Audio Indications window.

24.5.6. Deleting Audio Indications

- Select the audio indication to be deleted.

 Click **Delete**.

25. The Status Control Monitor

The Status Control Monitor provides at-a-glance information on:

- the status of devices connected to the PC, including positioning equipment
- service execution
- PC performance
- logfile recording.

The window is found in the **Control** category on the Navigator's Menu tab.

Generally speaking, the Status Control Monitor indicates *what last happened*: it does not provide comprehensive coverage but should be seen as a complement to other parts of the user interface. Each "LED"-style indicator is accompanied by a text string that details the significance of the indicator's current color.

25.1. Equipment Connection

This indicator relates to the status of data collecting devices other than positioning equipment.

Symbol	Meaning
green	A new device (EQ) has been activated in TEMS Investigation.
yellow	A device which is activated has stopped delivering data.
red	A device has been deactivated in TEMS Investigation.
no color	No devices detected.

Compare the Navigator's **Equipment** tab: see section 6.3.

25.2. Positioning

This indicator reflects the status of the currently preferred positioning device. (Regarding the definition of “preferred”, see section 6.5.)

Symbol	Meaning
green	The preferred positioning device is delivering valid data.
red	The preferred positioning device has stopped delivering valid data.
no color	No positioning device detected.

Compare the Navigator’s **Equipment** tab: see section 6.3.

25.3. Service Status

This indicator relates to service usage. It covers both service sessions that are initiated manually (from the bottom pane of the Navigator’s **Equipment** tab: see sections 7.2, 7.3) and service sessions controlled by a script (see chapter 12). However, if you initiate a service directly on the device, using the device keypad, such an action does not affect this indicator.

Symbol	Meaning
green	Last service execution OK, everything in order.
yellow	Service execution failed once or twice.
red	Service execution failed repeatedly (at least three times in a row).
no color	No service executing.

25.4. Computer Performance

This information is taken from Windows. Memory usage for all tasks, not only TEMS Investigation, is indicated.

Symbol	Meaning
green	CPU and memory usage both below 75%.
yellow	CPU and/or memory usage above 75%, but both below 95%.
red	CPU and/or memory usage above 95%.

25.5. Logfile Progress

This indicator relates to logfile recording only, not to logfile analysis.

Symbol	Meaning
green	Recording active.
red	One of the following: • Size of logfile not increasing due to an error. • Device deactivated.
no color	No recording in progress.

Compare the status bar, Recording section: see section 3.4.3.

25.6. Context Menu

You can record all text messages printed in the Status Control Monitor to a text file. Right-click in the Status Control Monitor, and a context menu will appear; from that menu you can start and stop the logging of the window contents. By default the message recording is turned off.

Part III: Presentation

26. Presentation: Basics

This chapter covers the fundamentals of data presentation.

26.1. Presented Data

The presentation windows are used to present *information elements*, *events*, and *messages*, either in real time or during logfile analysis. Data is presented in fundamentally the same way in both cases; differences are noted whenever relevant in the chapters that follow.

For an overview of information element categories, see Information Elements and Events, chapter 2. Full details on information elements follow in chapters 3 and 4 of that volume.

Regarding predefined events, see Information Elements and Events, chapter 8.

26.2. Types of Presentation Window

The following presentation windows are available in TEMS Investigation:

Window Type	Chapter Ref.
Status window	27
Event Counter window	28
Message window	29
Video Monitor	30
Line chart	31
Bar chart	32
Map window	33
GPS window	34

26.3. Device Channels: MS/DC/PS

In presentation windows, as opposed to the Navigator and Service Control components, devices are represented by their *channels*:

- **MS** for radio measurements
- **DC** for data service measurements
- **PS** for positioning equipment.

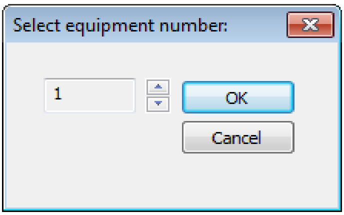
A special designation **MQ** is used in presenting information elements from the Media Quality category (Information Elements and Events, section 3.9).

The **EQ** designations currently do not appear in presentation windows.

26.3.1. "Set Equipment Number" Function

There is a shortcut for changing which device to present data from in an entire worksheet:

- Bring the worksheet of interest forward by clicking it.
- From the **Worksheet** menu, choose **Set Equipment Number**. Alternatively, right-click any empty part of the worksheet, and choose the same item from the context menu.
- Select the equipment (EQ/MS/DC) number in the dialog.



- The change will affect all presentation windows that display data from a specified device (as opposed to, for example, Event Counter windows).

26.4. Window Updating and Synchronization

A fundamental distinction can be made between

- *"snapshot"* windows, which show the situation at one instant in time and are constantly refreshed in drive testing mode (status windows, bar charts, GPS window, Video Monitor)

and

- *"history"* windows, which accumulate information and display the whole history of the testing session, or statistics on it (maps, line charts, message windows, Event Counter windows).

All windows are synchronized. When you select a point in time in a history window, other history windows highlight the same time instant, whereas the snapshot windows are updated to show the data that was current at this time.

> **Note:** The above applies without qualifications in analysis mode. In drive testing mode, however, things are somewhat different: it is still possible to inspect previously recorded data, but in many window types, as soon as a new message arrives from the device, the presentation automatically reverts to the present time.

The exactness of the synchronization is limited by the time resolutions of the various presentations. For example, the line chart plots two points every second. The map plots a maximum of two new theme markers every second.

Regarding synchronization between message windows and other windows, see section 29.5.

26.5. Clearing of Presentation Windows

In drive testing mode, presentation windows are cleared when you start recording a new logfile.

In analysis mode, presentation windows are cleared when you close the logfile currently loaded.

26.6. Color Ranges

In many types of presentation windows, it is possible to visualize numeric information element values by means of a range of colors. These colors are defined in the Navigator; see section 4.3 for details. You can always turn off the color coding and use a fixed color for drawing.

In status windows, custom color ranges for information elements can be defined, for use in that window only.

Whenever an information element is invalid, or has no color defined for its current value, it is drawn in black in graphical presentations and left out in textual presentations.

26.7. Other Window Properties

The appearance of any presentation window can be changed by altering the window properties, which are accessed by right-clicking in the window and choosing **Properties** from the context menu.

26.8. Export/Import of Presentation Windows

Status windows, line charts, maps, and message windows can be exported, that is, saved along with all their current settings in a file separate from the workspace. You can later import the window into the application again by opening the file.

26.8.1. Export

To export a presentation window, proceed as follows:

- Select the window.
- From the **File** menu, choose **Export**.
- Type a file name and click **Save**. The extension depends on the window type; see appendix B.

26.8.2. Import

To import a saved presentation window, proceed as follows:

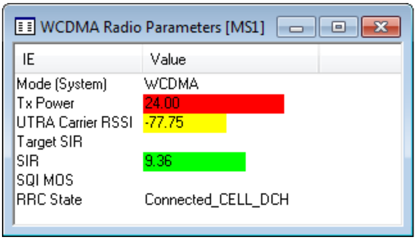
- Focus a presentation window of the same type as the one you want to import. (Open a new window if necessary, and click it.)
- From the **File** menu, choose **Import**.
- Select the desired file and click **Open**.

27. Status Windows

This chapter explains the workings of status windows.

27.1. General

The status windows present information elements in tabular form.



A number of ready-made windows are provided for presenting particular categories of information; these are listed in Information Elements and Events, chapter 10. In addition, a blank template is available which you can use to compose your own status windows.

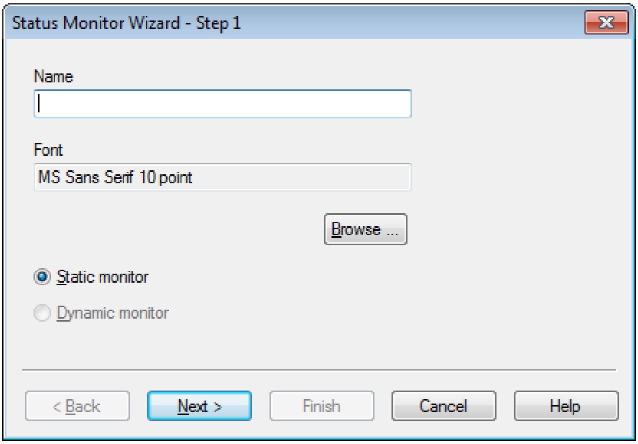
To set up a status window, use the setup wizard (section 27.2). The setup wizard is intended to be run only once. Later on, you can modify the window using the Properties dialog, which is described in section 27.3.

27.2. Setting Up Status Window Contents

The contents of a status window are conveniently set up using the setup wizard.

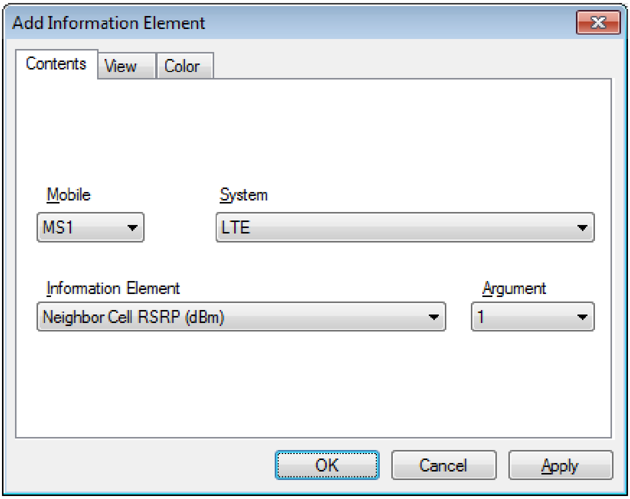
> **Note:** Setting the number of columns and rows in the status window cannot be done with the setup wizard. Also, you cannot enter text in the status window using this tool. For these purposes you must use the **Properties** dialog. See section 27.3.

- Right-click in the status window and choose **Setup Wizard**.



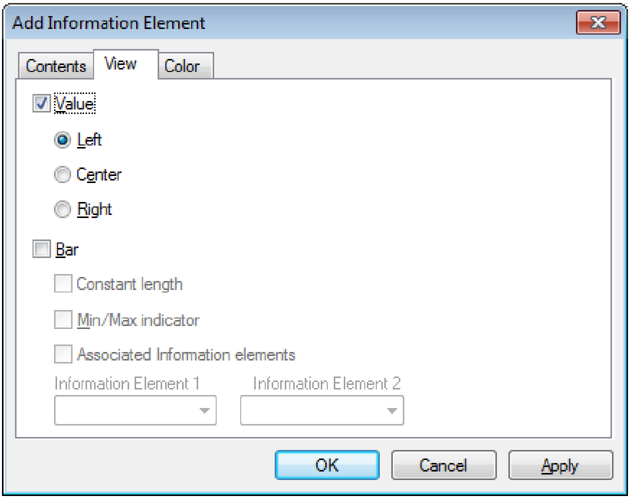
Name	Name the new status window. Note that changing the name later will create a new status window, and the contents of the current window will be lost.
Font	Click Browse and select a font.

- Click **Next** to proceed to step 2 of the setup wizard.
- To add an information element, click **Add**. This dialog opens:



Mobile	Choose which device to pick the information element from.
System	Choose an information element category. See Information Elements and Events, chapter 2.
Information element	Choose an information element.
Argument	Enter an argument for the information element (if it needs one).

- Select the **View** tab to customize how data is displayed.



Value — Check to display values alphanumerically.

Left, Center, Right — Choose alignment for the displayed values.

Bar — Check to display numeric values as colored bars.

Constant length — Draw the bar with constant length. This is useful for information elements that represent states, etc. and can only assume a limited number of values.

Min/Max indicator — Keep track of the all-time-low and all-time-high values by means of vertical lines.

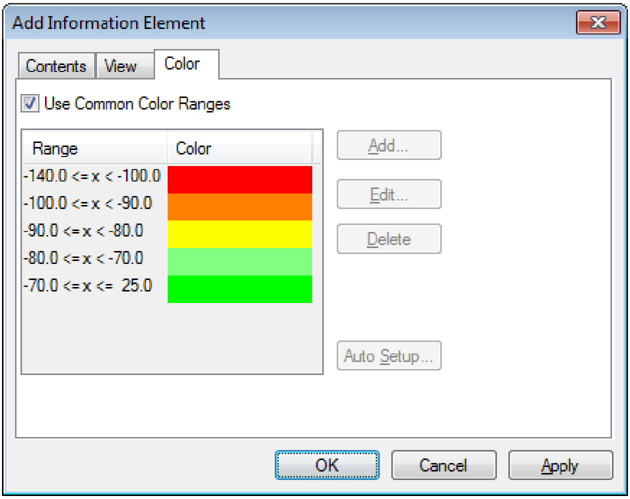
Associated information elements

Information Element 1

Information Element 2 — This checkbox with accompanying combo boxes is enabled only for the CDMA window **Finger Info**. In that window, you can visualize the thresholds “T-Add (dB)” and “T-Drop (dB)” as vertical black lines drawn on top of the bars in the **Energy** column.

See screenshot in section 27.6.2.

- Finally, select the **Color** tab to customize colors and color ranges.



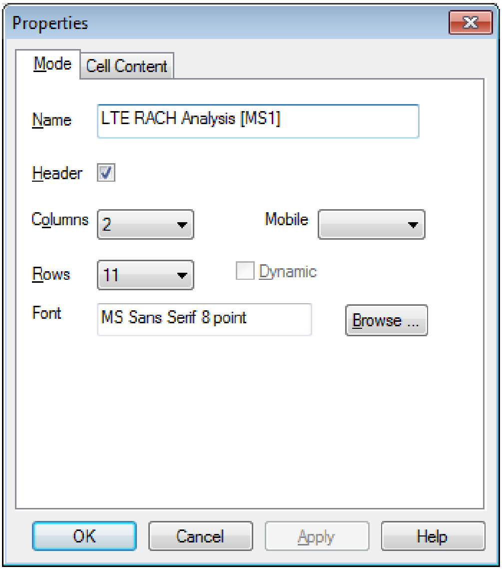
Use common color ranges Check the box if you want to use the default color range of the information element. If you want to define a special color range here, uncheck the box and specify the range (see section 4.3 for details on how to do this).

- Click **Apply** to add more information elements.
- Click OK when you are done adding information elements. Then exit the setup wizard by clicking **Finish**.

27.3. Changing Status Window Properties

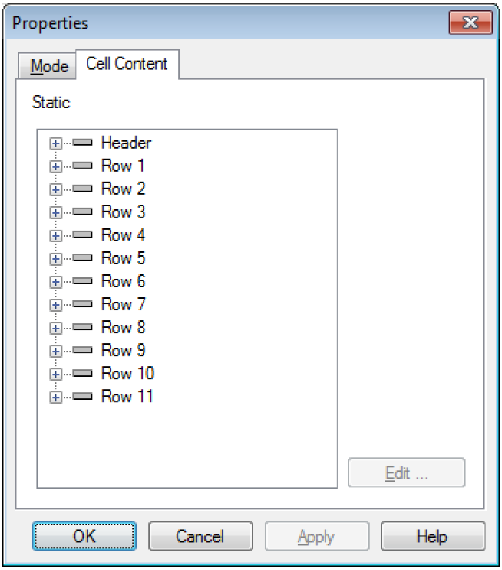
- Right-click in the status window and choose **Properties** from the context menu.

The **Mode** tab governs the layout and appearance of the window:



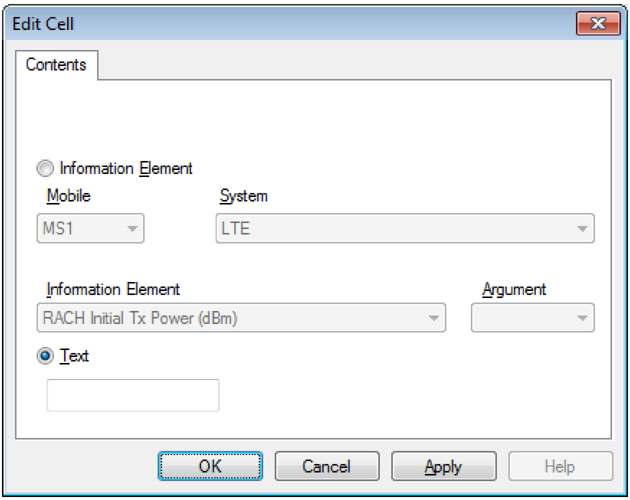
Name	Enter a new name if desired.
Header	Check if you want a header in the window. (The contents of the header are defined on the Cell Content tab.)
Columns	Set the number of columns.
Rows	Set the number of rows.
Font	Click Browse and select a font.
Mobile	If you choose a device in this box, all the information elements currently shown in the window will be taken from that device, regardless of earlier settings. (To pick individual information elements from a different device, use the **Cell Content** tab. See below.)

- To edit the contents of the status window, select the **Cell Content** tab.



- Double-click on a row and select an information element from the list. Then click **Edit**.

The dialog that appears is identical with the **Add** dialog in the setup wizard (see section 27.2 above), except that it has an extra field for entering text:



In a status window, you might want to show the same information element for several devices. To do this, create new columns as needed on the Mode tab, and modify headers and insert information elements on the Cell Content tab.

27.4. Repeating Columns in Multiple Groups

In status windows with a small number of columns (up to four), you can optionally rearrange the data by dividing the rows into several groups (up to three) and displaying these groups side by side horizontally. All columns are then repeated once or twice in the window.

This feature is handy when the default window layout has a large number of rows; multiple column groups reduce or eliminate the need for vertical scrolling.

- Right-click in the status window and select **Column Group** from the context menu, then select the desired number of column groups.

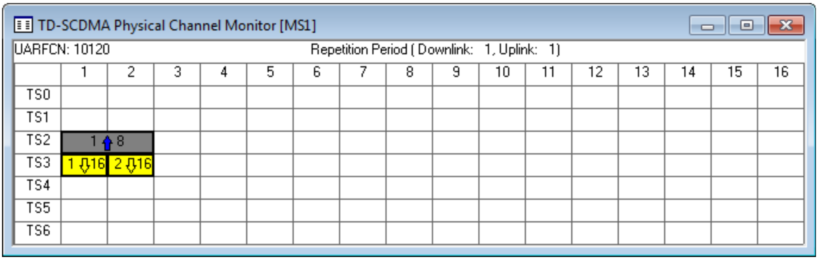
27.5. Changing the Status Window Font Size

You can adjust the font size in the status window by right-clicking in the window and selecting **Zoom**, then selecting the desired percentage of the current font size. Use the **In** and **Out** options to step the font size up and down, respectively. The size of the window itself is not affected by these operations.

27.6. Non-standard Status Windows

27.6.1. TD-SCDMA Physical Channel Monitor

This window has a unique design and presents data on TD-SCDMA Dedicated Physical Channels (DPCHs).



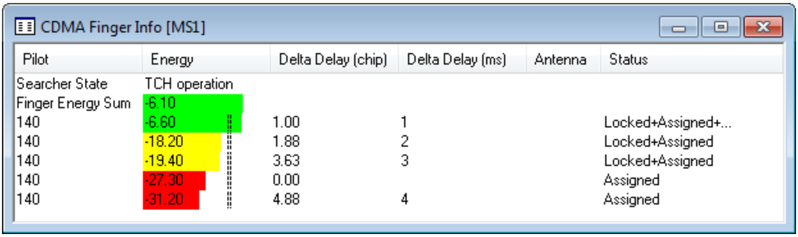
- In the top left corner is displayed the current Work UARFCN.
- Repetition period: This is the DPCH repetition period on the downlink and uplink respectively, expressed as a number of radio subframes (5 ms). A repetition period *p* means that the DPCH is transmitted in every *p*th subframe.
- In the grid, *rows* represent timeslots, and *columns* represent the leaves of the channelization code tree for the DPCH (i.e. the number of codes available when the maximum spreading factor is used).
  – A code in use in a timeslot is indicated by an entry in the corresponding row and column(s) in the grid. If a code straddles multiple columns, this means that the spreading factor for that timeslot is reduced. Specifically, if the code takes up *m* columns, the spreading factor is 16/*m*.
  – The arrow shows the direction of transmission: up arrow (blue) = uplink, down arrow (yellow) = downlink.
  – The numbers are to be read as follows: $x \Uparrow y$ = channelization code no. *x* out of the total number of channelization codes *y* in that timeslot (the latter being conditioned by the value of the spreading factor).
  – Codes are colored according to the same criteria as the information element “Timeslot ISCP (dBm)”, i.e. the interference signal code power for the timeslot. The color gray means that no valid ISCP measurement is available (which is always the case on the uplink).

27.6.1.1. Window Properties

You can right-click in this window to select which devices to display data from.

27.6.2. CDMA Finger Info

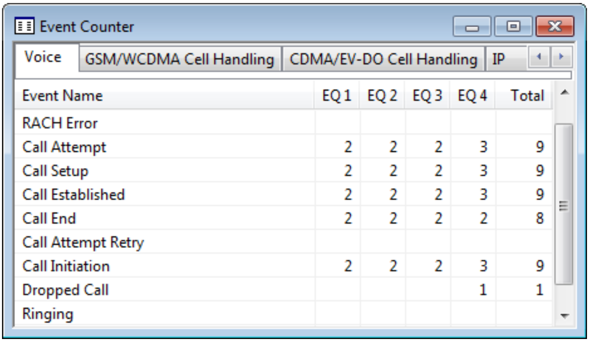
This window indicates the T-Add and T-Drop thresholds by means of a window-specific feature, as shown in the screenshot below. For the setup, see section 27.2 (**View** tab).



CDMA Finger Info window with T-Add and T-Drop thresholds drawn as dashed vertical lines in the Energy column. In this case, T-Add = –13 dB and T-Drop = –15 dB.

28. Event Counter Windows

An **Event Counter** window keeps track of the number of times a set of events have occurred. What events to show is user-configurable.



28.1. Window Tabs

Tabs are provided in this window to allow grouping of events into categories. In the Event Counter window provided under **Presentation** → **Analysis**, a number of tabs are preconfigured.

- To add a new tab, right-click in the window and choose **New Tab** from the context menu.
- To rename a tab, right-click it to open its **Properties** dialog. See section 28.4.1.
- To remove an existing tab, right-click in the window and choose **Remove Tab** from the context menu.

28.2. Copying Window Contents

You can copy the entire contents of a tab in an Event Counter window to the Windows clipboard. This way it can be transferred to a spreadsheet application or other suitable program.

- Right-click the tab and choose **Copy to Clipboard** from the context menu.
- Paste the copied selection into the desired application.

28.3. Resetting Event Counter Windows

The counters in an Event Counter window can be reset by the user at any time by right-clicking in the window and choosing **Reset Event Counter Windows**. This resets all counters in *all* open Event Counter windows.

Counters are reset automatically, in both drive testing mode and analysis mode:

- when a new logfile is opened
- when a logfile is closed.

28.4. Changing Event Counter Window Contents and Properties

- Right-click in the Event Counter window and choose **Properties** from the context menu.

28.4.1. General Tab

On this tab you choose which devices to show events from. The event counting in the window is done in a separate column for each selected device. A **Total** column is also provided which adds up the number of events from all selected devices.

The General tab also holds the window title, which is user-editable.

28.4.2. Events Tab

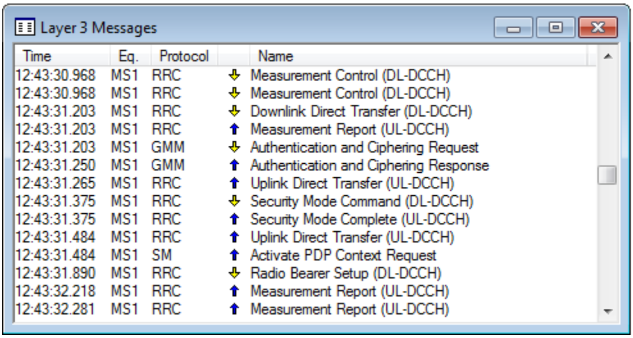
Here you choose which event types to display on the currently active tab (the tab from which you access the Properties dialog).

- Using the arrow buttons, move the events you want to display to the **Selected Events** list box.

29. Message Windows

The message windows are used to list messages and reports received or transmitted by external devices (Layer 2 and Layer 3 messages, mode reports, and error reports). They are also used to present events generated by TEMS Investigation.

Preconfigured message windows are listed in Information Elements and Events, chapter 10.



29.1. Changing Message Window Contents and Properties

- To access the message window Properties dialog, right-click in the window and choose **Properties**.

29.1.1. General Tab

On this tab you choose which devices to show messages from. MS and DC channels are distinguished.

The tab also holds the window title, which is user-editable.

29.1.2. Messages Tab

Here you choose which message categories to display in the window. The ready-made windows are preconfigured in this regard.

If at least one item in a category has been deselected, the checkbox next to the category is shaded gray.

The item **Mode Reports** → **Sony Ericsson** → **Legacy Reports** contains mode reports originating from certain older Sony Ericsson GSM phones that are no longer offered for sale with TEMS Investigation.

The item **Mode Reports** → **WiFi** contains Wi-Fi scanning reports which may be present in TEMS Pocket logfiles.

29.1.3. Events Tab

Here you choose which events to display in the message window.

- Using the arrow buttons, move the events you want to display to the **Selected Events** list box.

Any type of event can always be shown, regardless of the nature of the messages.

Note that if you add a user-defined event (section 24.3), you must select it on this tab in order for it to display in the message window.

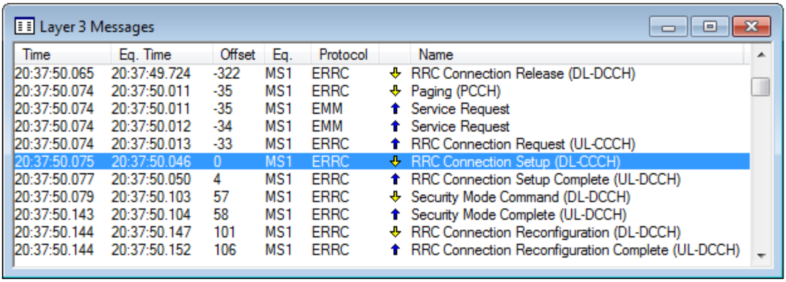
29.1.4. Columns Tab

Here you decide which columns to display in the message window:

- **Equipment (shown as "Eq."):** The device that delivered the message.
- **Mobile System ("System"):** The wireless technology from which the message originates.
- **Event & Message Symbols:** Event icon or arrow showing message direction (both types of symbol being placed in the same column).
- **Event Symbols:** Event icon.
- **Message Symbols:** Arrow showing message direction.
- **Message Name ("Name"):** Name of message or event.
- **Message Info ("Info"):** Message or event information.

- **Information Element:** Value of a user-selected information element. To select the element, first move “Information Element” to the **Selected Columns** box, then select this item and click **Edit**. A new dialog now appears where you select what information element to display. Its name will appear in the column header.
- **Time:** Timestamp of message according to the PC clock.
- **Protocol:** The protocol to which the message belongs.
- **Equipment Time (“Eq. Time”):** Timestamp of message as reported by the mobile device. This data is available for Qualcomm and Hisilicon chipset based devices only.
- **Equipment Time Offset (“Offset”):** The offset (in ms) of the device-reported message timestamp relative to the message currently selected in the window. You must select a message for offsets to appear. This data is available for Qualcomm and Hisilicon chipset based devices only.

The Equipment Time columns are not visible by default. Below is an example of what they may look like when shown.


Layer 3 Messages

Time	Eq. Time	Offset	Eq.	Protocol	Name
20:37:50.065	20:37:49.724	-322	MS1	ERRC	RRC Connection Release (DL-DCCH)
20:37:50.074	20:37:50.011	-35	MS1	ERRC	Paging (PCCH)
20:37:50.074	20:37:50.011	-35	MS1	EMM	Service Request
20:37:50.074	20:37:50.012	-34	MS1	EMM	Service Request
20:37:50.074	20:37:50.013	-33	MS1	ERRC	RRC Connection Request (UL-CCCH)
20:37:50.075	20:37:50.046	0	MS1	ERRC	RRC Connection Setup (DL-CCCH)
20:37:50.077	20:37:50.050	4	MS1	ERRC	RRC Connection Setup Complete (UL-DCCH)
20:37:50.079	20:37:50.103	57	MS1	ERRC	Security Mode Command (DL-DCCH)
20:37:50.143	20:37:50.104	58	MS1	ERRC	Security Mode Complete (UL-DCCH)
20:37:50.144	20:37:50.147	101	MS1	ERRC	RRC Connection Reconfiguration (DL-DCCH)
20:37:50.144	20:37:50.152	106	MS1	ERRC	RRC Connection Reconfiguration Complete (UL-DCCH)

29.2. Plain-text Message Decoding

In all message windows, you can double-click a message to open a new window detailing the contents of the message. You can copy text from this window to the Windows clipboard by selecting the text, then right-clicking in the window and choosing **Copy** from the context menu.

Each message window normally reuses a single detail window. For example, if you double-click one Layer 3 message and then another, the second message will replace the first in the Layer 3 detail window. To open a message in a new window, right-click the message and choose **New Detail Window**. The new window now becomes the active one. The old window will remain open, but its contents will not change any further.

29.3. Presentation of Discarded Messages

Layer 3 messages (from certain Sony Ericsson phones) that have been *discarded* according to the settings on the phone property page (see section 14.3.2.10) are highlighted in *red* in the Layer 3 Messages window. Further, an explanatory string is added to the plain-text decoding of such messages.

29.4. Message Window Catch-up

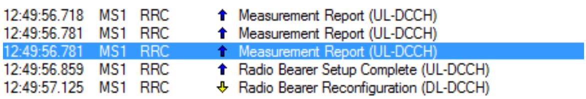
If you open a new message window when in drive testing mode, the new window will not load any messages (for performance reasons). However, when you have deactivated all external devices, you can make the window catch up by right-clicking it and choosing **Reload**.

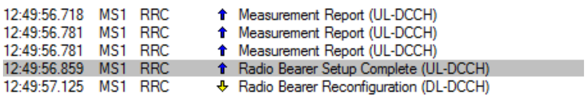
To abort the reload procedure, right-click again and choose **Cancel Reload**.

29.5. Message Window Synchronization

When message windows synchronize with each other and with other presentation windows, one or more rows are selected (colored) in each message window. Suppose, for example, that you just clicked somewhere in a line chart. The message windows are then updated according to the following criteria:

- If one message window row matches the user-selected item better than any other, that row alone will be selected. If several rows match equally well (for example, a message and one or several events triggered by that message), all these rows are selected.
- If the user-selected item and the message window selection belong to the same air interface message, the message window selection is colored blue. If there is no such exact correspondence, the row or rows immediately *preceding* the user-selected item are selected and colored gray. (If no such rows exist, nothing is selected in the window.)





29.6. Freezing a Message Window

This section applies to drive testing mode only.

You can freeze a message window by clicking an arbitrary message. The window will then stop updating, and its message flow is halted. The freeze affects only the message window you clicked in, not any other windows.

You can unfreeze the window in any of the following ways:

- by dragging its scroll bar
- by right-clicking the scroll bar and choosing **Bottom**
- by pressing the End key on the keyboard.

29.7. Filtering, Searching, and Highlighting in Message Windows

A number of functions for filtering, searching, and highlighting message window contents are available from the message window context menu.

29.7.1. Filtering Functions

These are found under **Show/Hide** in the context menu.

- **Show only messages of this type:** Reloads window contents to show only messages with the same log code/name as the selected message.
- **Hide messages of this type:** Reloads window contents, hiding all messages with the same log code/name as the selected message.
- **Undo:** Undoes a “show only” or “hide” command that is currently in force and reverts to unfiltered presentation.

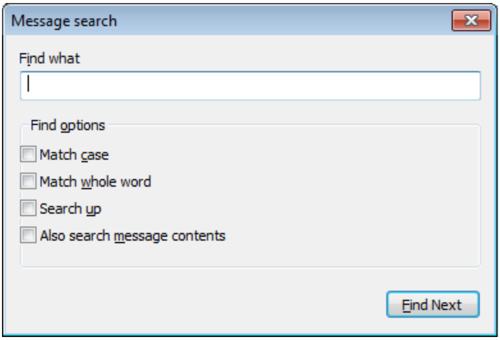
29.7.2. Search Functions

These are found under **Search** in the context menu.

- **Find next message of this type:** Finds the next message of the same type as the one selected (going forward in time).
- **Find previous message of this type:** Finds the previous message of the same type as the one selected (going backward in time).
- **Search for message:** Opens a dialog **Message Search** which is explained below.

- **Search again:** Repeats the search last performed in the Message Search dialog.

Message Search Dialog



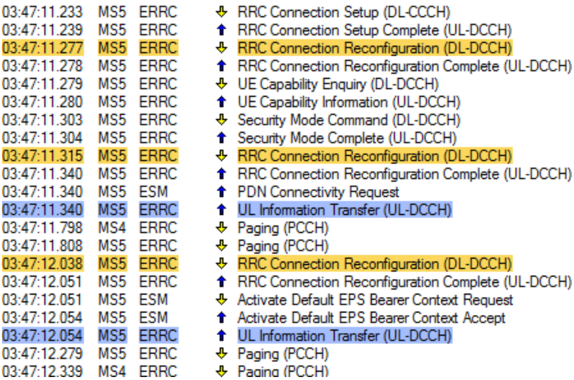
Find what	String to match in message header (and also in its contents, if the Also search message contents option is checked). As you type text in this field, a drop-down is continuously updated with matching message names, from which you can optionally make a selection.
Match case	Only match items with casing that exactly matches the search string. For example, “UL” matches “UL-DCCH” but not “Scheduling”.
Match whole word	Only match items where the search string occurs as a whole word.
Search up	Search backward (up) instead of forward (down) in the message flow. The latter is the default.
Also search message contents	Also look for matches in (plain-text decoded) the message contents. By default only the message header is searched.

- Click **Find Next** (or press the right arrow key) to go to the next message matching the search criteria. This action is equivalent to the **Search again** command on the context menu.

29.7.3. Highlighting Functions

These are found under **Highlight** in the context menu.

- *Color bars:* Select a color in which to highlight all messages of the same type as the selected message. Multiple highlights can be applied, with different colors representing different message types. See the example below.
- **None:** Removes the highlighting (if any) for all messages of the selected type.



29.8. Window-specific Features

29.8.1. Mode Reports Window

In the **General** window, under **WCDMA**, you can adjust the updating frequency (in the TEMS Investigation application) for List Search reports from Qualcomm-based terminals.

30. Video Streaming over RTP and the Video Monitor

> **Note:** This chapter deals with streaming over RTP only. Streaming can also be done over HTTP, in which case the video replay takes place in an external player, and the information elements are almost entirely different. Streaming over HTTP is otherwise covered in the same places as RTP streaming: for the setup, see section 12.20.6.4; regarding the information elements, see Information Elements and Events, section 3.8.

TEMS Investigation supports streaming of video recordings via suitable connected devices. The application is equipped with a built-in streaming video client which has been designed to imitate as closely as possible the corresponding client software found in mobile devices.

The application supports both *on-demand* streaming, where a video clip of known length is downloaded, and various forms of *live* streaming (such as tapping into a live stream or repeating playlist delivered by a streaming server), where the duration of the streaming session is specified by the user.

30.1. How to Test RTP Video Streaming

To test the video streaming service, you need a device capable of handling this service. All devices sold with TEMS Investigation 15.3 possess this capability.

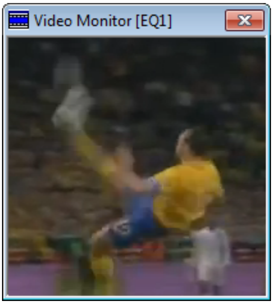
The mechanics of setting up and conducting a streaming session are handled by the **Streaming** activity in scripts: see section 12.20.6.4.

Video clips suitable for testing are supplied in the TEMS Investigation video Clips” installation package. A readme file in this directory explains the file name syntax used and gives reference VSQI values obtained for these video clips in clean conditions.

If you are using files of your own for testing streaming, the file names should contain a numeric value followed by “kbps”. This value should indicate the bit rate of the stream (video + audio), not counting overhead. If multiple numeric values are given in the file name, the first is used. If the file name does not contain a numeric value, the VSQI algorithm (see chapter 44) will use a bit rate value received from the server, but the VSQI score will then be less accurate.

30.2. The Video Monitor

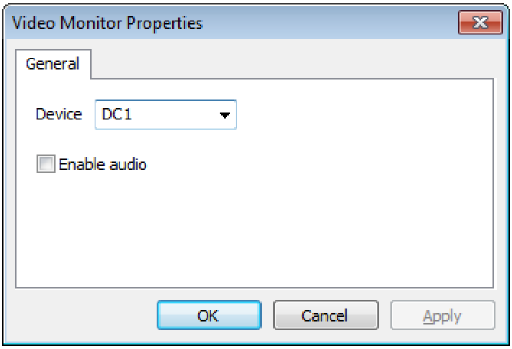
To display the streamed video clip, you use the **Video Monitor** window:



Only one instance of the Video Monitor can be open, so only one video stream can be replayed at a time. (On the other hand, it is perfectly possible to do streaming with several devices simultaneously and monitor information elements and events for all these sessions in other presentation windows.)

30.2.1. Properties of the Video Monitor

- Right-click in the Video Monitor to access its **Properties** dialog:



Device Here you select the device that delivers the video stream.

Enable audio Check this box to play the streamed audio through the PC speakers.

30.3. Evaluating RTP Video Streaming Performance

Throughput and other performance measures for video streaming are presented in the “Streaming” information elements belonging to the **Data** category. See Information Elements and Events, section 3.8.

Data on which video streaming KPIs are based is delivered in the form of KPI events; see Information Elements and Events, section 8.4.

Some of these data items deserve special comment:

- Information element Streaming Packet Loss: Packet loss is of particular interest for streaming, since the received signal is presented in real time in TEMS Investigation.
- Information element Streaming VSQI and events Streaming Quality VSQI, Streaming Intermediate VSQI: VSQI (Video Streaming Quality Index) is a quality measure developed specifically for estimating the viewer-perceived video and audio quality of a video streaming session. It is described in more detail in chapter 44. VSQI is also the subject of a technical paper which includes general discussions of video streaming as well as video quality measurement. This paper, “Video Streaming Quality Measurement with VSQI”, is found in the TEMS Investigation documentation package.

- Information element Streaming MTQI and event Streaming Quality MTQI: MTQI (Mobile TV Quality Index) is a refinement of VSQI which is discussed in chapter 45. It appraises video quality only.
- Event Streaming State: This event is provided for monitoring the activities of the streaming video client.

30.4. Troubleshooting RTP Video Streaming

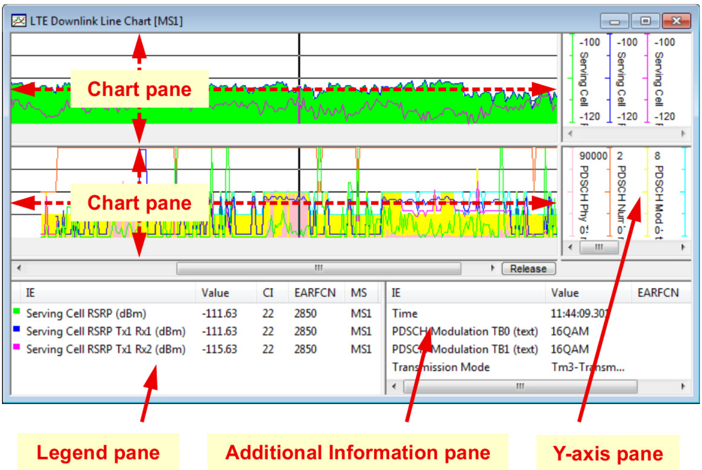
- UDP ports for video streaming must be free. See the Device Configuration Guide, section 13.2.7.
- Testing of video streaming with TEMS Investigation requires that RTP/ UDP traffic can be run with the device used as modem. The function cannot be used if RTP or UDP traffic to and from the Internet is blocked (intentionally by the operator, or for whatever reason).
- For close-up scrutiny and troubleshooting of the video streaming service, you can monitor the message traffic over the RTP, RTSP, and RTCP protocols in the **IP Protocol Reports** window. See Information Elements and Events, section 10.9.

31. Line Charts

In line charts you can plot numeric information elements in order to visualize how their values evolve over time. Line charts can also present events.

Preconfigured line charts are listed in Information Elements and Events, chapter 10.

31.1. Organization of the Line Chart Window



The Line Chart is subdivided into the following panes:

- one or several **Chart** panes, containing the charts themselves
- a **Y-axis** pane for each chart, showing the scales for the plotted information elements
- a **Legend** pane, describing the nature and origin of the information elements shown, and indicating their values at a single point in time
- an **Additional Information** pane, displaying arbitrary information elements in textual format.

A maximum of four charts can be accommodated, along with their associated Y-axis panes. The legend can only gloss one chart at a time.

The relative sizes of the panes can be freely adjusted by dragging the interior frame handles.

31.2. Contents of the Line Chart Panes

The Chart Pane

The information elements that can be plotted in a line chart are chiefly measurements of physical quantities. The plotting can be done either as a curve or in the form of successive vertical bars.

Events are indicated by thin vertical lines accompanied by a symbol identifying the event type. The symbols used for predefined events are given in Information Elements and Events, chapter 8. To see the names of the events, open an **Events** window.

The Chart pane is synchronized with the Legend and Additional Information panes (as well as with all other open presentation windows, as explained in section 26.4).

During logfile analysis, clicking in the Chart pane displays details on the selected time instant in the two text panes. You can also move backwards and forwards in a logfiles segment with the left and right arrow keys on your keyboard. In the chart, a thick vertical line indicates the point in time currently selected in the presentation.

Scrolling the chart by means of the scroll bar does not change the time instant selected, so neither the text panes nor other presentation windows will be updated. To select a new point in time, just click in the chart.

While recording, you can freeze the line chart by clicking the **Hold** button. Clicking the button once more (now labeled **Release**) makes the chart catch up with the presentation in the other windows.

The Y-axis Pane

The Y-axis pane associated with a chart shows the scales of the information elements plotted there. Each scale is drawn in the same color as the information element, except when several elements share the same scale, in which case the scale is black. If the pane is too narrow to show all scales at once, you can scroll between scales using the arrow buttons.

The scales can be changed; see section 31.4.3 (**Upper visible limit ...**, etc.).

The Legend Pane

In the legend full details are provided (for one chart at a time) on the information elements plotted for the currently selected time instant. At the extreme left in the legend, the color coding of the chart is explained. Parameters (SC/BSIC, [U]ARFCN, PN) associated with elements are given in columns of their own wherever possible.

To focus the legend on a different chart, right-click anywhere in the Line Chart window and choose the desired **Legend Chart** item from the context menu.

The Additional Information Pane

This is a sort of status window where an arbitrary set of information elements can be displayed (for example, elements which cannot be plotted). You can choose different contents in this pane for different charts, as described in section 31.4 under Additional Information Tab. However, as long as contents have only been defined for one single chart, this data will be shown in the pane regardless of which chart the legend currently refers to.

31.3. Time Scale

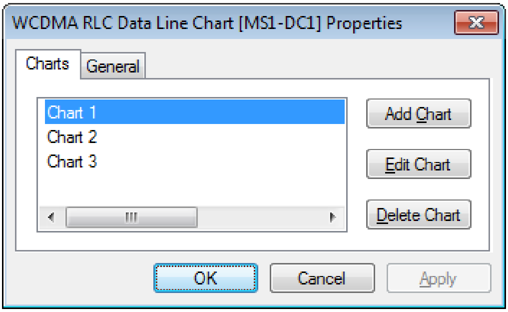
The horizontal axis of the line chart does not have an exact time scale, and so is not labeled with a unit of time. However, as a rule of thumb, two points are plotted each second both in idle and dedicated mode.

In GSM, if the device spends some time in no service mode, there will be a gap in the chart to show this; but the length of this gap might not be equivalent to the period of time with no service.

31.4. Changing Line Chart Contents and Properties

To edit the contents of the line chart and their presentation, right-click anywhere in the Line Chart window and choose **Properties**.

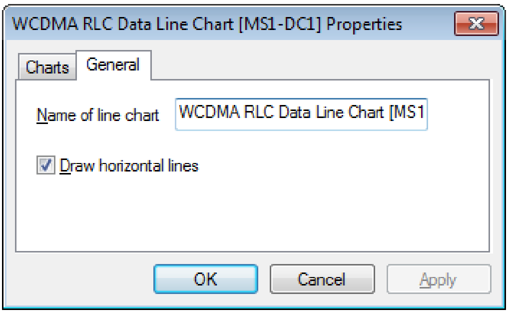
31.4.1. Adding Charts



- To add a new chart in the Line Chart window, click **Add Chart**.

31.4.2. Editing General Properties of a Chart

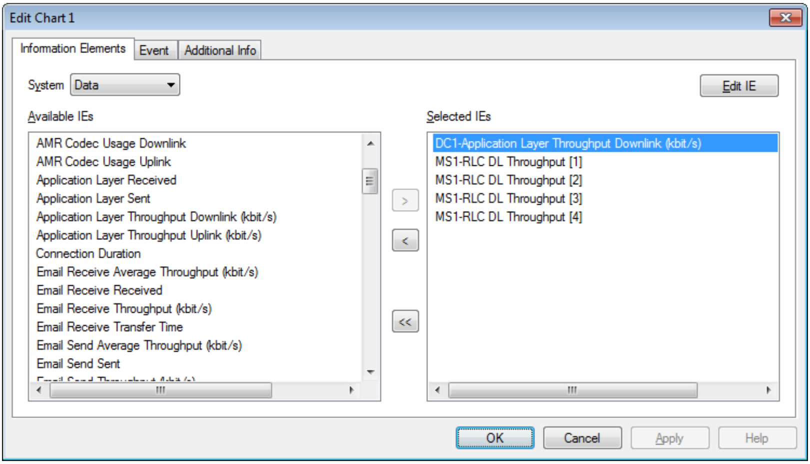
On the **General** tab of the Line Chart Properties dialog, you can edit the line chart window name and deselect the horizontal grid lines which by default are drawn in the background.



31.4.3. Editing the Contents of a Chart

- Select the chart you want to edit in the list box.
- Click **Edit Chart**.

This dialog appears:



Information Elements Tab

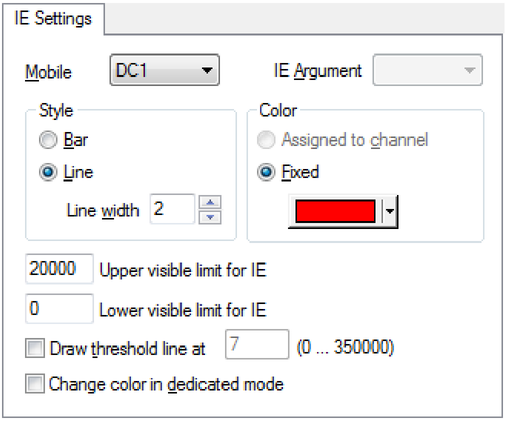
Here you edit the set of information elements to plot and how to present them. The information elements that can be plotted are chiefly those that represent or are derived from measured physical quantities (e.g. signal strength). Flags, frequency and channel numbers, scrambling code indices, timeslot indicators, and the like cannot be plotted.

- First select information element category in the **System** combo box. See Information Elements and Events, chapter 2.
- Using the arrow buttons, move the elements you want to present from the **Available IEs** to the **Selected IEs** list box. A maximum of seven elements can be presented. You can use the Ctrl and Shift keys to select multiple items in the boxes.

The first time you move an information element to Selected IEs, it will be picked from the device the line chart is drawn for (see the title bar; for the Line Chart template it is MS1). From elements with an argument the value with the lowest argument is picked. If you move the same element to Selected IEs again, one of two things will happen:

- if the element has an argument, it is taken from the same device as before, and the value with the next higher argument is shown;
- otherwise, the element is taken from the next device.

Naturally, the MS and argument can also be edited directly at any time. This is done by clicking the **Edit IE** button. In the ensuing dialog you also customize the presentation of the information element:



Mobile	The device to pick the information element from. Note that it is possible to change the device for all chosen elements at once. See section 31.4.4.
IE Argument	The argument (if any) of the information element.
Style: Bar	Choose this if you want the element to be plotted as successive, tightly packed vertical bars.
Style: Line	Choose this if you want the element to be plotted as a line. You can adjust the line width.
Color: Assigned to channel	This option is available only for elements made up of sorted channel lists (e.g. neighbors, scanned channels). If it is chosen, the application automatically assigns a color on the basis of what channel is shown. The point of this is to ensure that you can easily see when the sort order of the list (e.g. the neighbor ranking) changes. As far as possible, one and the same color is used throughout for a given channel.
Color: Fixed	This option is available for all elements, and consists simply in your selecting one fixed color yourself.

Upper visible limit for IE Upper limit of the value range shown for this information element. That is, this setting adjusts the range in the Y-axis pane. For complex information elements, the limit is automatically changed for all other arguments as well.

Lower visible limit for IE Lower limit of the value range shown for this information element. This setting works the same way as **Upper visible limit for IE**.

Draw threshold line at Check this if you want to compare the plotted values with a threshold line drawn at a specified value.

Change color in dedicated mode If you check this box, the plot color turns deeper when the device enters dedicated mode, and the brighter color chosen in the Color box is reserved for idle mode. (The dedicated mode color is not user-customizable.)

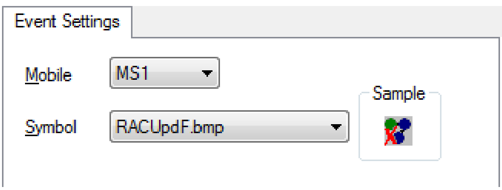
Events Tab

Here you decide which events should appear in the line chart presentation.

- Using the arrow buttons, move the events you want to present to the **Selected Events** list box.

The first time you move an element to Selected Events, it will be picked from the device the line chart is drawn for (see the title bar). If you move the same element to Selected Events again, it is taken from the next device.

Clicking the **Edit Event** button pops up the following dialog:



Mobile The device to pick the event from.

Symbol The image file used to label the vertical line indicating the event.

Additional Information Tab

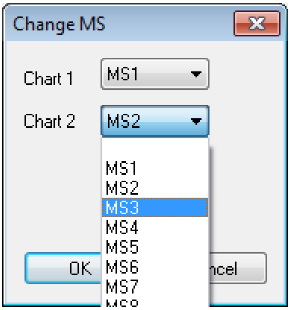
Here you choose the information elements to view in the Additional Information pane. This tab works exactly like the Information Elements tab, except that here any information element can be selected.

Clicking the **Edit IE** button in this case only enables you to change the device and argument, since the additional information is presented only as text and not graphically.

31.4.4. Presenting Data from a Different Device

If you want to present the same data as before in a chart but from a different device, it is impractical to edit the MS field for each information element separately as described in section 31.4.3. A shortcut is therefore provided for this operation.

- Right-click in the Line Chart window. From the context menu, choose **Change MS**:



- For each chart, select the device to pick data from. (The information elements and events selected in the charts will be unchanged.)

31.4.5. Deleting a Chart

- In the Line Chart Properties dialog, select the chart you want to delete and click the **Delete Chart** button.

31.5. Exporting the Line Chart Window

The line chart window can be exported separately to a file with extension .lch. See section 26.8.

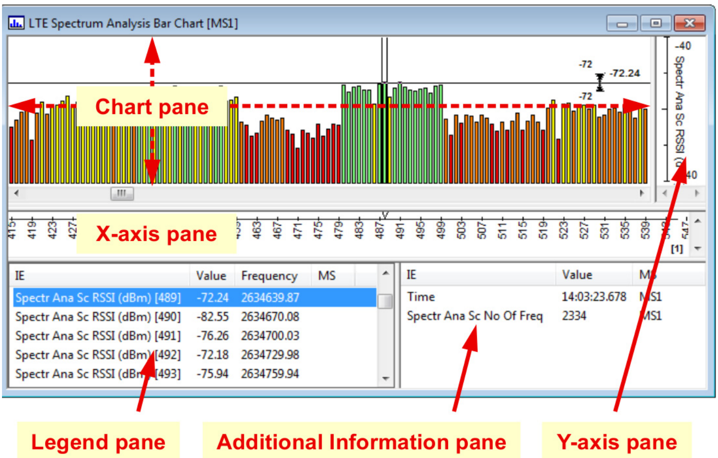
32. Bar Charts

Bar charts are used to view successive snapshots in time of a selected set of information elements. The bar chart is especially suited to the presentation of frequency scans, but the bar chart window itself is generic and can present any measurement data.

The bar chart has a number of presentation modes. One of these is a parallel coordinates presentation, which is strictly speaking a different means of visualization but is integrated into the bar chart window.

Preconfigured bar charts are listed in Information Elements and Events, chapter 10.

32.1. Organization of the Bar Chart Window



The bar chart is subdivided into the following panes:

- one or several **Chart** panes, containing the charts themselves
- a **X-axis** pane, displaying labels for the bars drawn

- a **Y-axis** pane for each chart, showing the scales for the displayed information elements
- a **Legend** pane, describing the nature and origin of the information elements shown, and indicating their current values
- an **Additional Information** pane, displaying arbitrary information elements in textual format.

A maximum of four charts can be accommodated, along with their associated Y-axis panes. The legend can only gloss one chart at a time.

The relative sizes of the panes can be freely adjusted by dragging the interior frame handles.

32.2. Contents of the Bar Chart Panes

The Chart Pane

The information elements that can be plotted in a bar chart are chiefly measurements of physical quantities.

The Chart pane is synchronized with the Legend and Additional Information panes, as well as with all other open presentation windows, as explained in section 26.4.

Clicking a bar displays max and min indicators, which will from then on keep track of the maximum and minimum values assumed by this parameter since the bar was clicked. To reset the max and min indicators, just click once more on the bar.

The X-axis Pane

The X-axis pane provides labels for the data distributed on the x-axis (for one chart at a time). By default the labels are simply consecutive numbers, but they can also show the value of an information element or consist of arbitrary text. See section 32.4.2.

The Y-axis Pane

Along the y-axis of a chart are shown the scales of the information elements plotted there. Each scale is drawn in the same color as the information element, except when several elements share the same scale, in which case the scale is black. If the pane is too narrow to show all scales at once, you can scroll between scales using the arrow buttons.

The value range visible on the y-axis can be changed; see, for instance, section 32.4.1.1 (**Visible limit for IE**).

The Legend Pane

In the legend full details are provided (for one chart at a time) on the information elements displayed in that chart. At the extreme left in the legend, the color coding of the chart is explained. The (U)ARFCN and SC/BSIC are left out if they are not directly relevant to an element (e.g. one indicating transmit power).

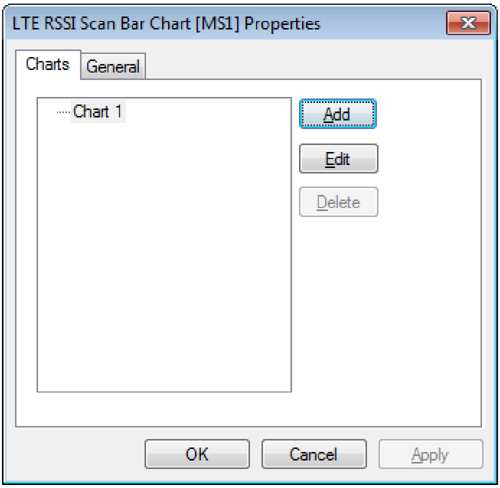
To refocus the legend on a different chart, just click in that chart.

The Additional Information Pane

This is a sort of status window where an arbitrary set of information elements can be displayed (for example, elements which cannot be drawn in a bar chart). You can choose different contents in this pane for different charts, as described in section 32.4.3.

32.3. Setting Up General Bar Chart Properties

To set up some general properties of the bar chart and its presentation, right-click anywhere in the bar chart window and choose **Properties**.



32.3.1. Adding a Chart

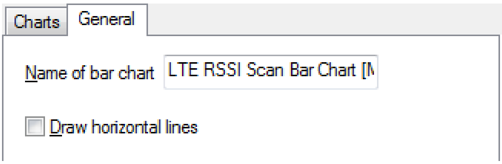
- To add a new chart in the bar chart window, click the **Add** button.

32.3.2. Deleting a Chart

- To delete a chart, select the chart you want to delete and click the **Delete** button.

32.3.3. Editing General Properties of a Chart

On the **General** tab of the Bar Chart Properties dialog, you can edit the bar chart window name and specify that horizontal grid lines should be drawn in the background.



32.4. Setting Up Bar Chart Contents

- In the Bar Chart Properties dialog, select the chart you want to set up in the list box.
- Click **Edit**.

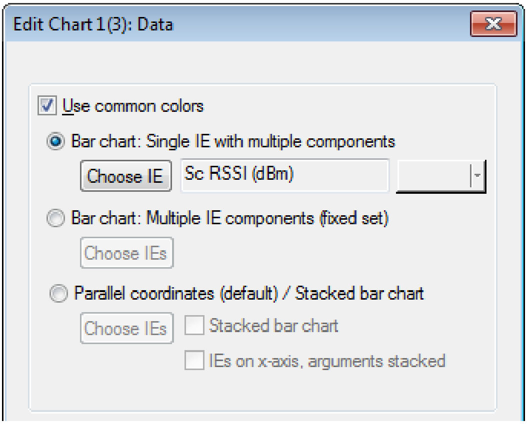
You will now work through a sequence of three dialogs. In doing so you specify

1. what data to plot in the chart, and how to present it
2. what interval to show on the x-axis, and how to label it
3. what data to display in the Additional Information pane.

The procedures are gone through in detail in sections 32.4.1–32.4.3. Examples of bar chart presentations are found in section 32.5.

The first dialog that appears is this:

32.4.1. Presentation Mode, Data, Colors



In this step you select the following (full details on subsequent pages):

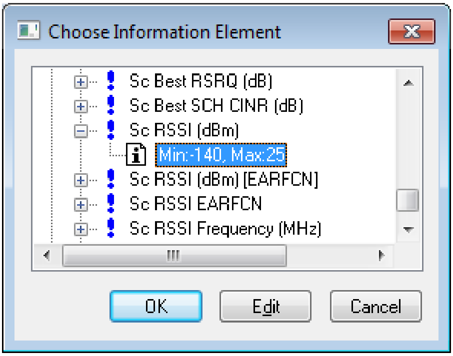
- *Presentation mode.* The bar chart is very flexible in that it can be configured in a variety of ways. These fundamental presentation modes are offered:
  - Bar chart: Single IE with multiple components
  - Bar chart: Components from multiple IEs (fixed set)
  - Parallel coordinates presentation/Stacked bar chart
- *Data:* One or several information elements, or a set of components of complex information elements, are chosen. The information elements that can be displayed are chiefly those that represent or are derived from measured physical quantities (e.g. signal strength, quality measures). Flags, channel numbers, timeslot indicators, and the like cannot be displayed.
- *Colors:* You can always keep the default color range for the information elements. Besides, there is one other option: either to define your own colors for use in the bar chart, or to use predefined, fixed, window-specific colors. (Which choice is available depends on the presentation mode.) The default color range is defined in the Navigator and is dependent on the information element value (see section 4.3).

32.4.1.1. Single IE Presentation Mode

In this mode a *single information element* is displayed. The element must be one with arguments, i.e. one which consists of several components.

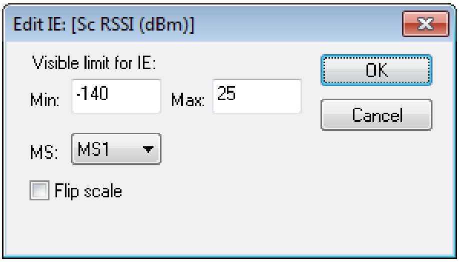
It is possible to dynamically adjust the number of components to show, by making it dependent on another (suitably chosen) information element: see section 32.4.2.

- In the Edit Chart dialog, select **Bar chart: Single IE with multiple components**.
- Click **Choose IE** to select an information element:



The item contained in each element indicates what the visible range of the element will be in the bar chart, and whether the scale will be flipped with the lowest value at the top. If you want to change these settings:

- Double-click the item (or click the **Edit** button):



Visible limit for IE: Min, Max	The visible range of the information element. By default this range is equal to the native range of the element (as stated in the Range/Unit column in Information Elements and Events).
MS	The device from which to pick the information element.
Flip scale	Check this if you want to flip the y-axis for this information element so that the lowest value is at the top and the highest at the bottom.

- Make your changes, then click OK.
- Click OK in the Choose Information Element dialog.
- Back in the Edit Chart dialog, decide what colors should be used in the chart. You have two options:
  – Keep the default color range for the information element. To this end, check the **Use common colors** box.
  – Define one fixed color to be used throughout in this chart, disregarding the default color range. To do this, uncheck **Use common colors** and select a color in the box next to the information element.
- Now click **Next** to proceed to the next step.

For an example of a Single IE presentation, see section 32.5.

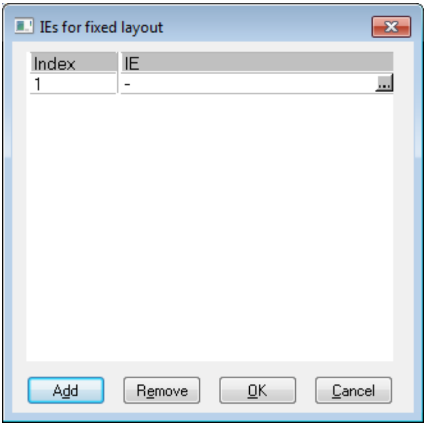
32.4.1.2. Multiple IE Components Presentation Mode

This mode displays an *arbitrary fixed set* of information element components.

To set up this presentation, proceed as follows:

- First decide whether you want to use the default color ranges of the information elements or define a fixed color for each element. To keep the default colors, check the **Use common colors** box in the Edit Chart dialog. Otherwise, uncheck it. You will then be prompted to define colors later on.

- Select **Bar chart: Multiple IE components (fixed set)**.
- Click **Choose IEs** to select your data. This dialog appears:



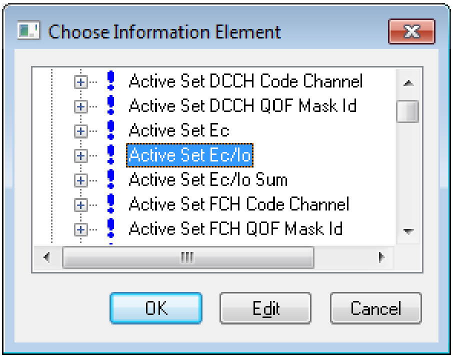
Here, a varying number of information elements may already be listed, depending on the type of bar chart concerned (template or predefined, etc.).

For each index you select one piece of data: an information element with no arguments, or one component of an element having arguments.

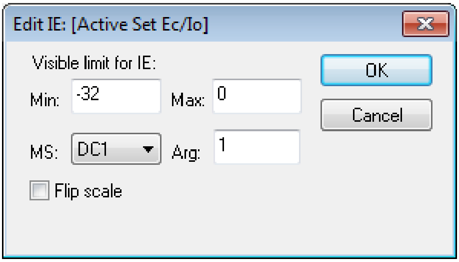
If you have checked Use common colors, the **Color** column will be absent from this dialog.

- To specify the data that should be represented by a bar (i.e. an index on the x-axis), click the ... button in the IE column, in the relevant table row. To add a new bar, click the **Add** button. A new row will then be inserted at the bottom of the table once the contents of the bar have been specified.

In either case, the **Choose Information Element** dialog appears:

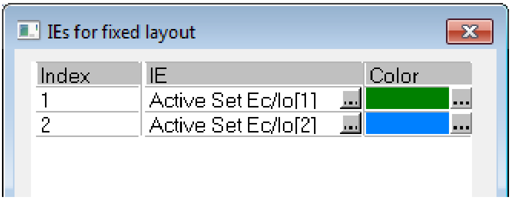


- Select an information element.
- Double-click the item (or click the **Edit** button):



- Specify range and scale properties, as described for the Single IE presentation mode (see section 32.4.1.1).
- If the information element is one with arguments, pick an argument.
- Click OK to exit the Edit IE dialog.
- Click OK in the Choose Information Element dialog.
- If you have unchecked **Use common colors**, you are now prompted to define a color for this data item. The standard Windows color dialog appears. Pick a color and click OK.

To the **IE for Fixed Layout** dialog is now added the data item and color defined for the selected index. The table will look something like this:



- To remove items from the bar chart, select the corresponding rows in the table, and click **Remove**. You can select all rows with Ctrl + A. The indices of the removed rows disappear from the table, but when you exit the dialog all items will be renumbered starting at 1.
- When you are done specifying the bar chart contents, click OK to return to the Edit Chart dialog.
- Click **Next** to proceed to the next step.

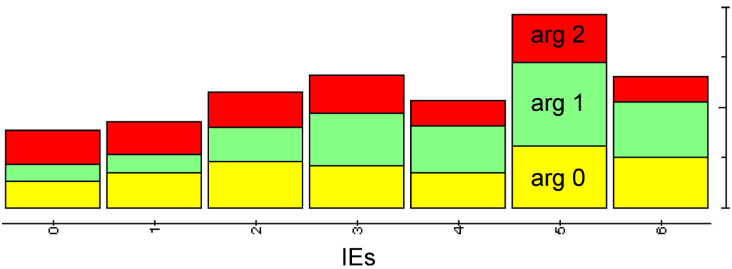
For an example of a Multiple IE Components presentation, see section 32.5.

32.4.1.3. Parallel Coordinates/Stacked Bar Chart Presentation Mode

This presentation mode is the most complex one. It has the following fundamental properties:

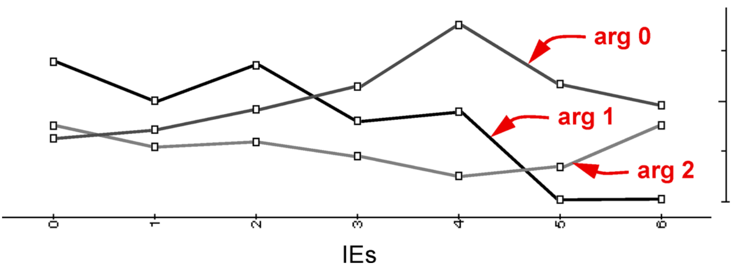
- A set of information elements is shown.
- Each information element may have arguments, and an arbitrary number of components of each element may be shown at the same time. The information elements are distributed on the x-axis, and arguments are displayed in the y-direction.
- There are two graphical representations of the above (conceptually quite distinct): a *stacked bar chart* and a *parallel coordinates* presentation.

In the stacked bar chart, one composite bar is drawn for each information element, all its components being stacked on top of each other:



Optionally, this arrangement may be reversed (one bar for each argument, information elements stacked).

The parallel coordinates presentation does not use bars and is thus not a bar chart in the literal sense. Rather, it plots all components of each information element on the y-axis, at a fixed x-axis coordinate, and connects with a line each set of components that have the same argument:



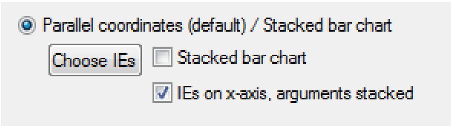
The parallel coordinates presentation is selected by default in this mode.

Setting Up Basic Properties of the Presentation

To set up this presentation, proceed as follows:

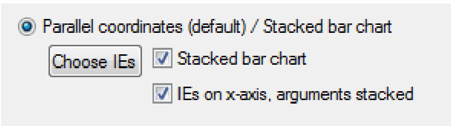
- Select **Parallel coordinates (default) / Stacked bar chart**.

If you want a *parallel coordinates presentation*, use these settings:



Do not uncheck **IEs on x-axis, arguments stacked**; such a presentation is possible but hardly has any natural interpretation within the TEMS Investigation framework.

If you want a *stacked bar chart* instead, check the Stacked bar chart box:

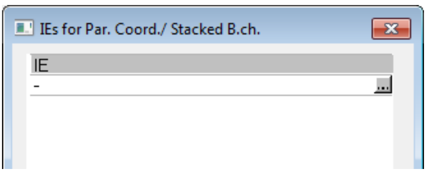


- Uncheck **IEs on x-axis, arguments stacked** if you want to reverse the roles of the axes so that arguments, rather than information elements, are distributed on the x-axis.

Selecting Data

After deciding the basic properties of the presentation:

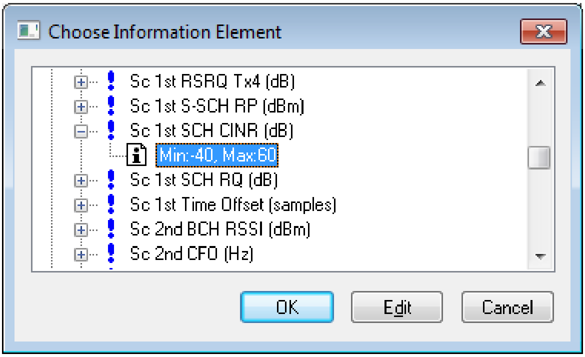
- Click **Choose IEs** to select your data. This dialog appears:



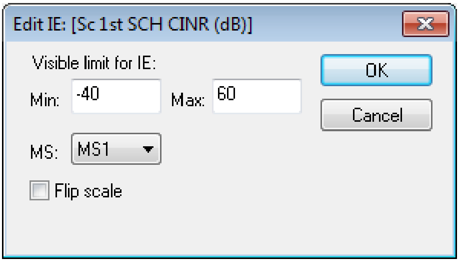
Here, a varying number of information elements may already be listed, depending on the type of bar chart concerned (template or predefined, etc.).

- To specify the details of how an information element should be presented, click the corresponding button. To add a new information element, click **Add**. A new row will then be inserted at the bottom of the table once the details have been specified.

In either case, the **Choose Information Element** dialog appears.



- Select an information element.
- Double-click the item (or click the **Edit** button):



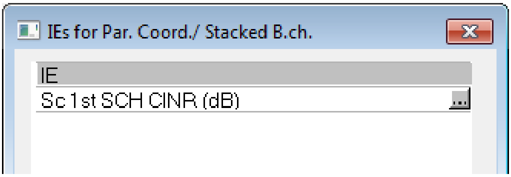
- Specify range and scale properties, as described for the Single IE presentation mode (see section 32.4.1.1).

> **Note:** The y-axis scales look the same also for stacked bar charts, despite the fact that the bar segments (except the bottom one) will be displaced in relation to the scale bar.

- Click OK to exit the Edit IE dialog.

- Click OK in the Choose Information Element dialog.

To the **IEs for Par. Coord. ...** dialog is now added the data item defined for the selected index. For example:



- To remove information elements from the bar chart, select the corresponding rows in the table and click **Remove**. You can select all rows with Ctrl + A. The indices of the removed rows disappear from the table, but when you exit the dialog all items will be renumbered starting at 1.
- When you are done specifying the bar chart contents, click OK to return to the Edit Chart dialog.

Finally, you need to decide what colors should be used in the chart. You have two options:

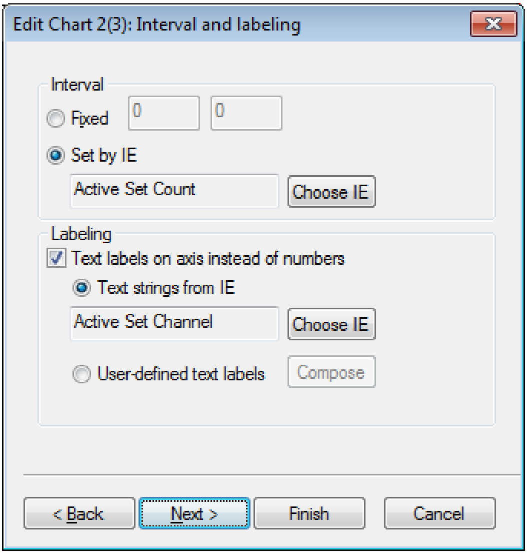
- Keep the default color ranges for the information elements. To this end, check the **Use common colors** box.
- Use fixed colors, one for each argument. The colors are chosen by the application and cannot be edited. Choose this option by unchecking **Use common colors**.

When you are done:

- Click **Next** to proceed to the next step.

For an example of a Parallel Coordinates/Stacked Bar Chart presentation, see section 32.5.

32.4.2. Interval and Labeling



In this step you take care of the following:

- Indicating the interval to show on the x-axis. Note that this is done independently of the data selected in the preceding step.
- *(Optional)* Specifying text labels on the x-axis instead of the default numeric indices.

Interval

The interval selected here governs what portion of the x-axis will be visible in the bar chart.

- Choose **Fixed** to set an unchanging interval. The default values in the boxes are dependent on the data selected in the previous step, so that accepting the defaults will cause all data to be shown.
- Choose **Set by IE** to have the interval dynamically governed by an information element. This element must denote the current number of something in order to make sense, and only such elements are selectable. *Example:* If you want to display scan data, e.g. Scanned RxLev, it may be a good idea to have the interval governed by Scanned Channels No Of. Then the number of indices on the axis will always be

equal to the number of channels currently scanned, and the space available in the chart will be fully utilized at all times, the bar width being adapted continuously.

> **Note:** The Set by IE option is disabled for the Multiple IE Components presentation, since this by itself stipulates a fixed number of x-axis indices.

Labeling

By default the x-axis is labeled simply with numbers, either those given under **Fixed** or the arguments of the information element chosen under **Set by IE**. Alternatively, you can replace the numbering with text labels.

- To enable user-defined text labels, check **Text labels on axis...** .

There are two options:

- Select **Text strings from IE** to pick labels from a text-format information element. *Example:* If you want to display data on neighbors, you might want to label the x-axis with the neighbor cell names, found in the information element Neighbor Cell Name.
- Select **User-defined text labels** to specify arbitrary text as labels. Click the **Compose** button. A dialog appears where you enter a string for each index.

32.4.3. Additional Information

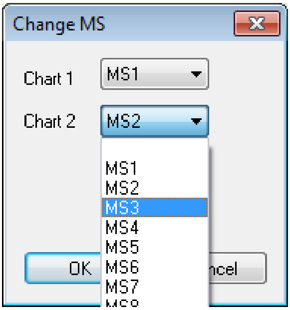
Here you choose the information elements to view in the Additional Information pane. This dialog works like the Information Elements tab in the line chart properties (see section 31.4.3), but since the additional information is presented only as text and not graphically,

- any information element can be selected
- clicking the **Edit IE** button only enables you to change the device and argument.

32.4.4. Presenting Data from a Different Device

If you want to present the same data as before in a chart but from a different device, it is impractical to edit the MS field for each information element separately as described in section 32.4.1.1. Therefore, there is a shortcut for this operation.

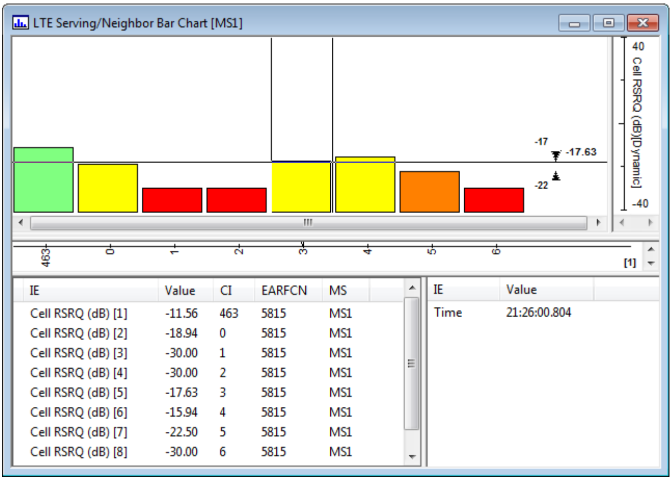
- Right-click in the bar chart window. From the context menu, choose **Change MS**:



- For each chart, select the device to pick data from. (The information elements selected in the charts will be unchanged.)

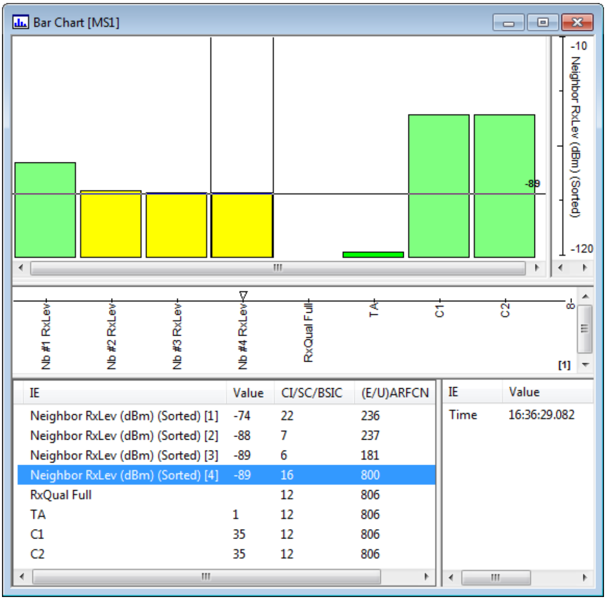
32.5. Examples of Bar Chart Presentations

Single IE



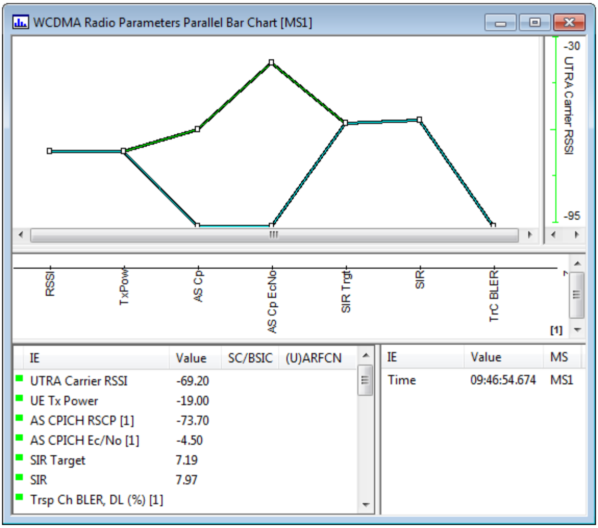
Single IE presentation: LTE serving and neighbor RSRQ (dB).

Multiple IE Components



Multiple IE Components presentation displaying an assortment of single-value IEs and selected components of multivalue IEs, and with user-defined text labels added on the x-axis.

Stacked Bar Chart, Parallel Coordinates



Parallel coordinates presentation (the predefined Radio Parameters Parallel Bar Chart for WCDMA). Each point on the horizontal axis represents a network parameter, and the colored lines, each connecting a set of parameter values, represents a moment in time. This arrangement allows the user to spot instantaneously any pattern that is out of the ordinary (that is, any unexpected line shape).

32.6. Exporting the Bar Chart Window

The bar chart window can be exported separately to a file with extension .bch. See section 26.8.

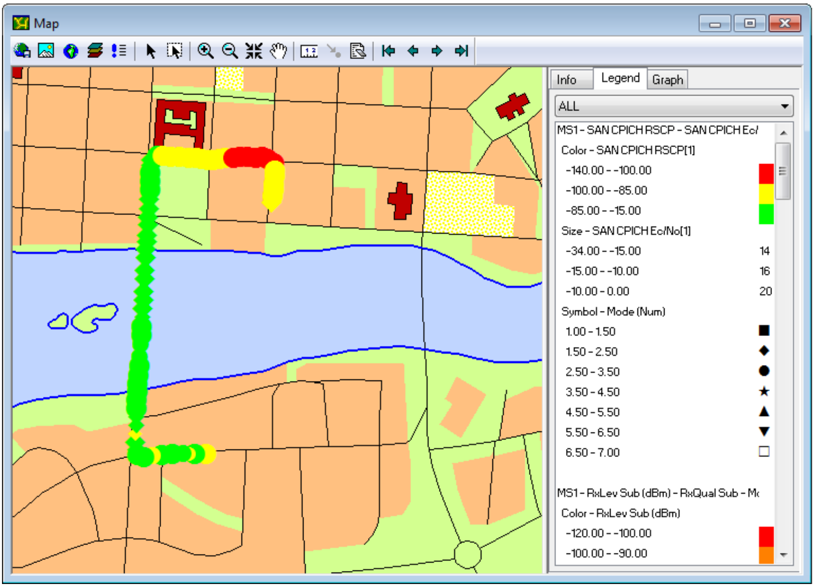
33. Map Windows

Map windows are used to display a map of your testing area and present your drive test route graphically on this map. Data on cells, events, and information elements are shown along the route in symbolic form; numeric values can also be easily accessed. Like the other presentation windows, Map windows are fully user-configurable.

This chapter deals with the presentation of data in Map windows. The preliminaries of loading map images into a Map window are gone through in chapter 8.

Note that to be able to plot measurements on a map, TEMS Investigation must have access to positioning data.

A map of the world is provided with the installation. In the example below, a different map has been loaded.



33.1. Map Concepts

This section defines some central concepts relating to Map windows. It is intended as a reference.

Map

A map is a set of geographical features which are treated as a unit. A map usually consists of several map layers (see Layer) and is presented in a Map window.

TEMS Investigation supports the following map formats:

- MapInfo
- TIF (uncompressed only).

Layer

A layer is a set of data from a particular category which is displayed in a Map window. There are two types of layer: *map layers*, which make up the map itself, and *presentation layers*, which contain information relating to the cellular network.

A map layer may, for example, consist of all the roads or all the water areas on the map.

A presentation layer contains one or several themes, all of the same main type (see Theme below). One presentation layer is predefined for each main type of theme. Additional layers can be defined by the user.

Theme

A theme is a component of a presentation layer, displaying, for example, an information element or a type of event.

Label

A label is a text string that belongs to a map and can be displayed on it.

GeoSet

A GeoSet (file extension .gst) is a special type of workspace used for map layers. A GeoSet contains settings regarding layer order, projections, zoom levels, labels, colors, etc.

33.2. Presenting Data: Themes

This section describes how to present cellular network data on the map.

Briefly stated, in order to present data, you use *presentation layers* and fill these with *themes*. A set of presentation layers is already supplied in the application. Therefore, to get started with presenting data, you do not need to worry about handling presentation layers; all your work is to do with themes and is covered in the present section. However, you can also modify presentation layers and create new ones. How to do this is described in section 33.4.

33.2.1. Themes and Theme Types

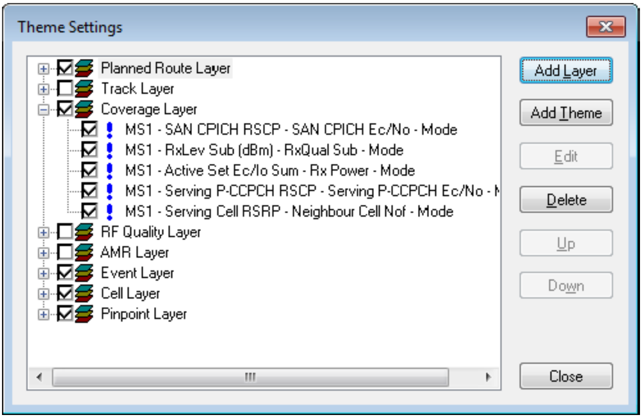
A theme is basically a bundle of settings describing how to present a set of data. These are the main types of theme, each presenting a different kind of data:

- **Information element (IE)** themes, presenting a set of information elements (at most three); see section 33.2.3.
- **Event** themes, presenting an event; see section 33.2.4.
- **Cell** themes, presenting cell information; see section 33.2.5. There are several subtypes of cell theme.
- The **Track** theme, presenting GPS positions; see section 33.2.6.
- The **Pinpoint** theme, presenting pinpointing information; see section 33.2.7.
- The **Planned Route** theme, presenting planned routes created in GPX format; see section 33.2.8.

33.2.2. Presentation Layers

When you create a theme, you always put it in a presentation layer.

Click **Add/Edit Themes** to view the current presentation layers and the themes within them. Certain presentation layers are predefined, along with a number of themes, as is seen in this screenshot (where some layers have been expanded).



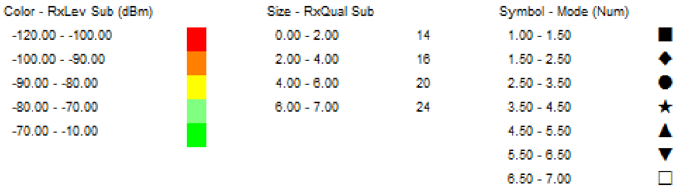
The various types of theme are put in different layers:

- IE themes in the **Coverage**, **RF Quality**, and **AMR** layers
- event themes in the **Event** layer
- cell themes in the **Cell** layer
- the Track theme in the **Track** layer
- the Pinpoint theme in the **Pinpoint** layer
- the Planned Route theme in the **Planned Route** layer.

You can add further presentation layers if desired. How to manipulate layers is the subject of section 33.4.

33.2.3. Presenting Information Elements

To present information elements, you create *information element themes* (hereafter called *IE themes*). These govern the appearance of a marker that is plotted on the map. By varying its color, size, and shape, the marker can code the values of up to three numeric information elements. For example, you can have the marker color governed by RxLev and the marker size by RxQual, and use different symbols when the device is in idle mode, dedicated mode, and so on:

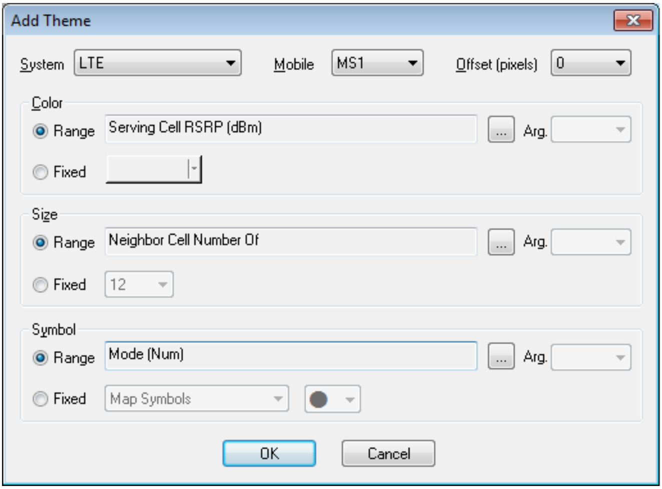


More generally, it is appropriate to use the color and size attributes for information elements with a continuous value range, and to use a suite of symbols for such things as status parameters having a small set of possible values.

The colors, sizes, and symbols used in the map are always the default ones for each information element, as set on the **Info Element** tab of the Navigator: see section 4.3. It is not possible to define these attributes differently in the map.

To create a new IE theme:

- In the Theme Settings dialog, select one of the layers (or create a new layer to put the theme in: see section 33.4).
- Click **Add Theme**:



System — Choose an information element category. See Information Elements and Events, chapter 2.

Mobile — Choose the device from which to pick the information element.

Offset (pixels) — This setting decides how far from its true position on the map the theme marker will be drawn. The offset direction is at right angles to the direction of travel; a positive offset is to the right relative to the direction of travel. Using offsets enables you to display several routes side by side.

Color — In this section you specify a rule for the theme marker color:

- Choose **Range** to have the color governed by an information element. Select an element, and select an argument if applicable.
- Choose **Fixed** to use a fixed color. This means, of course, that the color will not carry any information.

Size — In this section you specify a rule for the theme marker size, in the same way as for the color. See above.

Symbol In this section you specify a rule for choosing the shape of the theme marker, in the same way as for the color. If you choose **Fixed**, pick a font in the first combo box, then pick a symbol in the second.

The **Fixed** options are useful if you want to use an IE theme just for plotting the route, and not for showing measurement data. Uniform markers, for instance circles, will then be plotted along the route at the shortest possible time intervals (about factors influencing this updating rate, see section 33.2.3.1 below). Note that some information elements are not updated this often.

Once the IE theme has been defined, it appears in the box in the Theme Settings dialog under the layer it belongs to.

33.2.3.1. Notes on Route Plotting and Updating

The updating frequency for IE themes is governed by a number of factors. A general rule is that new theme markers are drawn at most twice a second. Another basic fact to keep in mind is that the position of a theme marker does not necessarily correspond exactly to a pair of GPS or pinpointing coordinates.

Here is a summary of the factors that affect theme plotting and updating:

- *Interpolation.* Map positions, whether delivered by a GPS or pinpointed, are constantly interpolated (linearly) to enable plotting at half-second intervals. However, whether markers are actually plotted at this rate depends on other circumstances. See below.
- *Arrival of new measurement data.* A new theme marker is plotted only if a message with fresh data has been delivered by the measurement device. Updates will thus be less frequent in idle mode than in dedicated mode. Note also that certain information elements are not updated regularly at all but only on special occasions (for example, when the device switches to a different RAB). If you want to plot such an IE with high frequency, include another IE that is frequently updated in the same theme.
- *Loss of positioning data.* If GPS data is lost for an extended period of time (for instance while driving through a tunnel) but GPS coverage is eventually regained, positions will still be interpolated and plotted throughout the gap. On the other hand, if no more positioning data is obtained, interpolation is of course impossible, and no *extra*polation of the route is attempted by TEMS Investigation.

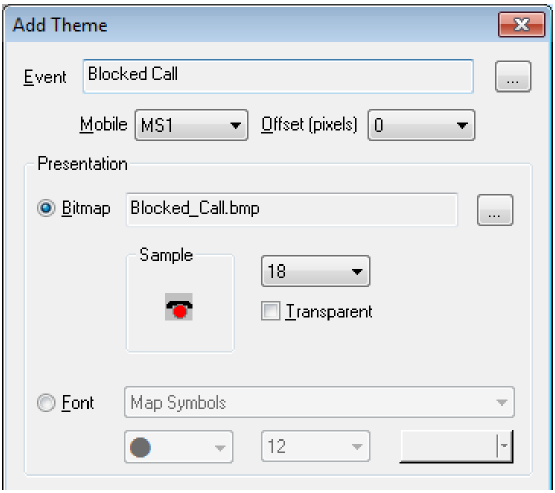
- *Map zoom.* The plotting density on the map is dependent on the current zoom of the Map window. When you zoom in, more markers are filled in to show the route in more detail; when you zoom out, markers are drawn more sparsely. Specifically, a new theme object (whether a symbol or a line) is drawn next to the latest one if the centers of the two objects will be more than 5 pixels apart on the screen.

33.2.4. Presenting Events

To present an event, you create an event theme.

> **Note:** If you create a new event theme for a user-defined event after loading a logfile, you must reload the logfile to make this event theme visible.

- In the Theme Settings dialog, select the layer named **Event Layer**.
- Click **Add Theme**:



Event	Choose an event type.
Mobile	Choose the device from which to pick this type of event.

Offset (pixels) Set the offset. It has the same meaning as for information elements; see section 33.2.3.

For events it is appropriate to use a non-zero offset (for instance 20 pixels) so that event theme symbols are not hidden by the IE theme markers plotted on the route.

Bitmap Select this to use a bitmap image as event symbol. Select your image, and set its size.

Transparent
- If this is checked, all white pixels in the bitmap become transparent, i.e. the underlying layer shines through. Note that this requires a bitmap with a white background; otherwise no transparency is achieved.
- If this is not checked, the bitmap is drawn exactly as-is.

Font Select this to pick an event symbol from a font. Select the font, then pick a symbol and set its size and color.

33.2.5. Presenting Cell Information

To present cell information[1], you create cell themes. The themes can be defined at any time; you do not have to load a cell file first. (In fact, a couple of cell themes are predefined, as is evident from section 33.2.2.)

Cell information for different technologies can be kept apart in the presentation, with a separate theme for each. It is also possible to draw cell information for multiple technologies in the same theme. Furthermore, in the XML cell file format, individual cells can be tagged with a type. This enables the creation of cell themes displaying arbitrary groups of cells. See section 33.2.5.1 below.

How to load cell files is described in section 9.3. It is possible to have more than one cell file loaded.

---

1. This presentation also applies to WiMAX cells and Wi-Fi access points defined in an XML cell file (see the Technical Reference, sections 4.7.9 and 4.7.10). Where the presentation differs between cellular technologies, Wi-Fi and WiMAX both follow GSM, with the obvious exception of GSM-specific information such as the Cell ARFCN theme.

The following kinds of cell theme exist:

- Basic plotting of cell sites (**Cell** theme): section 33.2.5.1
- Indication of serving cell and handover (**Cell Line** theme): section 33.2.5.2
- Visualization of neighbor relations (**Cell Color** theme): section 33.2.5.3
- *(GSM:)* Indication of cells using the same ARFCN as a given cell (**Cell ARFCN** theme): section 33.2.5.4

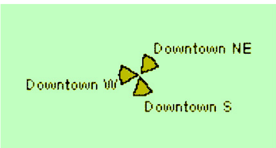
To create a new cell theme, proceed as follows:

- In the Theme Settings dialog, select **Cell Layer**.
- Click **Add Theme**. The Select Theme Type dialog appears.
- Choose a cell theme type.

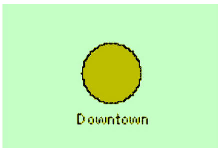
33.2.5.1. The Cell Theme

This theme is concerned with basic plotting of cell sites.

Presentation on Map



Three-sector site
(three cells)



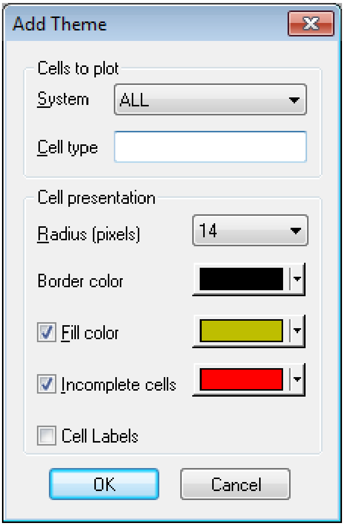
Omni cell

The zoom of the Map window does not affect this theme. All cell sites are always plotted, regardless of the zoom setting.

Each cell is tagged with a text label if you turn on the **Cell labels** option (see below). However, to avoid clutter, text labels have been turned off in most of the remaining illustrations in section 33.2.5.

Note that certain cells are filled with other colors by other cell themes, which by default hide the **Cell** theme; see sections 33.2.5.3 and 33.2.5.4.

Setup Dialog



Cells to plot This section governs which of the cells defined in the cell file will be plotted.

System Choose **ALL** to plot cells from all technologies. Choose a cellular technology to plot only cells from that technology. You might want to create one Cell theme for each technology.

(Regarding cellular technology support in the CEL and XML cell file formats, see the Technical Reference, chapters 3 and 4.)

Cell type Type of cell indicated in cell file. In XML cell files this is identical with the CELL_TYPE element: see the Technical Reference, section 4.7.13. In CEL files, GSM and WCDMA cells are told apart by inspection of what type of channel is defined (ARFCN or UARFCN).

Cell presentation This section governs how cells are drawn.

Radius (pixels)	The radius of each cell symbol (circle/sector of circle) in pixels.
Border color	The color to be used for the border of the cell symbol.
Fill color	The color to be used for the interior of the cell symbol, provided that the cell is completely described in the cell file. Uncheck to make the symbol transparent. When you select a cell, it turns red; see the illustration in section 33.3. (However, this highlighting ceases to be visible if a **Cell Color** or **Cell ARFCN** theme is also displayed: see sections 33.2.5.3 and 33.2.5.4).
Incomplete cells	The default color to be used for cells that are incompletely described in the cell file. If you uncheck this option, incompletely described cells will not be marked as such in any way. In either case, the following plotting rules apply: • If the antenna direction is not stated in the cell file, it is set to zero degrees in the plot (sector centered on “twelve o’clock”). • If the beam width is not stated, it is set to 360° in the plot (omni cell, full circle).
Cell labels	If you check this option, a text label will be printed next to each cell. The displayed information, taken from the cell file, is as follows: • **LTE:** Cell name • **WCDMA:** Cell name and SC • **GSM:** Cell name • **TD-SCDMA:** Cell name • **CDMA:** Cell name

33.2.5.2. The Cell Line Theme

This theme is used to indicate serving cells and positions where handovers have taken place.

The Cell Line theme has different meanings depending on the data source: UE or scanner.

Use with UE Data

For a UE, this theme is used to indicate

- the serving cell (LTE; WCDMA/CDMA idle mode; GSM; TD-SCDMA)
- active set members (WCDMA connected mode/CDMA traffic mode)

(The user interface uses only the term “serving cell”.)

Additionally, the theme indicates positions where handovers have taken place. Inter-system handovers are visualized in the same way as intra-system handovers, provided that cells from both cellular technologies are visible in the **Cell** theme (section 33.2.5.1).

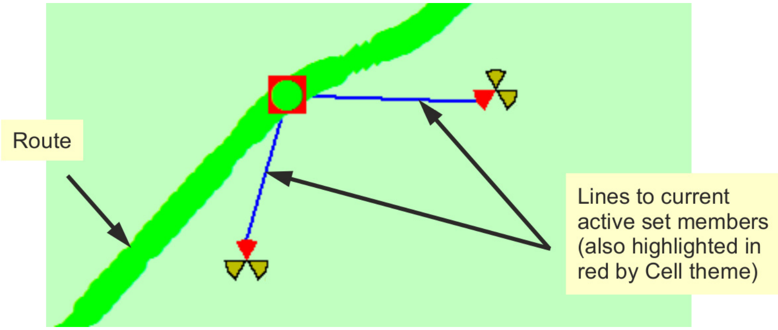
Use with Scan Data

With scan data, the Cell Line theme gives a *best server indication*. This points out the cell that uses the currently strongest signal as measured by the scanning device. Of course, no interaction with base stations is involved during scanning; rather, GPS data and the contents of a signal strength information element are correlated with the coordinates in the cell file, and the cell is identified which a user terminal at the same position would be most likely to use.

Technology-specific information: Parameters used to measure signal strength

- **LTE:** RSRQ
- **WCDMA:** Aggregate Ec
- **GSM:** RxLev
- **TD-SCDMA:** Ec/Io
- **CDMA:** Aggregate Ec
- **WiMAX:** Channel RSSI
- **Wi-Fi:** WLAN RSSI

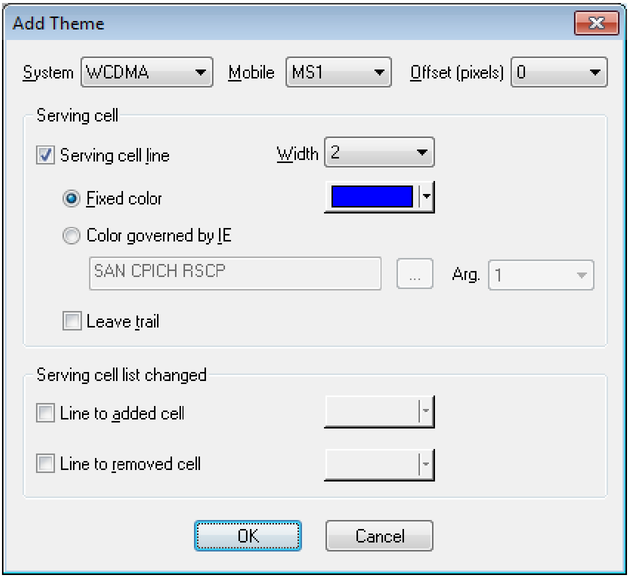
Presentation on Map



Like IE theme markers (section 33.2.3.1), cell lines are plotted with a variable density. This density is governed among other things by the zoom of the Map window, ensuring that large swaths of the map are not completely covered by such lines when the **Leave trail** option is checked.

Setup Dialog

Below, all that is said of serving cells/active set also applies to best server indications.



System Governs what IEs are selectable. See **Color governed by IE** below.

Mobile Choose the device whose serving cells are to be displayed.

Offset (pixels) Set the offset for the starting point of the line. It has the same meaning as for information elements (see section 33.2.3), i.e. the line is shifted in the same way as an IE theme marker.

Serving cell These settings govern the indication of current and past serving cells/active set members.

Serving cell line Check this to continually display a line connecting the current position along the route with the current serving cell/active set members. The line width is adjustable.

Fixed color Select this to have the serving cell line drawn in a fixed color. Pick a color in the combo box.

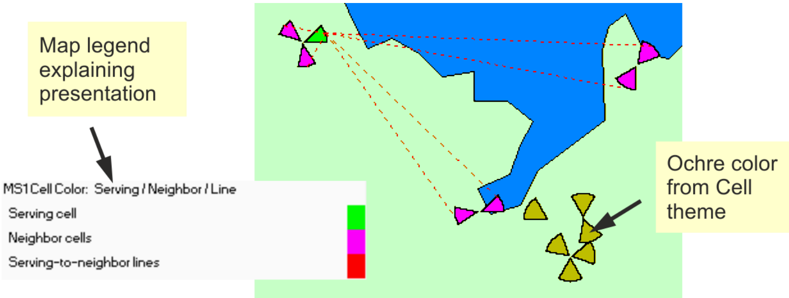
Color governed by IE	Select this to have the color of the connecting line(s) governed by an information element. Before choosing the information element (and an argument if applicable), choose the desired category in the **System** combo box.
Leave trail	Check this to leave all serving cell lines on the map.
Serving cell list changed	These settings refer to indication of handovers. Note that they are independent of the **Serving cell** settings.
Line to added cell	At handover, a line is drawn from the position where the new serving cell or active set member is first used. The line remains after the device has moved on. This feature is available also for best server indications, although no actual handover is involved.
Line to removed cell	At handover, a line is drawn from the position where the old serving cell or active set member is last used. The line will remain on the map. This feature is available also for best server indications, although no actual handover is involved.

33.2.5.3. The Cell Color Theme

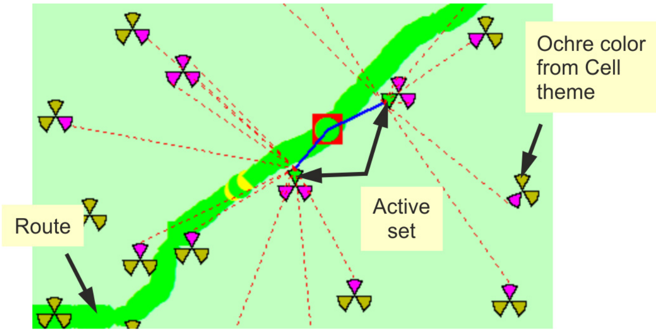
This theme is used to visualize the neighbor relations of the current serving cell/active set members or of an arbitrary user-selected cell (only one cell at a time). The neighbor relations shown are those indicated in the loaded cell file; the neighbor presentation is *not* affected by the device’s neighbor reporting. The only device data fed into this theme is the serving cell data.

By default, therefore, in the realtime presentation as well as during logfile analysis, the cell drawn in green will be the device’s current serving cell. However, if you click an arbitrary cell, the theme will be displayed with that cell as serving cell instead, *independently* of the device’s interaction with the network.

Presentation on Map



GSM example: Cell Color theme (no route).

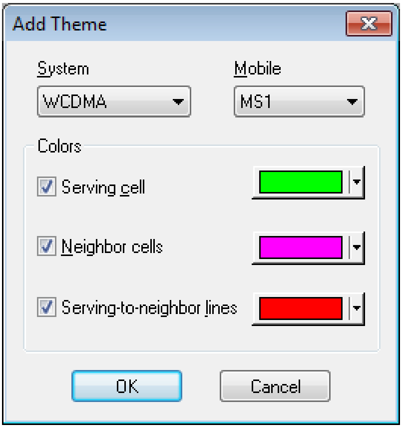


WCDMA example: Cell Color and Cell Line themes. Active set members pointed out by solid blue lines. Neighbors indicated for all active set members (dashed red lines).

- The presentation for **LTE** and **TD-SCDMA** is similar to that for **GSM**.
- The presentation for **CDMA** is similar to that for **WCDMA**.

By default the Cell Color theme is drawn on top of the **Cell** theme (section 33.2.5.1). That is, cells drawn in yellow (or highlighted in red) in the Cell theme will be overlaid with the differently colored cells of the Cell Color theme, as in the above figures.

Setup Dialog



System Not used; the choice does not matter.

Mobile Choose the device whose serving cell is to be displayed.

Colors: Serving cell The fill color to use for the serving cell. If you uncheck this box, the cell is not drawn (and, by default, the version of it displayed in the underlying **Cell** theme will be visible instead).

Colors: Neighbor cells The fill color to use for neighbors of the serving cell. If you uncheck this box, the neighbor cells are not drawn in this theme.

Colors: Serving-to-neighbor lines

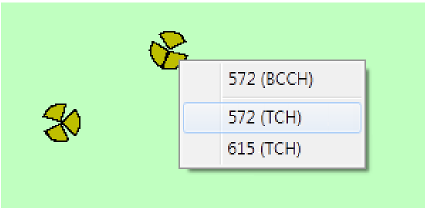
- *If single serving cell in use:* Check this to display dashed lines connecting the serving cell with each of its neighbors.
- *If multi-cell active set in use:* Check this to display, for each active set member, dashed lines connecting the active set member with each of its neighbors.

33.2.5.4. The Cell ARFCN Theme (GSM)

This theme is used to point out other cells that use a specified BCCH or TCH of a selected cell. It is intended as an aid in GSM interferer identification, a function no longer supported in TEMS Investigation. The theme is retained since loading of old logfiles containing interferer identification data is still supported.

To display the theme, do as follows:

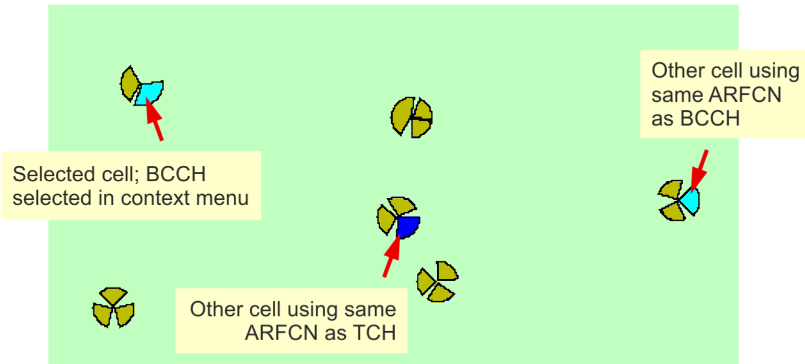
- Right-click the cell of interest. A context menu appears, listing the BCCH and the TCHs that it uses. Choose the ARFCN that you want to search for among other cells:



By default, matching cells are colored as follows:

- Cells that use the selected ARFCN as BCCH are colored cyan (light greenish blue).
- Cells that use the selected ARFCN as TCH are colored blue.

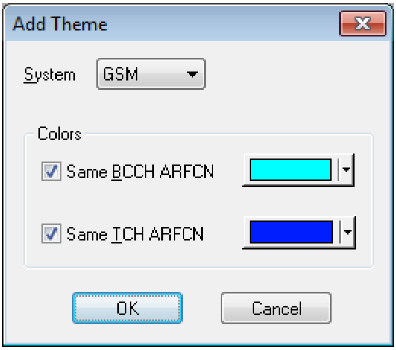
Presentation on Map



Cell ARFCN theme.

By default the Cell ARFCN theme is drawn on top of the **Cell** theme but beneath the **Cell Color** theme, so you may need to hide the latter or change the ordering of the themes.

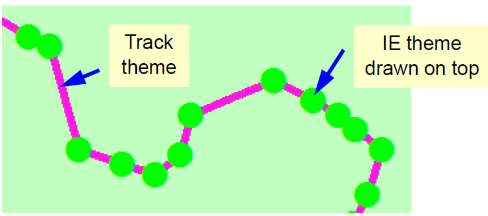
Setup Dialog



System	Not used; the choice does not matter.
Same BCCH ARFCN	The fill color to use for cells that use the selected ARFCN as BCCH.
Same TCH ARFCN	The fill color to use for cells that use the selected ARFCN as TCH.

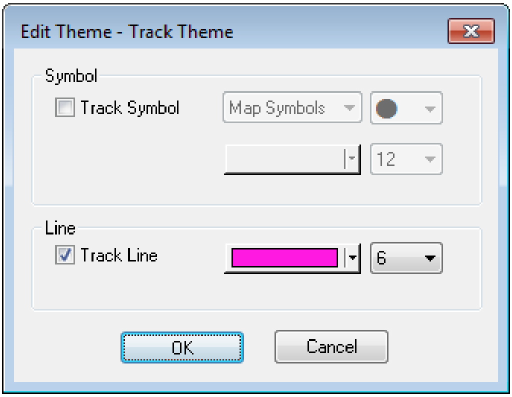
33.2.6. Presentation of GPS Positions

The **Track** theme present the GPS positions of the drive testing route. The point of providing this theme is to enable displaying of the entire route driven, regardless of how logfile recording is handled. (All data in presentation windows, and thus also IE themes leaving a route trail in the Map window, are cleared when you start recording a new logfile; see section 26.5.)



By default, the Track theme is hidden.

The following properties can be edited for the Track theme:



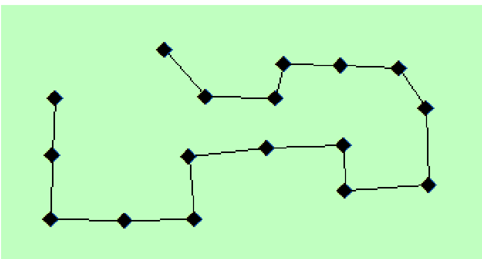
Track Symbol Shape, size, and color of symbol plotted at each GPS position. By default, no symbol is plotted.

Track Line Color and width of lines connecting GPS positions.

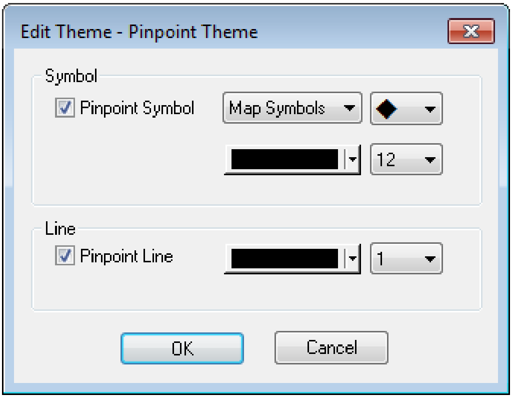
33.2.7. Presentation of Pinpointing

The **Pinpoint** theme presents the markers that you create when positioning data by pinpointing in the Map window (see section 10.1.4).

> **Note:** The Pinpoint theme is needed in order for the Map window pinpointing mechanism itself to work. Therefore, this theme should never be removed.



The following properties can be edited for the Pinpoint theme:



Pinpoint Symbol Shape, size, and color of waypoint symbols.

Pinpoint Line Color and width of lines connecting waypoints.

33.2.8. Presentation of GPX-format Planned Routes

The **Planned Route** theme presents drive testing routes created in GPX format and loaded into TEMS Investigation (see section 8.4).

Note: The Planned Route theme should never be removed.

The editable properties of the Planned Route theme are the same as for the Pinpoint theme; see section 33.2.7. By default, however, planned routes are drawn in a different color (blue).

33.2.9. Editing Themes

To edit a theme:

- In the Theme Settings dialog, select the theme you want to edit.
- Click **Edit**.

33.2.10. Visibility of Themes

In the Theme Settings dialog, the checkbox next to each layer and theme governs whether or not it is visible.

- To show a theme, check the box.
- To hide a theme, uncheck the box.

The same also applies to layers (section 33.4).

33.2.11. Reordering Themes

To change the order in which themes are superimposed within a layer:

- In the Theme Settings dialog, select the theme you want to move.
- To move the theme upwards, click **Up**.
- To move the theme downwards, click **Down**.

The ordering is of particular relevance for cell-related themes (section 33.2.5).

33.2.12. Deleting Themes

To delete a theme:

- In the Theme Settings dialog, select the theme you want to delete.
- Click **Delete**.

33.3. The Right-hand Pane

33.3.1. Information on Single Theme Markers (Info Tab)

When you select a *single theme marker* on the map, the marker is highlighted in red,[1] and the **Info** tab shows (some of) the data represented by this marker.

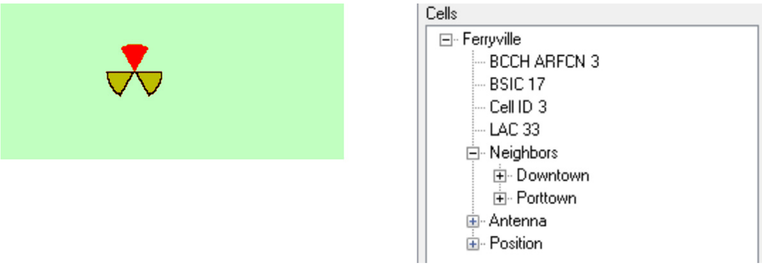
---

1. Exception: If a **Cell Color** theme is active, the selected cell is presented as a serving cell and is colored green.

Information element marker

Event marker

For cells, a selection of cell and channel parameters are shown, along with the cell’s defined neighbors and some other data (the red cell is highlighted):



Cell markers

For Wi-Fi access points, the cell parameters are replaced by a set of Wi-Fi parameters.

There is further interplay between the map and the Info tab. For example, if you click a neighbor of the cell described in the **Cells** section of the Info tab, the neighbor will take over the role of serving cell in the **Cell Color** theme, so that its own neighbors are displayed instead.

If a *group* of theme markers is selected, the Info tab instead shows statistics on the selected data: see section 33.3.2.

33.3.2. Theme Statistics (Info and Graph Tabs)

You can view some basic statistics for a *set of theme markers* selected on the map. Textual information is then presented on the **Info** tab, and graphs are drawn on the **Graph** tab.

There are two ways to select a set of theme markers:

To select all objects within a *rectangular area*, use the **Area Statistics Tool**. Click and drag in the map pane to mark the rectangle.

To select a *segment of a route*, use the **Selection Tool**. Click the marker where you want the segment to begin. Press and hold Ctrl, then click the marker that is to be the endpoint of the segment.

(It is not possible to select an arbitrary set of objects.)

When you release the mouse, statistics for the chosen marker set are computed and shown on the Info tab:

- The **Information Elements** box holds the information elements contained in the selected theme markers. Next to the name of an element is shown the mean value of the element calculated over the selected markers. (Averaging of signal strength values takes place in the mW domain.) Expand the information element to view the full set of statistics: mean, minimum, maximum, and number of samples.
- The **Events** box shows the number of occurrences of every event that has a theme defined for it (not just those actually found among the selected theme markers).
- The **Cells** box shows all cells that have been used as serving cells at the positions included in the marker set. For the Area Statistics tool, cells that are within the rectangle but have never been serving cells are not shown.

On the **Graph** tab, a histogram is drawn for each information element contained in the selected theme markers. A green curve indicates the cumulative distribution.

Statistics can be computed in both recording and analysis mode. It should be noted that the map plotting may be more or less thinned out (see section 33.2.3.1), so that more data goes into the statistics than actually appears on the map.

33.3.3. Theme Legend (Legend Tab)

The **Legend** tab gives an overview of all presentation themes, or selected ones, displaying full details of theme settings. Use the combo box at the top to select what to show.

33.4. Layers

Section 33.2 introduced the concept of presentation layer. This section treats layers in more detail.

Generally speaking, layers are sets of data which together make up the contents of a Map window. Besides the presentation layer, there are also *map layers*, which make up the map itself and cannot be edited. In both types of layers, however, it is possible to make a number of settings that do not affect the contents of the layers, for instance to set the visibility of each layer. These settings are detailed below.

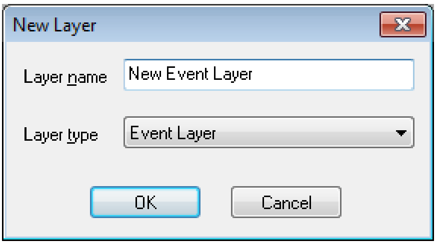
33.4.1. Adding Presentation Layers

Normally there is no need to add new presentation layers, since predefined layers are provided for the various types of theme. However, if you should want to define a set of data that you want to manage separately in a convenient way (for instance turn the visibility on and off), then you should put that data in a separate presentation layer.

To create a new presentation layer, proceed as follows:

Click **Add/Edit Themes**.

- In the dialog that appears, click **Add Layer**:



Layer name Name the new presentation layer.

Layer type Choose a layer type, corresponding to the theme types listed in section 33.2.1.

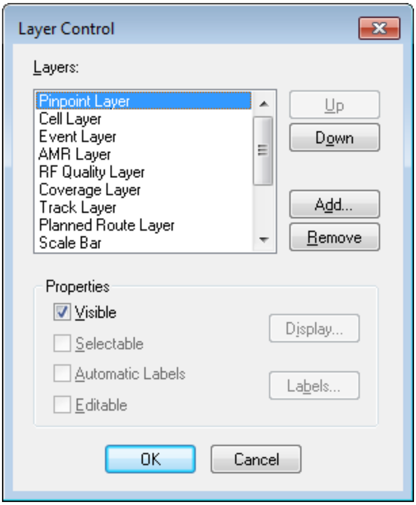
33.4.2. Layer Control

The Layer Control dialog is used to edit various properties of layers.

> **Note:** The Layer Control can be accessed either from a Map window or from the GeoSet Manager. Changes made from a Map window affect only that window and cannot be saved. If you want to make changes that can be saved, use the Layer Control of the GeoSet Manager (see section 33.7).

- To open the Layer Control:

Click the **Layer Control** button.



Up, Down Change the order in which layers are superimposed on the screen. (The top layer is first in the list.) To move a layer upwards, select it and click **Up**. To move a layer downwards, select it and click **Down**.

Add	Add a layer. Select a TAB file and click **Open**.
Remove	Remove the selected layer.
Visible	Check to make the selected layer in the list visible. Note that the visibility of presentation layers can also be set in the **Theme Settings** dialog (see section 33.2.10).
Selectable	Not used. Disabled for presentation layers; should be turned off for map layers.
Automatic Labels	Check to make the labels of the selected layer visible. For labels to be visible, the layer they belong to must be visible. Disabled for presentation layers. Note that the visibility of labels may be conditioned by the zoom range. See **Labels** below.
Editable	Not used. Disabled for presentation layers; should be turned off for map layers.
Display	Set display properties for the selected layer.
Labels	Set label properties for the selected layer.

33.5. Map Context Menu

When you right-click in the map, a context menu appears with choices as described below.

33.5.1. The Scale Bar

This command shows and hides a scale bar showing distance in kilometers or miles. The unit of distance is governed from the Control Panel in Windows (e.g. **Regional Options** → **Numbers** → **Measurement System**).

33.5.2. Previous View

This command returns you to the previous map view. (No further history of views is maintained.)

33.5.3. View Entire Layer

This commands zooms out to show the whole of the chosen layer. For example, choose an information element layer to view the whole of your route.

33.5.4. Setting the Map Projection

This command allows you to set the map projection. It should be the same as in the cell file.

33.6. The Map Window Toolbar

This section gives a description of the Map window toolbar buttons. Some of these activate functions described earlier in this chapter, but many others relate to map handling and have not been previously mentioned.

GeoSet Manager: Start the GeoSet Manager which is used for creating new GeoSet files and for changing the properties of a GeoSet. See sections 8.3 and 33.7.

Open Map: Open a map.

Position Map: Position a map that is currently unpositioned. See section 8.2.

Layer Control: Manage layers or change displaying or labeling properties. Changes are only temporary and cannot be saved. See section 33.4.2. To make changes to the GeoSet, use the layer control in the GeoSet Manager; see section 33.7.1.

Add/Edit Themes: Add or remove presentation layers, or add, edit or remove themes. See section 33.2.

Selection Tool: Click a presentation layer object to select it. Double-click the object to inspect what information it contains. Press and hold Ctrl to select a segment of a route (see section 33.3.2).

Area Statistics Tool: Click and drag to view statistics for presentation layer objects within a rectangle (see section 33.3.2).

Zoom In: Enlarge a portion of the map to view it in more detail.

Zoom Out: View a larger area than the current map view.

Holding down the Ctrl key swaps the zoom operations.

If you have zoomed in and want to view the entire route again, right-click in the map, choose **View**, choose **Entire Layer**, and specify one of the presentation layers.

Center Map: Click a spot in the map to center it around this spot.

Pan Tool: Move the map by clicking and dragging.

Ruler: Measure the distance of a route on the map consisting of straight line segments. Click in the map to indicate a starting point, then click at each turn. The distance of the last segment and the total distance are shown on the status bar at the bottom of the Map window. Double-click at the endpoint.

To change the unit of distance, right-click in the map, choose **Map Properties**, and select the **Defaults** tab.

Pinpoint: Mark waypoints on the map. Regarding positioning of logfile data by pinpointing in the Map window, see section 10.1.4.

Clear Map: Remove all data in presentation layers from the map, except cell site data.

The following buttons are enabled only when an object belonging to a theme has been selected:

First Item: Select the first object of the same type.

Previous Item: Select the previous object of the same type.

Next Item: Select the next object of the same type.

Last Item: Select the last object of the same type.

33.7. GeoSet Manager

The GeoSet Manager looks and works much like a Map window. However, while changes made in a Map window cannot be saved, changes made using the GeoSet Manager can be saved to the GeoSet (*.gst) file associated with the map.

To start the GeoSet Manager, click the **Start GeoSetManager** button on the Map window toolbar.

33.7.1. Layer Control

The Layer Control works the same way as in Map windows. See section 33.4.2.

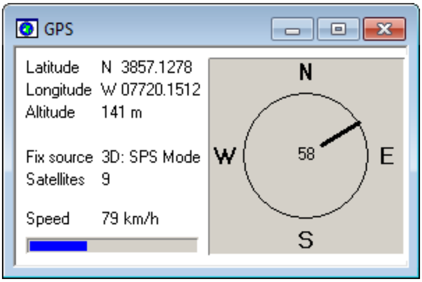
33.7.2. Projections

It is possible to set which projection to use for a GeoSet. If your GeoSet contains multiple layers with different projections, make sure you choose the projection of the layer you usually work with.

- To change the projection, choose **Map** → **Projections**.

34. The GPS Window

This window shows data from the GPS unit. If several GPS units have been detected by TEMS Investigation, the window shows data from the one currently selected as “Preferred” (see section 6.5). Exactly what data is displayed depends on the type of GPS; below is an example:



The fix source is one of the following:

- 2D
- 2D with DGPS (Differential GPS)
- 2D: SPS Mode (Standard Positioning Service)
- 2D: PPS Mode (Precise Positioning Service)
- 3D
- 3D with DGPS
- 3D: SPS Mode
- 3D: PPS Mode
- DR (Dead Reckoning)

34.1. Changing GPS Window Properties

The GPS window can be configured to show only the parameters of interest:

Units Tab

Speed	Choose km/h or mph.
Altitude	Choose meters or feet.

View Tab

Basic	Check to show the latitude, longitude, altitude and speed of the GPS unit, the fix source, and the number of satellites seen.
Heading	Check to show the direction of travel, graphically and numerically, in degrees clockwise from north.
Show invalid positions	Check to also plot samples whose position is labeled as invalid by the GPS unit.[1]

1. This option exists to allow presentation of positions incorrectly regarded by the GPS as invalid.

35. The General Window

In the **General** window, found on the Navigator’s **Menu** tab in the **Configuration** folder, are collected miscellaneous settings that affect the behavior of the TEMS Investigation application. These settings are covered elsewhere in this manual in the appropriate contexts.

Part IV: In-depth

36. Key Performance Indicators – KPIs (UMTS)

KPIs (*Key Performance Indicators*) are offered in TEMS products for measuring the user-perceived performance of a number of circuit-switched and packet-switched services.

KPIs are not computed in TEMS Investigation or handled explicitly in the application in any way; however, all data needed for KPIs is recorded in TEMS Investigation logfiles. TEMS Discovery is the product to use for explicitly generating KPIs and reports that present them.[1]

The present chapter gives an general discussion of KPIs as well as an overview of how to obtain them with TEMS products. Listings and brief definitions of the KPIs are found in the Technical Reference, chapter 11. Further details on technical matters are given in the document “KPI Definitions in TEMS Products”, which is found in the TEMS Investigation documentation package.

In the present version of TEMS Investigation, KPI data can be collected for GSM and WCDMA.

36.1. Purpose of KPIs

Most of the KPIs have been designed according to ▶ ETSI TS 102 250-2 V2.2.1 for performance measurements, that is, to measure *accessibility*, *retainability*, and *integrity*.

A number of KPIs are not present in the ETSI specification; these are tagged “not in ETSI” in the Technical Reference, chapter 11.

1. Note that this is different from certain previous TEMS Investigation versions, where a “KPI Report” function was provided.

36.1.1. Accessibility

Accessibility is the ability of the user to obtain a service within specified tolerances and under other given conditions. For example, in order for a service to be accessible in a packet-switched network, the user must be able to execute a chain of operations:

- accessing the packet-switched network as such, i.e. performing an attach and a PDP context activation
- within an active PDP context, accessing an IP service
- (for WAP and MMS) activating a WAP session.

36.1.2. Retainability

Retainability is the ability of the user to keep a service, once it has been accessed, under given conditions for a requested period of time.

Retainability of a service or session also implies that the user does not have to perform any manual operations that are not necessary under stable network conditions, such as (in the packet-switched case) manual re-activation of the PDP context.

36.1.3. Integrity

Integrity indicates the degree to which a service is maintained without major disturbances once it has been accessed.

Integrity KPIs show the performance of successful service attempts. Even if a service was accessed successfully, the user’s perception of the performance may vary greatly, from very good to unacceptably bad.

36.2. Obtaining KPIs with TEMS Products

36.2.1. General Procedure

To obtain KPIs, perform the following steps:

1. Compose a TEMS Investigation *script* that executes one or several services. The script structure should be modeled on the predefined *snippets* that are provided for each service type in order to ensure that all aspects of the data collection are in accordance with ETSI KPI definitions. Furthermore, the service testing should be enclosed by the

control activities **Start Recording** and **Stop Recording**. See chapter 12, and particularly section 12.9 on snippets.

2. *Run* the script in TEMS Investigation.
3. *Open* the logfile(s) produced by the script in TEMS Discovery, and generate KPI statistics there. For details, please consult TEMS Discovery documentation.

Never use quick recording with automatic logfile switching when collecting data for KPIs; see section 10.1.3.

36.2.2. Obtaining Significant KPI Statistics

To obtain reliable KPI statistics you need to collect sufficient amounts of data. The mathematical relationships between sample size and statistical accuracy are given in a separate document, “Statistical Guidelines for Collecting KPI Data”, found in the TEMS Investigation documentation package.

36.2.3. “Events of KPI Type”

When you test services in TEMS Investigation, special KPI events are displayed in the window Events Of KPI Type; see Information Elements and Events volume, section 8.4, “Data Events”. These events underlie the computation of KPIs.

37. Audio Quality Measurement (AQM): General

Audio quality measurement, including PESQ and POLQA, can be purchased as an option with TEMS Investigation. It can be performed in LTE, WCDMA, GSM, and CDMA networks.

37.1. The PESQ Algorithm

PESQ, short for Perceptual Evaluation of Speech Quality, is an algorithm which measures end-to-end speech quality by comparing one party's undistorted input signal (serving as reference) with the degraded version of the same signal received by the other party. The severity of the degradation as perceived by human listeners is assessed using highly refined models of the human ear and the brain's processing of auditory input.

The PESQ algorithm is defined by the ITU-T standard P.862. ▶ www.itu.int/rec/T-REC-P.862/en

37.2. The POLQA Algorithm

POLQA (Perceptual Objective Listening Quality Analysis), defined in the ITU P.863 standard, is the successor of PESQ and has been specially developed for HD voice, 3G and 4G/LTE, and VoIP.

The POLQA algorithm is designed along similar lines as PESQ, being a reference-based method that compares the degraded speech with the undistorted original to assess quality. However, it has been refined to eliminate known weaknesses of PESQ, particularly in these areas:

- Handling of new and complex types of distortions that arise from today's convergence and coexistence of voice, data, and multimedia application services. One example is the effects of packet loss and of packet loss concealment.
- Performance for higher-bandwidth audio signals (wideband, super-wideband).

- Performance for CDMA speech codecs and hence for CDMA networks in general.

More information about POLQA is available at ▶ www.itu.int/rec/T-REC-P.863/en.

37.3. Measurement Setups in TEMS Investigation

Audio quality measurement (AQM) in TEMS Investigation can be done in a number of contexts and hardware configurations. A summary of the possibilities is given in the following table:

Service	Call Parties	Auxiliary Components	AQM Computed By	PESQ	POLQA	Chapt. or Sect. Ref.
CS voice	Mobile to fixed	Audio Capturing Unit (ACU R2)	PC	✓	✓	38
		CallGenerator; AQM modules	AQM modules	✓		40.1
	Mobile to mobile	Audio Capturing Unit (ACU R2); optionally, several PCs can be used	PC(s)	✓	✓	38
		Audio Capturing Unit (TerraTec)	PC	✓	✓	39
		Mobile Receiving Unit (MRU)	AQM modules	✓		40.2
		On-device clients: No auxiliary components[1]	On-device clients		✓	15.6.2
VoIP	Mobile to mobile	PC VoIP client: 2 PCs used	PC at either end	✓	✓	41
		On-device VoIP clients: No auxiliary components[1]	On-device clients or PC[2]	✓	✓	15.6.1

1. An ACU R2 can optionally be used in this setup as well.
2. On-device clients if ODM Call Control and ODM POLQA are used; PC if ODM MTSI is used.

37.4. Merging Uplink AQM Data into Logfiles

If your test setup includes a CallGenerator performing measurements on the uplink, then use the logfile export function to merge the uplink AQM data into the logfile (which already contains the downlink AQM scores). See section 10.7 for details on how to do this.

37.5. Presentation of AQM Data

37.5.1. Information Elements

All AQM data is available as information elements, so that they can be included in any presentation. The same family of information elements is used regardless of the choice of AQM setup, although details differ as to which elements are populated. See Information Elements and Events, chapter 5.

Status windows named **Speech Quality** are provided where all AQM information elements (as well as some other data) are presented.

37.5.2. AQM Data Time-lag

When viewing (downlink) AQM data in real time, you must keep in mind that this data may lag behind other information elements because of the processing delay in computing it. However, all AQM data is correctly time-aligned when written to the logfile.

37.5.3. PESQ/POLQA Key Performance Indicator

A PESQ- or POLQA-based KPI is computable on the basis of TEMS Investigation data. See the Technical Reference, section 11.1.4.

38. AQM with ACU R2

This AQM method measures audio quality during CS voice calls. Each mobile device is connected to an Audio Capturing Unit (ACU R2), which relays the audio to the PC. The ACU R2 supports connection of up to four mobile devices.

AQM with ACU R2 can be realized in a variety of hardware configurations:

- M2M, mobile-to-mobile
- Multi-location M2M
- M2F, mobile-to-fixed

Each of these setups can be expanded up to the full capacity of the ACU R2, meaning that up to four phones can be connected to each PC used. The setup types can also be mixed in various ways. Examples are given in the diagrams in section 38.1.

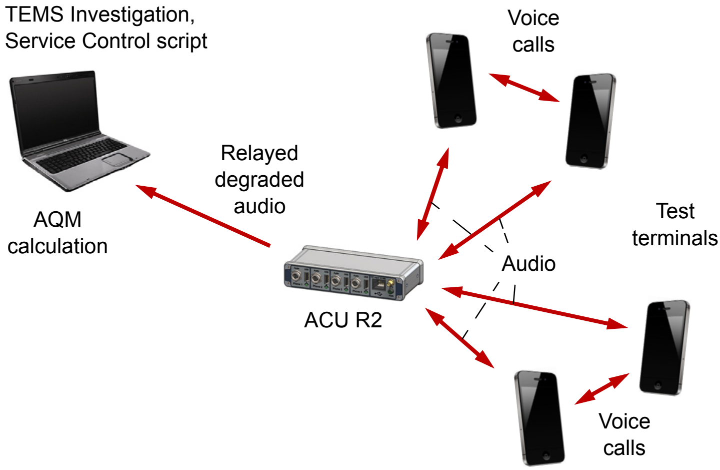
AQM with ACU R2 makes use of the **Voice Quality** activity in Service Control scripts (see section 12.20.7.4).

An ACU R2 can optionally be used in AQM configurations for (on-device client) VoIP as well. This makes no difference to the testing setup, except that the ACU R2 must then be selected as audio source in the Voice Quality activity. Again, see section 12.20.7.4. This possibility is not further commented on or exemplified in the present chapter.

38.1. Measurement Configurations in Detail

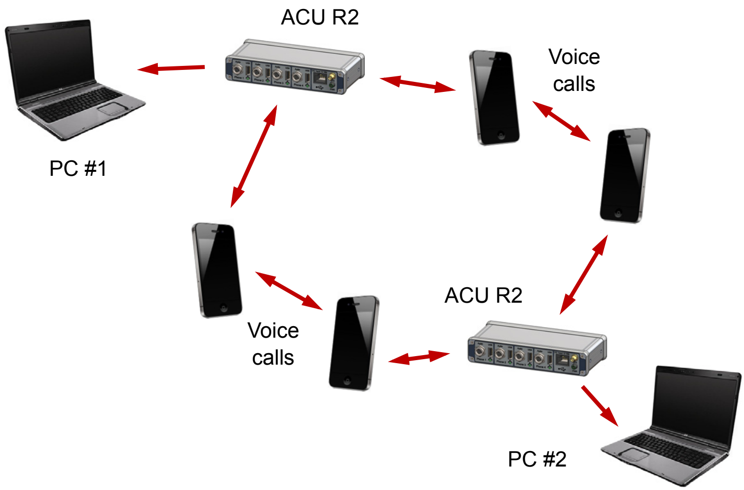
Mobile-to-mobile (M2M) Configuration

In this setup, all phones are connected to the same ACU and PC; that is, they are all controlled by the same instance of TEMS Investigation. Calls are made between phones in this set.



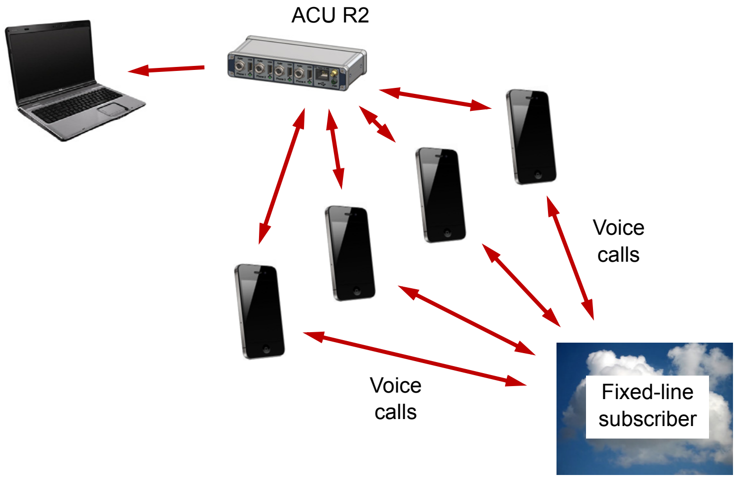
Multi-location M2M Configuration

Another possibility is to have phones that call each other controlled by different PCs, which may reside in separate locations. Each PC runs its own instance of TEMS Investigation and has its own ACU, to which the phones it controls are connected. Below is one example of such a configuration.



Mobile-to-fixed (M2F) Configuration

Finally, in the mobile-to-fixed configuration, phones connected to a single ACU and PC are used to call fixed-line subscribers, for example, a CallGenerator.



38.2. Obtaining AQM Data

38.2.1. Prerequisites

You need to possess the following:

- License for collecting AQM data: see the Installation Guide, section 3.3.3.
- Phone supporting audio quality measurement: one of those listed as AQM-capable in the Device Configuration Guide, section 2.4.1.
- Audio Capturing Unit (ACU R2).
- USB hub for phones (delivered with ACU).
- Custom audio cables. These are phone model specific and need to be ordered separately. See the Device Configuration Guide, section 2.4.1.1.
- Audio adaptor cables for connecting audio cables to the ACU (delivered with ACU).

38.2.2. Preparations

See the Device Configuration Guide, chapter 5.

38.2.3. Recording AQM Data

This section assumes that all equipment has been prepared and interconnected as described in the Device Configuration Guide, chapter 5.

- Compose a script similar to the examples in section 38.2.3.1 below. These sample script files are also provided in the directory [My] Documents\TEMS Product Files\TEMS Investigation 15.3\Scripts. Regarding the **Voice Quality** activity, refer to section 12.20.7.4.
- Run the script and record your logfiles.

38.2.3.1. Recommended Structure of AQM Scripts

Please note that the logfile recording commands have been left out of the diagrams in this section.

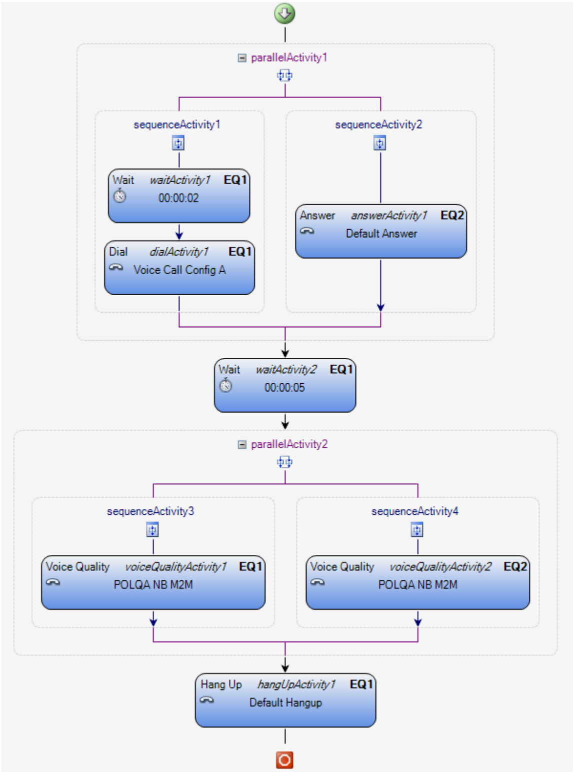
When any of these snippets are put inside a while loop, a Wait on the order of 5 s should be added at the end, that is, in between calls.

Mobile-to-mobile (M2M): All Devices Connected to the Same PC

The example given here shows one pair of phones calling each other. If you are using four phones, just add another structure like the one below, in parallel with the first.

The Wait before the Dial serves to make certain that the receiving phone is always ready to answer the call when it arrives.

Another Wait is inserted before the voice quality activities to ensure that the parties are in sync before starting the voice quality measurement.



Note: With certain device combinations, a further Wait is needed to achieve correct timing. Specifically, if one phone in a pair is from the subset listed below, and the other phone is *not* from that subset, then the *latter* needs to have a **7 s** Wait inserted before its Voice Quality activity.

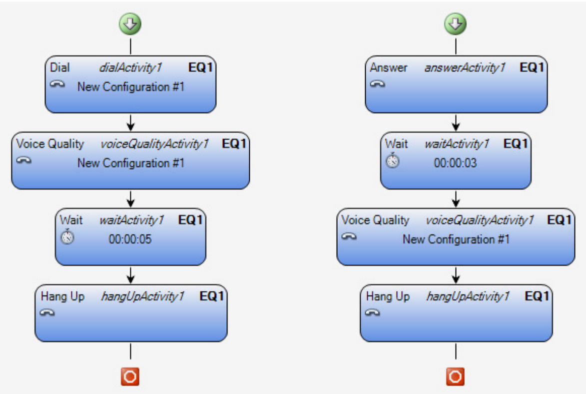
- Sony Ericsson Xperia arc S LT18a, LT18i
- Sony Ericsson Xperia arc LT15a, LT15i
- Sony Ericsson W995, W995a, W995 EDGE
- LG Optimus G F180S
- Qualcomm MSM8960 MTP

Multi-location M2M: Devices Connected to Different PCs

In this configuration you need to prepare two scripts, one for the dialing side and one for the answering side. Below is shown the simplest case, where each PC has a single phone connected and these phones call each other.

For the answering party, a 3 s Wait before the Voice Quality activity is recommended in order to prevent any possible problems with the calculation of the first AQM score. This Wait duration is suitable for two phones of identical make and model; if two different phones are used, the duration may need to be modified.

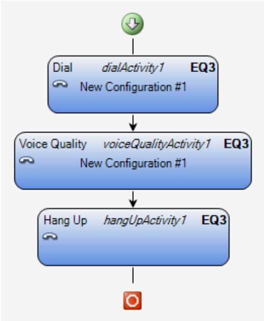
When running this test, start the script on the answering side first, and then the script on the dialing side. This is to ensure that the answering party is ready and waiting when the call arrives.



Left: AQM script for dialing PC. Right: AQM script for answering PC.

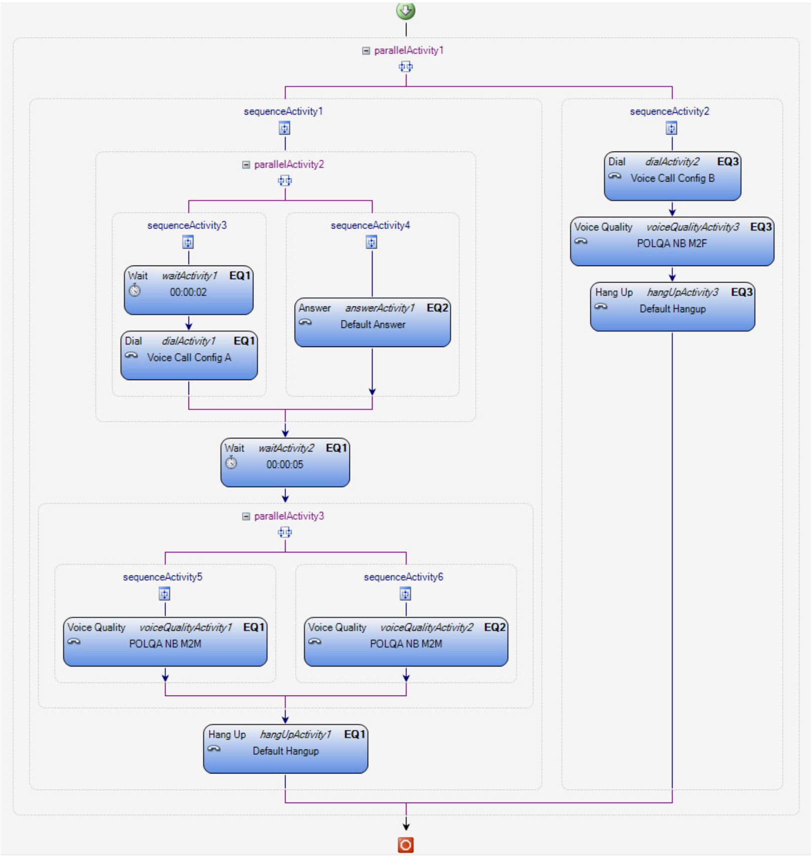
Mobile-to-fixed (M2F)

In the mobile-to-fixed configuration, the mobile phone calls the fixed-line subscriber.



Mixture of Mobile-to-mobile (M2M) and Mobile-to-fixed (M2F)

There is nothing to prevent several of the above configurations being combined in a single script. In the example that follows, devices EQ1 and EQ2 call each other (M2M), while EQ3 is engaged in M2F testing.



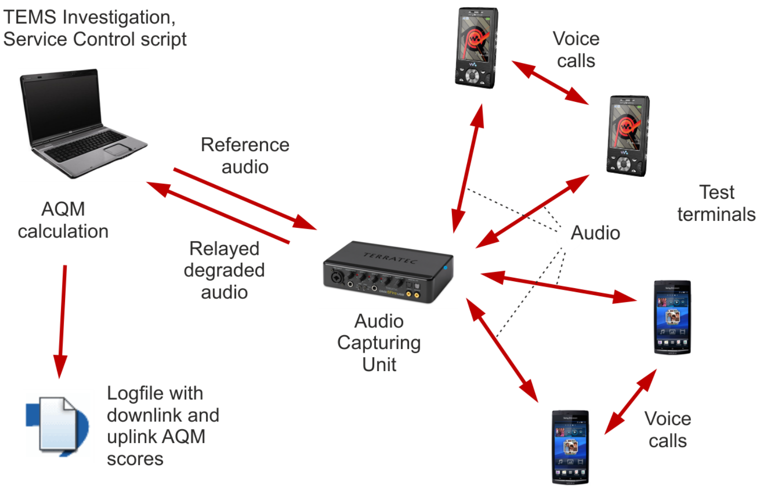
38.3. Notes on AQM Scores Obtained with Individual Phone Models

Regarding the Sony Ericsson Xperia arc, the same applies as when the phone is used with a TerraTec ACU. See the discussion in section 39.3.

39. AQM for CS Voice with ACU TerraTec

This AQM method measures audio quality during CS voice calls. Up to four mobile devices, which call each other in pairs, are connected to an Audio Capturing Unit (ACU; TerraTec box) which relays the audio to the PC.

This configuration is referred to by the **M2M DL + UL** option in the **AQM Measurement** activity of the Service Control script (see section 12.20.7.6).



39.1. Obtaining AQM Data

Here is an overview of how to set up the Audio Capturing Unit AQM configuration and how to record audio quality measurements.

39.1.1. Prerequisites

You need to possess the following:

- License for collecting AQM data: see the Installation Guide, section 3.3.3.
- Phone supporting audio quality measurement: one of those listed as AQM-capable in the Device Configuration Guide, section 2.4.2.
- Audio Capturing Unit (TerraTec DMX 6Fire USB).
- USB hub for phones (delivered with ACU).
- Custom audio cables. These are phone model specific and need to be ordered separately. See the Device Configuration Guide, section 2.4.2.3.
- Audio adaptor cables for connecting audio cables to the ACU (delivered with ACU).

39.1.2. Preparations

See the Device Configuration Guide, chapter 6.

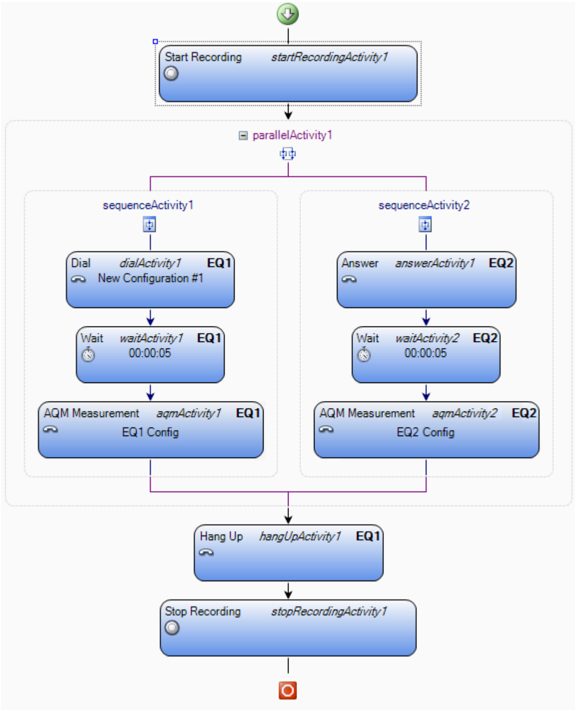
39.1.3. Recording AQM Data

This section assumes that all equipment has been prepared and interconnected as described in the Device Configuration Guide, chapter 6.

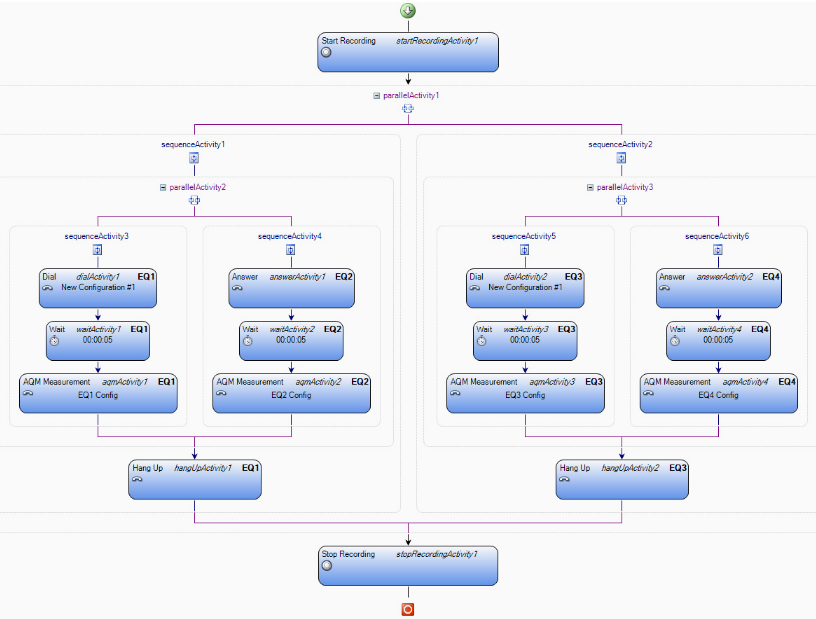
- Compose a script similar to the sample script files which are provided in [My] Documents\TEMS Product Files\TEMS Investigation 15.3\Scripts. For each phone pair, use a **Parallel** activity with one branch for each phone, one dialing and the other answering. Regarding the **AQM Measurement** activity, refer to section 12.20.7.6. The diagrams in section 39.1.3.1 below show the structure of the ready-made scripts.
- Run the script and record your logfiles.

Note: Be sure *never* to alter volume levels *anywhere* during measurement – whether in the phones, on the TerraTec box using the physical controls, in the TerraTec PC user interface, or in Windows. If the volume is not kept constant, incorrect AQM scores will result.

39.1.3.1. Recommended Structure of AQM Scripts



AQM script for one pair of phones.



AQM script for two pairs of phones.

39.2. Notes on Presentation of AQM Data

One thing is special about the presentation of AQM data obtained in the ACU TerraTec configuration:

- Downlink PESQ/POLQA scores for one phone in a pair are also presented as uplink scores for the other phone in that pair.

39.3. Notes on AQM Scores Obtained with Individual Phone Models

UMTS

For UMTS, PESQ and POLQA scores obtained with various phones using the setup described in this chapter generally correlate closely with PESQ as measured with AQM modules (chapter 40).

There is one exception, namely when the Sony Ericsson Xperia arc (**Note:** *not* arc S) acts as sender, with any of the supported UMTS phones as receiver. Tests consistently show markedly lower PESQ and POLQA scores with this configuration compared to other phone model pairings. The reason is believed to consist in the different filtering applied to the audio output in the Xperia arc phone, a kind of filtering that is judged unfavorably by the AQM algorithms. By contrast, for audio samples *received* by the Xperia arc, the AQM score is not affected. The described characteristics of the Xperia arc must be taken into account when evaluating AQM scores obtained with the device. – Please note again that the above does *not* apply to the Xperia arc S.

CDMA

For CDMA, the Huawei C8600 exhibits behavior similar to that of the Sony Ericsson Xperia arc, causing a lowering of PESQ/POLQA scores.

39.4. Certification and Standard Compliance

All system components used in the TEMS Investigation AQM configuration with a TerraTec box are declared to be CE compliant by the corresponding manufacturers. Additionally, Ascom tested the entire abovementioned AQM configuration to ensure that no additional emission resulted from interconnecting the individual components. The TEMS Investigation AQM configuration was found to comply with the EN55022:2006 A1:2007 standard for a Class B device. Tests were performed by a certified laboratory, and the test reports are available upon request.

40. AQM for CS Voice with AQM Modules

This AQM method measures audio quality during CS voice calls, with dedicated hardware units called AQM modules computing the AQM scores.[1]

The voice calls are mobile-originated, and they may be received:

- by a stationary component known as CallGenerator, connected to the fixed telephone network (section 40.1), or
- by a Mobile Receiving Unit (MRU) housed in a mobile phone (section 40.2).

Further technical information about these methods of audio quality measurement is found in the document “AQM in TEMS Products”, which is included in the TEMS Investigation documentation package. A separate MRU User’s Manual is also available.

Please note that POLQA is not available with these configurations.

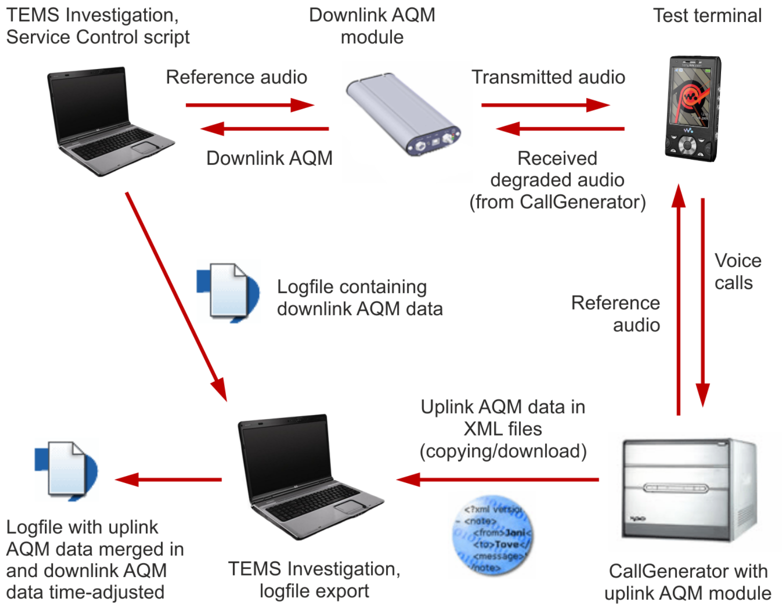
40.1. Mobile-to-fixed Audio Quality Measurement with CallGenerator

This section describes the AQM setup where a CallGenerator acts as the receiver of AQM calls. It is referred to by the **M2F DL + UL** option in the **AQM Measurement** activity of the Service Control script (see section 12.20.7.6).

The computation of AQM scores is done in the AQM modules: one connected to the phone and to the PC, handling the downlink; and one housed in the CallGenerator, taking care of the uplink. These modules contain DSP hardware. The downlink AQM module can optionally be mounted along with the phone in an equipment case.

1. Please note that this AQM configuration is not available for purchase with TEMS Investigation 15.3: AQM modules and MRUs are no longer for sale. TEMS Investigation 15.3 does however still support the use of this AQM method with previously purchased components.

Below is an overview of the measurement configuration.



The measurement procedure can be summarized as follows:

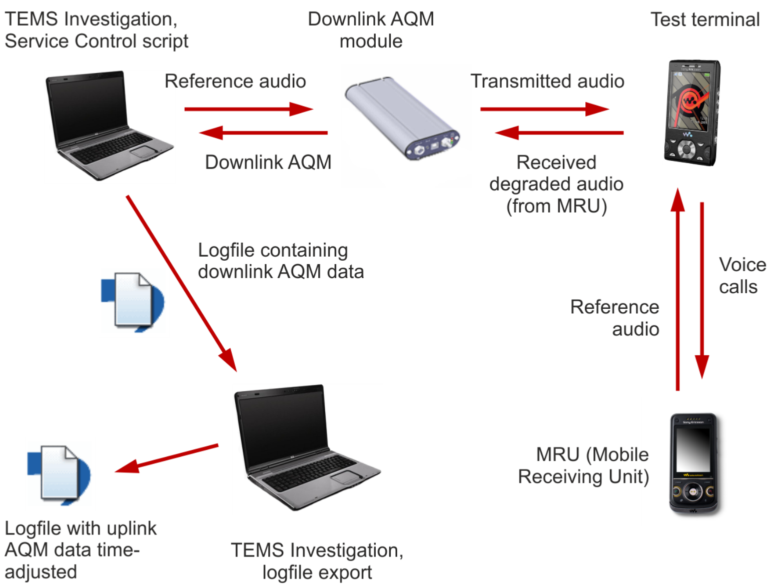
- The speech segments to be used as references are loaded into the AQM modules and into the test phone.
- The phone calls the CallGenerator and plays the reference sentences. The CallGenerator responds by playing the same reference sentences.
- The received (degraded) signals at either end are forwarded to the respective AQM modules, where the signals are compared with the originals, yielding uplink and downlink PESQ scores. The AQM modules also record a number of further audio quality measurements such as echo delay, echo attenuation, and volume. See Information Elements and Events, section 3.1.
- The downlink AQM data is written to regular TEMS Investigation logfiles. The uplink AQM data is stored in XML files.
- To merge uplink AQM data into the logfiles, the logfile export function is used. See section 10.7.

40.2. Mobile-to-mobile Audio Quality Measurement with MRU

The main difference between this setup and that described in section 40.1 is that the fixed CallGenerator is replaced by a Mobile Receiving Unit, MRU, as recipient of the AQM calls. This is the **M2M DL** option in the AQM Measurement activity of the Service Control script (see section 12.20.7.6).

Another important difference is that only *downlink* AQM scores are obtained with this method; the MRU does not have an AQM module.

Measurement configuration:



40.3. Obtaining AQM Data

Here is an overview of how to record and present audio quality measurements in practice. It covers the both the CallGenerator configuration and the MRU configuration.

40.3.1. Prerequisites

You need to possess the following:

- License for collecting AQM data: see the Installation Guide, section 3.3.3.
- Phone supporting audio quality measurement: one of those listed as AQM-capable in the Device Configuration Guide, section 2.4.3.
- One or several downlink AQM modules (either stand-alone units or DSP cards mounted in an equipment case). One AQM module is required for each phone that you want to measure AQM with.
- CallGenerator or MRU.

40.3.2. Practical Considerations

- You can plug a headset into the AQM module during measurement to listen live to the received audio. However, you must *not* adjust the volume using the headset, since that would distort the AQM output. The AQM algorithms require a fixed preset volume.

40.3.3. Recording AQM Data

The description below assumes that a single phone is used to make audio quality measurements. It is possible to perform such measurements with several phones at once, using a different AQM module with each phone.

- Compose a script as follows (for details of all activities, see chapter 12):
  - Add a **Dial** activity.
  - Add a **AQM Measurement** activity after the Dial. See section 12.20.7.6. For mobile-to-fixed AQM, set **Measurement Type** to "**M2F DL + UL**". The phone will then make voice calls to a CallGenerator (identified by its phone number). For mobile-to-mobile AQM, set Measurement Type to "**M2M DL**" to designate an MRU as receiving party in the same manner. Finally, set a value for **AQM Duration**, which governs how long to maintain the call and collect audio quality measurements.
  - Conclude with a **Hang Up** activity.
  - If you wish to synchronize AQM calls from multiple phones, put the calls (i.e. sequences of the form **Dial** → **AQM Measurement** → **Hang Up** as just described) in separate branches in a **Parallel** construct. To

also make all calls terminate at the same time, simply use the same **AQM Duration** for all calls.

– Book-end all of the above activities with **Start Recording** and **Stop Recording** to have the calls recorded in a logfile.

– To have the above procedure automatically repeated as many times as desired, enclose everything defined so far within a **While** construct.

- Connect your AQM equipment case (or alternatively your phone and stand-alone AQM module) to the PC and point to the requisite driver files as described in the Device Configuration Guide, section 3.10.
- Associate the phone with the AQM module on the Navigator’s **Equipment** tab: see section 13.11. The red LED on the AQM module should go out.
- Make sure that the phone’s number is defined in TEMS Investigation and enter the number manually if necessary: see section 6.3.2.2.
- When using the AQM module for the first time after connecting it, you must wait for the AQM module to start up its DSP and finish some pre-processing. Wait until the reports “Dsp Started Ver. 2” and “Pre Processing Ready” appear in the Mode Reports window.
- Run the script and record your logfiles.

40.4. Open Source Licensing Information

The USB driver (libusb0) used for the AQM module is part of the open source libusb Windows project. This project can be found on the Internet at ► sourceforge.net/apps/trac/libusb-win32/wiki. The libusb-win32 project retains all rights and copyrights to the libusb-win32 code. The library (DLL) is distributed under the terms of the GNU Lesser General Public License (LGPL) and the driver is distributed under the terms of the GNU General Public License (GPL). The LGPL and GPL license text can be found in the TEMS Investigation driver ZIP archive (compare the Device Configuration Guide, section 3.10). The source code for libusb-win32 is freely available and can be found in the same ZIP archive.

41. AQM for VoIP

Audio quality measurement can also be performed during VoIP testing. This can be done:

- with PC-based VoIP clients, or
- with device-based VoLTE clients (an instance of on-device measurement).

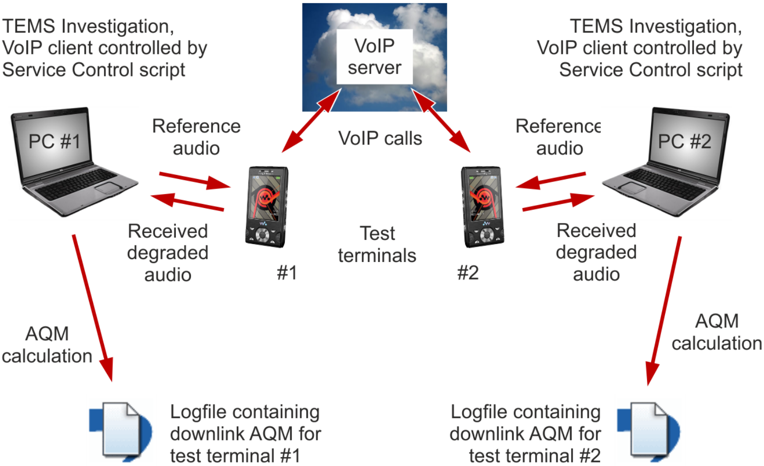
41.1. VoIP Testing with PC-based Clients

41.1.1. Overview

In this measurement setup, no auxiliary hardware components are involved, but instead two PCs are used, each of which have a mobile phone connected. The AQM computation is done on the PCs.

VoIP calls are controlled by the same Service Control activities as CS voice calls, and the audio quality measurement is governed by the **Voice Quality** activity. Everything about the Service Control mechanisms is covered in section 12.20.7. For a comprehensive treatment of PC-based VoIP testing, including AQM, please turn to the document “VoIP Testing with TEMS Investigation PC-based Clients”, found in the TEMS Investigation documentation package.

A quick overview of the measurement setup follows below:



The calling device is connected to one PC and the called device to the other. Audio is sent in semi-duplex fashion between the parties, that is, in both directions but only in one direction at a time. Each instance of TEMS Investigation has a built-in VoIP client; the VoIP clients thus reside in the PCs and not in the mobile devices.

41.1.2. Obtaining AQM Data

Full instructions are given in the document "VoIP Testing with TEMS Investigation with PC-based Clients", which see.

41.1.3. Presentation of AQM Data

This too is covered exhaustively in the document "VoIP Testing with TEMS Investigation PC-based Clients". The crucial information elements are the PESQ and POLQA IEs in the Media Quality category: see Information Elements and Events, section 3.9.

41.2. VoIP Testing with On-device Clients

This setup is covered in chapter 15, which deals with on-device testing (ODM). All AQM processing is done by the devices in this configuration. An ACU R2 can optionally be used between the PC and the mobile devices.

42. Speech Quality Index – SQI

TEMS products offer the quality measure SQI (Speech Quality Index) for estimating the downlink speech quality in a GSM, WCDMA, or CDMA cellular network as perceived by a human listener.

Computing SQI for GSM and WCDMA requires data collected with Sony Ericsson phones. SQI for CDMA can be based on data from any CDMA phone that is connectable in TEMS Investigation.

This chapter examines the workings of the SQI algorithm. See also the document “Speech Quality Measurement with SQI” which is included in the TEMS Investigation documentation package.

42.1. Background

42.1.1. SQI for UMTS

SQI for GSM and WCDMA is a long-standing feature of TEMS products. In TEMS Investigation 9.0, the SQI algorithm was completely reworked, although its fundamental function remains similar to that of the previous algorithm (the output of which is still available in TEMS Investigation).

The focus of this chapter is to describe the new algorithm (called “SQI-MOS” in the application; see section 42.3). Reference is made to the previously used algorithm (the “old SQI”), and attention is drawn to certain important differences between the algorithms, but no comprehensive point-by-point comparison is made.

As wideband speech codecs are now being deployed in mobile phones and networks, the SQI-MOS algorithm includes a model for rating wideband speech.

42.1.2. SQI for CDMA

SQI for CDMA uses an SQI-MOS algorithm similar to those for GSM and WCDMA. SQI for CDMA currently does not support wideband.

42.2. Input to the SQI-MOS Algorithm

42.2.1. UMTS

SQI-MOS for UMTS takes the following parameters as input:

- The *frame error rate* (FER; GSM) or *block error rate* (BLER; WCDMA), i.e. the percentage of radio frames/blocks that are lost on their way to the receiving party, usually because of bad radio conditions.

  Frame/Block errors also occur in connection with *handover*, and these are treated like any other frame/block errors by the SQI-MOS algorithm. It should be noted that in WCDMA, handover block errors can usually be avoided thanks to the soft handover mechanism. In GSM, on the other hand, every handover causes a number of frames to be lost.

  Handovers are not modeled independently in any way by SQI-MOS.[1] More generally, the current algorithm also does not consider the *distribution* of frame/block errors over time.

- The *bit error rate (BER).* This is available in GSM only; no such quantity is reported by UEs in WCDMA mode.
- The *speech codec* used. The general speech quality level and the highest attainable quality vary widely between codecs. Moreover, each speech codec has its own strengths and weaknesses with regard to input properties and channel conditions. The same basic SQI-MOS model is used for all supported speech codecs, but the model is tuned separately for each codec to capture its unique characteristics.

SQI-MOS for UMTS is implemented for the following codecs:

- GSM EFR, GSM FR, and GSM HR
- all GSM AMR-NB and AMR-WB modes up to 12.65 kbit/s:
  - for narrowband, 4.75 FR/HR, 5.15 FR/HR, 5.9 FR/HR, 6.7 FR/HR, 7.4 FR/HR, 7.95 FR/HR, 10.2 FR, and 12.2 FR;
  - for wideband, 6.60, 8.85, and 12.65

1. By contrast, the old SQI algorithm includes a special “handover penalty” mechanism lowering the SQI score whenever a handover has occurred.

- all WCDMA AMR-NB and AMR-WB modes up to 12.65 kbit/s:
  – for narrowband, 4.75, 5.15, 5.9, 6.7, 7.4, 7.95, 10.2, and 12.2;
  – for wideband, 6.60, 8.85, and 12.65.

42.2.2. CDMA

SQI-MOS for CDMA closely resembles WCDMA SQI; compare section 42.2.1. Input parameters are:

- Frame error rate
- Speech codec used, including bit rate information

The general discussion of these parameters in section 42.2.1 applies equally to CDMA (with the term “handoff” substituted for “handover”).

SQI-MOS for CDMA is implemented for the following codecs:

- QCELP13K
- EVRC
- SMV
- VMR-WB (narrowband input only)

42.3. SQI-MOS Output

The output from the SQI-MOS calculation is a score on the ACR[1] MOS scale which is widely used in listening tests and familiar to cellular operators. The score is thus a value ranging from 1 to 5.

The SQI-MOS algorithm produces a new quality estimate at intervals of

- *(UMTS)* approximately 0.5 s
- *(CDMA)* 2–4 s

Such a high update rate is possible thanks to the low computational complexity of the algorithm.

1. ACR stands for Absolute Category Rating: this is the “regular” MOS test where speech samples are rated without being compared to a reference.

42.3.1. Narrowband vs. Wideband SQI-MOS (UMTS)

It is necessary to point out that narrowband and wideband SQI-MOS scores are not directly comparable. The same MOS scale and range are used for both (as is the custom in the field of speech quality assessment); however, a given MOS score indicates, in absolute terms, a higher quality for wideband than for narrowband. This is because wideband speech coding models a wider range of the speech frequency spectrum and is thus inherently superior to narrowband coding. The highest attainable quality is therefore markedly better for wideband. It follows from this that when interpreting a figure such as SQI-MOS = 4.0, it is necessary to consider what speech bandwidth has been encoded. A further complicating circumstance is that there is no simple mapping between wideband and narrowband SQI-MOS, for reasons sketched in section 42.4.1.

42.3.2. SQI-MOS vs. Old SQI (UMTS)

The old SQI (still available in the application) is expressed in dBQ. It should be stressed that SQI-MOS cannot be derived from these dBQ scores; the two algorithms are distinct (even if similar in general terms), and no exact mapping exists in this case either.

42.4. Alignment of SQI-MOS and PESQ

The SQI-MOS algorithm has been designed to correlate its output as closely as possible with the PESQ measure (Perceptual Evaluation of Speech Quality).[1] In fact, the SQI-MOS models have mostly been trimmed using PESQ scores, rather than actual listening tests, as benchmarks.[2] The exception is the wideband modes, where adjustments to the models have been made using the results of external listening tests. Regarding the latter, see section 42.4.1.

Note carefully that PESQ and SQI-MOS do not have the same scope. PESQ measures the quality end-to-end, that is, also taking the fixed side into account, whereas SQI reflects the radio link quality only. This means that

1. See ▶ www.itu.int/rec/T-REC-P.862/en.
2. This is completely different from the old SQI algorithm, which was trained using listening tests alone. At the time that work was done, no objective speech quality measure of the caliber of PESQ was yet commercially available.

PESQ and SQI values may differ while both being accurate in their respective domains.

Also bear in mind that PESQ and SQI-MOS use fundamentally different approaches to quality measurement:

- PESQ is a *reference-based* method which compares the received degraded speech signal with the same signal in original and undistorted form.
- SQI-MOS, on the other hand, is a *no-reference* method that works with the received signal alone and extracts radio parameters from it (as described in section 42.2).

Both methods try to assess to what degree the distortions in the received signal will be audible to the human ear; but they do it in completely different ways.

PESQ scores need to be averaged over a range of speakers in order to eliminate speaker bias, i.e. variation stemming from the characteristics of individual speakers. Such averaging is not required in the case of SQI-MOS, since the speaker-contingent variation is already built into the model (it has been trained with a large number of speakers).

42.4.1. Notes on PESQ for Wideband (UMTS)

(This subsection is relevant for UMTS only, since CDMA SQI currently does not extend to wideband.)

The PESQ algorithm for wideband (8 kHz) speech coding – as opposed to that for narrowband (4 kHz) – is afflicted with certain recognized shortcomings. The use of PESQ as a benchmark therefore complicated the development of SQI-MOS for wideband. Below is a brief discussion of this topic.

One relevant fact is that, in certain circumstances, wideband PESQ has been found to produce lower scores than narrowband PESQ, even for clean speech.[1] This difference in output range would not in itself be problematic if wideband PESQ behaved similarly to narrowband PESQ as a function of FER/BLER; a mapping could then be applied to align the wideband scores to narrowband.

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1. This is a phenomenon independent of the circumstances described in section 42.3.

Unfortunately, things are not that simple. Wideband PESQ is much more sensitive to speaker bias than is narrowband PESQ (compare the introduction of section 42.4): at a fixed FER/BLER, wideband PESQ scores for different speakers show a spread of more than one point on the MOS scale. For narrowband, this variability is limited to a few tenths of a MOS point.

The upshot of this is that no straightforward mapping between wideband and narrowband PESQ can be constructed, and consequently outputs from the two are not directly comparable. Attempts have been made within ITU to develop such a mapping, but so far with no satisfactory results. (It is probable that the task of assessing wideband speech quality requires further refinement of the mathematical models used.)

For the reasons explained above it was necessary to resort to other reference material besides PESQ scores in order to avoid biasing the wideband SQI-MOS model. The material used was the results from listening tests conducted during standardization of the AMR speech codec.[1] Only clean speech ratings from these tests were used.

This tuning resulted in an adjustment of the SQI-MOS model that is linear as a function of FER/BLER. The largest correction was applied to the clean-speech SQI-MOS score (i.e. at zero FER/BLER), while the rock-bottom SQI-MOS (the worst possible score, attained at very high FERs/BLERs[2]) was left unchanged.

42.5. Comparison with Other Radio Parameters

GSM

In the past, speech quality in GSM networks was often measured by means of the RxQual parameter (which is also available in TEMS products). Since RxQual is merely a mapping of time-averaged bit error rates into a scale from 0 to 7 (▶ 3GPP 45.008, section 8.2.4), it cannot of course provide more than a rough indication of speech quality.

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1. See ▶ 3GPP TR 26.975, "Quality in Clean Speech and Error Conditions", version 7.0.0.
2. FER = 60% was selected as endpoint. Samples with FER > 60% were excluded from the SQI-MOS modeling, since PESQ (as is well known) sometimes judges severely disturbed speech in a misleading manner: certain very bad (almost muted) samples receive high PESQ scores.

43. Video Telephony Quality Index – VTQI

The information element VTQI (Video Telephony Quality Index) estimates the viewer-perceived video and audio quality achieved during video telephony calls. How this algorithm works is the subject of the present chapter.

See also the document “Video Telephony Quality Measurement with VTQI” which is included in the TEMS Investigation documentation package.

43.1. General Properties of VTQI

Like SQI (chapter 42), VTQI is a no-reference method which judges the quality of the received signal on its own merits, without knowledge of the original.

The kind of subjective test which VTQI strives to imitate is one where viewers are instructed to assess both video and audio and combine their perception of each into an overall “multimedia quality” score.

The output from the VTQI algorithm is expressed as a value between 1 and 5, conforming to the MOS (Mean Opinion Score) scale which is frequently used in subjective quality tests. The unit for VTQI is called “MOS-VTQI”.

VTQI estimates the quality of the video call as perceived by the viewer at a moment in time. It is updated continuously during the call. There is no overall assessment of entire calls analogous to static VSQI computed for entire streaming clips (as described in section 44.4.1).

43.2. What VTQI Is Based On

The VTQI score is based on the following non-perceptual input:

- The quality of the encoded (compressed) signal prior to transmission. This quality is straightforwardly a function of the codecs used and the bit rate. However, since the radio bearer currently used in UMTS for video telephony is always a 64 kbit/s bearer, bit rate variation is in fact not an issue. This leaves the codecs:

  – For the H.263 and MPEG-4 video codecs, the “clean” quality in terms of VTQI has been computed in advance. In practice, what codec is used in the video call is deduced from the signaling between server and client. (In the current implementation of VTQI in TEMS Investigation, the video codec is assumed to be H.263, but a VTQI model for MPEG-4 also exists.)
  – The audio codec is assumed always to be AMR-NB operating at 12.2 kbit/s.

- BLER (block error rate). This is the most important single cause of poor quality in video telephony. Focusing on BLER means that VTQI will faithfully reflect the impact of air interface conditions on QoE.

Bit error rate (BER), on the other hand, is not reported by current WCDMA user terminals and so is not available for use in the VTQI model.

43.3. What VTQI Does Not Consider

VTQI does not directly consider the signal presented to the human viewer; that is, no analysis of perceptual input is performed to detect specific visible artifacts. The transferred video is not analyzed frame by frame in any way. Thanks to the monitoring of BLER, however, even slight degradations impacting video and audio perception will still be noticed by the algorithm and affect the VTQI score.

43.4. Update Rate

VTQI is reported as the information element VTQI Realtime Score. This element is updated regularly – at intervals of length 1–2 s depending on the phone model – throughout the video call.

Each VTQI score is a time average taken over the last 8 seconds; the first score is thus obtained 8 s into the video call. This windowing procedure prevents short block error bursts from impacting the VTQI score in a disproportionate manner.

44. Video Streaming Quality Index – VSQI

The information element VSQI (Video Streaming Quality Index) estimates the viewer-perceived video and audio quality achieved during video streaming sessions. This chapter takes a look the VSQI algorithm.

See also the document “Video Streaming Quality Measurement with VSQI” which is included in the TEMS Investigation documentation package.

Compare chapter 45 on MTQI.

44.1. General Properties of VSQI

Like SQI (chapter 42), VSQI is a no-reference method which judges the quality of the received signal on its own merits, without knowledge of the original.

The kind of subjective test which VSQI strives to imitate is one where viewers are instructed to assess both video and audio and combine their perception of each into an overall “multimedia quality” score.

The output from the VSQI algorithm is expressed as a value between 1 and 5, conforming to the MOS (Mean Opinion Score) scale which is frequently used in subjective quality tests. The unit for VSQI is called “MOS-VSQI”.

44.2. What VSQI Is Based On

The VSQI score is based on the following non-perceptual input:

1 The quality of the encoded (compressed) signal prior to transmission. This quality is straightforwardly a function of the video and audio codecs used, and their bit rates. The information actually used by the VSQI algorithm is the video codec type and the total (video + audio) bit rate. The “clean” quality has been computed in advance for the codecs listed in section 44.4.1.

2. The amount of initial delay and the subsequent interruptions during playback of the video sequence: that is, the time required for initial buffering and the incidence of rebuffering.
3. The amount of packet loss at the application level (i.e. in the video streaming client).

44.3. What VSQI Does Not Consider

VSQI does not directly consider the signal presented to the human viewer; that is, no analysis of perceptual input is performed to detect specific visible artifacts. The transferred video is not analyzed frame by frame in any way. Thanks to the monitoring of packet loss (item no. 2 in section 44.2 above), however, even slight problems with blockiness, jitter, and so on will still be noticed by the algorithm and affect the VSQI score.

44.4. Static and Dynamic VSQI

Two versions of the VSQI algorithm have been devised: one static and one dynamic version.

Static VSQI is presented in the event Streaming Quality VSQI. It does not appear as an information element. Dynamic VSQI, on the other hand, is contained in the information element Streaming VSQI.

44.4.1. Static VSQI

The static version of VSQI takes an entire streamed video clip as input and assigns a single quality score to it.

Input parameters to the static version of VSQI are as follows:

- Video codec used (H.263, H.264, or MPEG4)
- Total bit rate (video + audio)
- Duration of initial buffering
- Number of rebuffering periods
- Duration of rebuffering periods
- Amount of packet loss

With some degree of simplification, we may describe the calculation of static VSQI with the following formula:

$$VSQI_{\text{static}} = VSQI_{\text{clean}} - \text{buffering penalty} - \text{packet loss penalty}$$

Here, $VSQI_{clean}$ is the “clean value” obtained for the clip prior to transmission. This score is determined by the quality of the encoding, which is in turn dependent on the choice of codecs and bit rate.

The size of the buffering penalty depends on the time taken for initial buffering, the time spent rebuffering, and the number of rebuffering events.

The size of the packet loss penalty is determined as follows. A running packet loss average over the last 4 s is computed approximately every second, and the values thus obtained are weighted and summed to yield an appropriate overall measure of the packet loss. The latter is then translated into a deduction from the VSQI score.

The static VSQI algorithm has been fine-tuned for clips of around 30 s and should therefore in practical use be applied to clips of similar duration. The video sequences must not be too short because of how the buffering works: each instance of rebuffering takes several seconds to complete, and moreover if the clip is short enough it will have been buffered in its entirety before the replay starts, so that no rebuffering will ever occur. For clips considerably longer than 30 s, on the other hand, disturbances towards the end will be more harshly penalized by viewers than those occurring early on, simply because the late ones are remembered more vividly. Therefore, since the current VSQI algorithm does not take into account such memory effects, it would probably perform slightly worse for long clips. (The dynamic version of VSQI naturally is not affected by this limitation.)

44.4.2. Dynamic (Realtime) VSQI

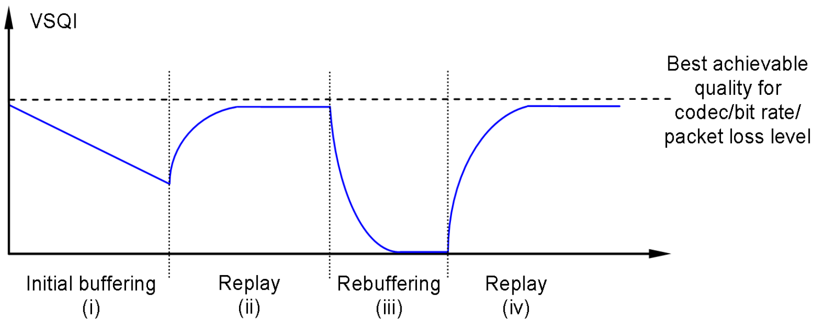
The dynamic or realtime version of VSQI estimates the quality of a streaming video clip as perceived by viewers at a moment in time. It is updated regularly – at intervals of the order of 1 s – while the video clip is playing. Each VSQI output value is dependent on the recent history of the streaming session (i.e. recent packet loss levels and possible recent buffering events).

The design of dynamic VSQI is based on the following:

- Previous research suggesting approximate times taken for the perceived quality to drop to MOS-VSQI 1 (during buffering) and to rise to the highest attainable VSQI (during normal replay)
- Modeling of the impact of packet loss on perceived quality

- Tailoring of mathematical functions for expressing viewer annoyance/ satisfaction as a function of time (in each of the states that are possible during replay)
- Codec and bit rate parameters as in the static version

The graph below shows in rough outline the different ways in which dynamic VSQI can evolve during the replay of a streaming video clip. The best achievable quality, i.e. the “ceiling” in the graph, is dependent on the codec/bit rate combination but is also affected by the amount of packet loss. In this example the packet loss is assumed to be constant so that the influence of buffering can be clearly discerned.



1. The user tolerates (and might even expect) a certain amount of initial delay; but the longer the buffering drags on, the more the user loses patience.
2. Once the replay gets going, the perceived quality picks up again and soon approaches the highest achievable level.
3. If rebuffering occurs, VSQI deteriorates rapidly. Rebuffering events are much less tolerated by viewers than initial buffering, especially if repeated; VSQI captures the latter by making the slope of the curve steeper for each new rebuffering event.
4. After the replay has recommenced, VSQI recovers reasonably quickly, but not infrequently from a rock bottom level.

45. Mobile TV Quality Index – MTQI

MTQI (Mobile TV Quality Index) is a refinement of the video part of the VSQI quality measure (see chapter 44). Unlike VSQI, MTQI does *not* include an assessment of audio quality.

The MTQI algorithm can be concisely characterized as follows.

- Algorithm components:
  - Modeling of clean quality
  - Modeling of packet loss
  - Modeling of corruption duration (total duration of corrupted frames)
- Buffering with and buffering without *skipping* are distinguished. Buffering with skipping means that frames are skipped in connection with buffering; no skipping means that every frame is replayed.
- Supported video codecs: H.263, H.264, REAL, MPEG4
- Supported video formats: QCIF, QVGA

46. VQmon Video and Audio Quality Metrics

This chapter deals with certain aspects of VQmon video and audio perceptual quality metrics, which are computed in the course of HTTP streaming. The metrics are listed in Information Elements and Events, section 3.8: Streaming IEs; for the service testing setup, see section 12.20.6.4 of the present document.

The VQmon algorithms have been developed by Telchemy, and the information that follows is taken from Telchemy documentation.

46.1. VQmon Mean Opinion Scores (MOS)

VQmon provides a set of Mean Opinion Scores (MOS) estimating the quality of each video and audio stream as perceived by end-users. Each MOS value ranges from 1 to 5, where 1 represents the verdict “Unacceptable” and 5 means “Excellent”:

- **MOS-V:** Video MOS, considering the effects of the video codec, frame rate, packet loss distribution, and group-of-pictures structure on video quality.
- **MOS-A:** Audio MOS, considering the effects of the audio codec, bit rate, sample rate, and packet loss on viewing quality.
- **MOS-AV:** Audio–Video MOS, considering the effects of both picture and audio quality as well as audio–video synchronization on the overall user experience.

46.1.1. Absolute and Relative MOS-V

When comparing MOS values, it is important to consider that some types of video inherently produce a higher level of quality than others. Relying solely on absolute MOS values can be misleading when comparing dissimilar types of video service, as viewers tend to form expectations of quality based in part on the perceived capabilities of the medium.

For example, a video viewed on a handset with a small screen might receive an absolute MOS of 3.1 when little or no quality degradation is evident, while for a handset with a larger screen, the same MOS value might suggest that some noticeable impairments were present.

To facilitate quality comparisons between different video service types, VQmon provides both Absolute and Relative MOS-V:

- *Absolute* MOS-V considers the impact of frame resolution, frame rate, codec, compression level, transmission impairments, and frame loss concealment on video quality.
- *Relative* MOS-V considers the impact of all of the factors used to determine Absolute MOS-V except frame resolution, producing a MOS relative to the ideal for the current video format.

All VQmon MOS scores are reported as separate instantaneous, minimum, maximum, and average values, the last three spanning the current streaming session.

46.2. Video Service Transmission Quality (VSTQ)

The VQmon metric Video Service Transmission Quality (VSTQ) is a codec-independent score that measures the ability of the network to reliably transport video. VSTQ is expressed in the range 0–50.

47. C/I Measurement (GSM)

This chapter explains in some detail how GSM C/I measurements are made and why they are useful.

The discussion provided here is centered on the voice service. It should however be noted that the C/I measure is just as useful in the context of packet-switched data services. In fact, towards the high end of the C/I range, speech quality is not further improved, while packet-switched transmissions very clearly do benefit from every extra dB, particularly if EDGE is used.

47.1. Why Measure C/I?

The carrier-over-interference ratio is the ratio between the signal strength of the current serving cell and the signal strength of undesired (interfering) signal components. The C/I measurement function built into TEMS Investigation enables the identification of frequencies that are exposed to particularly high levels of interference, something which comes in useful in the verification and optimization of frequency plans.

C/I can be measured in dedicated mode.

47.2. Requirements on a Robust C/I Measure

Downlink quality in a radio network can be monitored using the TEMS Speech Quality Index, SQI (see chapter 42). In this way, areas with inadequate quality can be identified. However, if frequency hopping is used in the network, it is difficult to pin down the frequencies that are affected by the degradation. To help resolve such ambiguities, TEMS Investigation offers the possibility of measuring average C/I for each of the frequencies used in a call.

To obtain a correct C/I estimate, one must take into account the possible use of power control and/or discontinuous transmission (DTX). In the past, rough C/I measurements have sometimes been carried out by comparing the BCCH signal power of the serving cell with that of neighboring cells using the same traffic channels (but different BCCHs). Since such a scheme fails to allow for power control and DTX on the TCHs, it may produce misleading results. By contrast, TEMS Investigation does consider these network functions and is thus able to indicate the actual C/I experienced by the phone.

47.3. Details on C/I Measurements

In dedicated mode, average C/I is presented approximately twice a second, which is equal to the ordinary measurement interval. If frequency hopping is employed, the average C/I for each frequency is presented.

The measurement range extends from 0 dB to 35 dB. A C/I below 0 dB can be regarded as highly unlikely; in addition, if the number of hopping frequencies is low, C/I values below this limit would normally result in a dropped call. Beyond the upper limit, the performance is not further improved (at least not with today's modulation schemes). Hence, the limitation of the measurement range is not a restriction.[1]

If downlink DTX is used, the number of bursts transmitted from the base station to the phone may be lower than the maximum, depending on the speech activity level on the transmitting side. TEMS Investigation makes measurements only on the bursts actually sent from the base station and disregards bursts not transmitted.

47.4. Accuracy

The number of hopping frequencies determines the number of bursts used for the C/I measurement on each frequency. For example, if four frequencies are used, 25 bursts (on average) per frequency are received in each half-second (to be precise, 480 ms) interval. With more frequencies, there are fewer bursts for each frequency. This implies that the accuracy of the measurements is better for small sets of hopping frequencies.

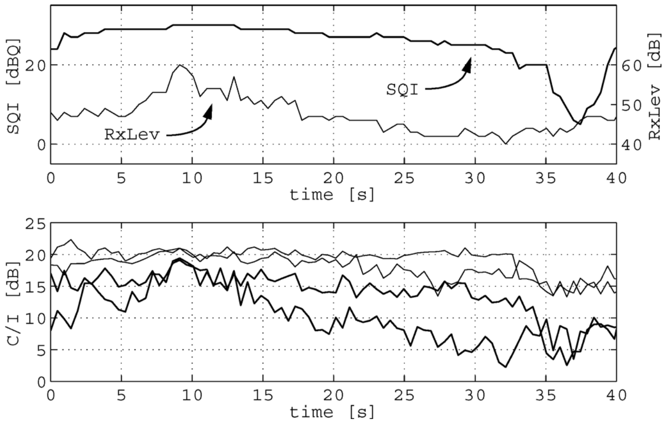
If true C/I is within the range 0 to 15 dB, and four frequencies are used for transmission, and there are no DTX interruptions, the measurement error is typically smaller than 1 dB.

47.5. An Example

To illustrate the use of C/I, data from a test drive is depicted in the figure below. The test drive lasts 40 seconds. EFR speech coding and cyclic

1. The C/I information elements preserve a wider value range –5 ... 35 dB, which reflects the performance of older technology.

frequency hopping with four frequencies are employed throughout. The upper part of the graph shows SQI and RxLev, while the lower part shows C/I for each of the four frequencies:



As appears from the upper graph, SQI dips sharply towards the end of the test drive (after 35 s), indicating poor speech quality. On the other hand, RxLev stays about 50 dB above –110 dBm the whole time. This means that the dip in quality is not due to low signal power level, that is, the quality problem is to do with interference rather than coverage. In fact, and interestingly, RxLev increases during the SQI dip, probably because the power of the interferer increases.

Now, looking at the C/I graph, one sees that two of the four frequencies (the thick lines) have a C/I worse than 10 dB during the SQI dip. This explains the poor speech quality, identifying precisely which channels are disturbed. Such information can then be utilized in the process of optimizing the frequency plan for the area.

48. Available Bandwidth Measurements: Blixt™

This chapter describes Ascom Network Testing's Blixt™ technology for available bandwidth measurements, or ABM for short.

For the testing setup, see section 12.20.3.10. Devices supporting ABM are listed in the Device Configuration Guide, section 2.6. ABM servers are hosted by Ascom.

48.1. Background

Mobile networks are in the process of becoming the world's leading medium for data traffic. As ever faster data rates are offered by mobile network technologies, the use of real-time applications such as media streaming in such networks is becoming increasingly commonplace.

Now, as is well known, mobile network performance depends crucially on the radio environment, which is subject to very rapid fluctuations. For example, Rayleigh fading conditions change on a millisecond basis, as do scheduling and cross-traffic (such as data from other users). Nonetheless, mobile network operators are expected to be able to maintain uniform bandwidth availability to all customers who are paying for a given service level (or class, or experience). Accomplishing this requires metrics and measurement tools designed specifically for the wireless environment.

As such measurements are performed in live commercial networks with paying subscribers, it is important to prevent the measurements from affecting the subscribers' quality of experience. Ascom's approach to Available Bandwidth Measurements (ABM), trademarked as **Blixt™**, solves this problem by keeping the level of test and measurement intrusiveness to an absolute minimum. ABM identifies the throughput that can be delivered over the measured wireless link at a given place and at a given point in time.

48.2. Aspects of LTE and HSPA Networks That Must Inform ABM Design

Methods traditionally used to measure available bandwidth in wireless networks have been comparatively simple and have involved the downloading and uploading of files via FTP. While by no means ideal – having only limited mechanisms for adapting to changes in the radio environment, for one thing – these methods have been sufficient for technologies such as WCDMA Release 99 and older.

Technologies such as LTE and HSPA, on the other hand, have a number of features that render traditional ABM methods inadequate. The most salient of these features are as follows:

- In LTE and HSPA, the radio channel is a **shared resource** between all users in a cell. An FTP file transfer to one user in a cell (for example, the testing device) will significantly affect other users in that cell, as will any other traditional drive test activity.
- It is also possible for multiple operators (carriers) to **share the same radio access network**. This puts requirements on parallel testing, as subscribers of different network operators might, for example, share the radio network but use separate core networks.
- **High data rates.** To pick a typical state-of-the-art configuration, using a Category 3 user equipment (“UE”) in an optimal, unloaded LTE network with 20 MHz system bandwidth, it is theoretically possible to attain transfer rates of up to 100 Mbit/s. Just filling up such a large channel with data in order to measure the channel’s true bandwidth can be a challenge; every part of the system, all the way from the server to the FTP client, must be carefully tuned to manage such transfer rates. UE-based performance testing applications, especially, will have problems handling all the data and filling the bit-pipe due to the UE’s limited CPU performance, which in turn is constrained chiefly by the performance of the UE battery.
- **Rich configuration possibilities.** An LTE network can employ a large array of different MIMO configurations, and the scheduler used in this technology has very powerful and flexible mechanisms for maximum utilization of the radio path (both uplink and downlink). Traditional ABM techniques do not adapt to such rapid variations in the link capacity.

48.3. Requirements on ABM for LTE/HSPA

Taken together, the points in section 48.2 boil down to the following essential requirements on an ABM method fit for use in an LTE or HSPA network:

1. **Maximum network load with minimum intrusion.** To be able to probe the limits of bandwidth availability, the method must be capable of loading the bit-pipe up to the maximum. At the same time, however, it must have low intrusiveness – meaning that it must keep down the time-averaged network load as far as possible to minimize interference with regular network users.
2. **Fast adaptation in time domain.** The method must take into account the properties of a radio link with Rayleigh fading conditions varying on a millisecond time scale.
3. **Adaptation to network and user equipment configuration.** The method must take into account different MIMO configurations, channel bandwidths, and UE capability categories.
4. **Adaptation to scheduling.** The method must take into account the network scheduler's mechanisms for maximizing the utilization of the radio path. The network scheduler adapts the resource allocation to traffic patterns, quality of service settings, and load.

48.4. Description of Ascom's Blixt ABM Algorithm

48.4.1. Algorithm Overview

Here's a summary of how the Blixt algorithm for available bandwidth measurement addresses the requirements stated in section 48.3:

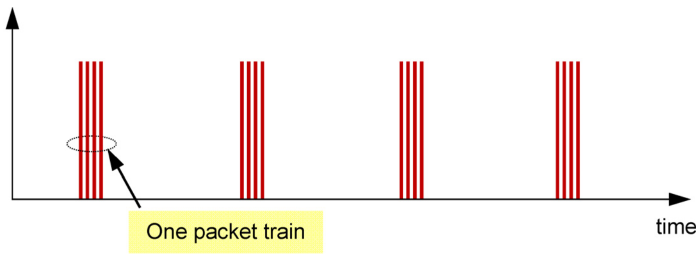
- Data is sent in **short, intense bursts** ("chirps") with much longer pauses in between. The peak load is high enough to reach the network's theoretical maximum, while the average load is kept low. This scheme allows us to sound out the available bandwidth while still making minimum use of network resources.
- Using short bursts also meets the requirement of a **high temporal resolution**. That is to say: at least once in a while, we can expect optimal radio conditions to prevail throughout a data burst (provided that the network configuration and the device's position permit this in the first place).

- The algorithm adapts to network configuration parameters: the **amount of data sent is adjusted** according to the network’s maximum throughput while keeping the level of intrusiveness to a minimum at all times.
- The packet train transmissions are designed to **make full use** of the maximum bandwidth, without the throughput rate being limited by slow-start or low-load scheduling mechanisms.
- The whole design is based on a **device communicating with an ABM server**, where the server reflects the packets back to the device, including timestamps and other information included in the packets. The device can then easily be configured to test the performance of different parts of the network by accessing different servers.

48.4.2. Blixt Measurement Procedure

Data bursts are sent at one-second intervals. In between these bursts, whose duration is always a small fraction of a second, nothing is sent.

Each data burst consists of a number of packets sent back-to-back, collectively referred to as a packet train.



ABM data bursts (symbolic representation).

48.4.3. Example: LTE

Suppose we want to measure available bandwidth in an LTE network with 20 MHz bandwidth using a Category 3 device, whose maximum achievable downlink throughput in optimal radio conditions is 100 Mbit/s on the physical layer.

In order to fully load the bit-pipe and be able to attain this maximum throughput rate, we need to transmit 100 kbit in each Transmission Time Interval (TTI), since the TTI length in LTE is 1 ms. For the sake of obtaining a reliable measurement, as further discussed in section 48.4.5, we want to make use of several consecutive TTIs. To be precise, in this case we will send 58 packets each of size 1,500 bytes on the application layer, resulting in about 750,000 bits in total on the physical layer (58 × 1500 × 8 = 696,000 bits plus a protocol overhead of about 7%).

Assuming the network's full capacity is available to our ABM-testing UE, the measurement will be finished in just above 8 ms, meaning that the level of intrusiveness (the fraction of time occupied with taking the ABM) is as low as 0.75% if the available bandwidth is measured once per second ([1 × 750,000] / 100,000,000 = 0.75%).

The uplink in this configuration has a maximum throughput close to half of the downlink, or 50 Mbit/s. Consequently, when doing ABM on the uplink, using the same packet train, the level of intrusiveness will be about twice as high, but still as low as 1.5%.

48.4.4. Output

The core ABM information elements are those that report on the throughput:

- ABM Throughput Downlink (kbit/s)
- ABM Throughput Uplink (kbit/s)

As an added bonus of Ascom's approach to measuring ABM, **packet loss** rate and **delay** measurements are obtained "for free" from the packet timestamps and sequence numbering. From the information in the packets, it is possible to deduce packet loss and trip times for the uplink (UE-to-server) and downlink (server-to-UE) directions separately. By removing the queue delay in the server, the effective round-trip time can be calculated as well.

Links to information elements:

- ABM Packet Loss Downlink, ABM Packet Loss Uplink
- ABM Downlink Trip Time, ABM Uplink Trip Time, ABM Round Trip Time

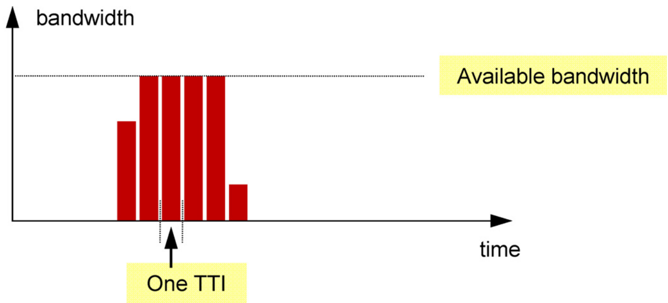
You can measure available bandwidth against multiple servers concurrently, as explained in section 12.20.3.10. The ABM Server element lists all of these servers.

48.4.5. Accuracy Considerations

The accuracy of the ABM method is determined by the number of packets in the packet train and the packet size, as well as by the instantaneous data rate, which is chosen to correspond to the maximum bandwidth according to current System Information parameters, UE capabilities, and other settings (see section 48.4.6 below).

To safeguard measurement accuracy, it is necessary to send not just a single packet but a sequence of packets that are contiguous in time. The reason for this is that if only one packet were sent, it would most likely not fill up one TTI, or it would be scheduled across two TTIs, meaning that the full available bandwidth would not be utilized in any TTI. On the other hand, with multiple packets sent back-to-back and scheduled in consecutive TTIs, it is ensured that the ABM service has the network’s full available capacity allotted to it at least for some TTIs in the middle of the burst.

Assuming that one TTI can accommodate 100,000 bits, the maximum size of one IP packet is 1,500 bytes (= 12,000 bits). So in this case it takes at least 8.3 packets (100,000 / 12,000) to fill one TTI. It is important to transmit at least a few times this number of packets to ensure that a reasonable number of TTIs are filled with ABM traffic. However, note the trade-off here: the level of intrusiveness of the measuring activity rises in direct proportion to the number of packets sent.



Distribution of one ABM data burst across TTIs. The bandwidth allocated to other users is not represented in this figure; furthermore, optimal radio conditions are assumed. The point illustrated here is that at the beginning and end of the burst, the ABM transmission is not competing for the whole of a TTI.

48.4.6. Adaptation of Blixt ABM to Network Configuration and UE Capabilities

The amount of data sent in performing ABM must be adapted to the fundamental network capacity (radio access technology). In the technical paper “A New Approach to Available Bandwidth Measurements for Wireless Networks”, doc. no. NT13-16812, a number of representative use cases are described along with their associated ABM setups, designed to achieve a good trade-off between level of intrusiveness and measurement accuracy as discussed in section 48.4.5.

The ABM packet train properties (packet size and interval) are selected to suit the particular radio bearer configuration. Consequently, different ABM setups will typically be used for different networks/operators. Likewise, as a testing session proceeds, the ABM setup will frequently vary over time as the UE moves between cells, or to another carrier, or switches to a different radio access technology (for example, between a WCDMA and an LTE network).

48.4.7. TWAMP as Time-stamping Protocol

Ascom's ABM technique relies on a time-stamping protocol commonly known as Two-Way Active Measurement Protocol or TWAMP. Other time-stamping protocols could have been used; our reason for selecting TWAMP was that it is a standard protocol in the field which has a simple implementation and is easily extendable. See ▶ IETF RFC 5357 for more details.

48.5. Comparison with Traditional ABM

48.5.1. Data Rate Ramp-up

Below, one feature of traditional ABM methods is described which is not used in the Blixt ABM algorithm.

Traditional ABM methods used in fixed-line networks often start out by probing the bit-pipe between the server and the client at a low data rate, then ramp up the data rate until the "bottleneck" (the maximum bandwidth or data transfer rate) of the bit-pipe is reached. The load is kept at that threshold level for a short time so that the connection is just about overloaded and the available bandwidth is sampled. Finally, the load is released until the next measurement is made (which may be, for example, once every second). When this procedure is iterated and its output filtered, a reliable estimate of the available bandwidth is obtained.

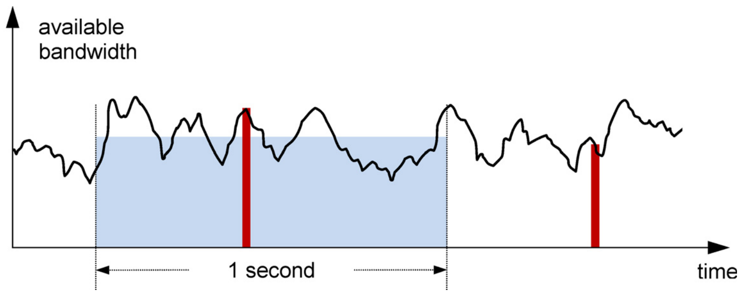
By contrast, in Ascom's implementation, there is no ramping up of the amount of data until the "knee" is encountered. Rather, the bit pipe is loaded to its maximum – just as in an FTP session – but for a much shorter time, down to a few milliseconds. In other words, the data rate always stays above the "knee".

48.5.2. Use of FTP for ABM

Traditionally, ABM in mobile networks has been conducted by running FTP sessions. Throughput is then typically averaged over one-second intervals and reported once every second at the application layer. There is no way to obtain higher-resolution performance metrics from the application layer; that is, without drilling down into RF data.

Now it is highly unlikely that a one-second throughput average will ever reflect the full available bandwidth, since that would require perfect radio conditions to have prevailed throughout the one-second interval. As the radio environment typically undergoes substantial change on a millisecond time scale, such a scenario is highly improbable.

ABM as implemented in Blixt, by contrast, samples much shorter time intervals (down to 8 ms for LTE, as described in section 48.4.3) and is therefore able to hit the maximum bandwidth, or somewhere very close to it. For this reason, ABM as implemented by Ascom can be expected to give a more accurate (though also more varying) estimate of the available bandwidth than an FTP-based method.



Comparison of approaches to ABM. The **black line curve** indicates the true available bandwidth as a function of time. The **red bars** represent TEMS ABM data bursts. Near-maximum bandwidth is attained for the second ABM data burst. The **blue area** represents ABM performed by means of an FTP data transfer (1 s segment). The average throughput over this one-second period is substantially below the maximum throughput reached.

There is, in fact, an additional and grave shortcoming to using FTP with currently available UEs: it has proven impossible during LTE network testing to reach bit rates higher than about 60 Mbit/s (one-second average) even in perfect radio conditions and with no other users present. The bottleneck here is the UE processor, whose performance is hampered by the tasks imposed on it by the UE operating system (running applications, background processes, etc.). Since the packet trains used in Ascom’s ABM approach minimize the load on the UE processor, measuring and reporting on the network’s full bandwidth is now possible.

49. Some LTE Functions of Special Interest

This chapter spotlights some pieces of especially useful and interesting LTE-related functionality in TEMS Investigation.

49.1. LTE Cell Frame Timing

Inter-cell synchronization is a central concept in LTE networks. For TD-LTE in particular with its unpaired spectrum, the same frequency being used on both uplink and downlink, accurate synchronization between cells is crucial. Compared to FDD there is also a more complex range of interference issues to handle, including interference between UEs in adjacent cells and between eNodeBs. Still, even for FDD, synchronization is necessary within a site owing to the overlap between its cells; it is also highly beneficial between sites, since this enables the use of techniques such as CoMP (coordinated multipoint), scheduling traffic in an efficient way among multiple cells.

TEMS Investigation has information elements for presenting **cell frame timing** data on the current LTE serving cell and neighbors. This information can for example be used to:

- Verify and troubleshoot synchronization in the network.
- Compare and evaluate synchronization techniques.
- Optimize heterogeneous cell deployment: for example, adjust timing in a pico cell to a surrounding macro cell, taking into account the propagation delay from the macro cell eNodeB.
- Identify co-sited cells (having identical or nearly identical timing offsets) in an unknown network.
- Estimate distance to a site and determine its position by triangulation.

By inspecting the timing data, LTE synchronization problems can be detected at a moment’s notice. Without the aid of TEMS Investigation, on the other hand, fault tracing in this area is exceedingly slow and difficult.

Links to information elements: Serving Cell Frame Timing Rx1, Neighbor Cell Frame Timing Rx1, Neighbor Cell Frame Timing Offset Rx1. The same set is provided for Rx antenna no. 2.

49.2. LTE Cell Load Evaluation

The PCFICH/CFI Info status window displays the number of OFDM symbols allocated for control signaling. More symbols means that more users are active in the cell. This presentation is convenient for analyzing cell load and identifying the proper actions to optimize resource usage.

Also relevant in this context are the information elements PDSCH Resource Blocks (%) and PUSCH Resource Blocks (%) which can be used to estimate the cell load.

49.3. LTE Cell Tx Antenna Balancing

The information element Serving Cell Tx1-Tx2 Per Rx Antenna indicates the difference in transmit power between the Tx antennas of an eNodeB. These measurements can be used to determine in real time if a newly deployed site has a problem with one of the Tx antennas, for example:

- Feeders mistakenly swapped with another sector.
- Problem with one of the x-polarization branches.
- Feeder connector inadequately fastened (wrong torque applied?).

Compared to traditional methods of diagnosis, this feature can reduce troubleshooting turnaround time by several days.

49.4. Automatic Neighbor Relation (ANR) Diagnostics

ANR, Automatic Neighbor Relation detection, is an **automated mechanism for adding neighbor cell relations** that are missing in the network with a view to achieving better handover performance and a lower session drop rate. The actual measurements involved in scouting for new neighbor candidates are delegated to the UEs, which report their findings to the fixed side. On the basis of this data, neighbor lists are then supplemented as appropriate.

TEMS Investigation comes with an ANR Information status window holding a set of new information elements that are diagnostic of ANR usage in a network. From this data you learn:

- Whether ANR is enabled in the network. This is useful in benchmarking contexts.
- Whether a given device is capable of performing ANR measurements.
- If ANR activity is taking place:
  - What cells the device is instructed to measure on and where these cells are located (intra-frequency, inter-frequency, inter-RAT).
  - What cells the device actually reports.

49.5. CS Fallback Events and Information

The “circuit-switched fallback” mechanism allows a user terminal connected to EUTRAN to be redirected to the CS domain via GERAN, UTRAN, or EV-DO HRPD/eHRPD. A number of events report on the resulting interaction between the terminal and networks:

- CSFB Blocked Call
- CSFB Call Attempt
- CSFB Call Established
- CSFB Call Initiation
- CSFB Call Setup
- CSFB During IP Call Setup
- EUTRAN Reselection Time After CSFB Call
- PS Data Interruption Time Due To CSFB

Also relevant for CS fallback is the Attach Type information element.

49.6. SRVCC Handover

When voice calls are handled within LTE by means of VoLTE, a mechanism called SRVCC (Single Radio Voice Call Continuity), is resorted to in case the VoLTE call needs to be handed over to a 3G or 2G network – for example, if the user moves out of LTE coverage.

SRVCC is distinguished as a special handover type in the Handover From EUTRAN event. A KPI event SRVCC Handover Interruption Time (User Plane) is generated in this connection, reporting the length of time for which the voice call audio was silent due to the handover.

49.7. Carrier Aggregation

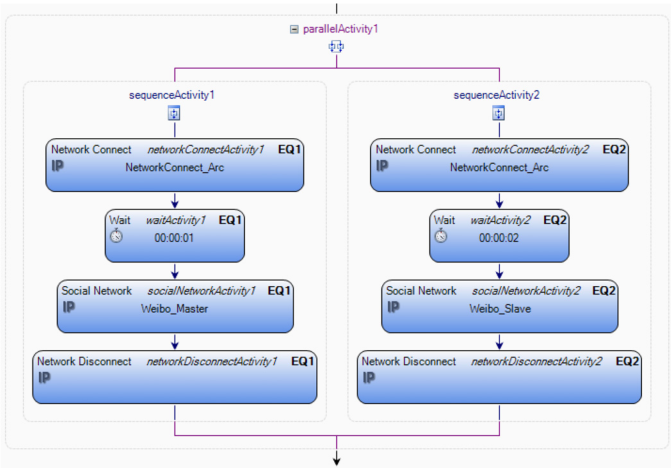
Part of the LTE Advanced concept, carrier aggregation is a key strategy for increasing user bandwidth and hence the maximum bit rate in LTE networks. It basically consists in pooling the resources of multiple carriers (EARFCNs) in a coverage area and putting them all at the disposal of devices located there. For bursty applications especially, where the peak load is very high compared to the average load, this bundling can bring great gains in capacity.

TEMS Investigation comes prepared for carrier aggregation by accommodating multi-serving cell measurements. The LTE Serving Cell information elements distinguish primary and secondary serving cells.

50. Social Network Testing

Testing of social networks should be handled by a Parallel activity which has the master device in one branch and the slave device in the other, each executing a Social Network activity, as depicted below.

Please note that the logfile recording and equipment activation/deactivation commands have been left out of the workflow.



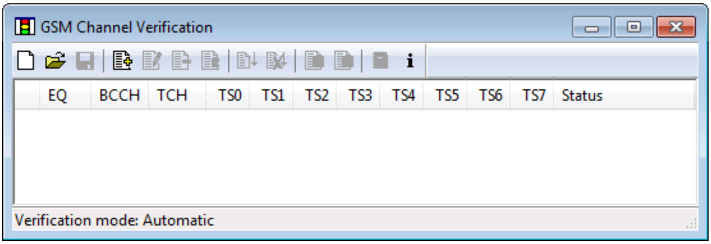
51. GSM Channel Verification

The GSM Channel Verification tool allows you to check the availability of a set of GSM traffic channels, typically those used in one cell or a set of cells. TEMS Investigation lets one or several GSM-capable Sony Ericsson phones[1] make calls repeatedly on the chosen channels until all timeslots of interest have been tested.

Since there is no way for TEMS Investigation to control the timeslot allocation, traffic channel verification may take a non-trivial amount of time to complete. To reduce the testing time, you can use several phones.

51.1. The GSM Channel Verification Window

- To perform GSM channel verification, open the **GSM Channel Verification** window from the Control folder on the Navigator's Menu tab.



In this window, each row corresponds to a particular combination of BCCH and TCH.

Throughout the present chapter, the following terminology will be used:

- *Test case:* One row in the GSM Channel Verification window, i.e. one BCCH/TCH combination.

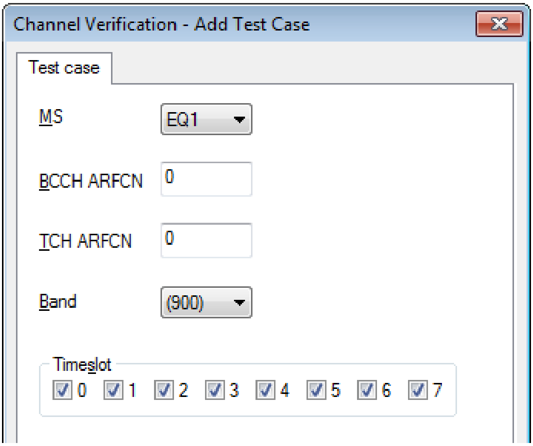
---

1. Sony Ericsson phones with both GSM and WCDMA capability must be locked on GSM (see section 13.13) to be able to perform GSM channel verification.

- *Group, Test case group:* All test cases with the same BCCH, corresponding to one cell. Note that test case groups are not explicitly separated in the user interface.
- *Test:* All rows in the window, or in other words the complete contents of the *.tch file (see section 51.11).

51.2. Adding a Test Case

To add a test case, click **Add**. The following dialog appears:



MS The phone that should execute this test case.

BCCH ARFCN The ARFCN of the BCCH to be tested.

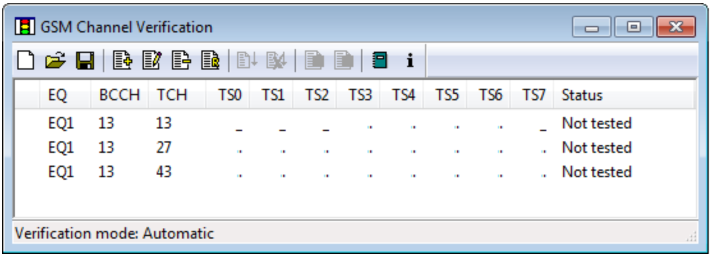
TCH ARFCN The ARFCN of the TCH to be tested. Note that a special test case must be prepared to test TCH timeslots on C_0.

Example: If C_0 has ARFCN 10, with BCCH in timeslot 0 and TCHs in timeslots 2–7, and C_1 has ARFCN 20, then you must prepare two test cases: one with {BCCH = 10, TCH = 10} and one with {BCCH = 10, TCH = 20}.

Band The frequency band where the channels are located.

Timeslot Check the timeslots you wish to test.

You can add multiple test cases without exiting the dialog, by entering the settings for one test case at a time and clicking Apply after each. The result in the GSM Channel Verification window will look like this:



Here, timeslots to be tested are indicated by full stops/periods ("."), while timeslots not concerned by the test are marked by underscores ("_").

51.3. Editing and Removing Test Cases

To edit a test case, select it in the GSM Channel Verification window and click the **Edit** button.

Note that to edit a test case which has been partially executed, you must reset the test case (section 51.8). That is, you cannot keep any of the old test results in the window; but you do have the option to create a report on these results (section 51.10) or save the test case in a special file format (section 51.11).

To remove a test case, select it and click the **Delete** button.

51.4. Automatic vs. Manual Verification

There are two fundamentally different ways of performing channel verification.

- *Automatic* verification: For each timeslot, TEMS Investigation decides whether the timeslot can be accepted or not. In order for a timeslot to pass, the call must be set up correctly and maintained for a user-specified period of time, and in addition a set of user-specified quality requirements must be satisfied.
- *Manual* verification: For each timeslot, you decide yourself whether to accept or reject the result of the test, by clicking either of two buttons. How to take this decision is up to the user. You might be content with

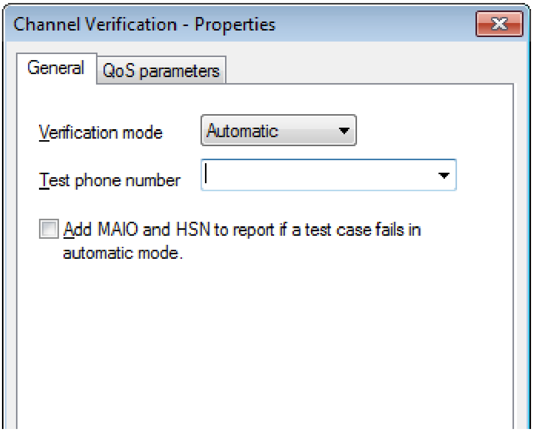
assessing the downlink quality by calling a service such as the speaking clock, or you might want to “call a friend” in each instance to have the uplink quality checked as well.

Automatic verification can be done more quickly, but is a less reliable indicator of what a user’s experience of the radio conditions would be like. Manual verification is more work-intensive and probably more time-consuming, but also yields an improvement in reliability proportional to the work invested.

You choose how to perform the test in the Properties dialog.

In the GSM Channel Verification window, click the **Properties** button.

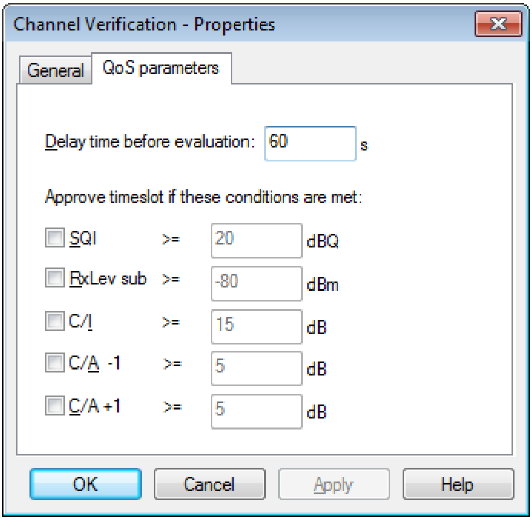
General Tab



Verification mode	Choose Manual or Automatic (see explanation above).
Test phone number	Enter the phone number to call when testing. Valid characters in the phone number are {*, +, #, 0–9}.
Add MAIO and HSN...	Check this to have the Mobile Allocation Index Offset (MAIO) and the Hopping Sequence Number (HSN) indicated in the test report (section 51.10) for any test case that fails in automatic verification mode.

QoS Parameters Tab

On this tab you can set down conditions for accepting a timeslot in automatic verification mode.



Delay time before evaluation

The time to wait before evaluating the quality parameters.

Approve timeslot if these conditions are met:

Check the conditions you want to use, and specify thresholds. The conditions will be evaluated at one point in time, namely as soon as the delay period has expired. The checked conditions must all be satisfied in order for the timeslot to be accepted, i.e. they are ANDed together.

51.5. Activating Phones

Before running the test you must naturally activate the phones assigned to do the testing. See section 6.4.

> **Note:** In manual verification mode, only one phone can be used.

51.6. Running the Test

51.6.1. Getting Started

To be able to execute a test you must have done the following:

- Prepared your test cases according to sections 51.1–51.3.
- Chosen manual or automatic verification mode, and indicated a phone number to call: see section 51.4.
- Activated the phone or phones to be used in the test.

Then, to start running the test currently displayed in the GSM Channel Verification window:

Click **Start**.

TEMS Investigation will now start attempting calls on the TCHs specified, having locked the phone on the corresponding BCCH. The test cases currently executed are tagged with a blue arrow in the leftmost column.

While the test is running, handover is disabled, as are all other phone control functions in TEMS Investigation.

If you have listed several test case groups (see section 51.1), they will be executed one at a time, in the order they have been entered. Note that there is no requirement to keep test case groups apart in the GSM Channel Verification window, although it may of course be practical to do so.

When the testing of a timeslot begins, it is marked with a question mark in a gray box. In the frequency hopping case, this timeslot is tested for all channels in the hopping sequence at once, so that multiple gray boxes appear.

51.6.2. Manual Verification

If you have chosen manual verification, the application will now wait for you to either accept or reject this timeslot.

To accept a timeslot, click **Accept**.

An accepted timeslot will be marked with a green rectangle (with an “**h**” for hopping channels). If all timeslots in the test case are now accepted, the status of the test case will change to **Passed**.

To reject a timeslot, click **Reject**.

A rejected timeslot will be marked with a red rectangle (with an “**h**” for hopping channels). The test case will ultimately be put in status **Failed**, though not until all timeslots have been either accepted or rejected.

When you have made a decision, the application proceeds to make a new call. When a call is made in a previously accepted or rejected timeslot, the **Accept** and **Reject** buttons are disabled, and a new call is made within a few seconds.

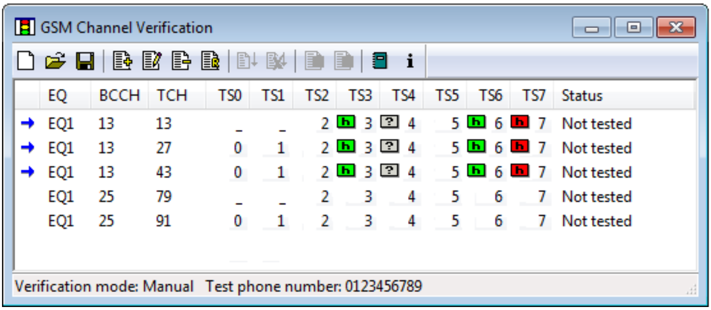
51.6.3. Automatic Verification

If you have chosen automatic verification, the application will itself accept the timeslot (if possible), marking it green h; otherwise it will try to make a new call the next time this timeslot is allocated. Automatic verification never rejects a timeslot, but keeps attempting calls indefinitely, within certain limits; see section 51.13.

When a timeslot is allocated which has already been accepted or rejected, the call is aborted (not affecting the earlier result), and a new call is begun immediately.

51.6.4. Example

Here is an example of an ongoing verification session:



The cell described by the first three rows (tagged with blue arrows) is under test. Manual verification has been chosen. Frequency hopping is used in this cell (as shown by the “**h**” symbols), so any timeslot tested will be verified for all three TCHs at once. At this point, the user has accepted the performance of timeslots 3 and 6 (green markers), while rejecting timeslot 7 (red markers). Timeslot 4 is currently being tested, which is indicated by question marks.

51.7. Stopping the Test

In order to stop the test currently running:

In the GSM Channel Verification window, click **Stop**. All test cases that are in status **Testing** will change to **Stopped**.

To resume the test, just click **Start** again. The test will continue from the point where it was halted. All test cases that are not finished will be put in status **Testing** again.

51.8. Resetting a Test Case

You can erase the results for a test case by resetting it. If the test is executing, it must be stopped first. The status value of the test case reverts to **Not tested**; when execution is resumed, the test case will be processed from scratch again.

51.9. Summary of Test Case Status Values

A test case has one of the following status values:

Status Value	Meaning
Not tested	No work done yet on this test case, *or:* The test case has been reset.
Testing	Execution of this test case is ongoing. This is also indicated in the leftmost column by a blue arrow .
Stopped	Execution of this test case has been begun but the test is currently stopped.
Passed	All timeslots in the test case have been accepted.
Timeslot(s) rejected	At least one timeslot in the test case has been rejected.

Status Value	Meaning
Call lost BCCH lost Invalid TCH Timeout MS not connected Call setup failure	These status values signify errors. See section 51.13. The error condition is also indicated in the leftmost column by the symbol ! .

51.10. Creating Test Reports

At any stage of execution of a test, an HTML report can be generated summarizing the results obtained so far. (If the test is executing, it must be stopped first.) The report indicates

- the verification mode: manual or automatic
- the test phone number
- the QoS parameter settings
- the test result for each timeslot (where available) as well as the status of each test case at the time of creating the report.

In case of call setup failure, the used MAIO and HSN is indicated for that test case.

To generate a test report, click the **Report** button, and select an output location for the HTML file.

Status values are as in the GSM Channel Verification window; see section 51.9. Timeslots are marked with one of the following:

Timeslot Data	Meaning
OK	Timeslot accepted.
FAIL	Timeslot rejected.
TESTING	Test of timeslot not yet completed.
–	Timeslot not included in test.

51.11. Saving and Opening Tests

Channel verification tests can be saved to file at any stage of execution. (The test must be stopped first.) The file will include full information on the results obtained so far and on the status of each test case at the time of saving.

To save the complete current contents of the GSM Channel Verification window, click **Save**. The test will be saved in a file with extension .tch.

To open a previously saved *.tch file, click **Open** and select your file.

51.12. Notes on Performance

It is possible to speed up the verification process by letting several phones share the work. This will, as a rule, considerably reduce the time taken to perform the test. You may assign different test cases to different phones, or assign identical test cases to several phones, or you may do both. If several phones are set to execute identical test cases, to begin with they will all work independently. However, as soon as a timeslot is accepted by one phone, it is marked green for all other identical test cases, and no phone will test it further.

51.13. Error Conditions

In certain situations the application judges it impossible to complete the verification and therefore aborts the test. The test cases affected by the error executed are tagged with the symbol in the leftmost column.

The status value of the test case indicates what has gone wrong:

Status Value	Cause
Call lost	Two possible causes: • Two idle mode reports received while in dedicated mode (i.e. ongoing call has been lost). • One idle mode report received from wrong cell while in dedicated mode (i.e. lock on BCCH has broken down).

Status Value	Cause
BCCH lost	Two possible causes: • No channel report received from correct BCCH for 20 seconds after previous successful locking on this BCCH (i.e. lock on BCCH has broken down). • Three idle mode reports from wrong cell or two no service reports received while trying to lock on BCCH (i.e. lock on BCCH has failed).
Invalid TCH	Test case attempted 10 times in a row without the right TCH being allocated, and no timeslots marked green or red (typically occurs when the chosen TCH is in fact not used where assumed).
Timeout	Ten consecutive calls made where the call setup procedure could not be concluded successfully.
MS not connected	Phone not activated at start of measurement.

Part V: Appendices

Appendix A. Keyboard Shortcuts

A.1. General Shortcuts

Function	Shortcut
Help	F1
Exit application	Alt + F4
Previous worksheet	F11
Next worksheet	F12
Focus on next window in worksheet	Ctrl + Tab
Open TEMS Settings Manager	Ctrl + M
New workspace	Ctrl + N
Open workspace	Ctrl + O
Print workspace	Ctrl + P
Generate logfile report	Ctrl + R
Save workspace	Ctrl + S

A.2. Drive Testing Shortcuts

Function	Shortcut
Activate all	F2
Deactivate all	Ctrl + F2
Insert filemark	F5
Start recording	F6

Function	Shortcut
Stop recording	Ctrl + F6

A.3. Logfile Load Shortcuts

Function	Shortcut
Open logfile	Shift + F10
Stop logfile load	Ctrl + F10

A.4. Shortcuts for Active Window

Function	Shortcut
Print window	Ctrl + P

Status Window, Line Chart, Bar Chart

Function	Shortcut
Show properties	Shift + P
Show setup wizard (status window only)	Shift + W

Message Window

Function	Shortcut
Show only messages of this type	Ctrl + Y
Hide messages of this type	Ctrl + H
Undo (show only/hide)	Ctrl + Z
Find next message of this type	Right arrow
Find previous message of this type	Left arrow

Function	Shortcut
Search for message	Ctrl + F
Search again	F3

Map Window

Function	Shortcut
Open Layer Control dialog	Alt + L
Open Theme Settings dialog	Alt + T
Activate zoom in	Shift + Z
Activate zoom out	Alt + Shift + Z
Go to first route marker[1]	Home
Step to previous route marker	Left arrow
Step to next route marker	Right arrow
Go to last route marker[1]	End

1. Some route sample must already be selected.

Service Control Designer Window

Function	Shortcut
Select all	Ctrl + A
Copy	Ctrl + C
New script	Ctrl + N
Open script	Ctrl + O
Save script	Ctrl + S
Paste	Ctrl + V
Cut	Ctrl + X

Appendix B. File Types in TEMS Investigation

These TEMS-specific file types are used by TEMS Investigation:

Extension	File Type
.aex	Setup file for ArcView format logfile export
.bch	Bar chart export file
.cel	Cell file
.config	Service Control configuration set
.eth	Setup file for Ethereal (Wireshark) format logfile export
.evt	User-defined event
.fmt	Logfile exported in text format
.lch	Line chart export file
.log	TEMS Investigation logfile (old format)
.map	Map window export file
.mex	Setup file for MapInfo format logfile export
.mw	Message window export file
.pex	Setup file for Planet format logfile export
.rpt	Setup file for logfile report
.stm	Status window export file
.svt	Audio indication for event
.tdc	TEMS Investigation workspace
.tex	Setup file for text format logfile export
.trp	TEMS Investigation logfile (current format)

Extension	File Type
.tsc	Service Control script

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Information Elements and Events

Contents

1. What’s In This Manual

This book catalogs all **information elements** and **events** presented in TEMS Investigation, as well as all preconfigured **presentation windows** supplied in the application.

What information elements can be obtained from various connectable devices appears from the tables in chapter 4.

Conventions

For the sake of brevity, the following conventions are used in this book:

- The TEMS Investigation User’s Manual is referred to as “UM”.
- The TEMS Investigation Technical Reference is referred to as “TR”.

2. Information Element Categories

The information elements are divided into categories in the application as follows:

Category	Contents	Section Ref.
GSM	• Elements reported by GSM-capable UEs when in GSM mode, including GPRS/ EGPRS elements and (where applicable) WCDMA and TD-SCDMA neighbor measurements. • Elements from GSM scanning. • Elements reported by GAN-capable GSM devices when connected to a GAN.	3.1
WCDMA	• Elements reported by WCDMA-capable UEs when in WCDMA mode, including HSPA elements and GSM neighbor measurements. • Elements from WCDMA scanning.	3.2
LTE	• Elements reported by LTE-capable UEs, including inter-RAT cell reselection measurements on GSM, WCDMA, and CDMA. • Elements from LTE scanning.	3.3

Category	Contents	Section Ref.
TD-SCDMA	• Elements reported by TD-SCDMA-capable UEs when in TD-SCDMA mode, including (if applicable) GSM and LTE neighbor measurements. • Elements from TD-SCDMA scanning.	3.4
CDMA	• Elements reported by CDMA phones (including EV-DO and Analog elements). • Elements from CDMA scanning.	3.5
WiMAX	• Elements from WiMAX scanning.	3.6
Position	• Elements reported from positioning devices.	3.7
Data	• Elements related to data service testing. These are not reported directly by devices but are calculated by the TEMS Investigation software.	3.8
Media Quality	• Elements related to quality testing of media such as voice.	3.9
GSM Uplink	• Elements originating from GSM uplink data files.	3.10
Wi-Fi	• Elements originating from Wi-Fi measurements using a Wi-Fi network card, or from Wi-Fi scanning recorded in TEMS Pocket logfiles.	3.11

3. Information Elements

The tables below list all information elements that can be presented by TEMS Investigation. For ease of reference, each category on the **Info Element** tab of the Navigator is still covered in one single, alphabetically ordered list. (Certain minor deviations from strict alphabetical order occur in the application in order to achieve more logical orderings and groupings.) However, since the number and diversity of the information elements are great, a special column with codes is used in some tables to distinguish important subgroups among the elements.

3.1. GSM Information Elements

3.1.1. General

3.1.1.1. Properties of Information Elements: The Asterisk Column

In the column marked *, a set of codes is used to state conditions under which an information element is

- *valid:* a non-trivial condition must be fulfilled for the element to be valid
- *not valid:* the element is normally valid, but in certain circumstances it is not (code ends in "–")
- *extended* compared to the simplest GSM case: the element sometimes carries more information, for example when frequency hopping is used (code ends in "+")

If nothing is written in the asterisk column, the element is always valid (provided it is supported by the device).

Code	Meaning
c	Valid if a cell file is loaded.
g	Valid when running GPRS. Not valid for voice.
g+	The element is richer for (E)GPRS, in one of the following ways: • more values, i.e. more arguments – e.g. C/I Best • values have a more complex meaning – e.g. C/I Hopping List (average over timeslots) • larger range of possible values – e.g. Channel Type.
g–	Not valid when running (E)GPRS.
ga	Valid in GAN mode or for GAN-capable devices.
h	Valid if frequency hopping is used.

Code	Meaning
h+	The element is richer if frequency hopping is used. If frequency hopping is used, the element covers all channels in the hopping list. • No GPRS connection: One value for each channel (arguments 0 through 63) • GPRS: One value for each timeslot used on each channel (arguments 0 through $64 \times 8 - 1 = 511$). Exception: C/I Hopping List has only one value for each channel (arguments 0 through 63). If frequency hopping is not used, the element contains values for the single channel employed. • No GPRS connection: One single value (argument 0). • GPRS: One value for each timeslot used on the channel (arguments 0 through 7). Example: C/I Best.
hc+	If frequency hopping is used, the element covers all channels in the hopping list. One value for each channel (arguments 0 through 63). No separate values for each timeslot for a GPRS connection. Example: C/I Hopping List.
h–	Not valid if frequency hopping is used.
hs	Valid when running HSCSD. Not valid for voice.
hs+	The element is richer for HSCSD, in one of the following ways: • more values, i.e. more arguments – e.g. C/I Best • values have a more complex meaning – e.g. C/I Hopping List (average over timeslots) • larger range of possible values – e.g. Channel Type.
hs–	Not valid when running HSCSD.
p	Reported by positioning equipment.
s	Reported from GSM RSSI scanning.

Code	Meaning
si	(Reported from interference scanning with a Sony Ericsson GSM phone.) This function is *no longer supported* in any connectable device, but the information elements are retained in this description since old logfiles with interference scan data can still be loaded in the application.
ss	Reported from GSM spectrum scanning.

3.1.1.2. “Full” and “Sub” Values

Information elements with “Full” in their names are calculated on all blocks.

Information elements with “Sub” in their names are calculated only on the blocks known to be sent also when downlink DTX is active (in each 104-multiframe, one TCH block with SID information and one SACCH block).

3.1.1.3. GSM RxLev Units

GSM RxLev units are defined in ▶ 3GPP 45.008, section 8.1.4.

3.1.2. Information Element Table

IE Name	Range/Unit	Arg.	*	Description
Adjacent RxLev	–10 ... 100 GSM RxLev units	1 ... 4	h–	Signal strength of adjacent channel. **Argument:** 1: Serving cell –2 (–400 kHz) 2: Serving cell –1 (–200 kHz) 3: Serving cell +1 (+200 kHz) 4: Serving cell +2 (+400 kHz) Invalid if frequency hopping is used.
Adjacent RxLev (dBm)	–120 ... –10 dBm	1 ... 4	h–	Same as Adjacent RxLev but in dBm. Invalid if frequency hopping is used.

IE Name	Range/Unit	Arg.	*	Description
Adjacent Scan	0, 2	–		Use of C/A measurements in device. See UM section 14.3.2.4. 0: Not activated 2: Activated
Altitude (ft)	–1312 ... 29028 ft	–	p	Height above sea level in feet.
Altitude (m)	–400 ... 8848 m	–	p	Height above sea level in meters.
AMR Active Set DL	Text	0 ... 3		Current active set of AMR speech codecs on downlink, each codec being described by a text string, e.g. "12.2 kbit/s rate". **Argument:** 0 gives the first member of the active set, etc.
AMR Active Set UL	Text	0 ... 3		Current active set of AMR speech codecs on uplink, each codec being described by a text string, e.g. "12.2 kbit/s rate". **Argument:** 0 gives the first member of the active set, etc.
AMR C/I	–5 ... 35 dB	–		C/I value used as input to mode control in AMR. This parameter is distinct from the ordinary C/I information elements, although the value should be similar.
AMR C/I Hi Limit	–5 ... 35 dB	–		C/I limit for codec change to higher bit rate, calculated from AMR Hysteresis and AMR Threshold.
AMR C/I Lo Limit	–5 ... 35 dB	–		C/I limit for codec change to lower bit rate, calculated from AMR Hysteresis and AMR Threshold.

IE Name	Range/Unit	Arg.	*	Description
AMR Codec Call DL (%)	0 ... 100 %	0 ... 16		Distribution of downlink AMR codec usage for the current call. Invalid if no call is ongoing. **Argument:** Indicates the AMR codec. See also ▶ 3GPP 26.071, 26.190. 0: AMR-NB 12.2 kbit/s 1: AMR-NB 10.2 kbit/s 2: AMR-NB 7.95 kbit/s 3: AMR-NB 7.40 kbit/s 4: AMR-NB 6.70 kbit/s 5: AMR-NB 5.90 kbit/s 6: AMR-NB 5.15 kbit/s 7: AMR-NB 4.75 kbit/s 8: AMR-WB 6.60 kbit/s 9: AMR-WB 8.85 kbit/s 10: AMR-WB 12.65 kbit/s 11: AMR-WB 14.25 kbit/s 12: AMR-WB 15.85 kbit/s 13: AMR-WB 18.25 kbit/s 14: AMR-WB 19.85 kbit/s 15: AMR-WB 23.05 kbit/s 16: AMR-WB 23.85 kbit/s
AMR Codec Call UL (%)	0 ... 100 %	0 ... 16		Distribution of uplink AMR codec usage for the current call. Invalid if no call is ongoing. **Argument:** See AMR Codec Call DL (%).
AMR Codec Cell DL (%)	0 ... 100 %	0 ... 16		Distribution of downlink AMR codec usage since the device started using the current serving cell. **Argument:** See AMR Codec Call DL (%).

IE Name	Range/Unit	Arg.	*	Description
AMR Codec Cell UL (%)	0 ... 100 %	0 ... 16		Distribution of uplink AMR codec usage since the device started using the current serving cell. **Argument:** See AMR Codec Call DL (%).
AMR Codec DL (%)	0 ... 100 %	0 ... 3		Current distribution of downlink AMR codec usage across the active set being used. **Argument:** 0 gives the first member of the active set, etc., the members being ordered as in AMR Active Set DL.
AMR Codec UL (%)	0 ... 100 %	0 ... 3		Current distribution of uplink AMR codec usage across the active set being used. **Argument:** 0 gives the first member of the active set, etc., the members being ordered as in AMR Active Set UL.
AMR Hysteresis	0 ... 15	1 ... 3		Hysteresis values in AMR mode switch mechanism. **Argument:** One hysteresis value for each possible mode transition (a maximum of four AMR codecs can be active simultaneously).
AMR Threshold	0 ... 63	1 ... 3		Threshold values in AMR mode switch mechanism. **Argument:** See AMR Hysteresis.

IE Name	Range/Unit	Arg.	*	Description
ARFCN BCCH	GSM 450: 259 ... 293 GSM 850: 128 ... 251 P-GSM 900: 1 ... 124 E-GSM 900: 0 ... 124, 975 ... 1023 GSM 1800: 512 ... 885 GSM 1900: 512 ... 810	–		Absolute Radio Frequency Channel Number of Broadcast Control Channel.
ARFCN Current	See ARFCN BCCH	–	h–	In idle mode: Same as ARFCN BCCH. In dedicated mode: Same as ARFCN TCH. Not valid when frequency hopping is used.
ARFCN TCH	See ARFCN BCCH	–	h–	Absolute Radio Frequency Channel Number of Traffic Channel. Valid only in dedicated mode and only for channels where no frequency hopping is used.
Attach Time (ms)	0 ... 60000 ms	–	g	Time from Attach Request to Attach Complete.
Band Control	0, 2	–		Use of band control function in device. See UM section 13.6. 0: Not activated 2: Activated
BER Actual (%)	0 ... 26 %	–	g–hs–	Bit error rate, calculated taking DTX into account, i.e. the figure is based only on blocks actually transmitted. Valid for voice only.

IE Name	Range/Unit	Arg.	*	Description
BER/Timeslot (%)	0 ... 26 %	0 ... 7	g hs	Bit error rate for each used timeslot. Valid for data services only. **Argument:** 0 represents the first used timeslot (*not* TS 0), etc.
BLER/Timeslot (%)	0 ... 100 %	0 ... 7	g hs	Block error rate for each timeslot used. Valid for data services only. **Argument:** 0 means the first used timeslot (*not* TS 0), etc.
BSIC	Text	–		Base Station Identity Code as text string.
BSIC (Num)	00 ... 77 (octal)	–		Base Station Identity Code in numeric format.
C Value	0 ... 63 GSM RxLev units	–		Normalized signal level received at the MS (normalization with running average filter).
C/A –3	–100 ... 100 dB	–	h–	"Carrier over Adjacent". Calculated as (RxLev for serving cell) – (Adjacent RxLev for –3), i.e. the adjacent channel's frequency is 600 kHz below the serving cell's. Invalid if frequency hopping is used.
C/A –2 ... C/A +3	–100 ... 100 dB	–	h–	As C/A –3 but with adjacent channel at –400 kHz, –200 kHz, +200 kHz, +400 kHz, and +600 kHz respectively.

IE Name	Range/Unit	Arg.	*	Description
"C/I" IEs: General remark	Sony Ericsson UEs report C/I values for traffic channels. If the BCCH is not used as traffic channel, the C/I Absolute element will be invalid for the BCCH ARFCN. The above applies to the Xperia arc S as well. Nokia UEs report a single C/I value which is associated with the BCCH in the presentation. See also notes on individual elements below.			
C/I Absolute	–5 ... 35 dB	See range of ARFCN BCCH		Carrier-over-interference ratio for all channels. **Argument** = ARFCN. Concerning the range, see UM chapter 47.
C/I Best	–5 ... 35 dB	0 ... 511 (8·64–1)	g+ hs+ h+	For Sony Ericsson UEs, this element gives C/I values for all hopping channels in all used timeslots. The whole list is sorted by descending C/I. For Nokia UEs, a single C/I value is obtained which is an average over all hopping channels. That value is found at argument 0 of this element. For PCTel scanners, one C/I value is obtained for each channel scanned. **Argument:** 0 gives the C/I of the best channel, 1 gives that of the second best, etc.
C/I Best: ARFCN	See ARFCN BCCH	0 ... 511 (8·64–1)	g+ hs+ h+	ARFCN list corresponding to the C/I Best element (which see). For Nokia UEs, the BCCH ARFCN is given at argument 0. **Argument:** 0 gives the ARFCN of the channel with the best C/I, etc.

IE Name	Range/Unit	Arg.	*	Description
C/I Best: Timeslot	0 ... 7	0 ... 511 (8·64–1)	g hs h+	For multislot allocations: Timeslot list corresponding to the C/I Best element (which see). **Argument:** 0 gives the timeslot of the channel with the best C/I, etc.
C/I For Worst ARFCN	–5 ... 35 dB	0 ... 7	g hs h+	C/I for the worst channel in the hopping list for each used timeslot. **Argument:** 0 represents the first used timeslot (*not* TS 0), etc.
C/I Hopping List	–5 ... 35 dB	0 ... 63	g+ hs+ hc+	C/I values (unsorted) for the channels in the hopping list. For multislot channels, the mean value across all used timeslots is given. **Argument:** 0 gives the C/I of the first channel in the hopping list, etc.
C/I Hopping List: ARFCN	See ARFCN BCCH	0 ... 63	h+	ARFCNs of the channels in the hopping list (see C/I Hopping List). **Argument:** 0 gives the ARFCN of the first channel in the hopping list, etc.
C/I On BCCH Carrier	–5 ... 35 dB	–		C/I on the current BCCH. If frequency hopping is used, then if the BCCH is used as hopping frequency, the C/I for that channel is reported. If frequency hopping is not used, then if the BCCH is equal to the TCH, the C/I for that channel is reported. Invalid otherwise.

IE Name	Range/Unit	Arg.	*	Description
C/I Worst	–5 ... 35 dB	0 ... 511 (8·64–1)	g+ hs+ h+	For Sony Ericsson UEs, this element gives C/I values for all hopping channels in all used timeslots. The whole list is sorted by ascending C/I. For Nokia UEs, a single C/I value is obtained which is an average over all hopping channels. That value is found at argument 0 of this element. For PCTel scanners, one C/I value is obtained for each channel scanned. **Argument:** 0 gives the C/I of the worst channel, 1 gives that of the second worst, etc.
C/I Worst: ARFCN	See ARFCN BCCH	0 ... 511 (8·64–1)	g+ hs+ h+	ARFCN list corresponding to the C/I Worst element (which see). For Nokia UEs, the BCCH ARFCN is given at argument 0. **Argument:** 0 gives the ARFCN of the channel having the worst C/I, etc.
C/I Worst: Timeslot	0 ... 7	0 ... 511 (8·64–1)	g hs h+	For multislot allocations: Timeslot list corresponding to the C/I Worst element (which see). **Argument:** 0 gives the timeslot of the channel having the worst C/I, etc.
C1	–127 ... 127 dB	–		Pathloss criterion C1. Valid only in idle mode.
C2	–127 ... 127 dB	–		Cell reselection criterion C2. Valid only in idle mode.

IE Name	Range/Unit	Arg.	*	Description
C31	–127 ... 127 dB	–	g	GPRS signal strength threshold criterion C31. Valid both in packet idle and packet dedicated mode.
C32	–127 ... 127 dB	–	g	GPRS cell ranking criterion C32. Valid both in packet idle and packet dedicated mode.
Cell EGPRS Support	Text: “Yes”/“No”	–		EDGE supported/not supported in the cell. This information is available also to non-EDGE devices.
Cell GPRS Support	Text: “Yes”/“No”	–		Indicates whether GPRS is supported in the cell.
Cell Id	0 ... 65535	–		Cell Identity.
Cell Id (Hex)	Text: “0000” ... “FFFF”	–		Same as Cell Id but coded as hexadecimal.
Cell Name	Text	–	c	Name of serving cell. Requires cell file. Calculated using a number of different algorithms: see Cell Name Algorithm.

IE Name	Range/Unit	Arg.	*	Description
Cell Name Algorithm	1 ... 3	–	c	Indicates the input used by the cell name determination algorithm and (for values 2 and 3) the result of the cell search: 1: MCC, MNC, LAC, and CI used. 2: BSIC, ARFCN, and position information used. Unique cell found matching these parameters within a 35 km radius. 3: BSIC, ARFCN, and position information used. Several matching cells found within a 35 km radius, closest cell selected. Requires cell file.
CGI	Text	–		Cell Global Identity. Consists of Mobile Country Code, Mobile Network Code, Location Area Code and Cell Identity. Presented on the format “MCC MNC LAC CI”.
CGI (Hex)	Text	–		Same as CGI, but LAC and CI coded as hexadecimal.
Channel Mode	Text	–		Activity on channel: Signaling only, speech transmission, or data transmission.
Channel RxLev	–10 ... 100 GSM RxLev units	See range of ARFCN BCCH		Measured signal strength level for all channels. **Argument** = ARFCN. **Note:** Unlike RxLev Full/RxLev Sub, this element is also updated by scan reports.

IE Name	Range/Unit	Arg.	*	Description
Channel RxLev (dBm)	–120 ... –10 dBm	See range of ARFCN BCCH		Same as Channel RxLev but in dBm. **Argument** = ARFCN.
Channel Type	Text	–	g+ hs+	Channel type, also indicating which speech coder is used. Examples: "TCH/F + FACCH/F and SACCH/M", "BCCH", "PDCH".
Ciphering Algorithm	Text	–		Currently used ciphering (A5/1, A5/2, GEA/1, etc.), whether for circuit-switched or packet-switched. ► 3GPP 43.020
Coding Scheme DL	Text	–	g	Modulation coding scheme used on downlink. EDGE: One of: "MCS-1" ... "MCS-9", "MCS-5-7", "MCS-6-9", "MCS-3 (pad)", "MCS-6 (pad)". MCS-5-7 and MCS-6-9 are explained in ► 3GPP 44.060. "(pad)" means that an RLC block is retransmitted using MCS-3 and MCS-6 respectively. GPRS: One of "CS-1" ... "CS-4".
Coding Scheme DL Usage (Own Data) (%)	0 ... 100 %	1 ... 4	g	Distribution of coding scheme usage on downlink (for own data only). **Argument:** 1 means CS-1, etc.
Coding Scheme DL Usage (Total) (%)	0 ... 100 %	1 ... 4	g	Distribution of coding scheme usage on downlink (overall, not limited to own data). **Argument:** 1 means CS-1, etc.

IE Name	Range/Unit	Arg.	*	Description
Coding Scheme UL	Text	–	g	Modulation coding scheme used on uplink. For the possible values, see Coding Scheme DL.
CS-*n* DL Usage (Own Data) (%), *n* = 1 ... 4	0 ... 100 %	0 ... 7	g	These elements contain the distribution of coding scheme usage (on the downlink and for own data only) for each timeslot. **Argument:** 0 represents the first used timeslot (*not* TS 0), etc.
Current CS DL	1 ... 4	–	g	Coding scheme currently used on downlink.
Current CS UL	1 ... 4	–	g	Coding scheme currently used on uplink.
Current MCS DL	1 ... 9	–	g	Modulation coding scheme currently used on downlink.
Current MCS UL	1 ... 9	–	g	Modulation coding scheme currently used on uplink.
Data Mode	Text	–		Indicates whether the data transfer is performed over GPRS, EGPRS, or circuit-switched.
Data Mode (Num)	1 ... 3	–		Indicates whether the data transfer is performed over GPRS, EGPRS, or circuit-switched. 1: GPRS 2: EGPRS 3: CS
Disable Handover	0, 2	–		Use of Disable Handover function in device. See UM section 14.3.2.8.

IE Name	Range/Unit	Arg.	*	Description
Downlink Signalling Counter Current	0 ... 45	–		Current value of Downlink Signalling Counter (DSC). Valid only in idle mode.
Downlink Signalling Counter Max	0 ... 45	–		Initial value of Downlink Signalling Counter (DSC). Valid only in idle mode.
DTX Rate DL	0 ... 100 %	–	g–	Use of DTX on downlink. Calculated as the percentage of the total number of blocks that was not sent. Two mandatory blocks are always sent even if DTX is used: one TCH (with SID information) and one SACCH. Non-existent for packet-switched (no DTX).
EGPRS BEP (Mean)	0 ... 31 See Description	–		Mean value of bit error probability as reported in the Layer 3 message EGPRS Packet Downlink Ack/Nack. Coded according to the table in ▶ 3GPP 45.008, section 8.2.5.
EGPRS BEP (Variance)	0 ... 7 See Description	–		Variance of bit error probability as reported in the Layer 3 message EGPRS Packet Downlink Ack/Nack. Coded according to the table in ▶ 3GPP 45.008, section 8.2.5.
EGPRS BEP Total (Mean)	0 ... 31 See Description	–		Short-term mean value of bit error probability extracted from Layer 1. Coded according to the table in ▶ 3GPP 45.008, section 8.2.5.

IE Name	Range/Unit	Arg.	*	Description
EGPRS BEP Total (Variance)	0 ... 7 See Description	–		Short-term variance of bit error probability extracted from Layer 1. Coded according to the table in ▶ 3GPP 45.008, section 8.2.5.
EGPRS Link Quality Control UL	Text	–		Indicates whether Link Adaptation (LA) or Incremental Redundancy (IR) is used on the uplink.
EGPRS Window Size DL	64 ... 1024 RLC blocks	–		Retransmission buffer size on downlink (RLC protocol level).
EGPRS Window Size UL	64 ... 1024 RLC blocks	–		EDGE retransmission buffer size on uplink (RLC protocol level).
FER Actual (%)	0 ... 100 %	–	g–hs–	Frame erasure rate, calculated taking DTX into account, i.e. the figure is based only on blocks actually transmitted. Valid for voice only.
FER Full (%)	0 ... 100 %	–		Frame erasure rate, Full value. Calculated as the percentage of the total number of blocks that was erased. A block is erased when the parity check (CRC) fails.
FER Sub (%)	0 ... 100 %	–		Frame erasure rate, Sub value. For the calculation, see FER Full (%).
Firmware Version	Text	–		Version number of device firmware.

IE Name	Range/Unit	Arg.	*	Description
Forced GPRS Class	0, 2	–	g	Use of GPRS class forcing function in device. 0: Not activated 2: Activated Not supported by any currently connectable devices; see section 4.1 for details.
Forced Multislot Class	0, 2	–	g	Use of GPRS multislot class forcing function in device. 0: Not activated 2: Activated Not supported by any currently connectable devices; see section 4.1 for details.
Forced Power Class	0, 2	–		Use of power class forcing function in device. 0: Not activated 2: Activated Not supported by any currently connectable devices; see section 4.1 for details.
Forced Quality Of Service	0, 2	–	g	Use of PDP Context Request modification function in device. 0: Not activated 2: Activated Not supported by any currently connectable devices; see section 4.1 for details.
Frequency Band	Text	–		Frequency band of BCCH carrier, e.g. “850”, “1800”, “900E”, “900R”.
Frequency Band (Num)	450 ... 1900 MHz	–		Frequency band of BCCH carrier in numeric format.
Frequency Band For TCH	Text	–		Frequency band of current traffic channel or channels, e.g. “850”, “1800”, “900E”, “900R”.

IE Name	Range/Unit	Arg.	*	Description
GA-RC/ GA-CSR State	1 ... 4	–	ga	State of GA-RC or GA-CSR protocol. 1: GA-RC Deregistered 2: GA-RC Registered 3: GA-CSR Idle 4: GA-CSR Dedicated
GA-RC/ GA-CSR State (Text)	Text	–	ga	Same as GA-RC/ GA-CSR State but in text format.
GAN Access Point MAC Address	Text	–	ga	MAC address of connected WLAN access point (BSSID in ▶ IEEE 802.11).
GAN Access Point SSID	Text	–	ga	Service Set Identifier of connected WLAN access point.
GAN GERAN Cell Id	0 ... 65535	–	ga	Cell Identity in the GSM EDGE Radio Access Network (GERAN). Included in Register and Discovery messages if the device is in an area with GSM coverage and GSM-RR is the serving RR entity. Retrieved from GSM System Information.
GAN GERAN LAC	0 ... 65535	–	ga	Location Area Code in the GSM network. Retrieved from GSM System Information.
GAN GERAN MCC	000 ... 999	–	ga	Mobile Country Code in the GSM network. Retrieved from GSM System Information.
GAN GERAN MNC	000 ... 999	–	ga	Mobile Network Code in the GSM network. Retrieved from GSM System Information.

IE Name	Range/Unit	Arg.	*	Description
GAN GSM Coverage Indicator	0 ... 3	–	ga	Used to indicate the presence of GERAN coverage in the device’s current location. 0: Normal service 1: Limited service 2: Device has not found GERAN coverage 3: Device has found GERAN coverage, service state unknown
GAN GSM Coverage Indicator (Text)	Text	–	ga	Same as GAN GSM Coverage Indicator but in text format.
GAN Redirect Counter	0 ... 255	–	ga	Indicates to the GANC the number of times the device has been redirected (from one GANC to another) without obtaining service.
GAN WLAN Quality Level	0 ... 5	–	ga	WLAN signal level. 0: Unusable 1: Poor 2: Adequate 3: Good 4: Excellent 5: Not applicable
GAN WLAN Quality Level (Text)	Text	–	ga	Same as GAN WLAN Quality Level but in text format.
GAN WLAN RSSI	–254 ... 0 dBm	–	ga	WLAN received signal strength.
GANC IP Address	Text	–	ga	Points to the default GANC the device should use.
GANC SEGW IP Address	Text	–	ga	Points to the default GANC Security Gateway the MS should use.
GMM State	Text	–	g	State of GMM protocol: “Idle”, “Ready”, or “Standby”.

IE Name	Range/Unit	Arg.	*	Description
GRR State	Text	–	g	State of GRR protocol: “Packet Idle” or “Packet Transfer”.
Hardware	Text	–		Device model.
Hardware ID	Text	–		Device IMEI. ▶ 3GPP 23.003
Heading (deg)	0 ... 360 degrees	–	p	Direction of travel measured in degrees clockwise from north.
Hopping	Text	–		Use of frequency hopping (“YES”/”NO”).
Hopping List	Text	–	h	ARFCNs of the channels in the hopping frequency list, for example “1, 10, 19, 28”.
HSN	0 ... 63	–	h	Hopping Sequence Number, indicating which hopping frequency list to use.
Idle Channel Quality	0, 2	–		Use of idle mode RxQual measurement function in device. 0: Not activated 2: Activated Not supported by any currently connectable devices; see section 4.1 for details.
Ignore Cell Barred	0, 2	–		Use of ignore/reverse cell barred function in device. See UM sections 13.8, 14.3.2.5, 14.4.2. 0: Not activated 2: Activated
Interference Measured ARFCN	See ARFCN BCCH	–	si	The ARFCN scanned for interferers during interference scanning. (Interference scanning is no longer supported by any connectable devices.)

IE Name	Range/Unit	Arg.	*	Description
Interference BCCH ARFCN	See ARFCN BCCH	–	si	The BCCH ARFCN of the serving cell locked on during interference scanning. (Interference scanning is no longer supported by any connectable devices.)
Internal GPS Coverage (%)	0 ... 100 %	–		Percentage of valid GPS positions from the device's internal GPS.
Internal GPS Delta Difference (m)	0 ... 100 m	–	p	Difference in reported position between the device's internal GPS and the GPS currently selected as "Preferred" in TEMS Investigation.
LAC	0 ... 65535	–		Location Area Code.
LAC (Hex)	Text: 0000 ... FFFF	–		Same as LAC, but coded as hexadecimal.
Latitude	–90 ... 90 degrees	–	p	Latitude recorded by positioning equipment.
Latitude (Text)	Text	–	p	Latitude as text. For the presentation format, see TR section 3.4.
Latitude Decimal Degrees (Text)	Text	–	p	Latitude in decimal degrees, presented as text.
LLC BLER DL (%)	0 ... 100 %	–	g	Percentage of LLC data blocks erroneously decoded on downlink.
LLC BLER UL (%)	0 ... 100 %	–	g	Percentage of LLC data blocks resent on uplink.
LLC Bytes Received DL	0 ... $2 \cdot 10^9$ bytes	–	g	Number of bytes received at the LLC protocol level since PS attach.

IE Name	Range/Unit	Arg.	*	Description
LLC Bytes Sent UL	0 ... 2 · 10^9 bytes	–	g	Number of bytes sent at the LLC protocol level since PS attach.
LLC Throughput DL (kbit/s)	0 ... 384 kbit/s	–	g	Data throughput (including protocol headers, but excluding retransmissions) on downlink at the LLC protocol level.
LLC Throughput UL (kbit/s)	0 ... 384 kbit/s	–	g	Data throughput (including protocol headers, but excluding retransmissions) on uplink at the LLC protocol level.
LLC Window Size DL	1 ... 255 LLC blocks	–		LLC retransmission buffer size on downlink.
LLC Window Size UL	1 ... 255 LLC blocks	–		LLC retransmission buffer size on uplink.
Longitude	–180 ... 180 degrees	–	p	Longitude recorded by positioning equipment.
Longitude (Text)	Text	–	p	Longitude as text. For the presentation format, see TR section 3.4.
Longitude Decimal Degrees (Text)	Text	–	p	Longitude in decimal degrees, presented as text.
MAC Mode DL	0 ... 3	–	g	Type of GPRS connection on downlink: 0: Dynamic Allocation 1: Extended Dynamic Allocation 2: Fixed Allocation, not half duplex mode 3: Fixed Allocation, half duplex mode
MAC Mode DL (Text)	Text	–	g	Same as MAC Mode DL but in text format.
MAC Mode UL	0 ... 3	–	g	Type of GPRS connection on uplink. See MAC Mode DL.

IE Name	Range/Unit	Arg.	*	Description
MAC Mode UL (Text)	Text	–	g	Same as MAC Mode UL but in text format.
MAIO	0 ... 63	–	h	Mobile Allocation Index Offset. Indicates where in the hopping frequency list to start. Valid only if frequency hopping is used. ▶ 3GPP 45.002
MCC	000 ... 999	–		Mobile Country Code.
MCS-*n* DL Usage (Own Data) (%), *n* = 1 ... 9	0 ... 100 %	0 ... 7		These elements contain the distribution of modulation coding scheme usage (on the downlink and for own data only) for each timeslot. **Argument:** 0 represents the first used timeslot (*not* TS 0), etc.
Message Hex Dump Payload	Text	–		Contains the hexadecimal string of a Layer 3 message or mode report. Used for text-format logfile export only.
MNC	000 ... 999	–		Mobile Network Code. May consist of two or three digits.
Mode	Text	–		Same as “Mode (Num)” (which see) but in text format: “No service” etc.
Mode (Num)	1 ... 7	–		1: No service 2: Idle mode 3: Dedicated mode 4: Limited service mode 5: Scan mode 6: Packet mode 7: Packet Idle mode
Modulation DL	Text	–		Type of modulation on downlink.
Modulation UL	Text	–		Type of modulation on uplink.

IE Name	Range/Unit	Arg.	*	Description
MS Behavior Modified	Text: “B”, “C”, “G”, or a combination of these letters (or empty string)	–		Indicates whether the UE’s behavior has been changed from the default. Most of what follows is applicable only to Sony Ericsson GSM phones. Empty string: No modification of UE behavior “B”: Modification of behavior not related to channel selection (the information elements Adjacent Scan, Band Control, Forced Power Class, Idle Channel Quality) “C”: Modification of channel selection behavior (the information elements Disable Handover, Ignore Cell Barred, Prevent Handover List Active, Prevent Serving Cell List, Serving Cell List Active, Target Handover) “G”: Modification of GPRS behavior (the information elements Forced GPRS Class, Forced Multislot Class, Forced Quality Of Service). Any combination of these letters may appear.
MS Power Control Level	0 ... 31 See Description	–		UE transmit power ordered by the base station, mapped to a number between 0 and 31 according to the tables in ▶ 3GPP 45.005, section 4.1.1. Valid only in dedicated mode.

IE Name	Range/Unit	Arg.	*	Description
MS Tx Power (dBm)	GSM 850: 5 ... 39 GSM 900: 5 ... 39 GSM 1800: 0 ... 36 GSM 1900: 0 ... 33 dBm	–		UE transmit power in dBm. Valid only in dedicated mode.
Multiband Reporting	0, 2	–		Not used; the feature has been removed from TEMS Investigation. The element is retained in order to maintain compatibility with old logfiles.
Neighbor IEs: General remark	A number of elements have been left out of the table. These are the "Neighbor ... Band and SS ..." elements, which are mere variants of the ordinary "Neighbor" elements and are used in the status window Serving + Neighbors By Band (see section 10.1.1). What differs is the sorting order: first by band and then, within each band, by signal strength.			
Neighbor ARFCN	See ARFCN BCCH	1 ... 32		ARFCNs of neighbor cells, sorted by ARFCN. **Argument:** 1 gives the lowest ARFCN, etc.
Neighbor ARFCN (Sorted)	See ARFCN BCCH	1 ... 32		ARFCNs of neighbor cells, sorted by signal strength. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor BSIC	Text	1 ... 32		Base Station Identity Codes for neighbor cells (in text format), sorted by ARFCN. **Argument:** 1 represents the lowest ARFCN, etc.

IE Name	Range/Unit	Arg.	*	Description
Neighbor BSIC (Num)	00 ... 77 (octal)	1 ... 32		Base Station Identity Codes for neighbor cells (in numeric format), sorted by ARFCN. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor BSIC (Sorted)	Text	1 ... 32		Base Station Identity Codes for neighbor cells (in text format), sorted by signal strength. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor BSIC (Num) (Sorted)	00 ... 77 (octal)	1 ... 32		Base Station Identity Codes for neighbor cells (in numeric format), sorted by signal strength. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor C1	–127 ... 127 dB	1 ... 32		Pathloss parameter C1 for neighbor cells, sorted by ARFCN. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor C1 (Sorted)	–127 ... 127 dB	1 ... 32		Pathloss parameter C1 for neighbor cells, sorted by signal strength. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor C2	–127 ... 127 dB	1 ... 32		Cell reselection parameter C2 for neighbor cells, sorted by ARFCN. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor C2 (Sorted)	–127 ... 127 dB	1 ... 32		Cell reselection parameter C2 for neighbor cells, sorted by signal strength. **Argument:** 1 represents the strongest neighbor, etc.

IE Name	Range/Unit	Arg.	*	Description
Neighbor C31	–127 ... 127 dB	1 ... 32	g	GPRS signal strength threshold criterion C31 for neighbor cells, sorted by ARFCN. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor C31 (Sorted)	–127 ... 127 dB	1 ... 32	g	GPRS signal strength threshold criterion C31 for neighbor cells, sorted by signal strength. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor C32	–127 ... 127 dB	1 ... 32	g	GPRS cell ranking criterion C32 for neighbor cells, sorted by ARFCN. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor C32 (Sorted)	–127 ... 127 dB	1 ... 32	g	GPRS cell ranking criterion C32 for neighbor cells, sorted by signal strength. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor Cell Id	0 ... 65535	1 ... 32		Cell identities of neighbor cells, sorted by ARFCN. Decimal format. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor Cell Id (Sorted)	0 ... 65535	1 ... 32		Cell identities of neighbor cells, sorted by signal strength. Decimal format. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor Cell Id (Hex)	Text: “0000” ... “FFFF”	1 ... 32		Cell identities of neighbor cells, sorted by ARFCN. Hexadecimal format. **Argument:** 1 represents the lowest ARFCN, etc.

IE Name	Range/Unit	Arg.	*	Description
Neighbor Cell Id (Hex) (Sorted)	Text: "0000" ... "FFFF"	1 ... 32		Cell identities of neighbor cells, sorted by signal strength. Hexadecimal format. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor Cell Name	Text	1 ... 32	c	Names of neighbor cells, sorted by ARFCN. Requires cell file. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor Cell Name (Sorted)	Text	1 ... 32	c	Names of neighbor cells, sorted by signal strength. Requires cell file. **Argument:** 1 represents the strongest neighbor, etc.

IE Name	Range/Unit	Arg.	*	Description
Neighbor Cell Name Algorithm	1 ... 6	1 ... 32	c	Indicates, for each neighbor cell, the input used by the algorithm determining the neighbor cell name, and the result of the cell search (where applicable): 1: MCC, MNC, LAC, CI used. 2: BSIC, ARFCN, and position information used. Unique cell found matching the parameters within a 35 km radius. 3: BSIC, ARFCN, and position information used. Several matching cells found within a 35 km radius, closest cell selected. 4: Serving cell found with the method denoted by Cell Name Algorithm = 1; this neighbor identified as a cell appearing in the serving cell's neighbor list and having matching BSIC and ARFCN. 5: Serving cell found with the method denoted by Cell Name Algorithm = 2; this neighbor identified as a cell appearing in the serving cell's neighbor list and having matching BSIC and ARFCN. 6: Serving cell found with the method denoted by Cell Name Algorithm = 3; this neighbor identified as a cell appearing in the serving cell's neighbor list and having matching BSIC and ARFCN. Neighbors are sorted by ARFCN. – Requires cell file. **Argument:** 1 represents the lowest ARFCN, etc.

IE Name	Range/Unit	Arg.	*	Description
Neighbor Cell Name Algorithm (Sorted)	1 ... 6	1 ... 32	c	Same as Neighbor Cell Name Algorithm but sorted by signal strength. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor LAC	0 ... 65535	1 ... 32		Location Area Codes for neighbor cells, sorted by ARFCN. Decimal format. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor LAC (Sorted)	0 ... 65535	1 ... 32		Location Area Codes for neighbor cells, sorted by signal strength. Decimal format. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor LAC (Hex)	Text: “0000” ... “FFFF”	1 ... 32		Location Area Codes for neighbor cells, sorted by ARFCN. Hexadecimal format. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor LAC (Hex) (Sorted)	Text: “0000” ... “FFFF”	1 ... 32		Location Area Codes for neighbor cells, sorted by signal strength. Hexadecimal format. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor RxLev	–10 ... 100 GSM RxLev units	1 ... 32		Received signal strength of neighbors, sorted by ARFCN. **Argument:** 1 represents the lowest ARFCN, etc.
Neighbor RxLev (Sorted)	–10 ... 100 GSM RxLev units	1 ... 32		Received signal strength of neighbors, sorted in descending order. **Argument:** 1 represents the strongest neighbor, etc.
Neighbor RxLev (dBm)	–120 ... –10 dBm	1 ... 32		Same as Neighbor RxLev but in dBm.

IE Name	Range/Unit	Arg.	*	Description
Neighbor RxLev (dBm) (Sorted)	–120 ... –10 dBm	1 ... 32		Same as Neighbor RxLev (Sorted) but in dBm.
Neighbor (SI) ARFCN	Text	–	s	Neighbor list (obtained from System Information) of strongest cell scanned. The list is given in text format, for example: "[ARFCN: 17, BSIC: 3-2] 7, 18, 32". The data within square brackets pertains to the strongest cell, and the neighbor ARFCNs follow.
Network Control Order	Text	–	g	Cell reselection behavior of device. One of "NC0", "NC1", "NC2": NC0: MS reselection, no measurement reports NC1: MS reselection, measurement reports NC2: Network reselection ▶ 3GPP 45.008, section 10.1.4
Network Mode Of Operation	Text	–	g	Handling of paging in the network. I: All paging on GPRS channels; Gs signaling interface present II: All paging on PCH; no Gs III: All circuit-switched paging on PCH, all packet-switched paging on PPCH; no Gs.
Number Of Hopping Frequencies	0 ... 64	–	h	Number of frequencies in hopping list.
Number Of Used Timeslots DL	0 ... 8	–	g hs	Number of timeslots in use on downlink.

IE Name	Range/Unit	Arg.	*	Description
Number Of Used Timeslots UL	0 ... 8	–	g hs	Number of timeslots in use on uplink.
PBCCH Timeslot	0 ... 7	–	g	Timeslot used for PBCCH/ PCCCH, if any.
PDCH IEs: General remark	The **argument** represents a timeslot but is just a sequence number. That is, 0 represents the first used timeslot, 1 the second, etc.; the argument value does *not* equate to the corresponding timeslot index.			
PDCH Utilization Control DL (%)	0 ... 100 %	0 ... 7	g	Percentage of downlink PDCH capacity currently used for control signaling, or not used at all.
PDCH Utilization Control UL (%)	0 ... 100 %	0 ... 7	g	Percentage of the available uplink PDCH capacity currently used for control signaling.
PDCH Utilization Other Data DL (%)	0 ... 100 %	0 ... 7	g	Percentage of the downlink PDCH capacity currently used for other users' data.
PDCH Utilization Own Data DL (%)	0 ... 100 %	0 ... 7	g	Percentage of the downlink PDCH capacity currently used for own data.
PDCH Utilization Own Data UL (%)	0 ... 100 %	0 ... 7	g	Percentage of the available uplink PDCH capacity currently used for own data.
PDCH Utilization Free Data UL (%)	0 ... 100 %	0 ... 7	g	Percentage of the available uplink PDCH capacity that is currently unused.
PDP IEs: General remark	The **argument**, where present, refers to a PDP context index.			
PDP Access Point Name	Text	1 ... 11	g	Host name or network address for each active PDP context.
PDP Address	Text	1 ... 11	g	User address (IPv4/IPv6).

IE Name	Range/Unit	Arg.	*	Description
PDP Context Time (ms)	0 ... 60000 ms	–	g	Time from PDP Context Activation Request to PDP Context Activation Accept.
PDP Contexts Active	0 ... 11	–	g	Number of active PDP contexts.
PDP Delay Class	Text	1 ... 11	g	Delay class as defined by subscription.
PDP LLC SAPI	3 ... 11	1 ... 11	g	LLC Service Access Point Identifier.
PDP Mean Throughput	Text	1 ... 11	g	Mean throughput as defined by subscription.
PDP NSAPI	5 ... 15	1 ... 11	g	Network SAPI (Service Access Point Identifier).
PDP Peak Throughput	Text	1 ... 11	g	Peak throughput as defined by subscription.
PDP Precedence Class	Text	1 ... 11	g	Precedence class as defined by subscription.
PDP Radio Priority	Text	1 ... 11	g	Radio priority level as defined by subscription.
PDP Reliability Class	Text	1 ... 11	g	Reliability class as defined by subscription.
Preferred GAN Mode	0, 2	–	ga	Indicates whether a selection has been made on the GAN Mode Selection tab of the device’s property page. 0: No 2: Yes Not supported by any currently connectable devices; see section 4.1 for details.

IE Name	Range/Unit	Arg.	*	Description
Prevent Handover List Active	0, 2	–		Use of prevent handover function in device (handover to certain cells prevented in dedicated mode). See UM sections 13.9, 14.3.2.8. 0: Not activated 2: Activated
Prevent Serving Cell List	0, 2	–		Use of “prevent cell selection” function in device (camping on selected cells prevented in idle mode). See UM sections 13.9, 14.3.2.6. 0: Not activated 2: Activated
Q Search Power	Text	–		GPRS signal level criterion governing when to search for 3G cells (e.g. “Above –74 dBm”, “Below –54 dBm”, “Always”, “Never”). ▶ 3GPP 45.008, section 10.4
RAC	0 ... 255	–	g	Routing Area Code (8 bits).
RAC (Hex)	Text: “00” ... “FF”	–	g	Same as RAC, but coded as hexadecimal.
Radio Link Timeout Current	0 ... 64	–		Current value of Radio Link Timeout counter. ▶ 3GPP 45.008, section 5.2 Valid only in dedicated mode.
Radio Link Timeout Max	4, 8, ..., 64	–		Initial value of Radio Link Timeout counter. ▶ 3GPP 45.008, section 5.2 Valid only in dedicated mode.
RLA_P	–10 ... 100 GSM RxLev units	–	g	Received Level Average. GPRS signal strength measure. ▶ 3GPP 45.008, section 10.1
RLA_P (dBm)	–120 ... –10 dBm	–	g	Same as RLA_P but in dBm.

IE Name	Range/Unit	Arg.	*	Description
RLC BLER DL (%)	0 ... 100 %	–	g	Percentage of RLC data blocks erroneously decoded on downlink.
RLC BLER UL (%)	0 ... 100 %	–	g	Percentage of RLC data blocks resent on uplink.
RLC Block BSN IEs	0 ... 127	0 ... 23	g	RLC/MAC Block Sequence Number from header of data blocks. One element for each timeslot on downlink and uplink. Used for text-format logfile export only. **Argument:** Points to an individual GPRS radio block.
RLC Block Dump IEs	Text	0 ... 23	g	RLC/MAC block header as hex string (e.g. “80 1a 20”), for both data and control blocks. One element for each timeslot on downlink and uplink. Used for text-format logfile export only. **Argument:** Points to an individual GPRS radio block.
RLC Block TFI IEs	0 ... 31	0 ... 23	g	RLC/MAC Temporary Flow Identifier from header of control and data blocks. One element for each timeslot on downlink and uplink. Used for text-format logfile export only. **Argument:** Points to an individual GPRS radio block.

IE Name	Range/Unit	Arg.	*	Description
RLC Block Type IEs	Text	0 ... 23	g	RLC/MAC block type as string. Downlink: "Data Block to this MS", "Data Block to other MS", or "Control Block". Uplink: "Allowed but no data sent", "Data Block sent", "Control Block sent", or "Forbidden". One element for each timeslot on downlink and uplink. Used for text-format logfile export only. **Argument:** Points to an individual GPRS radio block.
RLC Bytes Received DL	0 ... $2 \cdot 10^9$ bytes	–	g	Number of bytes received at the RLC protocol level since GPRS attach.
RLC Bytes Sent UL	0 ... $2 \cdot 10^9$ bytes	–	g	Number of bytes sent at the RLC protocol level since GPRS attach.
RLC Throughput DL (kbit/s)	0 ... 384 kbit/s	–	g	Data throughput (including protocol headers, but excluding retransmissions) on downlink at RLC protocol level.
RLC Throughput DL (%)	0 ... 100 %	–	g	Data throughput (as defined above) on downlink at RLC protocol level, relative to theoretical maximum for current channel setup (coding scheme, number of timeslots).
RLC Throughput UL (kbit/s)	0 ... 384 kbit/s	–	g	Data throughput (including protocol headers, but excluding retransmissions) on uplink at RLC protocol level.

IE Name	Range/Unit	Arg.	*	Description
RLC Throughput UL (%)	0 ... 100 %	–	g	Data throughput (as defined above) on uplink at RLC protocol level, relative to theoretical maximum for current channel setup (coding scheme, number of timeslots).
RLP BLER DL (%)	0 ... 100 %	–	hs	Percentage of RLP data blocks erroneously decoded on downlink.
RLP BLER UL (%)	0 ... 100 %	–	hs	Percentage of RLP data blocks resent on uplink.
RLP Bytes Received DL	0 ... $2 \cdot 10^9$ bytes	–	hs	Number of bytes received at the RLP protocol level since dial-up.
RLP Bytes Sent UL	0 ... $2 \cdot 10^9$ bytes	–	hs	Number of bytes sent at the RLP protocol level since dial-up.
RLP Throughput DL (kbit/s)	0 ... 60 kbit/s	–	hs	Data throughput (including protocol headers, but excluding retransmissions) on downlink at RLP protocol level.
RLP Throughput DL (%)	0 ... 100 %	–	hs	Data throughput (as defined above) on downlink at RLP protocol level, relative to theoretical maximum for current channel setup (coding scheme, number of timeslots).
RLP Throughput UL (kbit/s)	0 ... 60 kbit/s	–	hs	Data throughput (including protocol headers, but excluding retransmissions) on uplink at RLP protocol level.
RLP Throughput UL (%)	0 ... 100 %	–	hs	Data throughput (as defined above) on uplink at RLP protocol level, relative to theoretical maximum for current channel setup (coding scheme, number of timeslots).

IE Name	Range/Unit	Arg.	*	Description
RxLev Full	–10 ... 100 GSM RxLev units	–		Received signal strength (Full value) expressed in GSM RxLev units.
RxLev Full (dBm)	–120 ... –10 dBm	–		Received signal strength (Full value) expressed in dBm.
RxLev Full In Service	–10 ... 100 GSM RxLev units	–		Same as RxLev Full but valid only when the device is in idle, dedicated, packet idle, or packet dedicated mode. Not valid when in limited service or no service mode.
RxLev Full In Service (dBm)	–120 ... –10 dBm	–		Same as RxLev Full (dBm) but valid only when the device is in idle, dedicated, packet idle, or packet dedicated mode. Not valid when in limited service or no service mode.
RxLev Sub	–10 ... 100 GSM RxLev units	–		Received signal strength (Sub value) expressed in GSM RxLev units.
RxLev Sub (dBm)	–120 ... –10 dBm	–		Received signal strength (Sub value) expressed in dBm.
RxLev Sub In Service	–10 ... 100 GSM RxLev units	–		Same as RxLev Sub but valid only when the device is in idle, dedicated, packet idle, or packet dedicated mode. Not valid when in limited service or no service mode.
RxLev Sub In Service (dBm)	–120 ... –10 dBm	–		Same as RxLev Sub (dBm) but valid only when the device is in idle, dedicated, packet idle, or packet dedicated mode. Not valid when in limited service or no service mode.

IE Name	Range/Unit	Arg.	*	Description
RxQual Full	0 ... 7 See Description	–		Received signal quality (Full value), calculated from the bit error rate according to the table in ▶ 3GPP 45.008, section 8.2.4.
RxQual Full (%)	0 ... 26 %	–		Bit error rate in percent (%) corresponding to RxQual Full.
RxQual Sub	0 ... 7 See Description	–		Received signal quality (Sub value), calculated from the bit error rate according to the table in ▶ 3GPP 45.008, section 8.2.4.
RxQual Sub (%)	0 ... 26 %	–		Bit error rate in percent (%) corresponding to RxQual Sub.
Scanned Adjacent ARFCN –2	See ARFCN BCCH	0 ... 63	h+	*C/A measurement:* ARFCNs of channels at –400 kHz. **Argument:** 0 means the channel adjacent to the first channel in the hopping list, etc.
Scanned Adjacent ARFCN –1	See ARFCN BCCH	0 ... 63	h+	Same as Scanned Adjacent ARFCN –2 but for the channels at –200 kHz.
Scanned Adjacent ARFCN C0	See ARFCN BCCH	0 ... 63	h+	*C/A measurement:* ARFCNs used by current serving cell. BCCHs are shown in idle mode, TCHs in dedicated mode. Note that this element does not itself refer to an adjacent channel but to the C_0. **Argument:** 0 means the first channel in the hopping list, etc.
Scanned Adjacent ARFCN +1	See ARFCN BCCH	0 ... 63	h+	Same as Scanned Adjacent ARFCN –2 but for the channels at +200 kHz.

IE Name	Range/Unit	Arg.	*	Description
Scanned Adjacent ARFCN +2	See ARFCN BCCH	0 ... 63	h+	Same as Scanned Adjacent ARFCN –2 but for the channels at +400 kHz.
Scanned Adjacent RxLev –2 (dBm)	–120 ... –10 dBm	0 ... 63	h+	*C/A measurement:* Scanned signal strength of the channels at –400 kHz. **Argument:** 0 gives the RxLev of the channel adjacent to the first channel in the hopping list, etc.
Scanned Adjacent RxLev –1 (dBm)	–120 ... –10 dBm	0 ... 63	h+	*C/A measurement:* Same as Scanned Adjacent RxLev –2 (dBm) but applies to channels at –200 kHz.
Scanned Adjacent RxLev C0 (dBm)	–120 ... –10 dBm	0 ... 63	h+	*C/A measurement:* Scanned signal strength of the channels used by the current serving cell. That is, BCCHs in idle mode and TCHs in dedicated mode. Note that this element does not itself refer to an adjacent channel but to the C_0. **Argument:** 0 gives the RxLev of the first channel in the hopping list, etc.
Scanned Adjacent RxLev +1 (dBm)	–120 ... –10 dBm	0 ... 63	h+	*C/A measurement:* Same as Scanned Adjacent RxLev –2 (dBm) but applies to channels at +200 kHz.
Scanned Adjacent RxLev +2 (dBm)	–120 ... –10 dBm	0 ... 63	h+	*C/A measurement:* Same as Scanned Adjacent RxLev –2 (dBm) but applies to channels at +400 kHz.
Scanned ARFCN	See ARFCN BCCH	0 ... 846	s	ARFCNs of scanned channels. **Argument:** 0 points to the channel with the lowest *frequency*, etc. (*not* ARFCN).

IE Name	Range/Unit	Arg.	*	Description
Scanned Band	450 ... 1900 MHz	0 ... 846	s	Frequency bands of scanned channels in numeric format. **Argument:** 0 points to the channel with the lowest *frequency*, etc. (*not* ARFCN).
Scanned BSIC	00 ... 77 (octal)	0 ... 846	s	BSICs of scanned channels. **Argument:** 0 gives the BSIC of the channel with the lowest frequency, etc. (*not* ARFCN).
Scanned BSIC On ARFCN	00 ... 77 (octal)	See range of ARFCN BCCH	s	BSICs of scanned channels. **Argument:** ARFCN.
Scanned C/A –2 (dB)	–100 ... 100 dB	0 ... 63	h+	*C/A measurement:* C/A values corresponding to Scanned Adjacent RxLev –2 (dBm).
Scanned C/A –1 (dB)	–100 ... 100 dB	0 ... 63	h+	*C/A measurement:* C/A values corresponding to Scanned Adjacent RxLev –1 (dBm).
Scanned C/A +1 (dB)	–100 ... 100 dB	0 ... 63	h+	*C/A measurement:* C/A values corresponding to Scanned Adjacent RxLev +1 (dBm).
Scanned C/A +2 (dB)	–100 ... 100 dB	0 ... 63	h+	*C/A measurement:* C/A values corresponding to Scanned Adjacent RxLev +2 (dBm).
Scanned C/I	–5 ... 35 dB	0 ... 846	s	C/I values for scanned channels. **Argument:** 0 points to the channel with the lowest frequency, etc. (*not* that with the lowest ARFCN).

IE Name	Range/Unit	Arg.	*	Description
Scanned Cell Name	Text	0 ... 846	c s	Cell names for scanned channels. Obtained only if both ARFCN and BSIC are scanned. Requires cell file. **Argument:** 0 points to the channel with the lowest frequency, etc. (*not* ARFCN).
Scanned Channels No Of	0 ... 847	–	s	Number of channels currently scanned.
Scanned RxLev	–10 ... 100 GSM RxLev units	0 ... 846	s	Received signal strength of scanned channels. **Argument:** 0 points to the channel with the lowest frequency, etc. (*not* ARFCN).
Scanned RxLev (dBm)	–120 ... –10 dBm	0 ... 846	s	Same as Scanned RxLev but in dBm.
Scanned RxLev On ARFCN	–10 ... 100 GSM RxLev units	See range of ARFCN BCCH	s	Received signal strength of scanned channels. **Argument:** ARFCN.
Scanned RxLev On ARFCN (dBm)	–120 ... –10 dBm	See range of ARFCN BCCH	s	Same as Scanned RxLev On ARFCN but in dBm.
Serving Cell Allocation List	Text	–		ARFCNs of all TCHs allocated to the serving cell. This set may be larger than the Hopping List.
Serving Cell List Active	0, 1, 2	–		Use of “lock on channel” function in device. See UM sections 13.9, 14.3.2.6, 14.4.1. 0: Not activated 1: Ordered by user, but not yet activated 2: Activated

IE Name	Range/Unit	Arg.	*	Description
Signal Strength Hopping List	–120 ... –10 dBm	0 ... 63	h+	Signal strength of each channel in the hopping list. This element thus gives more information than RxLev, which is an average over all channels in the hopping list. **Argument:** 0 means the first channel in the hopping list, etc. Not supported by any currently connectable devices; see section 4.1 for details.
Signal Strength On BCCH Carrier	–120 ... –10 dBm	–		Signal strength on the current BCCH. Especially useful for obtaining a correct measure of the cell size when frequency hopping is used and power control is applied to the TCHs. The following steps are used to find a value for the element: 1 Neighbor list. If the BCCH frequency is in the neighbor list, report its signal strength. 2 Hopping list. If the BCCH is used as hopping frequency (in dedicated mode), report its signal strength. 3 Idle mode. If the device is in idle mode, report RxLev (dBm). If frequency hopping is not used, step 2 becomes “If BCCH = TCH ...”. Invalid if no value is found in any of the above steps.
SNDCP BLER DL (%)	0 ... 100 %	–	g	Percentage of SNDCP data blocks erroneously decoded on downlink.

IE Name	Range/Unit	Arg.	*	Description
SNDCP BLER UL (%)	0 ... 100 %	–	g	Percentage of SNDCP data blocks resent on uplink.
SNDCP Bytes Received DL	0 ... $2 \cdot 10^9$ bytes	–	g	Number of bytes received at the SNDCP protocol level since GPRS attach.
SNDCP Bytes Sent UL	0 ... $2 \cdot 10^9$ bytes	–	g	Number of bytes sent at the SNDCP protocol level since GPRS attach.
SNDCP Throughput DL (kbit/s)	0 ... 384 kbit/s	–	g	Data throughput (including protocol headers, but excluding retransmissions) on downlink at SNDCP protocol level.
SNDCP Throughput UL (kbit/s)	0 ... 384 kbit/s	–	g	Data throughput (including protocol headers, but excluding retransmissions) on uplink at SNDCP protocol level.
Spectr Ana IEs: General remark	These elements are obtained from spectrum analysis. The **argument**, where present, is simply a sequence number pointing to scanned frequencies as indicated by the "Spectr Ana Sc DL Freq" element.			
Spectr Ana Sc DL Freq	930 ... 960 MHz	1 ... 2560	ss	Spectrum analysis: Scanned frequencies on downlink in ascending order.
Spectr Ana Sc DL No of Freq	0 ... 2560	–	ss	Spectrum analysis: The number of downlink frequencies swept by the scan.
Spectr Ana Sc DL RSSI (dBm)	–130 ... –20 dBm	1 ... 2560	ss	Spectrum analysis: RSSI of downlink frequencies scanned.
Speech Codec	Text	–		Currently used speech codec, e.g. "EFR".
Speed (km/h)	0 ... 250 km/h	–	p	Speed in km/h.
Speed (mph)	0 ... 155 mph	–	p	Speed in mph.

IE Name	Range/Unit	Arg.	*	Description
SQI	–20 ... 30 dBQ	–	g–	Speech Quality Index. See UM chapter 42. The range depends on the speech codec used: HR (Half Rate): –20 ... 17 dBQ FR (Full Rate): –19 ... 22 dBQ EFR (Enhanced Full Rate): –20 ... 30 dBQ AMR: Dependent on codec mode. The maximum SQI values for NB are as follows: 12.2 kbit/s: 30 dBQ 10.2 kbit/s: 28 dBQ 7.95 kbit/s: 28 dBQ 7.40 kbit/s: 27 dBQ 6.70 kbit/s: 27 dBQ 5.90 kbit/s: 24 dBQ 5.15 kbit/s: 21 dBQ 4.75 kbit/s: 19 dBQ Non-existent for GPRS (no voice data in packets).
SQI MOS	1 ... 5 MOS	–	g–	SQI expressed on the MOS scale. See UM chapter 42.
Strongest Scanned ARFCN	See ARFCN BCCH	0 ... 846	s	ARFCNs of scanned channels sorted by decreasing signal strength. **Argument:** Except in the case of neighbor list scanning, 0 means the strongest channel of those currently scanned, etc. When neighbor list scanning is performed, all neighbors come first, and then all other channels follow, both channel sets being sorted internally by decreasing signal strength.

IE Name	Range/Unit	Arg.	*	Description
Strongest Scanned Band	450 ... 1900 MHz	0 ... 846	s	Frequency bands of scanned channels sorted by decreasing signal strength. **Argument:** See Strongest Scanned ARFCN.
Strongest Scanned BSIC	Text	0 ... 846	s	BSICs of scanned channels sorted by decreasing signal strength. **Argument:** See Strongest Scanned ARFCN.
Strongest Scanned C/I	–5 ... 35 dB	0 ... 846	s	C/I for scanned channels sorted by decreasing signal strength. **Argument:** See Strongest Scanned ARFCN.
Strongest Scanned Cell Name	Text	0 ... 846	c s	Names of scanned channels sorted by decreasing signal strength. Obtained only if both ARFCN and BSIC are scanned. Requires cell file. **Argument:** See Strongest Scanned ARFCN.
Strongest Scanned RxLev (dBm)	–120 ... –10 dBm	0 ... 846	s	Signal strength of scanned channels in descending order. **Argument:** See Strongest Scanned ARFCN.
Sub Channel Number	0 ... 7	–		Number of subchannel used in SDCCH or TCH half-rate channel.
TA	0 ... 63 See Description	–		Timing Advance. Valid only in dedicated mode. For the significance of the parameter value, see ▶ 3GPP 45.010.

IE Name	Range/Unit	Arg.	*	Description
Target Handover	0, 1, 2	–		Use of lock handover function in device (handover restricted to a chosen set of cells; see UM sections 13.9, 14.3.2.8). 0: Not activated 1: Ordered by user, but not yet activated 2: Activated
TD-SCDMA Neighbor Cell Parameter ID	0 ... 127	1 ... 32		Neighbor Cell Parameter Identity of TD-SCDMA cells measured by TD-SCDMA capable device while in GSM mode. **Argument:** Neighbors sorted by signal strength in descending order.
TD-SCDMA Neighbor No Of	1 ... 32	–		Number of TD-SCDMA neighbors measured in GSM mode.
TD-SCDMA Neighbor RSCP	–116 ... –25 dBm	1 ... 32		Received signal code power of each TD-SCDMA neighbor measured in GSM mode.
TD-SCDMA Neighbor UARFCN	0 ... 16383 (frequency band dependent)	1 ... 32		UARFCN of each TD-SCDMA neighbor measured in GSM mode.
TFI DL	0 ... 31	–	g	Temporary Flow Id on downlink. Used to identify a one-block flow.
TFI UL	0 ... 31	–	g	Temporary Flow Id on uplink. Used to identify a one-block flow.
Time	Text	–		Current time in text format: “hh:mm:ss.dd”, where “dd” = decimal seconds.

IE Name	Range/Unit	Arg.	*	Description
Timeslot IEs: General remark	The **argument**, where present, represents a timeslot but is just a sequence number. That is, 0 represents the first used timeslot, 1 the second, etc.; the argument value does *not* equate to the corresponding timeslot index.			
Timeslot	0 ... 7	–		Timeslot used for current call. Valid only in dedicated mode.
Timeslot Channel Type DL	Text	0 ... 7	g hs	Type of channel in each timeslot on downlink. See Channel Type.
Timeslot Channel Type UL	Text	0 ... 7	g hs	Type of channel in each timeslot on uplink. See Channel Type.
Timeslot Used DL	Text	0 ... 7	g hs	Timeslots used on downlink.
Timeslot Used UL	Text	0 ... 7	g hs	Timeslots used on uplink.
TLLI	0 ... $2^{32} - 1$	–	g	Temporary Logical Link Identifier.
TLLI (Hex)	Text	–	g	Same as TLLI, but coded as hexadecimal.
Training Sequence Code	0 ... 7	–		Current training sequence code.
Uplink State Flag	0 ... 7	0 ... 7	g	Uplink State Flags, one for each timeslot, indicating to the device when it is allowed to send. **Argument:** Timeslot sequence number (compare Timeslot IEs: General remark).
WCDMA Neighbor CPICH Ec/No (dB)	–34 ... 0 dB	1 ... 32		CPICH Ec/No of measured WCDMA neighbors. **Argument:** 1 gives the neighbor with the highest signal strength, etc.

IE Name	Range/Unit	Arg.	*	Description
WCDMA Neighbor CPICH RSCP (dBm)	–140 ... –15 dBm	1 ... 32		CPICH RSCP of measured WCDMA neighbors. **Argument:** See WCDMA Neighbor CPICH Ec/No (dB).
WCDMA Neighbor SC	0 ... 511	1 ... 32		Scrambling codes of measured WCDMA neighbors. **Argument:** See WCDMA Neighbor CPICH Ec/No (dB).
WCDMA Neighbor UARFCN	0 ... 16383 (frequency band dependent)	1 ... 32		UARFCNs of measured WCDMA neighbors. **Argument:** See WCDMA Neighbor CPICH Ec/No (dB).
WCDMA Neighbors No Of	0 ... 32	–		Number of measured WCDMA neighbors.
Weakest Scanned ARFCN	See ARFCN BCCH	0 ... 846	s	ARFCNs of scanned channels sorted by increasing signal strength. **Argument:** Except in the case of neighbor list scanning, 0 means the weakest channel of those currently scanned, etc. When neighbor list scanning is performed, channels are sorted exactly in the opposite order to Strongest Scanned ARFCN. (The “Weakest” element serves no purpose in this context.)
Weakest Scanned Band	450 ... 1900 MHz	0 ... 846	s	Frequency bands of scanned channels sorted by increasing signal strength. **Argument:** See Weakest Scanned ARFCN.

IE Name	Range/Unit	Arg.	*	Description
Weakest Scanned BSIC	Text	0 ... 846	s	BSIC of scanned channels sorted by increasing signal strength. **Argument:** See Weakest Scanned ARFCN.
Weakest Scanned C/I	–5 ... 35 dB	0 ... 846	s	C/I for scanned channels sorted by increasing signal strength. **Argument:** See Weakest Scanned ARFCN.
Weakest Scanned Cell Name	Text	0 ... 846	c s	Names of scanned channels sorted by increasing signal strength. Obtained only if both ARFCN and BSIC are scanned. Requires cell file. **Argument:** See Weakest Scanned ARFCN.
Weakest Scanned RxLev (dBm)	–120 ... –10 dBm	0 ... 846	s	Signal strength of scanned channels in ascending order. **Argument:** See Weakest Scanned ARFCN.

3.2. WCDMA Information Elements

3.2.1. General

3.2.1.1. Properties of Information Elements: The Asterisk Column

In the column marked *, a set of codes is used to identify certain groups of information elements:

Code	Meaning
c	Requires that a cell file has been loaded.
dv	Reported when running DVB-H.
ne	GSM neighbor measurements reported by the UE while in WCDMA mode.
ns	Reported from network search scanning.
p	Reported by positioning equipment, or requires positioning data to make sense.
pi	Reported from pilot scanning.
rs	Reported from RSSI scanning.
ss	Reported from spectrum scanning.
ts	Reported from SCH timeslot scanning.

3.2.1.2. Notes on Quantities Denoting Signal Power

Below is a list of the signal power and power ratio quantities that appear in the names of information elements.

- **Eb:** E_b, scrambling code energy per *bit*.
- **Ec:** E_c, scrambling code energy per *chip*.
- **Es:** E_s, scrambling code energy per *symbol* (as measured by a scanning device during the SCH timeslot scan).
- **No:** N_0, total energy per chip (as measured by a UE).
- **Io:** I_0, total energy per chip (as measured by a scanning device).

- **Ec/No:** E_c/N_0, signal-to-noise ratio (as measured by a UE). Compare **No** above. ▶ 3GPP 25.215, section 5.1.5
- **Ec/Io:** E_c/I_0, signal-to-noise ratio (as measured by a scanning device). Compare **Io** above.
- **SIR:** Signal-to-interference ratio as measured on the DPCCH. ▶ 3GPP 25.215, section 5.2.2
- **RSCP:** Received signal code power, identical with **Ec**: ▶ 3GPP 25.215, section 5.1.5.
- **RSSI:** Received signal strength indicator, identical with **No**: ▶ 3GPP 25.215, section 5.1.5.

Eb and **Ec** are related by the equation

$$E_b \text{ [dBm]} = E_c \text{ [dBm]} + 10 \log_{10} \left(\frac{3.84 \times 10^6}{3 \times 10^4} \right) \text{dB}$$

that is,

$$E_b \text{ [dBm]} \approx E_c \text{ [dBm]} + 21.07 \text{ dB}$$

3.2.1.3. MIMO: Multiple-antenna vs. Single-antenna Information Elements

Certain information elements occur in variants with each of the suffixes "per Antenna" (with argument), "Antenna 1", "Antenna 2", "Sum". Such IEs are populated for MIMO, and the suffixes refer to the use of multiple antennas in the MIMO technology. The corresponding IEs without a suffix are populated in the single-antenna case.

3.2.1.4. Dual Carrier HSPA: "Primary Cell" vs. "Secondary Cell" Information Elements

Certain information elements occur in pairs with each of the suffixes "Primary Cell" and "Secondary Cell". These concepts apply to dual-cell (= dual-carrier) HSPA. In the single-carrier case, only the "Primary Cell" elements are populated.

3.2.2. Information Element Table

IE Name	Range/Unit	Arg.	*	Description
Altitude (ft)	–1312 ... 29028 ft	–	p	Height above sea level in feet.
Altitude (m)	–400 ... 8848 m	–	p	Height above sea level in meters.
"AMR Codec" IEs: General remark	These elements are valid also in GSM mode, where they appear side by side with the more elaborate GSM-specific elements relating to AMR (see section 3.1).			
AMR Codec Name	Text	1 ... 17		Names of AMR codecs. **Argument:** Identifies the AMR codec. See also ▶ 3GPP 26.071, 26.190. 1: AMR-NB 12.2 kbit/s 2: AMR-NB 10.2 kbit/s 3: AMR-NB 7.95 kbit/s 4: AMR-NB 7.40 kbit/s 5: AMR-NB 6.70 kbit/s 6: AMR-NB 5.90 kbit/s 7: AMR-NB 5.15 kbit/s 8: AMR-NB 4.75 kbit/s 9: AMR-WB 6.60 kbit/s 10: AMR-WB 8.85 kbit/s 11: AMR-WB 12.65 kbit/s 12: AMR-WB 14.25 kbit/s 13: AMR-WB 15.85 kbit/s 14: AMR-WB 18.25 kbit/s 15: AMR-WB 19.85 kbit/s 16: AMR-WB 23.05 kbit/s 17: AMR-WB 23.85 kbit/s
AMR Codec Usage (DL)	0 ... 100 %	1 ... 17		Current distribution of AMR codec usage on downlink. **Argument:** See AMR Codec Name.

IE Name	Range/Unit	Arg.	*	Description
AMR Codec Usage (UL)	0 ... 100 %	1 ... 17		Current distribution of AMR codec usage on uplink. **Argument:** See AMR Codec Name.
AS Cell Name	Text	1 ... 6	c	Cell name of each active set member. Requires cell file. **Argument:** Active set ID identifying an active set member.
AS CPICH Ec/No	–34 ... 0 dB	1 ... 6		CPICH Ec/No of each active set member. **Argument:** Active set ID.
AS CPICH RSCP	–140 ... –15 dBm	1 ... 6		CPICH received signal code power of each active set member. Also occurs in MIMO variants: Antenna 1, Antenna 2, Sum. See section 3.2.1.3. **Argument:** Active set ID.
AS No Of Members	0 ... 6	–		The number of base stations in the active set. Valid only in state Cell_DCH.
AS SC	0 ... 511	1 ... 6		Scrambling code of each active set member. **Argument:** Active set ID.
AS UARFCN DL	0 ... 16383 (frequency band dependent)	1 ... 6		Downlink UARFCN of each active set member. **Argument:** Active set ID.

IE Name	Range/Unit	Arg.	*	Description
Averaged BER (%)	0 ... 100 %	–		Bit error rate, measured using either the pilot bits or the TPC bits on the DPCCH channel (choice depends on slot format). Reported in Q11 format. A 100% error figure means 2047 detected errors. Averaged over reporting period.
BLER Target Control	0 ... 63	–		BLER Target value set on device property page (UM section 14.3.2.12), overriding BLER target set by network.
BLER Target Control (Text)	Text	–		Same as BLER Target Control but in text format.
Call Event Success Rate	0 ... 100 %	–		Calculated as: *# ends* / (*# blocks* + *# drops* + *# ends*) where *blocks* = Blocked Call events *drops* = Dropped Call events *ends* = Call End events Only events occurring in WCDMA mode are counted.
Cell Barred Control	0, 1	–		Use of cell barring related functions in device. See UM sections 14.3.2.11, 14.4.2.
Cell Barred Control (Text)	Text	–		Same as Cell Barred Control but in text format.
Compressed Mode	0, 1	–		Use of compressed mode. 0: False 1: True
CW scanning: Synonymous with RSSI scanning. See UM section 18.4.				
CW Sc No of UARFCNs	0 ... 255	–	rs	RSSI scanning: Number of UARFCNs scanned.

IE Name	Range/Unit	Arg.	*	Description
CW Sc RSSI	–130 ... –20 dBm	1 ... 255	rs	RSSI scanning: RSSI of UARFCNs scanned. **Argument:** The channels are sorted by ascending UARFCN. The argument 1 gives the channel with the lowest UARFCN.
CW Sc UARFCN	0 ... 16383 (frequency band dependent)	1 ... 255	rs	RSSI scanning: UARFCNs of channels scanned, sorted in ascending order. **Argument:** 0 gives the first channel currently scanned, 1 the second, etc.
Det Neigh Cell Name	Text	1 ... 6	c	Cell name of each detected neighbor. Requires cell file. **Argument:** Neighbor identity.
Det Neigh CPICH Ec/No	–34 ... 0 dB	1 ... 6		CPICH Ec/No of each detected neighbor. **Argument:** Neighbor identity.
Det Neigh CPICH RSCP	–140 ... –15 dBm	1 ... 6		CPICH received signal code power of each detected neighbor. Also occurs in MIMO variants: Antenna 1, Antenna 2, Sum. See section 3.2.1.3. **Argument:** Neighbor identity.
Det Neigh CPICH Tx Power	–31 ... 50 dBm	1 ... 6		CPICH transmit power of each detected neighbor. **Argument:** Neighbor identity.
Det Neigh No Of Members	0 ... 6	–		Number of detected neighbors.

IE Name	Range/Unit	Arg.	*	Description
Det Neigh Pathloss	30 ... 165 dB	1 ... 6		Pathloss of each detected neighbor. Calculated as Primary CPICH Tx Power – CPICH RSCP. **Argument:** Neighbor identity.
Det Neigh SC	0 ... 511	1 ... 6		Scrambling code of each detected neighbor. **Argument:** Neighbor identity.
Det Neigh UARFCN DL	0 ... 16383 (frequency band dependent)	1 ... 6		Downlink UARFCN of each detected neighbor. **Argument:** Neighbor identity.
DPCCH Power UL	–50 ... 33 dBm	–		DPCCH transmit power on uplink.
DTX Rate DL	0 ... 100 %	–		Use of DTX on downlink for the voice service.
DVB-H BER	0 ... 100 %	–	dv	DVB-H bit error rate.
DVB-H C/N	–5 ... 35 dB	–	dv	DVB-H carrier-to-noise ratio.
DVB-H MFER	0 ... 100 %	–	dv	DVB-H frame error rate after MPE-FEC decoding. ▶ ETSI TR 102 377 V1.2.1, section 10.3.2.1.
DVB-H Rx Power	–128 ... –20 dBm	–	dv	DVB-H received signal power.

IE Name	Range/Unit	Arg.	*	Description
"Finger" IEs: General remarks	The Rake fingers are not sorted by signal strength; they come in the order they are reported. The ordinal ("1st", etc.) refers to a UMTS frequency. Separate sets of Finger elements are provided for the full number of UMTS frequencies that can be scanned simultaneously. The "Finger" and "Finger Position" series of elements contain the same data. The latter series consists of arrays of size 2560 corresponding to the sequence of chips in a radio frame timeslot, with the received finger information positioned at the correct indices. These elements are provided for bar chart plotting. The Finger Slot Pos element is of course not needed in the Finger Position series and is consequently absent from it.			
Finger ... Ec/No	–34 ... 0 dB	1 ... 48		Ec/No for each Rake finger. **Argument:** Rake finger number.
Finger ... No Of	0 ... 48	–		Total number of Rake fingers.
Finger ... RSCP	–140 ... –15 dBm	1 ... 48		RSCP for each Rake finger. **Argument:** Rake finger number.
Finger ... RSSI	–130 ... –20 dBm	1 ... 48		RSSI for each Rake finger. **Argument:** Rake finger number.
Finger ... SC	0 ... 511	1 ... 48		Scrambling code for each Rake finger. **Argument:** Rake finger number.
Finger ... Slot	0 ... 15	1 ... 48		Radio frame timeslot index for each Rake finger. **Argument:** Rake finger number.
Finger ... Slot Pos	1 ... 2560	1 ... 48		Position (chip index) of each Rake finger within the radio frame timeslot. **Argument:** Rake finger number.
Finger ... Type	Text	1 ... 48		Type of channel on which each Rake finger is reported (e.g. CPICH). **Argument:** Rake finger number.

IE Name	Range/Unit	Arg.	*	Description
Finger ... UARFCN	0 ... 16383 (frequency band dependent)	1 ... 48		UARFCN for each Rake finger. **Argument:** Rake finger number.
Finger ... Position Ec/No	–34 ... 0 dB	1 ... 2560		Same as Finger ... Ec/No (see general remarks). **Argument:** Chip index.
Finger ... Position RSCP	–140 ... –15 dBm	1 ... 2560		Same as Finger ... RSCP (see general remarks). **Argument:** Chip index.
Finger ... Position RSSI	–130 ... –20 dBm	1 ... 2560		Same as Finger ... RSSI (see general remarks). **Argument:** Chip index.
Finger ... Position SC	0 ... 511	1 ... 2560		Same as Finger ... SC (see general remarks). **Argument:** Chip index.
Finger ... Position Slot	0 ... 15	1 ... 2560		Same as Finger ... Slot (see general remarks). **Argument:** Chip index.
Finger ... Position Type	Text	1 ... 2560		Same as Finger ... Type (see general remarks). **Argument:** Chip index.
Finger ... Position UARFCN	0 ... 16383 (frequency band dependent)	1 ... 2560		Same as Finger ... UARFCN (see general remarks). **Argument:** Chip index.
Firmware Version	Text	–		Version number of device firmware.
GSM Neigh ARFCN	See section 3.1 under "ARFCN BCCH"	1 ... 32	ne	ARFCNs of measured GSM neighbors. **Argument:** 1 gives the neighbor with the highest signal strength, etc.

IE Name	Range/Unit	Arg.	*	Description
GSM Neigh BSIC	Text	1 ... 32	ne	Base Station Identity Codes (in text format) of measured GSM neighbors. **Argument:** See GSM Neigh ARFCN.
GSM Neigh No Of	0 ... 32	–	ne	Number of measured GSM neighbors.
GSM Neigh RxLev	–120 ... –10 dBm	1 ... 32	ne	Received signal strength of measured GSM neighbors. **Argument:** See GSM Neigh ARFCN.
Hardware	Text	–		Device model.
Heading (deg)	0 ... 360 degrees	–	p	Direction of travel measured in degrees clockwise from north.
HO Event Type	0 ... 6	–		Type of latest handover. 0: Unknown (e.g. because no cell file loaded) 1: Soft 2: Softer 3: Hard 4: Handover to UTRAN 5: Handover from UTRAN 6: GSM
HO Event Type (Text)	Text	–		Same as HO Event Type but in text format.
"HS" IEs: General remark	All elements starting with "HS" (including channel names in "HS-") relate to HSPA. Special subgroups are "HS MIMO" and "HS UL"; see general remarks on these.			
HS 16-QAM Modulation Rate	0 ... 100 %	–		Use of 16-QAM as modulation method, expressed as a percentage of time.
HS 64-QAM Modulation Rate	0 ... 100 %	–		Use of 64-QAM as modulation method, expressed as a percentage of time.

IE Name	Range/Unit	Arg.	*	Description
HS CQI (Max)	0 ... 30 See Description	0 ... 1		The maximum value of the CQI (Channel Quality Indicator) during the latest reporting period. The definition of the CQI values is given in ▶ 3GPP 25.214, section 6A.2. **Argument:** Carrier index. Arg. 1 is used only for dual carrier sessions.
HS CQI (Median)	0 ... 30	0 ... 1		The median CQI value during the latest reporting period. Compare HS CQI (Max). **Argument:** Carrier index. Arg. 1 is used only for dual carrier sessions.
HS CQI (Min)	0 ... 30	0 ... 1		The minimum CQI value during the latest reporting period. Compare HS CQI (Max). **Argument:** Carrier index. Arg. 1 is used only for dual carrier sessions.
HS CQI Feedback Cycle	0 ... 255 ms × 2	–		CQI feedback cycle, controlling how often the UE transmits new CQI information on the uplink (▶ 3GPP 25.214, section 6A.1.2). A value of zero means that the UE shall not transmit any CQI information.
HS CQI Repetition Factor	0 ... 15	–		CQI repetition factor, controlling how often the UE repeats CQI information on the uplink (▶ 3GPP 25.214, section 6A.1.2).

IE Name	Range/Unit	Arg.	*	Description
HS-DSCH ACK Rate	0 ... 100 %	0 ... 1		ACK / (NACK + ACK) ratio on the HS-DSCH. **Argument:** Carrier index. Arg. 1 is used only for dual carrier sessions.
HS-DSCH BLER 1st	0 ... 100 %	–		Block error rate on the HS-DSCH for first transmission.
HS-DSCH BLER Residual	0 ... 100 %	–		Residual block error rate on the HS-DSCH (decoding unsuccessful after maximum number of retransmissions).
HS-DSCH BLER Residual Per Process	0 ... 100 %	0 ... 16		Same as HS-DSCH BLER Residual but for each active HARQ process separately. **Argument:** HARQ process index.
HS-DSCH DTX Rate	0 ... 100 %	0 ... 1		DTX rate on the HS-DSCH: Percentage of TTIs estimated by the device as “not used” on downlink. **Argument:** Carrier index. Arg. 1 is used only for dual carrier sessions.
HS-DSCH Error Blocks 1st No Of	0 ... 100	–		Number of block errors on the HS-DSCH (first transmission).
HS-DSCH Error Blocks Residual No Of	0 ... 100	–		Number of residual block errors on the HS-DSCH (decoding unsuccessful after maximum number of retransmissions).
HS-DSCH Error Blocks Residual No Of Per Process	0 ... 100	0 ... 16		Same as HS-DSCH Error Blocks Residual No Of but for each active HARQ process separately. **Argument:** HARQ process index.

IE Name	Range/Unit	Arg.	*	Description
HS-DSCH HARQ Processes No Of	0 ... 16	–		Number of active HARQ (Hybrid Automatic Repeat Request) processes on the HS-DSCH.
HS-DSCH NACK Rate	0 ... 100 %	0 ... 1		NACK / (NACK + ACK) ratio on the HS-DSCH. **Argument:** Carrier index. Arg. 1 is used only for dual carrier sessions.
HS-DSCH New Transmission Rate Per Process	0 ... 100 %	0 ... 16		New transmission rate on the HS-DSCH for each active HARQ process. **Argument:** HARQ process index.
HS-DSCH Post Rate	0 ... 100 %	–		Rate of use of postamble indicator after TTI where data is sent, notifying the Node B of the fact that the ACK/NACK sequence ends.
HS-DSCH Pre Rate	0 ... 100 %	–		Rate of use of preamble indicator prior to TTI where data is sent, notifying the Node B of the fact that a sequence of ACKs/NACKs will be sent.
HS-DSCH Retrans-mission Rate	0 ... 100 %	–		Retransmission rate on the HS-DSCH.
HS-DSCH Retrans-mission Rate Per Process	0 ... 100 %	0 ... 16		Same as HS-DSCH Retrans-mission Rate but for each active HARQ process separately. **Argument:** HARQ process index.
HS-DSCH Retrans-missions	0 ... 100	–		Number of retransmitted blocks on the HS-DSCH.

IE Name	Range/Unit	Arg.	*	Description
HS-DSCH Throughput (kbit/s)	0 ... 80000 kbit/s	–		Throughput on the HS-DSCH: The rate at which data is received by the MAC-hs reordering queue distribution layer (as defined in ▶ 3GPP 25.321), from all HARQ processes taken together.
HS H-RNTI	0 ... 65535	–		HS-DSCH Radio Network Temporary Identity.
HS MAC Queue ID DL	0 ... 127	1 ... 32		MAC-hs priority queue identity. **Argument:** MAC-hs priority queue index.
"HS MIMO" IEs: General remark	These IEs are populated when MIMO is in use on the downlink. Non-MIMO IEs which have a counterpart among MIMO IEs (such as the CQI elements) are not updated while MIMO is being used. However, certain other HS elements of a general nature are updated also during MIMO activity. The **argument**, where present, has the following significance: • Arg. = 1 means MIMO Type A with one transport block. • Arg. = 2 means MIMO Type A with two transport blocks. Regarding the designation "MIMO Type A", see ▶ 3GPP 25.214, section 6A.1.2.2.			
HS MIMO 16-QAM Modulation Rate	0 ... 100 %	1 ... 2		Use of 16-QAM as modulation method, expressed as a percentage of time.
HS MIMO 64-QAM Modulation Rate	0 ... 100 %	1 ... 2		Use of 64-QAM as modulation method, expressed as a percentage of time.
HS MIMO CQI (Max)	0 ... 30 See Description	1 ... 2		The maximum value of the CQI (Channel Quality Indicator) during the latest reporting period. The definition of the CQI values is given in ▶ 3GPP 25.214, section 6A.2.

IE Name	Range/Unit	Arg.	*	Description
HS MIMO CQI (Median)	0 ... 30	1 ... 2		The median CQI value during the latest reporting period. Compare HS MIMO CQI (Max).
HS MIMO CQI (Min)	0 ... 30	1 ... 2		The minimum CQI value during the latest reporting period. Compare HS MIMO CQI (Max).
HS MIMO DSCH ACK Rate	0 ... 100 %	1 ... 2		ACK / (NACK + ACK) ratio on the HS-DSCH.
HS MIMO DSCH BLER	0 ... 100 %	1 ... 2		Block error rate on the HS-DSCH for first transmission.
HS MIMO DSCH BLER Residual	0 ... 100 %	1 ... 2		Residual block error rate on the HS-DSCH (decoding unsuccessful after maximum number of retransmissions).
HS MIMO DSCH Error Block 1st No Of	0 ... 100 %	1 ... 2		Number of block errors on the HS-DSCH (first transmission).
HS MIMO DSCH Error Block Residual No Of	0 ... 100 %	1 ... 2		Number of residual block errors on the HS-DSCH (decoding unsuccessful after maximum number of retransmissions).
HS MIMO DSCH NACK Rate	0 ... 100 %	1 ... 2		NACK / (NACK + ACK) ratio on the HS-DSCH.
HS MIMO Multi TB Rate	0 ... 100 %	1 ... 2		**Argument** = 1: Percentage of TTIs with one transport block used. **Argument** = 2: Percentage of TTIs with two transport blocks used.

IE Name	Range/Unit	Arg.	*	Description
HS MIMO Phy Scheduled Throughput (kbit/s)	0 ... 80000 kbit/s	1 ... 2		Calculated as: (sum of TBSs for non-DTX blocks) / (total TTI time for non-DTX blocks) Only blocks sent to this device are considered in the calculation, and the CRC indication does not matter. The element gives an estimate of the throughput on the assumption that all blocks were successfully transferred.
HS MIMO Phy Served Throughput (kbit/s)	0 ... 80000 kbit/s	1 ... 2		Calculated as: (sum of TBSs for blocks with CRC OK) / (reporting period) Only blocks sent to this device are considered in the calculation, and the CRC must be OK. The element reflects the actual physical channel throughput.
HS MIMO QPSK Modulation Rate	0 ... 100 %	1 ... 2		Use of QPSK as modulation method, expressed as a percentage of time.
“HS MIMO Transport Block” IEs: General remark	**Argument** = “Transport block size sequence number” means that 0 represents the first TBS used, etc.; the argument value does *not* equate to the corresponding TBS index. This, however, does not apply to the max/median/min elements; see below.			
HS MIMO Transport Block Count Primary TB (Abs)	0 ... 65535	1 ... 42192		Block counts for all possible HSPA transport block sizes in the primary MIMO stream, accumulated over the current session. **Argument:** The transport block size itself in bits (not an index).

IE Name	Range/Unit	Arg.	*	Description
HS MIMO Transport Block Count Primary TB (Accu)	0 ... 65535	1 ... 295		Block counts for HSPA transport block sizes currently in use in the primary MIMO stream, accumulated over the current session. **Argument:** Transport block size sequence number.
HS MIMO Transport Block Count Primary TB (Curr)	0 ... 65535	1 ... 295		Block counts for HSPA transport block sizes currently in use in the primary MIMO stream, collected over the latest report period. **Argument:** Transport block size sequence number.
HS MIMO Transport Block Count Secondary TB (Abs)	0 ... 65535	1 ... 42192		Block counts for all possible HSPA transport block sizes in the secondary MIMO stream, accumulated over the current session. **Argument:** The transport block size itself in bits (not an index).
HS MIMO Transport Block Count Secondary TB (Accu)	0 ... 65535	1 ... 295		Block counts for HSPA transport block sizes currently in use in the secondary MIMO stream, accumulated over the current session. **Argument:** Transport block size sequence number.
HS MIMO Transport Block Count Secondary TB (Curr)	0 ... 65535	1 ... 295		Block counts for HSPA transport block sizes currently in use in the secondary MIMO stream, collected over the latest report period. **Argument:** Transport block size sequence number.

IE Name	Range/Unit	Arg.	*	Description
HS MIMO Transport Block Size Primary TB	0 ... 42192 bits	1 ... 295		HS-DSCH transport block sizes in the primary MIMO stream. **Argument:** Transport block size sequence number.
HS MIMO Transport Block Size Secondary TB	0 ... 42192 bits	1 ... 295		HS-DSCH transport block sizes in the secondary MIMO stream. **Argument:** Transport block size sequence number.
HS MIMO Transport Block Sizes Primary TB No Of	0 ... 295	1 ... 295		Number of HSPA transport block sizes currently in use in the primary MIMO stream. **Argument:** Transport block size sequence number.
HS MIMO Transport Block Sizes Secondary TB No Of	0 ... 295	1 ... 295		Number of HSPA transport block sizes currently in use in the secondary MIMO stream. **Argument:** Transport block size sequence number.
"HS MIMO Transport Block Size Max/Median/ Min" IEs: General remark	**Argument:** 1: Stream 0 2: Stream 1 (valid for dual stream MIMO traffic)			
HS MIMO Transport Block Size Max (Accu)	0 ... 65535 bits	1 ... 2		Maximum transport block size over the whole of the current session.
HS MIMO Transport Block Size Median (Accu)	0 ... 65535 bits	1 ... 2		Median transport block size over the whole of the current session.
HS MIMO Transport Block Size Min (Accu)	0 ... 65535 bits	1 ... 2		Minimum transport block size over the whole of the current session

IE Name	Range/Unit	Arg.	*	Description
HS MIMO Transport Block Size Max (Curr)	0 ... 65535 bits	1 ... 2		Maximum transport block size over the latest report period.
HS MIMO Transport Block Size Median (Curr)	0 ... 65535 bits	1 ... 2		Median transport block size over the latest report period.
HS MIMO Transport Block Size Min (Curr)	0 ... 65535 bits	1 ... 2		Minimum transport block size over the latest report period.
HS MIMO Type	0 ... 1	–		0: MIMO Type A with one transport block 1: MIMO Type A with two transport blocks
HS MIMO Type (Text)	Text	–		Same as HS MIMO Type but in text format.
HS MIMO Type A CQI Rate	0 ... 100 %	1 ... 2		**Argument** = 1: Percentage of TTIs with MIMO Type A CQI and one transport block used. **Argument** = 2: Percentage of TTIs with MIMO Type A CQI and two transport blocks used. ▶ 3GPP 25.214, section 6A.1.2.2
HS MIMO Type B CQI Rate	0 ... 100 %	–		Percentage of TTIs with MIMO Type B CQI. ▶ 3GPP 25.214, section 6A.1.2.2

IE Name	Range/Unit	Arg.	*	Description
HS-PDSCH Code Usage Primary Cell (Accu) %	0 ... 100 %	1 ... 15		Distribution of channelization code usage on the HS-PDSCH for the whole of the HSPA session. This element does not take DTX into account, so that values are computed as percentages of all blocks, whether used or unused. **Argument:** Channelization code index.
HS-PDSCH Code Usage Secondary Cell (Accu) %	0 ... 100 %	1 ... 15		Same as HS-PDSCH Code Usage Primary Cell (Accu) % but for the secondary cell; see section 3.2.1.4.
HS-PDSCH Code Usage Primary Cell (Curr) %	0 ... 100 %	1 ... 15		Current distribution of channelization code usage on the HS-PDSCH. This element takes DTX into account, so that values are computed as percentages of the total number of used blocks. **Argument:** Channelization code index.
HS-PDSCH Code Usage Secondary Cell (Curr) %	0 ... 100 %	1 ... 15		Same as HS-PDSCH Code Usage Primary Cell (Curr) % but for the secondary cell; see section 3.2.1.4.
HS Phy Requested Throughput (kbit/s)	0 ... 80000 kbit/s	–		Calculated as: (Average requested transport block size based on CQI) / (TTI length). ▶ 3GPP 25.214, tables 7a–7i

IE Name	Range/Unit	Arg.	*	Description
HS Phy Scheduled Throughput (kbit/s)	0 ... 80000 kbit/s	–		Calculated as: (sum of TBSs for non-DTX blocks) / (total TTI time for non-DTX blocks) Only blocks sent to this device are considered in the calculation, and the CRC indication does not matter. The element gives an estimate of the throughput on the assumption that all blocks were successfully transferred.
HS Phy Served Throughput (kbit/s)	0 ... 80000 kbit/s	–		Calculated as: (sum of TBSs for blocks with CRC OK) / (reporting period) Only blocks sent to this device are considered in the calculation, and the CRC must be OK. The element reflects the actual physical channel throughput.
HS Phy Served Throughput (kbit/s) Per Process	0 ... 80000 kbit/s	0 ... 16		Same as HS Phy Served Throughput (kbit/s) but for each active HARQ process separately. **Argument:** HARQ process index.
HS QPSK Modulation Rate	0 ... 100 %	–		Use of QPSK as modulation method, expressed as a percentage of time.
HS-SCCH Channelisation Code	0 ... 31	1 ... 8		Channelization codes used on the HS-SCCH, arranged in ascending order. **Argument:** Channelization code index.
HS-SCCH Channelisation Codes No Of	0 ... 8	–		Number of channelization codes used on the HS-SCCH.

IE Name	Range/Unit	Arg.	*	Description
HS-SCCH Channelisation Codes (Text)	Text	–		List of HS-SCCH channelization codes in text format.
HS-SCCH Decode Success Rate	0 ... 100 %	0 ... 1		Decode success rate on the HS-SCCH. For the decoding to count as a success, both the first and the second parts must have been completed successfully. **Argument:** Carrier index. Arg. 1 is used only for dual carrier sessions.
HS Serving Cell	0 ... 511	–		The scrambling code index of the HSPA serving cell.
HS Serving Cell Name	Text	–	c	Name of HSPA serving cell. Requires cell file.
HS Session	0 ... 3	–		Indicates the type of HSPA session. 0: Plain HSDPA, only downlink, based on R5 signaling 1: EUL/HSUPA config, based on R6 signaling 2: HSPA+ using MIMO configuration, based on R7 signaling 3: HSPA+ using dual cell (dual carrier), based on R8 signaling
HS Session (Text)	Text	–		Same as HS Session but in text format: one of "HSDPA Active" "HSPA Active" "HSPA+ (MIMO) Active" "DCHSPA Active"

IE Name	Range/Unit	Arg.	*	Description
“HS Transport Block” IEs: General remark	**Argument** = “Transport block size sequence number” means that 0 represents the first TBS used, etc.; the argument value does *not* equate to the corresponding TBS index. **Argument** = “Transport block size index” means that the argument represents the TBS index with this value. This, however, does not apply to the max/median/min elements; see below.			
HS Transport Block Count Primary Cell (Accu)	0 ... 65535	1 ... 295		Block counts for HSPA transport block sizes currently in use, accumulated over the current session. **Argument:** Transport block size sequence number.
HS Transport Block Count Secondary Cell (Accu)	0 ... 65535	1 ... 295		Same as HS Transport Block Count Primary Cell (Accu) but for the secondary cell; see section 3.2.1.4.
HS Transport Block Count Primary Cell (Curr)	0 ... 65535	1 ... 295		Block counts for HSPA transport block sizes currently in use, collected over the latest report period. **Argument:** Transport block size sequence number.
HS Transport Block Count Secondary Cell (Curr)	0 ... 65535	1 ... 295		Same as HS Transport Block Count Primary Cell (Curr) but for the secondary cell; see section 3.2.1.4.
HS Transport Block Count By Index Primary Cell (Accu)	0 ... 65535	1 ... 295		Block counts for HSPA transport block sizes currently in use, accumulated over the current session. **Argument:** Transport block size index.

IE Name	Range/Unit	Arg.	*	Description
HS Transport Block Count By Index Secondary Cell (Accu)	0 ... 65535	1 ... 295		Same as HS Transport Block Count By Index Primary Cell (Accu) but for the secondary cell; see section 3.2.1.4.
HS Transport Block Count By Index Primary Cell (Curr)	0 ... 65535	1 ... 295		Block counts for HSPA transport block sizes currently in use, collected over the latest report period. **Argument:** Transport block size index.
HS Transport Block Count By Index Secondary Cell (Curr)	0 ... 65535	1 ... 295		Same as HS Transport Block Count By Index Primary Cell (Curr) but for the secondary cell; see section 3.2.1.4.
HS Transport Block Size Primary Cell	0 ... 42192 bits	1 ... 295		Transport block sizes on the HS-DSCH. **Argument:** Transport block size sequence number.
HS Transport Block Size Secondary Cell	0 ... 42192 bits	1 ... 295		Same as HS Transport Block Size Primary Cell but for the secondary cell; see section 3.2.1.4.
HS Transport Block Size By Index Primary Cell	0 ... 42192 bits	1 ... 295		Transport block sizes on the HS-DSCH. **Argument:** Transport block size index.
HS Transport Block Size By Index Secondary Cell	0 ... 42192 bits	1 ... 295		Same as HS Transport Block Size By Index Primary Cell but for the secondary cell; see section 3.2.1.4.
HS Transport Block Sizes No Of Primary Cell	0 ... 295	–		Number of HSPA transport block sizes currently in use.

IE Name	Range/Unit	Arg.	*	Description
HS Transport Block Sizes No Of Secondary Cell	0 ... 295	–		Same as HS Transport Block Sizes No Of Primary Cell but for the secondary cell; see section 3.2.1.4.
"HS Transport Block Size Max/Median/ Min" IEs: General remark	**Argument:** 1: Primary carrier 2: Secondary carrier (valid for dual carrier traffic)			
HS Transport Block Size Max (Accu)	0 ... 65535 bits	1 ... 2		Maximum transport block size over the whole of the current session.
HS Transport Block Size Median (Accu)	0 ... 65535 bits	1 ... 2		Median transport block size over the whole of the current session.
HS Transport Block Size Min (Accu)	0 ... 65535 bits	1 ... 2		Minimum transport block size over the whole of the current session
HS Transport Block Size Max (Curr)	0 ... 65535 bits	1 ... 2		Maximum transport block size over the latest report period.
HS Transport Block Size Median (Curr)	0 ... 65535 bits	1 ... 2		Median transport block size over the latest report period.
HS Transport Block Size Min (Curr)	0 ... 65535 bits	1 ... 2		Minimum transport block size over the latest report period.
"HS UL" IEs: General remark	These elements pertain to HSUPA (EUL) and are updated primarily when that technology is in use. However, even if only HSDPA is available in the network, uplink activity occurring in the course of an HSDPA session may still cause some of the HS UL elements to be populated.			
HS UL Average Serving Grant	0 ... 800	–		Average value of serving grant (maximum allowed E-DPDCH/ E-DPCCH power ratio).

IE Name	Range/Unit	Arg.	*	Description
HS UL Average Serving Grant Index	0 ... 40	–		Average value of serving grant index.
HS UL Average TBS	0 ... 23000 bits	–		Average transport block size on E-DCH.
HS UL Average TBS / TBS Max E-TFCI	0 ... 100 %	–		Average value of: (transport block size on E-DCH) divided by (maximum transport block size on E-DCH as dictated by current E-TFCI). This is a measure of serving grant utilization.
HS UL BLER 1st	0 ... 100 %	–		Block error rate on the E-DCH for first transmission.
HS UL BLER Residual	0 ... 100 %	–		Residual block error rate on the E-DCH (decoding unsuccessful after maximum number of retransmissions).
HS UL Buffer Limited Tx Rate	0 ... 100 %	–		Percentage of time the transmission on the E-DCH was buffer limited.
HS UL DTX Rate	0 ... 100 %	–		Percentage of TTIs where nothing was sent on the E-DPCCH/E-DPDCH.
HS UL E-DCH Throughput (kbit/s)	0 ... 80000 kbit/s	–		Throughput on the E-DCH.
HS UL E-DCH TTI (ms)	2 ... 10 ms	–		E-DCH TTI length.
HS UL E-DPCCH Power	–50 ... 33 dBm	–		E-DPCCH transmit power.
HS UL E-DPDCH Power	–50 ... 33 dBm	–		E-DPDCH transmit power.

IE Name	Range/Unit	Arg.	*	Description
HS UL E-TFC Retrans-missions (Accu) %	0 ... 100 %	0 ... 127		Retransmission rate for each E-TFC, averaged over the current session. **Argument:** E-TFCI.
HS UL E-TFC Retrans-missions (Curr) %	0 ... 100 %	0 ... 127		Current retransmission rate for each E-TFC. **Argument:** E-TFCI.
HS UL E-TFC Usage (Accu) %	0 ... 100 %	0 ... 127		E-TFC usage distribution for the whole of the current session. **Argument:** E-TFCI.
HS UL E-TFC Usage (Curr) %	0 ... 100 %	0 ... 127		Current E-TFC usage distribution. **Argument:** E-TFCI.
HS UL Error Blocks No Of 1st (2nd, 3rd, 4th)	0 ... 100	–		Number of block errors for the first (second, third, fourth) transmission on the E-DCH.
HS UL Error Blocks Residual No Of	0 ... 100	–		Number of residual block errors on the E-DCH after maximum number of retransmissions.
HS UL Happy Rate	0 ... 100 %	–		Percentage of TTIs where the UE was happy. ▶ 3GPP 25.321, section 11.8.1.5
HS UL HICH ACK Rate	0 ... 100 %	–		ACK rate on the E-HICH.
HS UL HICH NACK Rate	0 ... 100 %	–		NACK rate on the E-HICH.
HS UL New Transmission Rate	0 ... 100 %	–		Number of new transmissions on E-DPCCH/E-DPDCH divided by the number of TTIs.
HS UL Non-Serving Cells No Of	0 ... 4	–		Number of non-serving cells in E-DCH active set.

IE Name	Range/Unit	Arg.	*	Description
HS UL Non-Serving E-RGCH Down No Of	0 ... 100	–		Number of times a non-serving cell in the E-DCH active set was ordered to lower its transmit power (relative grant = “Down”).
HS UL Number Of TTIs	0 ... 100	–		Number of TTIs in log report.
HS UL Power Limited Tx Rate	0 ... 100 %	–		Percentage of time the transmission was limited by the available Tx power.
HS UL Retrans-mission Rate	0 ... 100 %	–		Number of retransmissions on E-DPCCH/E-DPDCH divided by the number of TTIs.
HS UL Serving Grant Limited Tx Rate	0 ... 100 %	–		Percentage of time the transmission was limited by the current serving grant.
HS UL Successful E-AGCH Rate (All TTIs)	0 ... 100 %	–		Percentage of TTIs where the UE received an absolute grant on the E-AGCH.
HS UL Successful First Tx Rate	0 ... 100 %	–		Percentage of transport block successfully transmitted on first attempt.

IE Name	Range/Unit	Arg.	*	Description
HS UL Transmission Distribution (Accu) %	0 ... 100 %	1 ... 17		Distribution of transmission attempts with respect to the sequence number of the attempt. The residual case (no success after maximum number of retransmissions) is itself counted as an attempt. Each IE value is a percentage of the total number of transmission attempts. This IE is averaged over the whole of the current session. **Argument:** 1: First transmission 2 ... 16: First ... fifteenth retrans-mission 17: Residual
HS UL Transmission Distribution (Curr) %	0 ... 100 %	1 ... 17		Same as "HS UL Transmission Distribution (Accu) %" but for the latest reporting period. **Argument:** 1: First transmission 2 ... 16: First ... fifteenth retrans-mission 17: Residual
HS UL UE Transmission Power Headroom	0 ... 31 dB	–		UE transmission power headroom, defined as the ratio of the UE maximum transmission power to the current DPCCH transmission power. ▶ 3GPP 25.215, 25.309
IMEI	Text	–		International Mobile Equipment Identity, the unique equipment identity of the UE. ▶ 3GPP 23.003

IE Name	Range/Unit	Arg.	*	Description
Inter-freq Event Criteria	Text	1 ... 10		Event criteria governing when the UE should send inter-frequency measurement reports. **Argument:** One argument for each event criterion.
Inter-freq Event Name	Text	1 ... 10		Names of events governing sending of inter-frequency measurement reports by the UE. The events extracted to this element are “e2a”, “e2d”, and “e2f”. Other inter-frequency events are not extracted. **Argument:** One argument for each event criterion. There may be multiple criteria for the same event.
Inter-RAT Event Criteria	Text	1 ... 5		Event criteria governing when the UE should send inter-RAT measurement reports. **Argument:** One argument for each event criterion.
Inter-RAT Event Name	Text	1 ... 5		Names of events governing sending of inter-RAT measurement reports by the UE. The only event extracted to this element is “e3a”. Other inter-RAT events are not extracted. **Argument:** One argument for each event criterion. There may be multiple criteria for the same event.
Internal GPS Coverage (%)	0 ... 100 %	–		Percentage of valid GPS positions from the device’s internal GPS.

IE Name	Range/Unit	Arg.	*	Description
Internal GPS Delta Difference (m)	0 ... 100 m	–	p	Difference in reported position between the device's internal GPS and the GPS currently selected as "Preferred" in TEMS Investigation.
Intra-freq Cells	Text	–		Cells on which the UE has been ordered to perform intra-frequency measurements.
Intra-freq Event Criteria	Text	1 ... 10		Event criteria governing when the UE should send intra-frequency measurement reports. **Argument:** One argument for each event criterion.
Intra-freq Event Name	Text	1 ... 10		Names of events governing sending of intra-frequency measurement reports by the UE. The events extracted to this element are "e1a", "e1b", "e1c", and "e1d". Other intra-frequency events are not extracted. **Argument:** One argument for each event criterion. There may be multiple criteria for the same event.
Latitude	–90 ... 90 degrees	–	p	Latitude recorded by positioning equipment.
Latitude (Text)	Text	–	p	Latitude as text. For the presentation format, see TR section 3.4.
Latitude Decimal Degrees (Text)	Text	–	p	Latitude in decimal degrees, presented as text.
Longitude	–180 ... 180 degrees	–	p	Longitude recorded by positioning equipment.

IE Name	Range/Unit	Arg.	*	Description
Longitude (Text)	Text	–	p	Longitude as text. For the presentation format, see TR section 3.4.
Longitude Decimal Degrees (Text)	Text	–	p	Longitude in decimal degrees, presented as text.
MCC	0 ... 999	–		Mobile Country Code.
Message Hex Dump Payload	Text	–		Contains the hexadecimal string of a Layer 3 message or mode report. Used for text-format logfile export only.
MNC	0 ... 999	–		Mobile Network Code. May consist of two or three digits.
Mode (Num)	1 ... 7	–		Relevant values: 1: No service 2: Idle mode 3: Dedicated (Connected) mode
Mode - System	1 ... 9	–		The full set of values is as follows (only 1, 2, and 7 being relevant here): 1: WCDMA 2: GSM 3: CDMA (1x) 4: EV-DO 5: Analog 6: WiMAX 7: LTE 8: TD-SCDMA
Mode - System (Text)	Text	–		Same as Mode - System but in text format.
Mon Neigh Cell Name	Text	1 ... 6	c	Cell name of each monitored neighbor. Requires cell file. **Argument:** Neighbor identity.

IE Name	Range/Unit	Arg.	*	Description
Mon Neigh CPICH Ec/No	–34 ... 0 dB	1 ... 6		CPICH Ec/No of each monitored neighbor. **Argument:** Neighbor identity.
Mon Neigh CPICH RSCP	–140 ... –15 dBm	1 ... 6		CPICH received signal code power of each monitored neighbor. Also occurs in MIMO variants: Antenna 1, Antenna 2, Sum. See section 3.2.1.3. **Argument:** Neighbor identity.
Mon Neigh CPICH Tx Power	–31 ... 50 dBm	1 ... 6		CPICH transmit power of each monitored neighbor. **Argument:** Neighbor identity.
Mon Neigh No Of Members	0 ... 6	–		Number of monitored neighbors.
Mon Neigh Pathloss	30 ... 165 dB	1 ... 6		Pathloss of each monitored neighbor. Calculated as Primary CPICH Tx Power – CPICH RSCP. **Argument:** Neighbor identity.
Mon Neigh SC	0 ... 511	1 ... 6		Scrambling code of each monitored neighbor. **Argument:** Neighbor identity.
Mon Neigh UARFCN DL	0 ... 16383 (frequency band dependent)	1 ... 6		Downlink UARFCN of each monitored neighbor. **Argument:** Neighbor identity.

IE Name	Range/Unit	Arg.	*	Description
MS Behavior Modified (Text)	Text: "B", "C", or a combination of these letters (or empty string)	–		Indicates whether the UE behavior has been changed from the default. Empty string: No modification of UE behavior "B": Modification of UE behavior in network (information elements BLER Target Control, RAT Control) "C": Modification of UE reselection behavior: (information elements Cell Barred Control, Sector Control) Combinations of these letters may appear.
Network Search No of UARFCNs	0 ... 800	–	ns	*Network scanning:* The number of UARFCNs scanned.
Network Search SC	0 ... 511	1 ... 800	ns	*Network scanning:* Scrambling code detected on each UARFCN scanned. **Argument:** Position in list of scanned UARFCNs.
Network Search UARFCN	410 ... 10840 (frequency band dependent)	1 ... 800	ns	*Network scanning:* UARFCNs scanned. **Argument:** Position in list of scanned UARFCNs.

IE Name	Range/Unit	Arg.	*	Description
Other/Own, Max 1 SC	0 ... 10 dB	0 ... 10 dB	pi	*Pilot scanning* (UM section 18.2): Estimated ratio between polluting signal power and desired signal power on a CPICH control channel, based on the assumption that there is only one possible member in the active set. Applies to the *first* UMTS frequency scanned (lowest UARFCN). **Argument:** Power threshold (in dB) relative to the power of the strongest scrambling code; used to identify possible active set members. See UM section 18.2.9 for a full description.
Other/Own, Max 2 SCs	0 ... 10 dB	0 ... 10 dB	pi	As Other/Own, Max 1 SC except that the active set is assumed to have at most two possible members. Applies to the *first* UMTS frequency scanned. See UM section 18.2.9 for a full description.
Other/Own, Max 3 SCs	0 ... 10 dB	0 ... 10 dB	pi	As Other/Own, Max 1 SC except that the active set is assumed to have at most three possible members. Applies to the *first* UMTS frequency scanned. See UM section 18.2.9 for a full description.

IE Name	Range/Unit	Arg.	*	Description
Other/Own, Max 4 SCs	0 ... 10 dB	0 ... 10 dB	pi	As Other/Own, Max 1 SC except that the active set is assumed to have at most four possible members. Applies to the *first* UMTS frequency scanned. See UM section 18.2.9 for a full description.
"Other/Own 2nd (etc.)" IEs	0 ... 10 dB	0 ... 10 dB	pi	Same as "Other/Own, ..." but for the second (etc.) UMTS frequency scanned.
PDP IEs: General remark	The **argument**, where present, refers to a PDP context index.			
PDP Access Point Name	Text	1 ... 11		Host name or network address for each active PDP context.
PDP Address	Text	1 ... 11		User address (IPv4/IPv6).
PDP Contexts Active	0 ... 11	–		Number of active PDP contexts.
PDP Delay Class	Text	1 ... 11		Delay class as defined by subscription.
PDP LLC SAPI	3 ... 11	1 ... 11		LLC Service Access Point Identifier.
PDP Mean Throughput	Text	1 ... 11		Mean throughput as defined by subscription.
PDP NSAPI	5 ... 15	1 ... 11		Network SAPI (Service Access Point Identifier).
PDP Peak Throughput	Text	1 ... 11		Peak throughput as defined by subscription.
PDP Precedence Class	Text	1 ... 11		Precedence class as defined by subscription.
PDP Radio Priority	Text	1 ... 11		Radio priority level as defined by subscription.

IE Name	Range/Unit	Arg.	*	Description
PDP Reliability Class	Text	1 ... 11		Reliability class as defined by subscription.
Poss No of AS Members	0 ... 10	0 ... 10 dB	pi	Pilot scanning: The estimated number of possible members in the active set. Applies to the first UMTS frequency scanned (lowest UARFCN). **Argument:** Power threshold (in dB) relative to the power of the strongest scrambling code. See UM section 18.2.9 for a full description.
"Poss No of AS Members 2nd (etc.)" IEs	0 ... 10	0 ... 10 dB	pi	Same as Poss No of AS Members but for the second (etc.) UMTS frequency scanned.
Power Control Indication DL	–1 ... 1	–		Recent trend indication for inner loop power control on downlink: average of TPC_cmd values over the latest reporting period. ▶ 3GPP 25.214, section 5.2
Power Control Indication UL	–1 ... 1	–		Recent trend indication for inner loop power control on uplink: average of TPC_cmd values over the latest reporting period. ▶ 3GPP 25.214, section 5.1
RACH Initial TX	–50 ... 34 dBm	–		Transmit power of first RACH preamble in dBm.
RACH Max Preambles	0 ... 64	–		Maximum number of preambles in one preamble ramping cycle. ▶ 3GPP 25.214, section 6.1
RACH Message TX	–50 ... 34 dBm	–		Transmit power of last RACH preamble in dBm.
RACH Transmitted Preambles	0 ... 64	–		Number of preambles used in this preamble ramping cycle.

IE Name	Range/Unit	Arg.	*	Description
RAT Control	0 ... 3	–		Use of Lock to RAT function in UE. See UM section 13.13. 0: Lock to RAT disabled 1: Locked to GSM 900/1800 2: Locked to GSM 850/1900 3: Locked to WCDMA
RAT Control (Text)	Text	–		Use of Lock to RAT function in UE. Blank when no lock is engaged; "Active" when lock to RAT has been activated.
RB Setup UL DPCH SC	0 ... 10^8	–		The scrambling code of the uplink Dedicated Physical Channel.
RLC AM DL Log Ch Type	Text	1 ... 4		Radio Link Control (Acknowledged Mode): Type of downlink logical channel, e.g. "DCCH". **Argument:** Logical channel index.
RLC AM DL PDU Retran (%)	0 ... 100 %	1 ... 4		Radio Link Control (Acknowledged Mode, downlink): PDU retransmission percentage. Calculated as (number of NACKed PDUs) / (total number of PDUs) × 100. **Argument:** Logical channel index.
RLC AM DL PDU Thr	0 ... 80000 kbit/s	1 ... 4		Radio Link Control PDU throughput (Acknowledged Mode, downlink), counting both control PDUs and AM PDUs. Since the PDU throughput includes RLC headers, it will be slightly higher than the SDU throughput where such headers are absent. **Argument:** Logical channel index.

IE Name	Range/Unit	Arg.	*	Description
RLC AM DL SDU Thr	0 ... 80000 kbit/s	1 ... 4		Radio Link Control SDU throughput (Acknowledged Mode, downlink). **Argument:** Logical channel index.
RLC AM UL Log Ch Type	Text	1 ... 4		Radio Link Control (Acknowledged Mode): Type of uplink logical channel, e.g. "DCCH". **Argument:** Logical channel index.
RLC AM UL PDU Retran (%)	0 ... 100 %	1 ... 4		Radio Link Control (Acknowledged Mode, uplink): PDU retransmission percentage. Calculated as (number of NACKed PDUs) / (total number of PDUs) × 100. **Argument:** Logical channel index.
RLC AM UL PDU Thr	0 ... 80000 kbit/s	1 ... 4		Radio Link Control PDU throughput (Acknowledged Mode, uplink), counting both control PDUs and AM PDUs. Since the PDU throughput includes RLC headers, it will be slightly higher than the SDU throughput where such headers are absent. **Argument:** Logical channel index.
RLC AM UL SDU Thr	0 ... 80000 kbit/s	1 ... 4		Radio Link Control SDU throughput (Acknowledged Mode, uplink). **Argument:** Logical channel index.

IE Name	Range/Unit	Arg.	*	Description
RLC DL Entity Data Mode	Text	1 ... 32		Downlink RLC entity data mode. One of: "AM" = Acknowledged Mode "TM" = Transparent Mode "UM" = Unacknowledged Mode **Argument:** RLC entity.
RLC DL Throughput	0 ... 80000 kbit/s	1 ... 32		Total RLC downlink throughput. **Argument:** RLC entity.
RLC No Of Entities	0 ... 32	–		Total number of RLC entities on uplink and downlink.
RLC UL Entity Data Mode	Text	1 ... 32		Uplink RLC entity data mode. One of: "AM" = Acknowledged Mode "TM" = Transparent Mode "UM" = Unacknowledged Mode **Argument:** RLC entity.
RLC UL Throughput	0 ... 80000 kbit/s	1 ... 32		Total RLC uplink throughput. **Argument:** RLC entity.
RLC/Trsp DL Throughput (Best)	0 ... 80000 kbit/s	–		Highest downlink throughput for all RLC entities/transport channels.
RLC/Trsp UL Throughput (Best)	0 ... 80000 kbit/s	–		Highest uplink throughput for all RLC entities/transport channels.
RRC Connection Reject Cause	0, 1	–		Cause for rejection of RRC connection establishment request. 0: Congestion 1: Unspecified ▶ 3GPP 25.331, section 10.3.3.31

IE Name	Range/Unit	Arg.	*	Description
RRC Connection Reject Wait Time	0 ... 16 s	–		The time the UE has to wait before repeating the rejected RRC procedure. ▶ 3GPP 25.331, section 10.3.3.50
RRC State	0 ... 5	–		State of RRC protocol: 0: No service 1: Idle mode 2: Connected_Cell_FACH 3: Connected_Cell_DCH 4: Connected_Cell_PCH 5: Connected_URA_PCH The state is set to idle when the UE registers, and the information element is then updated each time the state changes. ▶ 3GPP 25.331, chapter 7
RRC State (Text)	Text	–		Same as RRC State but in text format.
"SAN" IEs: General remark	These elements are what is shown in the WCDMA Serving/Active Set + Neighbors status window.			
SAN Cell Id	0 ... 2^{28} – 1	1 ... 38		Cell identity of each cell listed. **Argument:** Indicates the row in the window. In Cell_DCH mode, the active set is on top (max 4 rows), whereas in other modes the serving cell is found on row 1. In either case the neighbors follow directly beneath.
SAN Cell Id (CI Part)	0 ... 2^{16} – 1	1 ... 38		Cell Identity part of SAN Cell Id: bits 12 through 27 (in decimal). **Argument:** See SAN Cell Id.

IE Name	Range/Unit	Arg.	*	Description
SAN Cell Id (CI Part Hex)	Text: “0000” ... “FFFF”	1 ... 38		Cell Identity part of SAN Cell Id: bits 12 through 27 in hexadecimal. **Argument:** See SAN Cell Id.
SAN Cell Id (RNC Part)	0 ... $2^{12} - 1$	1 ... 38		RNC part of SAN Cell Id: bits 0 through 11 (in decimal). **Argument:** See SAN Cell Id.
SAN Cell Id (RNC Part Hex)	Text: “000” ... “FFF”	1 ... 38		RNC part of SAN Cell Id: bits 0 through 11 in hexadecimal. **Argument:** See SAN Cell Id.
SAN Cell Name	Text	1 ... 38	c	Name of each cell listed. Requires cell file. **Argument:** Window row.
SAN Cell Type	1 ... 4	1 ... 38	c	Type of cell for each cell listed. 1: Serving cell 2: Active set member 3: Monitored neighbor 4: Detected neighbor Requires cell file. **Argument:** Window row.
SAN Cell Type Abbr Str	Text	1 ... 38	c	Same as SAN Cell Type but with text strings indicating the type of cell: SC: Serving cell AS: Active set member MN: Monitored neighbor DN: Detected neighbor **Argument:** Window row.
SAN CPICH Ec/No	–34 ... 0 dB	1 ... 38		CPICH Ec/No for each cell listed. **Argument:** Window row.

IE Name	Range/Unit	Arg.	*	Description
SAN CPICH RSCP	–140 ... –15 dBm	1 ... 38		CPICH RSCP for each cell listed. Also occurs in MIMO variants: Antenna 1, Antenna 2, Sum. See section 3.2.1.3. **Argument:** Window row.
SAN CPICH Tx Power	–31 ... 50 dBm	1 ... 38		Primary CPICH transmit power for each cell listed. **Argument:** Window row.
SAN HS Cell Type	1, 2	1 ... 38		Cell type for each cell in HSPA active set. 1: Serving cell 2: Non-serving cell
SAN HS Cell Type Abbr Str	Text	1 ... 38		Same as SAN HS Cell Type but in text format: “SC” or “N-SC”.
SAN No of Members	0 ... 38	–		Total number of cells listed.
SAN Pathloss	30 ... 165 dB	1 ... 38		Pathloss for each cell listed. Calculated as Primary CPICH Tx Power – CPICH RSCP. **Argument:** Window row.
SAN SC	0 ... 511	1 ... 38		Scrambling code for each cell listed. **Argument:** Window row.
SAN UARFCN DL	0 ... 16383 (frequency band dependent)	1 ... 38		Downlink UARFCN for each cell listed. **Argument:** Window row.
SAN URA Id	0 ... $2^{28} – 1$	1 ... 38		URA identity of each cell listed. **Argument:** Window row.

IE Name	Range/Unit	Arg.	*	Description
"Sc Best" IEs: General remark	These elements are derived from pilot scanning and combine scrambling codes from all scanned UMTS frequencies, sorted by descending Aggr Ec/Io. The sorting order within the "Best" elements is not affected by the settings in the General window (see UM section 18.2.14.1). The "*Freqs*" line in the IE Name indicates for how many individual scanned UMTS frequencies the IE exists; compare the remark on the "Sc 1st (etc.)" elements. Regarding pilot scanning in general, see UM section 18.2. **Argument** (where present): 1 is the scrambling code with the highest Aggr Ec/Io, etc.			
Sc Best Aggr Eb/Io (dB) *Freqs 1–4*	–10 ... 21 dB	1 ... 512	pi	The aggregate code power of the scrambling code (Eb, energy per bit) relative to the total signal power in the channel (Io).
Sc Best Aggr Ec (dBm) *Freqs 1–12*	–130 ... –25 dBm	1 ... 512	pi	The aggregate code power (energy per chip) of each scanned scrambling code. The aggregate code power is a measure of the total signal power (distributed around the main peak due to multipath propagation) that is above the PN threshold (see UM section 18.2.3).
Sc Best Aggr Ec/Io (dB) *Freqs 1–12*	–30 ... 0 dB	1 ... 512	pi	The aggregate code power of the scrambling code (Ec, energy per chip) relative to the total signal power in the channel (Io).
Sc Best Aggr-Peak Ec (dB) *Freqs 1–4*	0 ... 90 dB	1 ... 512	pi	The difference between the aggregate code power and peak code power.

IE Name	Range/Unit	Arg.	*	Description
Sc Best Cell Name *Freqs 1–12*	Text	1 ... 512	pi c p	Deduced name of the cell that uses each scanned scrambling code. The algorithm determining the cell name takes as input the SC number, the UARFCN, and the position reported. It searches the cell file for cells with matching SC number and UARFCN within a 50 km radius. If multiple matches are found, the cell closest to the position is selected. If no positioning data is available, the information element will still be presented, but the cell names may then of course be wrong. The algorithm in this case simply picks the first cell in the cell file with matching SC number and UARFCN. Requires cell file.
Sc Best Cell Type *Freqs 1–12*	1 ... 3	1 ... 512	pi c p	Categorization of the cells that use the scanned scrambling codes. 1: The cell with the strongest Aggr Ec. 2: All neighbors of the “1” cell, as indicated by the cell file. 3: All other cells. In the “Sc Best” element, this categorization is applied for each UMTS frequency, so there will be one “1” with associated “2”s for each frequency. Requires cell file.

IE Name	Range/Unit	Arg.	*	Description
Sc Best Delay Spread *Freqs 1–4*	0 ... 255 chips	1 ... 512	pi	Time in chips between the first and last Ec/Io peak that is above the PN threshold (see UM section 18.2.3). This is a measure of the signal spreading due to multipath propagation.
Sc Best Io *Freqs 1–12*	–115 ... –25 dBm	–	pi	The total signal power in the channel.
Sc Best No of SCs *Freqs 1–12*	0 ... 512	–	pi	The number of scrambling codes scanned.
Sc Best Peak Eb/Io (dB) *Freqs 1–4*	–10 ... 21 dB	1 ... 512	pi	The peak code power of each scanned scrambling code (Eb, energy per bit) relative to the total signal power in the channel (Io), i.e. the difference between them in dB.
Sc Best Peak Ec (dBm) *Freqs 1–4*	–130 ... –25 dBm	1 ... 512	pi	The peak code power of each scanned scrambling code (Ec, energy per chip) in dBm.
Sc Best Peak Ec/Io (dB) *Freqs 1–4*	–30 ... 0 dB	1 ... 512	pi	The peak code power of each scanned scrambling code (Ec, energy per chip) relative to the total signal power in the channel (Io), i.e. the difference between them in dB.
Sc Best P-SCH Ec (dBm) *Freqs 1–4*	–130 ... –25 dBm	1 ... 512	pi	The peak code power of each scanned scrambling code on the primary synchronization channel (P-SCH).
Sc Best P-SCH Ec/Io (dB) *Freqs 1–4*	–30 ... 0 dB	1 ... 512	pi	The peak code power (Ec) of each scanned scrambling code on the primary synchronization channel (P-SCH), relative to the total signal power in the channel (Io).

IE Name	Range/Unit	Arg.	*	Description
Sc Best Rake Finger Count *Freqs 1–4*	0 ... 51	1 ... 512	pi	The number of Ec/Io peaks (multipath components) that are above the PN threshold.
Sc Best SC *Freqs 1–12*	0 ... 511	1 ... 512	pi	The number of each scanned scrambling code.
Sc Best SC Group *Freqs 1–4*	0 ... 7	1 ... 512	pi	The number of the group to which each scanned scrambling code belongs.
Sc Best SIR (dB) *Freqs 1–4*	–25 ... 30 dB	1 ... 512	pi	Received SIR (in dB) for scanned scrambling codes.
Sc Best S-SCH Ec (dBm) *Freqs 1–4*	–130 ... –25 dBm	1 ... 512	pi	The peak code power of each scanned scrambling code on the secondary synchronization channel (S-SCH).
Sc Best S-SCH Ec/Io (dB) *Freqs 1–4*	–30 ... 0 dB	1 ... 512	pi	The peak code power (Ec) of each scanned scrambling code on the secondary synchro-nization channel (S-SCH), relative to the total signal power in the channel (Io).
Sc Best Time Offset *Freqs 1–4*	0 ... 38399 chips	1 ... 512	pi	The time offset of the radio frame (10 ms = 38,400 chips) for each scanned scrambling code.
Sc Best Time Offset Slot Pos *Freqs 1–4*	1 ... 2560	1 ... 512	pi	Equal to (Sc Best Time Offset mod 2560) + 1.
Sc Best UARFCN *Freqs 1–12*	410 ... 10840 (frequency band dependent)	–	pi	The UARFCN of the CPICH currently scanned.

IE Name	Range/Unit	Arg.	*	Description
Sc Best UL Interference *Freqs 1–12*	–110 ... –70 dBm	–	pi	Interference on uplink, extracted from SIB type 7.
Sc 1st (*etc.*) Intra-freq Cells *Freqs 1–12*	Text	–	pi	Neighbor list for the first scrambling code on the first (second, third, etc.) scanned UMTS frequency. Obtained from SIB. What scrambling code is the first depends on the sorting order set in the General window: see UM section 18.2.14.1. Given as a comma-separated string of scrambling codes, e.g. "1, 3, 5". No "Sc Best" version is provided for these elements, since that would be pointless.
"Sc 1st (etc.)" IEs *(except Intra-freq Cells)*	Same as "Sc Best" elements except that only the first (second, third, etc.) scanned UMTS frequency is considered. **Note:** More IEs are provided for frequencies 1–4 than for frequencies 5–12, as detailed for the "Sc Best" elements above. **Argument:** The sorting order within each element depends on the General window setting: see UM section 18.2.14.1.			

IE Name	Range/Unit	Arg.	*	Description
"SCH TS" IEs: General remark	These elements are obtained from SCH timeslot scanning.			
SCH TS Sc Es/Io (dB)	–24 ... 0 dB	1...2560 (max; see Descr.)	ts	SCH timeslot scanning (UM section 18.3): Power in each segment (1, 2, 4, or 8 chips depending on setup) of the scanned timeslot. **Argument:** Index of timeslot segment (*not* chip index). If **Every 2** has been chosen, the argument range is 1 ... 2560/2, i.e. 1 ... 1280; for **Every 4**, the range is 1 ... 640; for **Every 8**, the range is 1 ... 320.
SCH TS Sc No Of Segm	0 ... 2560	–	ts	SCH timeslot scanning: Number of scanned timeslot segments (each with length 1, 2, 4, or 8 chips depending on setup).
SCH TS Sc Segm	1 ... 2560	1...2560 (max; see Descr.)	ts	SCH timeslot scanning: Position of each timeslot segment scanned, expressed as a chip index. The first chip has number 1. **Argument:** Index of timeslot segment (*not* chip index). If **Every 2** has been chosen, the argument range is 1 ... 2560/2, i.e. 1 ... 1280; for **Every 4**, the range is 1 ... 640; for **Every 8**, the range is 1 ... 320.
SCH TS Sc Time Diff 1-2	1 ... 2560 chips	–	ts	The time separation in chips between the strongest peak and the second strongest.
SCH TS Sc Time Diff 2-3	1 ... 2560 chips	–	ts	The time separation in chips between the second strongest peak and the third strongest.

IE Name	Range/Unit	Arg.	*	Description
SCH TS Sc UARFCN	410 ... 10840 (frequency band dependent)	–	ts	UARFCN scanned.
Sector Control	0, 1	–		Use of Lock to Sector/Cell Selection function in UE in idle mode: 0: Lock to Sector disabled 1: Lock to Sector enabled See UM sections 14.3.2.13, 14.4.2.
Sector Control (Text)	Text	–		Same as Sector Control but in text format.
"Serving" IEs: General remark	These elements pertain to the serving cell. They are not valid in Cell_DCH mode.			
Serving Cell Id	0 ... $2^{28} - 1$	–		Cell identity of the serving cell.
Serving Cell Id (CI Part)	0 ... $2^{16} - 1$	–		Cell Identity part of Serving Cell Id: bits 12 through 27 (in decimal).
Serving Cell Id (CI Part Hex)	Text: "0000" ... "FFFF"	–		Cell Identity part of Serving Cell Id: bits 12 through 27 in hexadecimal.
Serving Cell Id (RNC Part)	0 ... $2^{12} - 1$	–		RNC part of Serving Cell Id: bits 0 through 11 (in decimal).
Serving Cell Id (RNC Part Hex)	Text: "000" ... "FFF"	–		RNC part of Serving Cell Id: bits 0 through 11 in hexadecimal.
Serving Cell LAC	0 ... 65535	–		LAC of serving cell.
Serving Cell LAC (Hex)	Text: "0000" ... "FFFF"	–		LAC of serving cell in hexadecimal format.

IE Name	Range/Unit	Arg.	*	Description
Serving Cell Name	Text	–	c	Name of the serving cell. Requires cell file.
Serving Cell RAC	0 ... 255	–		RAC of serving cell.
Serving Cell RAC (Hex)	Text: “00” ... “FF”	–		RAC of serving cell in hexadecimal format.
Serving CPICH Ec/No	–34 ... 0 dB	–		CPICH Ec/No of the serving cell.
Serving CPICH RSCP	–140 ... –15 dBm	–		CPICH received signal code power of the serving cell. Also occurs in MIMO variants: Per Antenna, Sum. See section 3.2.1.3.
Serving CPICH Tx Power	–31 ... 50 dBm	–		CPICH transmit power of the serving cell.
Serving Pathloss	30 ... 165 dB	–		Pathloss of the serving cell. Calculated as Primary CPICH Tx Power – CPICH RSCP.
Serving SC	0 ... 511	–		Scrambling code of the serving cell in idle, Cell_FACH, Cell_PCH, and URA_PCH mode.
Serving UARFCN DL	0 ... 16383 (frequency band dependent)	–		Downlink UARFCN of the serving cell in idle, Cell_FACH, Cell_PCH, and URA_PCH mode.
Serving URA Id	0 ... $2^{28} – 1$	–		URA identity of the serving cell.
SF DL	1 ... 512	–		Spreading factor on downlink.
SF UL	1 ... 512	–		Spreading factor on uplink.

IE Name	Range/Unit	Arg.	*	Description
SHO Event Rate	0 ... 50	0 ... 3600		Number of radio link events (both failures and successes) over the last *arg* seconds, where *arg* is the value of the argument. Regarding the events, see section 8.2. **Argument:** See above. Argument = 0 means that the events are counted from the beginning of the logfile.
SHO Event Success Rate	0 ... 100 %	–		Soft handover success rate. Calculated as: (# *add* + # *rem* + # *repl*) / # *all* where *add* = Radio Link Addition events *rem* = Radio Link Removal events *repl* = Radio Link Replacement events *all* = All radio link events, including failures Regarding the events, see section 8.2.

IE Name	Range/Unit	Arg.	*	Description
SHO Percent Softer	0 ... 100 %	–	c	A measure of the amount of softer handover. Calculated as: *# softer* / (*# softer* + *# soft*) where *softer* = Radio link event indicating success occurs while in softer handover (and with more than one member in active set) *soft* = Radio link event indicating success occurs while in soft handover (and with more than one member in active set) A radio link event is one of Radio Link Addition, Radio Link Removal, and Radio Link Replacement. About the events, see section 8.2. Requires that a cell file with Node B information has been loaded; otherwise the element is invalid.
SHO State	0 ... 2	–	c	Soft handover state. 0: Unknown (no cell data loaded) 1: Soft handover 2: Softer handover Requires that a cell file with Node B information has been loaded; otherwise the value will always be = 0. Invalid when AS No Of Members < 2.

IE Name	Range/Unit	Arg.	*	Description
SHO State (Text)	Text	–	c	Soft handover state as plain text: "Soft", "Softer", or "Unknown". See SHO State. Requires that a cell file has been loaded (otherwise the value will always be "Unknown"). Invalid when AS No Of Members < 2.
SIR	–20 ... 30 dB	–		Signal-to-interference ratio, measured on DPCCH. ▶ 3GPP 25.215, section 5.2.2
SIR Target	–20 ... 30 dB	–		SIR target governing SIR.
Spectr Ana IEs: General remark	These elements are obtained from spectrum analysis. The **argument**, where present, is simply a sequence number pointing to scanned frequencies as indicated by the "Spectr Ana Sc DL Freq" or "Spectr Ana Sc UL Freq" element.			
Spectr Ana Sc DL Freq	1930 ... 1990 or 2110 ... 2170 MHz	1 ... 2560	ss	Scanned frequencies on downlink in ascending order.
Spectr Ana Sc DL No of Freq	0 ... 2560	–	ss	The number of downlink frequencies swept by the scan.
Spectr Ana Sc DL RSSI (dBm)	–130 ... –20 dBm	1 ... 2560	ss	RSSI of downlink frequencies scanned.
Spectr Ana Sc UL Freq	1930 ... 1990 or 2110 ... 2170 MHz	1 ... 2560	ss	Scanned frequencies on uplink in ascending order.
Spectr Ana Sc UL No of Freq	0 ... 2560	–	ss	The number of uplink frequencies swept by the scan.

IE Name	Range/Unit	Arg.	*	Description
Spectr Ana Sc UL RSSI (dBm)	–130 ... –20 dBm	1 ... 2560	ss	RSSI of uplink frequencies scanned.
Speed (km/h)	0 ... 250 km/h	–	p	Speed in km/h.
Speed (mph)	0 ... 155 mph	–	p	Speed in mph.
SQI	–20 ... 30 dBQ	–		Speech Quality Index for WCDMA. The range is different depending on the AMR speech codec mode. The maximum SQI values for NB are as follows: 12.2 kbit/s: 30 dBQ 10.2 kbit/s: 28 dBQ 7.95 kbit/s: 28 dBQ 7.40 kbit/s: 27 dBQ 6.70 kbit/s: 27 dBQ 5.90 kbit/s: 24 dBQ 5.15 kbit/s: 21 dBQ 4.75 kbit/s: 19 dBQ
SQI MOS	1 ... 5 MOS	–		SQI expressed on the MOS scale. See UM chapter 42.
Str Neigh Cell Name	Text	1 ... 6	c	Cell names of neighbors (monitored as well as detected) sorted by signal strength in descending order. Requires cell file. **Argument:** 1 is the strongest neighbor, etc.
Str Neigh CPICH Ec/No	–34 ... 0 dB	1 ... 6		CPICH Ec/No of neighbors (monitored as well as detected) sorted by signal strength in descending order. **Argument:** 1 is the strongest neighbor, etc.

IE Name	Range/Unit	Arg.	*	Description
Str Neigh CPICH RSCP	–140 ... –15 dBm	1 ... 6		CPICH RSCP of neighbors (monitored as well as detected) sorted by signal strength in descending order. Also occurs in MIMO variants: Antenna 1, Antenna 2, Sum. See section 3.2.1.3. **Argument:** 1 is the strongest neighbor, etc.
Str Neigh SC	0 ... 511	1 ... 6		Scrambling codes of neighbors (monitored as well as detected) sorted by signal strength in descending order. **Argument:** 1 is the strongest neighbor, etc.
Str Neigh Type	3, 4	1 ... 6		Types of neighbors (monitored as well as detected) sorted by signal strength in descending order. The types are: 3: Monitored neighbor 4: Detected neighbor **Argument:** 1 is the strongest neighbor, etc.
Str Neigh UARFCN DL	0 ... 16383 (frequency band dependent)	1 ... 6		CPICH UARFCNs of neighbors (monitored as well as detected) sorted by signal strength in descending order. **Argument:** 1 is the strongest neighbor, etc.
Time (Text)	Text	–		Current time in text format: “hh:mm:ss.dd”, where “dd” = decimal seconds.
Trsp Ch BLER (%, Worst)	0 ... 100 %	–		Block error rate on the worst downlink transport channel (DCH only) in percent.

IE Name	Range/Unit	Arg.	*	Description
Trsp Ch BLER, DL (Log)	0 ... 63 See Description	1 ... 32		Block error rate on each downlink transport channel (DCH only), converted to logarithmic value. Regarding the conversion, see ► 3GPP 25.331, section 10.3.5.10. **Argument:** Transport channel index. **Note:** Nokia UEs do not deliver separate values for each transport channel, but only an average over all of them (argument = 1).
Trsp Ch BLER, DL (%)	0 ... 100 %	1 ... 32		Block error rate on each downlink transport channel (DCH only) in percent. ► 3GPP 25.215, section 5.1.6. Compare Trsp Ch BLER, DL (Log). **Argument:** Transport channel index.
Trsp Ch BLER Target (%)	0 ... 100 %	1 ... 32		Block error rate target for each downlink transport channel (DCH only) in percent. **Argument:** Transport channel index.
Trsp Ch Id DL	1 ... 32	1 ... 32		Identity of each downlink transport channel. The channel type is indicated by the element Trsp Ch Type DL. **Argument:** Transport channel index.
Trsp Ch No Of DL	0 ... 32	–		Number of downlink transport channels.
Trsp Ch No Of UL	0 ... 32	–		Number of uplink transport channels.

IE Name	Range/Unit	Arg.	*	Description
Trsp Ch No Of Error Blocks	0 ... 4095	1 ... 32		Number of erroneous blocks on each transport channel. (The number of reports over which this is summed varies between devices.) Compare Trsp Ch BLER, DL (Log). **Argument:** Transport channel index.
Trsp Ch Rec Blocks	0 ... 4095	1 ... 32		Number of blocks received on each transport channel. (The number of reports over which this is summed varies between devices.) **Argument:** Transport channel index.
Trsp Ch Throughput DL (kbit/s)	0 ... 80000 kbit/s	1 ... 32		Downlink throughput on each transport channel. **Argument:** Transport channel index.
Trsp Ch Throughput DL Total (kbit/s)	0 ... 80000 kbit/s	–		Total downlink throughput on all transport channels. **Argument:** Transport channel index.
Trsp Ch Throughput UL (kbit/s)	0 ... 80000 kbit/s	1 ... 32		Uplink throughput on each transport channel. **Argument:** Transport channel index.
Trsp Ch Throughput UL Total (kbit/s)	0 ... 80000 kbit/s	–		Total uplink throughput on all transport channels. **Argument:** Transport channel index.
Trsp Ch Type DL	Text	1 ... 32		Downlink transport channel type: DCH or FACH. **Argument:** Transport channel index.

IE Name	Range/Unit	Arg.	*	Description
Trsp Ch Type UL	Text	1 ... 32		Uplink transport channel type: DCH or RACH. **Argument:** Transport channel index.
UE Initial Transmit Power	–60 ... 44 dBm	–		UE initial transmit power in dBm.
UE Tx Power	–60 ... 44 dBm	–		UE transmit power in dBm. Valid only in connected mode.
UL Interference Serving	–110 ... –70 dBm	–		Interference on uplink, extracted from SIB type 7.
UTRA Carrier RSSI	–130 ... –20 dBm	–		Total energy measured by the UE within the downlink bandwidth. Also occurs in MIMO variants: Per Antenna, Sum. See section 3.2.1.3.
VTQI	1 ... 5 MOS	–		Video Telephony Quality Index; see UM chapter 43.

3.3. LTE Information Elements

IE Name	Range/Unit	Arg	Description
AFC Adjusted Offset	–100 ... 100	–	Automatic Frequency Control: Adjusted value of AFC frequency offset.
AFC Period	0 ... 65535	–	Automatic Frequency Control: Frequency offset adjustment period.
Altitude (ft)	–1312 ... 29028 ft	–	Height above sea level in feet. Reported by positioning equipment.
Altitude (m)	–400 ... 8848 m	–	Height above sea level in meters. Reported by positioning equipment.
ANR IEs: General remark	These elements relate to ANR, Automatic Neighbor Relation detection. Regarding this mechanism in general, see ▶ 3GPP 36.300, sections 22.3.2a and 22.3.3–4.		
ANR Cell For Which To Report CGI	Text	–	Physical cell identity of a cell which the UE has been instructed by the eNodeB to look for and report the CGI for. This may be an EUTRAN, UTRAN, or GERAN cell. ▶ 3GPP 36.331, sections 5.5.3–5 and 6.3.5, parameter cellFor-WhichToReportCGI The UE may conceivably have several such reporting orders assigned at the same time. If so, only one cell is presented.

IE Name	Range/Unit	Arg	Description
ANR Feature Group Indicators	Text	–	Feature group indicators determining the UE’s capability to perform ANR measurements. ► 3GPP 36.331, sections 6.3.6 and B.1 5: Long DRX cycle, DRX command MAC control element 17: Periodical measurement reporting for intra-frequency ANR 18: Periodical measurement reporting for inter-frequency ANR 19: Periodical measurement reporting for inter-RAT ANR
ANR Inter-frequency LTE Activated	Text	–	Populated when the UE is instructed to report CGI for an EUTRAN cell that is on a different carrier from the current serving cell. Cleared when the corresponding measId is removed. Example: “Yes, EARFCN: 6300, PCI: 38”
ANR Inter-RAT LTE Activated	Text	–	Populated when the UE is instructed to report CGI for a non-EUTRAN cell. Cleared when corresponding measId is removed. Examples: “Yes, RAT: GERAN, ARFCN: 19”; “Yes, RAT: UTRA, UARFCN: 10638, PSC: 14”
ANR Intra-frequency LTE Activated	Text	–	Populated when the UE is instructed to report CGI for an EUTRAN cell that is on the same carrier as the current serving cell. Cleared when corresponding measId is removed. Example: “Yes, PCI: 38”

IE Name	Range/Unit	Arg	Description
ANR LTE Configured	Text: “Yes”/“No”	–	This IE takes the value “Yes” if and when a reportConfig is observed with Purpose set to reportCGI: ▶ 3GPP 36.331, section 5.5.4.1. It does not follow that the UE is currently using the reportConfig; the value “Yes” only indicates that ANR as such is enabled in the network.
ANR Reported Cell	Text	–	Cell reported by the UE. Normally identical to ANR Cell For Which To Report CGI, except possibly if the UE has been given multiple reporting orders of this kind, in which case only one cell is presented. The string has the following format: • LTE intra-frequency: <PCI> • LTE inter-frequency: <EARFCN>, <PCI> • WCDMA inter-RAT: <UARFCN>, <SC> • GSM inter-RAT: <ARFCN>, <BSIC>
ANR Reported CGI	Text	–	CGI of the cell reported by the UE, that is, of ANR Reported Cell. Formats: • EUTRAN cell: MCC, MNC, TAC, Cell Id. • UTRAN cell: PLMN, LAC, UTRA Cell Id. • GERAN cell: PLMN, LAC, GSM Cell Id.
Antenna Correlation	Text	–	Degree of antenna correlation, classified as “Low”, “Medium”, or “High”.
Attach Type	Text	–	CS fallback: Current attach type. One of: “EPS Attach”, “Combined EPS/IMSI Attach”.

IE Name	Range/Unit	Arg	Description
Bearer IEs: General remark	The **argument** points to an EPS bearer.		
Bearer Default EPS Bearer ID	5 ... 15	1 ... 11	The default EPS bearer that each dedicated EPS bearer is associated with. Invalid if the bearer is itself a default bearer, i.e. only valid for dedicated bearers. Regarding the EPS bearer identity, see ▶ 3GPP 24.007.
Bearer Guaranteed Bitrate DL (kbit/s)	0 ... 350000 kbit/s	1 ... 11	Guaranteed downlink bit rate for each EPS bearer. ▶ 3GPP 24.301, section 9.9.4.3
Bearer Guaranteed Bitrate UL (kbit/s)	0 ... 350000 kbit/s	1 ... 11	Guaranteed uplink bit rate for each EPS bearer. ▶ 3GPP 24.301, section 9.9.4.3
Bearer ID	5 ... 15	1 ... 11	Identity number of each EPS bearer.
Bearer Initiator	Text	1 ... 11	The party that initiated each EPS bearer: UE or network.
Bearer Maximum Bitrate DL (kbit/s)	0 ... 350000 kbit/s	1 ... 11	Maximum downlink bit rate for each EPS bearer. ▶ 3GPP 24.301, section 9.9.4.3
Bearer Maximum Bitrate UL (kbit/s)	0 ... 350000 kbit/s	1 ... 11	Maximum uplink bit rate for each EPS bearer. ▶ 3GPP 24.301, section 9.9.4.3
Bearer Number Of	0 ... 11	–	Number of EPS bearers for the UE.
Bearer PDN Connection Index	0 ... 8	1 ... 11	The PDN connection that each EPS bearer is associated with.
Bearer QCI	1 ... 9	1 ... 11	QoS Class Indicator. ▶ 3GPP 24.301, section 9.9.4.3

IE Name	Range/Unit	Arg	Description
Bearer Status	Text	1 ... 11	Status of each EPS bearer. One of: "Free", "Used", "Not found".
Bearer Type	Text	1 ... 11	Type of each EPS bearer. One of: "Undefined", "Default", "Dedicated".
"Cell" IEs: General remarks	All elements prefixed with "Cell" (without a following "List") pertain to cell reselection measurements of one type or another (intra-frequency, inter-frequency, or inter-RAT). The arguments of all IEs associated with the same type of cell reselection are coordinated; for example, arg = 1 always refers (at a given moment in time) to the same E-UTRA frequency for all IEs related to inter-frequency cell reselection. In the specifications, see especially ▶ 3GPP 36.331, section 6.1.3 ("RRC information elements – System information blocks") and ▶ 3GPP 36.304, section 5.2.4.7 ("Cell reselection parameters in system information broadcasts").		
Cell Allowed Measurement Bandwidth Inter Frequency	6 ... 100 RBs	1 ... 8	Allowed bandwidth for inter-frequency cell reselection measurements. Given as a number of resource blocks (RBs). **Argument:** Points to an E-UTRA frequency.
Cell Allowed Measurement Bandwidth Intra Frequency	6 ... 100 RBs	–	Allowed bandwidth for intra-frequency cell reselection measurements. Given as a number of resource blocks (RBs).
Cell DL EARFCN Inter Frequency	0 ... 39649	1 ... 8	EARFCNs of E-UTRA cells that are candidates for inter-frequency cell reselection. **Argument:** Just a sequence number.
Cell GERAN ARFCN	0 ... 1023 (See section 3.1 under "ARFCN BCCH")	1 ... 16	ARFCNs of GERAN cells that are candidates for inter-RAT cell reselection. **Argument:** Just a sequence number.
Cell Q-Hysteresis (dB)	0 ... 24 dB	–	Q_{hyst}, hysteresis value for cell ranking criteria. ▶ 3GPP 36.304, section 5.2.4.7

IE Name	Range/Unit	Arg	Description
Cell Q-Offset Frequency	–24 ... 24 dB	1 ... 8	$Qoffset_{frequency}$, frequency-specific offset for equal-priority E-UTRA frequencies. ▶ 3GPP 36.304, section 5.2.4.7 **Argument:** Points to an E-UTRA frequency.
Cell Q-RxLevMin	–140 ... 44 dBm	–	Qrxlevmin, minimum required Rx level in cell. ▶ 3GPP 36.304, section 5.2.4.7
Cell Q-RxLevMin Offset	0 ... 8	–	Corresponds to Qrxlevminoffset, offset to the signaled Qrxlevmin taken into account in the Srxlev evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN. ▶ 3GPP 36.304, section 5.2.3.2 The actual IE value is equal to q-RxLevMinOffset, broadcast in SIB type 1 (▶ 3GPP 36.331, section 6.2.2). Qrxlevminoffset = IE value × 2 [dB].
Cell Reselection Priority Inter Frequency	0 ... 7	1 ... 8	Absolute priority of carrier frequency used in inter-frequency cell reselection procedure. Derived from SIB type 5. ▶ 3GPP 36.304, section 5.2.4.7 **Argument:** Points to an E-UTRA frequency.
Cell Reselection Priority Intra Frequency	0 ... 7	–	Absolute priority of carrier frequency as stated in SIB type 3. ▶ 3GPP 36.304, section 5.2.4.7
Cell T-Reselection CDMA2000	0 ... 7 s	–	Timer $Treselection_{RAT}$ for inter-RAT cell reselection to CDMA2000 (1x). ▶ 3GPP 36.304, section 5.2.4.7
Cell T-Reselection GERAN	0 ... 7 s	–	Timer $Treselection_{RAT}$ for inter-RAT cell reselection to GERAN (GSM).

IE Name	Range/Unit	Arg	Description
Cell T-Reselection Inter Frequency EUTRA	0 ... 7 s	1 ... 8	Timer Treselection$_{RAT}$ for inter-frequency cell reselection within E-UTRA. **Argument:** Points to an E-UTRA frequency.
Cell T-Reselection Intra Frequency EUTRA	0 ... 7 s	–	Timer Treselection$_{RAT}$ for intra-frequency cell reselection within E-UTRA.
Cell T-Reselection UTRA	0 ... 7 s	–	Timer Treselection$_{RAT}$ for inter-RAT cell reselection to UTRA (UMTS).
“Cell List” IEs: General remark	These elements are what is shown in the LTE Serving/Neighbor Cell status window. They contain the same information as the “Serving Cell” and “Neighbor Cell” elements, except that there is an additional element indicating the type of each cell: see below.		
Cell List Type	Text	1 ... 64	One of: SC: Serving cell (single carrier used) PCell: Primary serving cell (carrier aggregation used) SCell1 ... SCell7: Secondary serving cell no. 1 ... 7 (carrier aggregation used; nos. 2 and above are as yet theoretical) MN: Monitored neighbor DN: Detected neighbor
“Cell Threshold” IEs: General remark	“High” refers to a frequency or RAT with higher priority than the current serving frequency. Similarly, “Low” refers to a frequency or RAT with lower priority than the current serving frequency. ▶ 3GPP 36.304, section 5.2.4.7		
Cell Threshold Serving Low	0 ... 62 dB	–	Srxlev threshold used by the UE on the serving cell when reselecting towards a lower priority RAT/frequency.

IE Name	Range/Unit	Arg	Description
Cell Threshold X High CDMA2000	0 ... 62 dB	1 ... 32	CDMA2000 inter-RAT cell reselection Srxlev threshold “High”. **Argument:** Points to a CDMA2000 frequency.
Cell Threshold X High EUTRA	0 ... 62 dB	1 ... 8	E-UTRA inter-frequency cell reselection Srxlev threshold “High”. **Argument:** Points to an E-UTRA frequency.
Cell Threshold X High GERAN	0 ... 62 dB	1 ... 16	GERAN inter-RAT cell reselection Srxlev threshold “High”. **Argument:** Points to a GERAN frequency.
Cell Threshold X High UTRA (FDD)	0 ... 62 dB	1 ... 16	UTRA inter-RAT cell reselection Srxlev threshold “High” for FDD LTE. **Argument:** Points to a UTRA frequency.
Cell Threshold X High UTRA (TDD)	0 ... 62 dB	1 ... 16	UTRA inter-RAT cell reselection Srxlev threshold “High” for TDD LTE. **Argument:** Points to a UTRA frequency.
Cell Threshold X Low CDMA2000	0 ... 62 dB	1 ... 32	CDMA2000 inter-RAT cell reselection Srxlev threshold “Low”. **Argument:** Points to a CDMA2000 frequency.
Cell Threshold X Low EUTRA	0 ... 62 dB	1 ... 8	E-UTRA inter-frequency cell reselection Srxlev threshold “Low”. **Argument:** Points to an E-UTRA frequency.
Cell Threshold X Low GERAN	0 ... 62 dB	1 ... 16	GERAN inter-RAT cell reselection Srxlev threshold “Low”. **Argument:** Points to a GERAN frequency.

IE Name	Range/Unit	Arg	Description
Cell Threshold X Low UTRA (FDD)	0 ... 62 dB	1 ... 16	UTRA inter-RAT cell reselection Srxlev threshold "Low" for FDD LTE. **Argument:** Points to a UTRA frequency.
Cell Threshold X Low UTRA (TDD)	0 ... 62 dB	1 ... 16	UTRA inter-RAT cell reselection Srxlev threshold "Low" for TDD LTE. **Argument:** Points to a UTRA frequency.
CQI Code Word 0	0 ... 15	–	Channel Quality Indicator for antenna Rx1. ▶ 3GPP 36.213, section 7.2.3
CQI Code Word 1	0 ... 15	–	Channel Quality Indicator for antenna Rx2. ▶ 3GPP 36.213, section 7.2.3
CQI Periodicity	Text	–	Periodicity of CQI reporting using PUCCH. ▶ 3GPP 36.213, section 7.2.2
CQI Report Mode	Text	–	PUCCH CQI reporting mode as defined in ▶ 3GPP 36.213, section 7.2.2: one of "Mode 1-0", "Mode 1-1", "Mode 2-0", "Mode 2-1".
CQI Sub-band Code Word 0	0 ... 15	0 ... 24	Sub-band CQIs for antenna Rx1. **Argument:** Sub-band index.
CQI Sub-band Code Word 1	0 ... 15	0 ... 24	Sub-band CQIs for antenna Rx2. **Argument:** Sub-band index.
Cyclic Prefix	0 ... 1	–	Uplink cyclic prefix length.
DRX IEs: General remark	These elements relate to the Discontinuous Reception mechanism: ▶ 3GPP 36.321, especially section 5.7.		
DRX Cycle Type	Text	–	DRX cycle type: "Short DRX" or "Long DRX".
DRX Enabled	0 ... 1	–	DRX status. 0: DRX disabled 1: DRX enabled

IE Name	Range/Unit	Arg	Description
DRX Enabled On ANR	0 ... 1	–	Use of DRX for ANR (Automatic Neighbor Relation) measurements.
DRX Inactivity Timer	1 ... 2560 See Description	–	Number of consecutive PDCCH-subframes after the UE successfully decoded a PDCCH indicating an initial UL or DL user data transmission.
DRX Inactivity Timer Enabled	0 ... 1	–	Status of DRX Inactivity timer. 0: Disabled 1: Enabled
DRX Long Cycle	10 ... 2560 See Description	–	Length of long DRX cycle, expressed as a number of PDCCH-subframes.
DRX On Duration Timer	1 ... 200 See Description	–	Number of consecutive PDCCH-subframes at the beginning of a DRX cycle.
DRX On Duration Timer Enabled	0 ... 1	–	Status of DRX On Duration timer. 0: Disabled 1: Enabled
DRX Retrans-mission Timer	1 ... 33 See Description	–	Maximum number of consecutive PDCCH-subframes for which the UE has to monitor the PDCCH for an expected retransmission.
DRX Short Cycle	2 ... 640 See Description	–	Length of short DRX cycle, expressed as a number of PDCCH-subframes.
DRX Short Cycle Enabled	0 ... 1	–	Use of DRX short cycle. 0: Disabled 1: Enabled
DRX Short Cycle Timer	1 ... 16 See Description	–	Number of consecutive subframes for which the UE shall follow the short DRX cycle.

IE Name	Range/Unit	Arg	Description
DRX Start Offset	0 ... 2559 See Description	–	Subframe where the DRX cycle starts.
Duplex Mode	0 ... 1	–	Duplex mode indication. 0: FDD 1: TDD
Duplex Mode (Text)	Text	–	Same as Duplex Mode but in text format.
EMM State	Text	–	EPS Mobility Management state.
EMM Substate	Text	–	EPS Mobility Management substate.
EPower IEs: General remark	These elements originate from enhanced power scanning. **Argument:** Points to a frequency as specified by the EPower Ana Sc DL Freq (kHz) element.		
EPower Ana Sc DL Freq (kHz)	0 ... $6 \cdot 10^6$ kHz	1 ... 2559	List of frequencies scanned.
EPower Ana Sc DL No Of Freq	0 ... 2560	–	Number of frequencies scanned.
EPower Ana Sc DL RSSI (dBm)	–140 ... 25 dBm	1 ... 2559	RSSI for each frequency scanned.
Equipment Time	Text	–	Time as reported in device timestamp. Given in the format “hh:mm:ss.ddd”, where “ddd” = decimal seconds.
ESM State	Text	–	EPS Session Management state.
Firmware Version	Text	–	Version number of device firmware.
Hardware	Text	–	Scanner model.
Hardware ID	Text	–	Hardware identification string.

IE Name	Range/Unit	Arg	Description
Heading (deg)	0 ... 360 degrees	–	Direction of travel measured in degrees clockwise from north. Reported by positioning equipment.
IMSI	Text	–	International Mobile Subscriber Identity, the unique identity of the SIM in the device. ▶ 3GPP 23.003
Latitude	–90 ... 90 degrees	–	Latitude recorded by positioning equipment.
Latitude (Text)	Text	–	Latitude as text. For the presentation format, see TR section 3.4.
Latitude Decimal Degrees (Text)	Text	–	Latitude in decimal degrees, presented as text.
Longitude	–180 ... 180 degrees	–	Longitude recorded by positioning equipment.
Longitude (Text)	Text	–	Longitude as text. For the presentation format, see TR section 3.4.
Longitude Decimal Degrees (Text)	Text	–	Longitude in decimal degrees, presented as text.
MAC BLER TB0 DL (%)	0 ... 100 %	–	MAC layer block error rate in percent for downlink Transport Block 0.
MAC BLER TB1 DL (%)	0 ... 100 %	–	MAC layer block error rate in percent for downlink Transport Block 1.
MAC DL PDU Handover Interruption Time	0 ... 1000 ms	–	Duration of downlink data transfer interruption at the MAC layer in connection with a handover.
MAC DL Throughput	0 ... 350000 kbit/s	–	MAC layer downlink throughput. Available in kbit/s and Mbit/s versions.
MAC Random Access Time (ms)	0 ... 86,400,000 ms (= 24 h)	–	Start time of MAC random access procedure: absolute timestamp modulo (number of milliseconds in a day).

IE Name	Range/Unit	Arg	Description
MAC Random Access Completion Time (ms)	0 ... 86,400,000 ms	–	Time of completion of MAC random access procedure: absolute timestamp modulo (number of milliseconds in a day).
MAC Random Access Preamble Time (ms)	0 ... 86,400,000 ms	–	Time of preamble transmission during MAC random access procedure: absolute timestamp modulo (number of milliseconds in a day).
MAC UL PDU Handover Interruption Time	0 ... 1000 ms	–	Duration of uplink data transfer interruption at the MAC layer in connection with a handover.
MAC UL Throughput	0 ... 350000 kbit/s	–	MAC layer uplink throughput. Available in kbit/s and Mbit/s versions.
Message Hex Dump Payload	Text	–	Contains the hexadecimal string of a Layer 3 message or mode report. Used for text-format logfile export only.
MME Code	0 ... 255	–	Mobility Management Entity Code. ▶ 3GPP 23.003, section 2.8.1
MME Group ID	0 ... 65535	–	Mobility Management Entity Group ID. ▶ 3GPP 23.003, section 2.8.1
Mode	Text	–	Same as Mode (Num) but in text format.
Mode (Num)	1 ... 7	–	1: No service 2: Idle mode 3: Dedicated (Connected) mode 4: Limited service mode 5: Scan mode 6: Packet mode 7: Packet idle mode (E-RRC mode)

IE Name	Range/Unit	Arg	Description
Mode - System	1 ... 9	–	Relevant values: 1: WCDMA 2: GSM 3: CDMA (1x) 4: EV-DO 7: LTE For the full set of values, see the Mode - System element under WCDMA.
Mode - System (Text)	Text	–	Same as Mode - System but in text format.
MTMSI	Text	–	M-TMSI, M-Temporary Mobile Subscriber Identity. ► 3GPP 23.003
“Neighbor Cell” IEs: General remark	The **argument** points to an LTE cell. The sorting order depends on the setting in the General window: see UM section 19.2.8.1.		
Neighbor Cell Channel RSSI (dBm)	–140 ... 25 dBm	1 ... 8	Received signal strength on the EARFCN each neighbor is using. Regarding EARFCN numbering, ► 3GPP 36.101.
Neighbor Cell Distance (m)	0 ... 100000 m	1 ... 8	Distance to each neighbor cell. Requires cell file and UE positioning data.
Neighbor Cell DL EARFCN	0 ... 39649	1 ... 8	Downlink EARFCN of each neighbor. Regarding EARFCN numbering, ► 3GPP 36.101.
Neighbor Cell Frame Timing Rx1	0 ... 307199 LTE T_s units	1 ... 8	Cell frame timing relative to the network’s absolute time reference, as received on antenna Rx1.
Neighbor Cell Frame Timing Rx2	0 ... 307199 LTE T_s units	1 ... 8	Cell frame timing relative to the network’s absolute time reference, as received on antenna Rx2.
Neighbor Cell Frame Timing Offset Rx1	0 ... 307199 LTE T_s units	1 ... 8	Cell frame timing offset from serving cell as received on antenna Rx1, i.e. Neighbor Cell Frame Timing Rx1 – Serving Cell Frame Timing Rx1.

IE Name	Range/Unit	Arg	Description
Neighbor Cell Frame Timing Offset Rx2	0 ... 307199 LTE T_s units	1 ... 8	Cell frame timing offset from serving cell as received on antenna Rx2, i.e. Neighbor Cell Frame Timing Rx2 – Serving Cell Frame Timing Rx2.
Neighbor Cell Identity	0 ... 503	1 ... 8	Cell Identity (equal to 3 × PCIG + PCI) of each neighbor.
Neighbor Cell Name	Text	1 ... 8	Cell name of each neighbor. Requires cell file.
Neighbor Cell Number Of	1 ... 8	–	Number of neighbors in the neighbor list of the current serving cell.
Neighbor Cell RSRP (dBm)	–140 ... 25 dBm	1 ... 8	Reference Signal Received Power of each neighbor (sum of contributions from antennas Rx1 and Rx2).
Neighbor Cell RSRP Tx1 Rx1 (dBm)	–140 ... 25 dBm	1 ... 8	RSRP contribution from eNodeB antenna Tx1 as received on antenna Rx1.
Neighbor Cell RSRP Tx1 Rx2 (dBm)	–140 ... 25 dBm	1 ... 8	RSRP contribution from eNodeB antenna Tx1 as received on antenna Rx2.
Neighbor Cell RSRP Tx2 Rx1 (dBm)	–140 ... 25 dBm	1 ... 8	RSRP contribution from eNodeB antenna Tx2 as received on antenna Rx1.
Neighbor Cell RSRP Tx2 Rx2 (dBm)	–140 ... 25 dBm	1 ... 8	RSRP contribution from eNodeB antenna Tx2 as received on antenna Rx2.
Neighbor Cell RSRQ (dBm)	–40 ... 40 dB	1 ... 8	Reference Signal Received Quality of each neighbor (sum of contributions from eNodeB antennas Rx1 and Rx2).
Neighbor Cell RSRQ Tx1 Rx1 (dBm)	–40 ... 40 dB	1 ... 8	RSRQ contribution from eNodeB antenna Tx1 as received on antenna Rx1.
Neighbor Cell RSRQ Tx1 Rx2 (dBm)	–40 ... 40 dB	1 ... 8	RSRQ contribution from eNodeB antenna Tx1 as received on antenna Rx2.

IE Name	Range/Unit	Arg	Description
Neighbor Cell RSRQ Tx2 Rx1 (dBm)	–40 ... 40 dB	1 ... 8	RSRQ contribution from eNodeB antenna Tx2 as received on antenna Rx1.
Neighbor Cell RSRQ Tx2 Rx2 (dBm)	–40 ... 40 dB	1 ... 8	RSRQ contribution from eNodeB antenna Tx2 as received on antenna Rx2.
PBCH BLER (%)	0 ...100 %	–	PBCH block error rate for the latest reporting period.
PBCH BLER Accumulated (%)	0 ...100 %	–	PBCH block error rate, accumulated over the current session.
PCFICH CFI Information (%)	0 ...100 %	1 ... 4	The percentage of subframes encoded with a specific number of OFDM symbols during one second. **Argument:** OFDM symbol count.
PDCCH CCE Count (Accu)	0 ... $1 \cdot 10^6$	1 ... 4	Number of Control Channel Elements sent on the PDCCH, accumulated over the current session. **Argument:** OFDM symbol count.
PDCCH CCE Count (Curr)	0 ... 100	1 ... 4	Number of Control Channel Elements sent on the PDCCH during the latest reporting period. **Argument:** OFDM symbol count.

IE Name	Range/Unit	Arg	Description
PDCCH DCI Format Usage Distribution Accumulated	0 ... 65535	1 ... 11	Distribution of Downlink Control Information format usage on PDCCH. Accumulated over the current session. DCI formats are detailed in ► 3GPP 36.212, section 5.3.3.1. **Argument:** 1: Format 0 2: Format 1 3: Format 1A 4: Format 1B 5: Format 1C 6: Format 1D 7: Format 2 8: Format 2A 9: Format 2B 10: Format 3 11: Format 3A
PDCCH DCI Format Usage Distribution Current	0 ... 65535	1 ... 10	Distribution of Downlink Control Information format usage on PDCCH for the latest reporting period. DCI formats are detailed in ► 3GPP 36.212, section 5.3.3.1. **Argument:** See PDCCH DCI Format Usage Distribution Accumulated.
PDCCH DL Grant Count (Accu)	0 ... $1 \cdot 10^6$	–	Number of downlink grants on PDCCH, accumulated over the current session.
PDCCH DL Grant Count (Curr)	0 ... 100	–	Number of downlink grants on PDCCH during the latest reporting period.
PDCCH UL Grant Count (Accu)	0 ... $1 \cdot 10^6$	–	Number of uplink grants on PDCCH, accumulated over the current session.
PDCCH UL Grant Count (Curr)	0 ... 100	–	Number of uplink grants on PDCCH during the latest reporting period.

IE Name	Range/Unit	Arg	Description
PDCP DL PDU Handover Interruption Time	0 ... 1000 ms	–	Duration of downlink data transfer interruption at the PDCP layer in connection with a handover.
PDCP DL RB Throughput (kbit/s)	0 ... 350000 kbit/s	0 ... 37	Throughput on each PDCP downlink radio bearer. **Argument:** Radio bearer index.
PDCP DL Throughput	0 ... 350000 kbit/s	–	Total downlink throughput in the PDCP protocol layer (sum over all radio bearers). Available in kbit/s and Mbit/s versions.
PDCP UL PDU Handover Interruption Time	0 ... 1000 ms	–	Duration of uplink data transfer interruption at the PDCP layer in connection with a handover.
PDCP UL RB Throughput (kbit/s)	0 ... 350000 kbit/s	0 ... 37	Throughput on each PDCP uplink radio bearer. **Argument:** Radio bearer index.
PDCP UL Throughput	0 ... 350000 kbit/s	–	Total uplink throughput in the PDCP protocol layer (sum over all radio bearers). Available in kbit/s and Mbit/s versions.
PDN Connection IEs: General remark	These IEs relate to packet data network (PDN) connections. **Argument:** Just a sequence number pointing to a PDN connection.		
PDN Connection IPv4 Address	Text	1 ... 9	User address (IPv4).
PDN Connection IPv6 Address	Text	1 ... 9	User address (IPv6).
PDN Connection Address Type	Text	1 ... 9	Address type: IPv4 or IPv6.

IE Name	Range/Unit	Arg	Description
PDN Connection AMBR DL (kbit/s)	0 ... 350000 kbit/s	1 ... 9	Aggregate maximum bit rate on downlink. ► 3GPP 24.301, section 9.9.4.2
PDN Connection AMBR UL (kbit/s)	0 ... 350000 kbit/s	1 ... 9	Aggregate maximum bit rate on uplink. ► 3GPP 24.301, section 9.9.4.2
PDN Connection APN	Text	1 ... 9	Host name or network Access Point Name.
PDN Connection Default Bearer ID	5 ... 15	1 ... 9	EPS Default Bearer associated with each PDN connection.
PDN Connection Index	0 ... 8	1 ... 9	PDN connection index.
PDN Connection Number Of	0 ... 9	–	Number of active PDN connections.
PDSCH IEs: General remark	These elements concern the Physical Downlink Shared Channel, PDSCH.		
PDSCH BLER (%)	0 ... 100 %	–	Block error rate on the PDSCH.
PDSCH BLER TB0 (%)	0 ... 100 %	–	Block error rate for downlink Transport Block 0.
PDSCH BLER TB0 Ack Number Of	0 ... 75	–	Number of ACKs for downlink Transport Block 0 during the latest reporting period.
PDSCH BLER TB0 Nack Number Of	0 ... 75	–	Number of NACKs for downlink Transport Block 0 during the latest reporting period.

IE Name	Range/Unit	Arg	Description
PDSCH BLER TB1 (%)	0 ... 100 %	–	Block error rate for downlink Transport Block 1.
PDSCH BLER TB1 Ack Number Of	0 ... 75	–	Number of ACKs for downlink Transport Block 1 during the latest reporting period.
PDSCH BLER TB1 Nack Number Of	0 ... 75	–	Number of NACKs for downlink Transport Block 1 during the latest reporting period.
PDSCH MCS0	0 ... 31	–	Modulation Coding Scheme index for downlink Transport Block 0. ▶ 3GPP 36.213, section 7.1.7.1
PDSCH MCS1	0 ... 31	–	Modulation Coding Scheme index for downlink Transport Block 1.
PDSCH Modulation TB0 (bits)	0 ... 8	–	The number of bits used for modulation of downlink Transport Block 0. ▶ 3GPP 36.213, section 7.1.7.1
PDSCH Modulation TB0 (Text)	Text	–	Name of modulation method used for modulation of downlink Transport Block 0.
PDSCH Modulation TB1 (bits)	0 ... 8	–	The number of bits used for modulation of downlink Transport Block 1. ▶ 3GPP 36.213, section 7.1.7.1
PDSCH Modulation TB1 (Text)	Text	–	Name of modulation method used for modulation of downlink Transport Block 1.
PDSCH Number Of Used Transport Blocks	1 ... 2	–	Number of used downlink transport blocks.
PDSCH Phy Throughput	0 ... 350000 kbit/s	–	Throughput on the PDSCH, measured as the throughput rate from the physical layer to the MAC layer. Available in kbit/s and Mbit/s versions.

IE Name	Range/Unit	Arg	Description
PDSCH Phy Throughput CW0	0 ... 350000 kbit/s	–	Throughput on the PDSCH for Transport Block 0. Available in kbit/s and Mbit/s versions.
PDSCH Phy Throughput CW1	0 ... 350000 kbit/s	–	Throughput on the PDSCH for Transport Block 1. Available in kbit/s and Mbit/s versions.
PDSCH Resource Block Start	0 ... 100	–	Within the current TTI, index of the first PDSCH resource block that is allocated to this device.
PDSCH Resource Blocks	1 ... 110	–	Number of PDSCH resource blocks, equal to N_PRB in ▶ 3GPP 36.213, section 7.1.7.
PDSCH Resource Blocks (%)	0 ... 100 %	–	Percentage of the maximum number of PDSCH resource blocks, equal to N_PRB in ▶ 3GPP 36.213, section 7.1.7.
PDSCH Transmission Distribution CW0 (Accu) (%)	0 ... 100 %	0 ... 8	Distribution of downlink Transport Block 0 transmission attempts with respect to the sequence number of the attempt. Accumulated over the current session. CW = Code Word. **Argument:** 0: Residual 1: First transmission 2: First retransmission 3 ... 7: Second ... sixth retransmission 8: Seventh or later retransmission
PDSCH Transmission Distribution CW0 (Accu) Count	0 ... $1 \cdot 10^6$	0 ... 8	Same as PDSCH Transmission Distribution CW0 (Accu) (%) but expressing the distribution in terms of absolute numbers rather than percentages.

IE Name	Range/Unit	Arg	Description
PDSCH Transmission Distribution CW0 (Curr) (%)	0 ... 100 %	0 ... 8	Distribution of downlink Transport Block 0 transmission attempts with respect to the sequence number of the attempt. Valid for latest reporting period. **Argument:** See PDSCH Transmission Distribution CW0 (Accu) (%).
PDSCH Transmission Distribution CW0 (Curr) Count	0 ... 100	0 ... 8	Same as PDSCH Transmission Distribution CW0 (Curr) (%) but expressing the distribution in terms of absolute numbers rather than percentages.
PDSCH Transmission Distribution CW1 (Accu) (%)	0 ... 100 %	0 ... 8	Same as PDSCH Transmission Distribution CW0 (Accu) (%) but for Transport Block 1 (Code Word 1).
PDSCH Transmission Distribution CW1 (Accu) Count	0 ... $1 \cdot 10^6$	0 ... 8	Same as PDSCH Transmission Distribution CW0 (Accu) Count but for Transport Block 1 (Code Word 1).
PDSCH Transmission Distribution CW1 (Curr) (%)	0 ... 100 %	0 ... 8	Same as PDSCH Transmission Distribution CW0 (Curr) (%) but for Transport Block 1 (Code Word 1).
PDSCH Transmission Distribution CW1 (Curr) Count	0 ... 100	0 ... 8	Same as PDSCH Transmission Distribution CW0 (Curr) Count but for Transport Block 1 (Code Word 1).
PMI	0 ... 15	–	Precoding Matrix Indicator.
Protocol Version	Text	–	E-UTRA Access Stratum release supported by UE: “Rel-8”, “Rel-9”, etc. ▶ 3GPP 36.306, section 4.3.8.1

IE Name	Range/Unit	Arg	Description
PUSCH IEs: General remark	These elements concern the Physical Uplink Shared Channel, PUSCH.		
PUSCH BLER (%)	0 ... 100 %	–	Block error rate on the PUSCH.
PUSCH BLER Ack Number Of	0 ... 100000	–	Number of ACKs for the uplink transport block during the latest reporting period.
PUSCH BLER Nack Number Of	0 ... 100000	–	Number of NACKs for the uplink transport block during the latest reporting period.
PUSCH HARQ Max Transmissions	0 ... 1	–	Maximum number of HARQ transmissions.
PUSCH MCS	0 ... 31	–	Modulation Coding Scheme index for the uplink transport block. ▶ 3GPP 36.213, section 7.1.7.1
PUSCH Modulation (bits)	0 ... 8	–	The number of bits used for modulation of the uplink transport block. ▶ 3GPP 36.213, section 7.1.7.1
PUSCH Modulation (Text)	Text	–	Name of modulation method used for modulation of the uplink transport block.
PUSCH Phy Throughput	0 ... 350000 kbit/s	–	Throughput on the PUSCH. Available in kbit/s and Mbit/s versions.
PUSCH Resource Block Start	0 ... 100	–	Within the current TTI, index of the first PUSCH resource block that is allocated to this device.
PUSCH Resource Blocks	1 ... 110	–	Number of PUSCH resource blocks, equal to N_PRB in ▶ 3GPP 36.213, section 7.1.7.
PUSCH Resource Blocks (%)	0 ... 100 %	–	Percentage of the maximum number of PUSCH resource blocks, equal to N_PRB in ▶ 3GPP 36.214, section 8.6.2.

IE Name	Range/Unit	Arg	Description
PUSCH Transmission Distribution (Accu) %	0 ... 100 %	0 ... 6	Distribution of PUSCH transmission attempts with respect to the sequence number of the attempt. Accumulated over the current session. **Argument:** 0: Residual 1: First transmission 2: First retransmission 3 ... 5: Second ... fourth retransmission 6: Fifth or later retransmission
PUSCH Transmission Distribution (Curr) %	0 ... 100 %	0 ... 6	Distribution of PUSCH transmission attempts with respect to the sequence number of the attempt. Valid for latest reporting period. **Argument:** See PUSCH Transmission Distribution (Accu) %.
RACH Contention Resolution Timer	8 ... 64	–	Specifies the number of consecutive subframes during which the UE shall monitor the PDCCH after a RACH-related message of type “Msg3” is transmitted. ► 3GPP 36.321, section 5.1.5
RACH Current Tx Power (dBm)	–140 ... 25 dBm	–	Transmit power of last RACH preamble.
RACH Initial Tx Power (dBm)	–50 ... 25 dBm	–	Transmit power of first RACH preamble.
RACH Latency (TTI)	0 ... 32000	–	Time between request and response, measured in TTIs.
RACH Max Preamble Power	–50 ... 23 dBm	–	Maximum transmit power of RACH preamble.
RACH Max Preambles	3 ... 200	–	Maximum number of preambles in one preamble ramping cycle.
RACH Number Of Transmits	1 ... 255	–	Number of transmits required for the last random access procedure.

IE Name	Range/Unit	Arg	Description
RACH Preamble Responses with PUSCH Resource	0 ... 255	–	Number of RACH preamble responses with indication of PUSCH resource.
RACH Preamble Step	0 ... 255 dB	–	RACH preamble power step size in dB.
RACH Reason	Text	–	Reason for random access procedure, one of: “Connection Request”, “Radio Link Failure”, “Uplink Data Arrival”, “Downlink Data Arrival”, “Handover”.
RACH Result	Text	–	Outcome of random access procedure, e.g.: “Success”, “Failure at <message, reason>”, “Aborted”.
RACH RNTI	0 ... 65535	–	Random access Radio Network Temporary Identity (RA-RNTI).
RACH Signature	Text	–	UE identifier used for contention resolution in random access procedure. ▶ 3GPP 36.300, section 10.1.6
RACH Type	Text	–	Type of random access procedure: “Contention free” or “Contention based”. ▶ 3GPP 36.300, section 10.1.5
Random Access Period	Text	–	Window size for Random Access Response.
RI	1 ... 4	–	Rank Indication. ▶ 3GPP 36.212
RI 1 Number Of	0 ... 65535	–	Number of times the RI element has had the value 1, accumulated over the current session.
RI 2 Number Of	0 ... 65535	–	Number of times the RI element has had the value 2, accumulated over the current session.

IE Name	Range/Unit	Arg	Description
RLC IEs: General remark	The **argument**, where present, refers to an individual RLC radio bearer.		
RLC DL PDU Handover Interruption Time	0 ... 1000 ms	–	Duration of downlink data transfer interruption at the RLC layer in connection with a handover.
RLC DL RB ID	Text	1 ... 15	Identity of each RLC downlink radio bearer.
RLC DL RB Mode	Text	1 ... 15	RLC downlink radio bearer mode, one of: "AM" = Acknowledged Mode "TM" = Transparent Mode "UM" = Unacknowledged Mode
RLC DL RB Number Of	1 ... 15	–	Number of RLC downlink radio bearers.
RLC DL RB Throughput (kbit/s)	0 ... 350000 kbit/s	1 ... 15	Throughput on each RLC downlink radio bearer.
RLC DL State	Text	–	State of RLC DL protocol: 0: Inactive 1: Active
RLC DL Throughput	0 ... 350000 kbit/s	–	Total RLC downlink throughput for all radio bearers. Available in kbit/s and Mbit/s versions.
RLC UL PDU Handover Interruption Time	0 ... 1000 ms	–	Duration of uplink data transfer interruption at the RLC layer in connection with a handover.
RLC UL RB ID	Text	1 ... 15	Identity of each RLC uplink radio bearer.

IE Name	Range/Unit	Arg	Description
RLC UL RB Mode	Text	1 ... 15	RLC uplink radio bearer mode. One of: "AM" = Acknowledged Mode "TM" = Transparent Mode "UM" = Unacknowledged Mode
RLC UL RB Number Of	1 ... 15	–	Number of RLC uplink radio bearers.
RLC UL RB Throughput (kbit/s)	0 ... 350000 kbit/s	1 ... 15	Throughput on each RLC uplink radio bearer.
RLC UL State	Text	–	State of RLC UL protocol: 0: Inactive 1: Active 10: Inactive 11: Active
RLC UL Throughput	0 ... 350000 kbit/s	–	Total RLC uplink throughput for all radio bearers. Available in kbit/s and Mbit/s versions.
Roaming Status	Text	–	Device NAS status. One of: "Home", "Roaming", "Not Registered".
RRC State	Text	–	RRC state: "Idle" or "Connected".
"Sc 1st" IEs: General remark	These elements derive from LTE Signal scanning. The ordinal "1st" means that these IEs pertain to the first EARFCN scanned. **Argument:** Refers to an LTE cell. The sorting order within each element depends on the setting in the General window: see UM section 19.2.8.1.		
Sc 1st BCH RSSI (dBm) *Freqs 1–4*	–140 ... 25 dBm	0 ... 503	BCH RSSI for each cell scanned.
Sc 1st Cell Distance (m) *Freqs 1–12, B*	0 ... 100000 m	0 ... 503	Distance from scanning device to each cell scanned. Requires cell file and GPS positioning data for the scanning device.

IE Name	Range/Unit	Arg	Description
Sc 1st Cell Identity *Freqs 1–12, B*	0 ... 503	0 ... 503	Cell Identity (equal to 3 × PCIG + PCI) for each cell scanned.
Sc 1st Cell Name *Freqs 1–12, B*	Text	0 ... 503	Name of each cell. Requires cell file.
Sc 1st CFO (Hz) *Freqs 1–12*	–10000 ... 10000 Hz	0 ... 503	Center Frequency Offset of each cell scanned.
Sc 1st Channel RSSI (dBm) *Freqs 1–12, B*	–140 ... 25 dBm	–	The power in the entire LTE channel bandwidth.
Sc 1st Delay Spread (samples) *Freqs 1–4*	0 ... 1023 samples	0 ... 503	Delay spread, expressed as a number of sample times T_s, for each cell scanned. T_s is the shortest time interval defined in the LTE system, equal to 1 / (30.72 MHz) or 32.552 ns.
Sc 1st Duplex Mode *Freqs 1–12*	Text	–	Scanner duplex mode indication (FDD/TDD).
Sc 1st EARFCN *Freqs 1–12, B*	0 ... 39649	0 ... 503	EARFCN of each cell scanned.
Sc 1st MIMO Condition Number (2x2) (dB)	0 ... 25 dB	0 ... 503	Condition number of the channel matrix in a 2 × 2 MIMO configuration (2 Tx, 2 Rx) for each cell scanned. The condition number is a measure of the orthogonality of the MIMO streams, and hence an indication of whether the MIMO channel is currently capable of supporting spatial multiplexing. The lower the condition number, the better.

IE Name	Range/Unit	Arg	Description
Sc 1st MIMO Estimated Rank (2x2)	0 ... 2	0 ... 503	The estimated rank of the channel matrix in a 2 × 2 MIMO configuration (2 Tx, 2 Rx) for each cell scanned. Rank estimates are computed for both open-loop and closed-loop MIMO, and the better estimate is presented.
Sc 1st MIMO Estimated Rank Type	Text	0 ... 503	Type of MIMO that has the best estimated rank: "OL": Open-loop "CL": Closed-loop "OL + CL": Open-loop and closed-loop have equal rank
Sc 1st No Of Cell Identities *Freqs 1–12, B*	0 ... 504	–	Total number of detected Cell Identities on this EARFCN.
Sc 1st No Of Rx Antennas *Freqs 1–12*	1 ... 2	–	The number of scanner Rx antennas used in scanning this EARFCN.
Sc 1st No Of Tx Antennas	0 ... 4	0 ... 503	Number of Tx ports for each cell scanned.
Sc 1st P-SCH RP (dBm) *Freqs 1–4*	–140 ... 25 dBm	0 ... 503	P-SCH received power for each cell scanned.
Sc 1st RS CINR (dB) *Freqs 1–12, B*	–40 ... 60 dB	0 ... 503	Reference Signal CINR for each cell scanned.
Sc 1st RSRP (dBm) *Freqs 1–12, B*	–140 ... 25 dBm	0 ... 503	Reference Signal Received Power (sum total over all Tx ports) for each cell scanned.
"Sc 1st RSRP Rxi Txj (dBm)" IEs *Freqs 1–4*	–140 ... 25 dBm	0 ... 503	Reference Signal Received Power for Tx port *j* (*j* = 1 ... 4) as received on Rx antenna *i* (*i* = 1 ... 2), for each cell scanned.

IE Name	Range/Unit	Arg	Description
Sc 1st RSRQ (dB) *Freqs 1–12, B*	–40 ... 40 dB	0 ... 503	Reference Signal Received Quality (sum total over all Tx ports) for each cell scanned.
“Sc 1st RSRQ Rxi Txj (dB)” IEs *Freqs 1–4*	–40 ... 40 dB	0 ... 503	Reference Signal Received Quality for Tx port *j* (*j* = 1 ... 4) as received on Rx antenna *i* (*i* = 1 ... 2), for each cell scanned.
Sc 1st SCH CINR (dB) *Freqs 1–12, B*	–40 ... 60 dB	0 ... 503	DRT: Synch Channel (not specified as P-SCH or S-SCH) CINR for each cell scanned. PCTel: P-SCH CINR for each cell scanned. R&S: S-SCH CINR for each cell scanned.
Sc 1st SCH RQ (dB) *Freqs 1–12*	–40 ... 40 dB	0 ... 503	DRT: Synch Channel (not specified as P-SCH or S-SCH) Received Quality for each cell scanned. PCTel: P-SCH Received Quality for each cell scanned. R&S, Andrew: S-SCH Received Quality for each cell scanned.
Sc 1st S-SCH RP (dBm) *Freqs 1–4*	–140 ... 25 dBm	0 ... 503	S-SCH Received Power for each cell scanned.
Sc 1st Time Offset (samples) *Freqs 1–12*	0 ... 307199	0 ... 503	Time offset (in samples) from the beginning of the current frame, adjusted so that a frame begins at the GPS one-second tick epoch.
“Sc 2nd (etc.)” IEs: General remark	These elements are analogous to “Sc 1st” but pertain to the second (etc.) EARFCN scanned. **Note:** More IEs are provided for EARFCNs 1–4 than for EARFCNs 5–12, as detailed for the “Sc 1st” elements above.		

IE Name	Range/Unit	Arg	Description
"Sc Best" IEs: General remark	These elements combine cells from all scanned EARFCNs, sorted by descending RSRQ (Es/Io). The sorting order within the "Best" elements is not affected by the settings in the General window (see UM section 19.2.8.1). **Note:** Fewer IEs are provided than for any individual EARFCN, as detailed under the "Sc 1st" elements above ("*B*" for "Best").		
"Sc RSSI" IEs: General remark	These elements derive from RSSI scanning. The **argument**, where present, is a sequence number pointing to scanned frequencies as specified by the "Sc RSSI Frequency (MHz)" element, *unless* otherwise indicated.		
Sc RSSI (dBm)	–140 ... 25 dBm	1 ... 1000	RSSI for each scanned cell.
Sc RSSI (dBm) [EARFCN]	–140 ... 25 dBm	0 ... 39649	RSSI for each scanned cell. **Argument:** EARFCN.
Sc RSSI Band	Text	1 ... 1000	Band to which each scanned cell belongs.
Sc RSSI Bandwidth	Text	1 ... 1000	Bandwidth used for each scanned cell.
Sc RSSI Count	0 ... 1000	–	Number of cells scanned.
Sc RSSI EARFCN	0 ... 39649	1 ... 1000	EARFCN of each scanned cell. Regarding EARFCN numbering, see ► 3GPP 36.101.
Sc RSSI Frequency (MHz)	0 ... $6 \cdot 10^6$ MHz	1 ... 1000	Frequency of each cell scanned.
Schedule Request Status	Text	–	Schedule request status: "Idle" or "Pending".

IE Name	Range/Unit	Arg	Description
"Serving Cell" IEs: General remark	These elements pertain to the current serving cell or cells. In case of carrier aggregation (CA), primary and secondary serving cells are distinguished in a subset of IEs. **Argument:** Unless otherwise noted, 1 = primary serving cell and 2 = secondary serving cell (CA only). IEs lacking an argument are valid for the primary serving cell when CA is used. This is also true of elements whose argument has a different meaning, as detailed below.		
Serving Cell Channel RSSI (dBm)	–140 ... 25 dBm	1 ... 2	Received signal strength on the EARFCN each serving cell is using.
Serving Cell Count	1 ... 2	–	Number of serving cells: greater than one in case of carrier aggregation.
Serving Cell Distance (m)	0 ... 50000 m	–	Distance from UE to the serving cell. Requires cell file and UE positioning data.
Serving Cell DL Bandwidth	Text	–	Downlink bandwidth of serving cell. One of: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz.
Serving Cell DL EARFCN	0 ... 39649	1 ... 2	Downlink EARFCN of each serving cell. Regarding EARFCN numbering, see ▶ 3GPP 36.101.
Serving Cell DL Frequency (MHz)	0 ... 3000 MHz	–	Downlink frequency of serving cell.
Serving Cell DL Pathloss (dB)	–140 ... 25 dBm	–	Downlink pathloss for serving cell.
Serving Cell Frame Timing Rx1	0 ... 307199 LTE T_s units	1 ... 2	Cell frame timing of each serving cell relative to the network's absolute time reference, as received on antenna Rx1.
Serving Cell Frame Timing Rx2	0 ... 307199 LTE T_s units	1 ... 2	Cell frame timing of each serving cell relative to the network's absolute time reference, as received on antenna Rx2.

IE Name	Range/Unit	Arg	Description
Serving Cell Identity	0 ... 503	1 ... 2	Cell Identity of each serving cell, equal to 3 × PCIG + PCI.
Serving Cell MCC	0 ... 65535	–	MCC of serving cell.
Serving Cell MNC	0 ... 65535	–	MNC of serving cell.
Serving Cell Name	Text	–	Name of serving cell. Requires cell file.
Serving Cell PLMN	Text	–	PLMN (MCC and MNC) of serving cell.
Serving Cell RRC Identity	0 ... $2^{28} - 1$	–	RRC identity of serving cell.
Serving Cell RS CINR (dB)	–40 ... 60 dB	1 ... 2	CINR for Reference Signal of each serving cell.
Serving Cell RSRP (dBm)	–140 ... 25 dBm	1 ... 2	Reference Signal Received Power for each serving cell. Sum of contributions from antennas Rx1 and Rx2.
Serving Cell RSRP Tx1 Rx1 (dBm)	–140 ... 25 dBm	1 ... 2	RSRP contribution from eNodeB antenna Tx1 as received on antenna Rx1.
Serving Cell RSRP Tx1 Rx2 (dBm)	–140 ... 25 dBm	1 ... 2	RSRP contribution from eNodeB antenna Tx1 as received on antenna Rx2.
Serving Cell RSRP Tx2 Rx1 (dBm)	–140 ... 25 dBm	1 ... 2	RSRP contribution from eNodeB antenna Tx2 as received on antenna Rx1.
Serving Cell RSRP Tx2 Rx2 (dBm)	–140 ... 25 dBm	1 ... 2	RSRP contribution from eNodeB antenna Tx2 as received on antenna Rx2.
Serving Cell RSRP-DRS (dBm)	–140 ... 25 dBm	0 ... 1	The RSRP of the dedicated reference signal on each antenna port. **Argument:** Antenna port number.

IE Name	Range/Unit	Arg	Description
Serving Cell RSRQ (dB)	–40 ... 40 dB	1 ... 2	Reference Signal Received Quality. Sum of contributions from antennas Rx1 and Rx2.
Serving Cell RSRQ Tx1 Rx1 (dB)	–40 ... 40 dB	1 ... 2	RSRQ contribution from eNodeB antenna Tx1 as received on antenna Rx1.
Serving Cell RSRQ Tx1 Rx2 (dB)	–40 ... 40 dB	1 ... 2	RSRQ contribution from eNodeB antenna Tx1 as received on antenna Rx2.
Serving Cell RSRQ Tx2 Rx1 (dB)	–40 ... 40 dB	1 ... 2	RSRQ contribution from eNodeB antenna Tx2 as received on antenna Rx1.
Serving Cell RSRQ Tx2 Rx2 (dB)	–40 ... 40 dB	1 ... 2	RSRQ contribution from eNodeB antenna Tx2 as received on antenna Rx2.
Serving Cell SINR-DRS (dB)	–40 ... 60 dB	–	Average SINR of dedicated reference signals, taken over antenna ports 0 and 1.
Serving Cell TAC	Text	–	Tracking Area Code of serving cell.
Serving Cell Total RS Power (dBm)	–140 ... 25 dBm	–	Total Reference Signal power for serving cell, calculated from serving cell RSRP and channel bandwidth. Valid only for the bandwidths 5 MHz and 10 MHz.
Serving Cell Tx1-Tx2 Per Rx Antenna	–20 ... 20 dB	0 ... 2	Difference between transmit powers of eNodeB Tx1 and Tx2 antennas, as received on each Rx antenna. Each presented value is an average over 20 samples in the time domain. **Argument:** 0: Mean of Rx1 and Rx2 values 1: Rx1 2: Rx2

IE Name	Range/Unit	Arg	Description
Serving Cell UL EARFCN	0 ... 39649	–	Uplink EARFCN of serving cell. Regarding EARFCN numbering, see ▶ 3GPP 36.101.
Serving Cell UL Frequency (MHz)	0 ... 3000 MHz	–	Uplink frequency of serving cell.
"Spectr Ana" IEs: General remark	These elements are populated by spectrum analysis scanning. The same elements are used for both uplink and downlink bands. The **argument**, where present, is a sequence number pointing to scanned frequencies as indicated by the "Spectr Ana Sc Freq (kHz)" element.		
Spectr Ana Sc Freq (kHz)	0 ... $6 \cdot 10^6$ kHz	1 ... 3001	Scanned frequencies in ascending order.
Spectr Ana Sc No Of Freq	0 ... 3001	–	The number of frequencies swept by the scan.
Spectr Ana Sc RSSI (dBm)	–140 ... 25 dBm	1 ... 3001	RSSI of frequencies scanned.
Speed (km/h)	0 ... 250 km/h	–	Speed in km/h.
Speed (mph)	0 ... 160 mph	–	Speed in mph.
SRS TX Power	–50 ... 23 dBm	–	Transmit power of sounding reference signal. ▶ 3GPP 36.211, section 5.5.3
SRS Usage Rate	0 ... 100 %	–	Percentage of subframes in which the UE transmits a sounding reference signal.
"Strongest Sc RSSI" IEs: General remark	These elements contain RSSI scan data. **Argument:** The frequencies are sorted by decreasing RSSI.		
Strongest Sc RSSI (dBm)	–140 ... 25 dBm	1 ... 16	Received signal strength.
Strongest Sc RSSI Band	Text	1 ... 16	Scanned frequency band.

IE Name	Range/Unit	Arg	Description
Strongest Sc RSSI EARFCN	0 ... 39649	1 ... 16	Scanned EARFCN.
Strongest Sc RSSI Frequency (kHz)	0 ... 6 · 10^6 kHz	1 ... 16	Scanned frequency.
“TDD” IEs: General remark	These elements pertain to the TDD (Time Division Duplex) mode of operation within LTE, also known as TD-LTE.		
TDD Ack Reporting Mode	0 ... 1	–	ACK/NACK feedback mode for TDD. ▶ 3GPP 36.212, section 5.2.2.6 0: Multiplexing 1: Bundling
TDD Ack Reporting Mode (Text)	Text	–	Same as TDD Ack Reporting Mode but in text format.
TDD n_CCE (Average)	0 ... 96	–	Average number of the first CCE used for transmission of the corresponding PDCCH. ▶ 3GPP 36.213, section 10.1 (n_{CCE})
TDD n_CCE (Max)	0 ... 96	–	Maximum number of the first CCE used for transmission of the corresponding PDCCH. Compare TDD n_CCE (Average).
TDD n_CCE (Min)	0 ... 96	–	Minimum number of the first CCE used for transmission of the corresponding PDCCH. Compare TDD n_CCE (Average).

IE Name	Range/Unit	Arg	Description
TDD N_p Distribution (%)	0 ... 100 %	0 ... 14	Value distribution of N_p, used in the calculation of $n^{(1)}_{PUCCH}$, resource index for PUCCH formats 1/1a/1b. ▶ 3GPP 36.213, section 10.1 **Argument:** Represents possible values of N_p. 0: Value = 0 1: Value = 1 2: Value = 3 3: Value = 5 4: Value = 8 5: Value = 11 6: Value = 13 7: Value = 16 8: Value = 22 9: Value = 27 10: Value = 41 11: Value = 44 12: Value = 55 13: Value = 66 14: Value = 88
TDD N_(p+1) Distribution (%)	0 ... 100 %	0 ... 14	Value distribution of N_{p+1}, used in the calculation of $n^{(1)}_{PUCCH}$, resource index for PUCCH formats 1/1a/1b. ▶ 3GPP 36.213, section 10.1 **Argument:** See TDD N_p Distribution (%).
TDD Position Of Minimum k Distribution (%)	0 ... 100 %	0 ... 9	Value distribution of the index *m* for which k_m is the smallest value in the set *K* such that UE detects a PDCCH in subframe $n - k_m$ (▶ 3GPP 36.213, section 10.1). Used in calculating $n^{(1)}_{PUCCH}$, resource index for PUCCH formats 1/1a/1b. Valid only when TDD Ack Reporting Mode = Bundling. **Argument:** Represents possible values of *m*.
TDD Special Subframe Configuration	0 ... 8	–	TDD special subframe configuration. ▶ 3GPP 36.211, table 4.2-1

IE Name	Range/Unit	Arg	Description
TDD UL/DL Configuration	0 ... 6	–	TDD uplink–downlink configuration. ▶ 3GPP 36.211, table 4.2-2
TDD UL/DL Configuration Type	5 ... 10 ms	–	TDD downlink-to-uplink switch-point periodicity. ▶ 3GPP 36.211, table 4.2-2
TD-SCDMA Neighbor Carrier RSSI (dBm)	–140 ... 25 dBm	1 ... 16	Carrier RSSI of measured TD-SCDMA neighbors.
TD-SCDMA Neighbor CPID	0 ... 127	1 ... 16	Cell Parameter IDs of measured TD-SCDMA neighbors.
TD-SCDMA Neighbor Ec/No (dB)	–34 ... 0 dB	1 ... 16	Ec/No of measured TD-SCDMA neighbors.
TD-SCDMA Neighbor No Of	0 ... 16	–	Number of TD-SCDMA neighbors measured.
TD-SCDMA Neighbor RSCP (dBm)	–140 ... –15 dBm	1 ... 16	RSCP of measured TD-SCDMA neighbors.
TD-SCDMA Neighbor UARFCN	0 ... 16383	1 ... 16	UARFCNs of measured TD-SCDMA neighbors.
Time	Text	–	Current time in text format: “hh:mm:ss.ddd”, where “ddd” = decimal seconds.
Time (ms)	0 ... 86,400,000 ms (= 24 h)	–	Current time in ms.
Timing Advance	0 ... 2047 See Description	–	Timing Advance, an adjustment of uplink transmission timing in relation to downlink timing, introduced to compensate for propagation delay. Regarding the mechanism, see ▶ 3GPP 36.321, section 5.2. For the representation of values, see ▶ 3GPP 36.213, section 4.2.3.

IE Name	Range/Unit	Arg	Description
Timing Advance (meters)	0 ... $1 \cdot 10^6$ m	–	Timing Advance value converted to distance in meters.
Transmission Mode	Text	–	LTE transmission mode, corresponding to PDSCH transmission schemes as follows. ▶ 3GPP 36.213, Table 7.2.3-0 “Tm1”: Single transmit antenna “Tm2”: Transmit diversity “Tm3”: Open-loop spatial multiplexing with cyclic delay diversity “Tm4”: Closed-loop spatial multiplexing “Tm5”: Multi-user MIMO “Tm6”: Closed-loop spatial multiplexing using a single transmission layer “Tm7”: Beamforming “Tm8”: Dual-layer beamforming
UE Category	Text	–	E-UTRA UE category. ▶ 3GPP 36.306
UE PUCCH Tx Power (dBm)	–30 ... 30 dBm	–	UE PUCCH Channel average transmit power.
UE PUSCH Tx Power (dBm)	–30 ... 30 dBm	–	UE PUSCH Channel average transmit power.
UE Tx Power (dBm)	–30 ... 30 dBm	–	UE average transmit power.

3.4. TD-SCDMA Information Elements

3.4.1. General

This category includes a large number of elements that are not TDD-specific, as well as many that also make an appearance in the **GSM** and/or **WCDMA** categories. The latter elements relate to parts of the 3GPP specifications that TD-SCDMA shares with GSM and/or WCDMA.

Note that dual mode TD-SCDMA/GSM terminals also populate elements in the **GSM** category; see section 4.1 for specifics.

3.4.2. Information Element Table

IE Name	Range/Unit	Arg.	Description
Altitude (ft)	–1312 ... 29028 ft	–	Height above sea level in feet. Reported by positioning equipment.
Altitude (m)	–400 ... 8848 m	–	Height above sea level in meters. Reported by positioning equipment.
C-RNTI	0 ... 65535	–	Cell Radio Network Temporary Identity. ▶ 3GPP 36.321
DCH SIR (dB)	–20 ... 20 dB	–	Signal-to-interference ratio measured on the DCH.
DCH SIR Target (dB)	–20 ... 20 dB	–	SIR target ordered for DCH.
DPCH IEs: General remark	All of these elements are calculated over the device’s latest reporting period.		
DPCH C/I Average (dB)	–30 ... 60 dB	–	Average DPCH C/I taken over all timeslots.
DPCH C/I Best (dB)	–30 ... 60 dB	–	DPCH C/I for best timeslot.
DPCH C/I Worst (dB)	–30 ... 60 dB	–	DPCH C/I for worst timeslot.

IE Name	Range/Unit	Arg.	Description
DPCH ISCP Average (dBm)	–116 ... –25 dBm	–	Average DPCH ISCP taken over all timeslots.
DPCH ISCP Best (dBm)	–116 ... –25 dBm	–	DPCH ISCP for best timeslot.
DPCH ISCP Worst (dBm)	–116 ... –25 dBm	–	DPCH ISCP for worst timeslot.
DPCH RSCP Average (dBm)	–116 ... –25 dBm	–	Average DPCH RSCP taken over all timeslots.
DPCH RSCP Best (dBm)	–116 ... –25 dBm	–	DPCH RSCP for best timeslot.
DPCH RSCP Worst (dBm)	–116 ... –25 dBm	–	DPCH RSCP for worst timeslot.
DPCH Timeslot Count DL	1 ... 6	–	Number of downlink timeslots occupied by one or more DPCH(s) at least once during the latest reporting period.
DPCH Timeslot Count UL	1 ... 6	–	Number of uplink timeslots occupied by one or more DPCH(s) at least once during the latest reporting period.
Firmware Version	Text	–	Version number of device firmware.
GSM Neighbor ARFCN	See section 3.1 under “ARFCN BCCH”	1 ... 16	ARFCNs of measured GSM neighbors. **Argument:** 1 gives the neighbor with the highest signal strength, etc.
GSM Neighbor BSIC	Text	1 ... 16	Base Station Identity Codes (in text format) of measured GSM neighbors. **Argument:** See GSM Neighbor ARFCN.
GSM Neighbor RxLev (dBm)	–110 ... –47 dBm	1 ... 16	RxLev of measured GSM neighbors. **Argument:** See GSM Neighbor ARFCN.
Hardware	Text	–	Device model.

IE Name	Range/Unit	Arg.	Description
Heading	0 ... 360 degrees	–	Direction of travel measured in degrees clockwise from north.
H-RNTI	0 ... 65535	–	HSPA Radio Network Temporary Identity.
HS 16-QAM Modulation Rate	0 ... 100 %	–	Use of 16-QAM as modulation method, expressed as a percentage of time.
HS Assoc DPCH C/I (dB)	–30 ... 60 dB	–	C/I for non-HS DPCH associated with HS session.
HS Assoc DPCH ISCP (dBm)	–116 ... –25 dBm	–	ISCP for non-HS DPCH associated with HS session.
HS Assoc DPCH RSCP (dBm)	–116 ... –25 dBm	–	RSCP for non-HS DPCH associated with HS session.
HS Assoc DPCH SIR (dB)	–20 ... 20 dB	–	SIR for non-HS DPCH associated with HS session.
HS CQI (Max)	0 ... 30 See Description	–	The maximum value of the CQI (Channel Quality Indicator) during the latest reporting period. The definition of the CQI values is given in ► 3GPP 25.214, section 6A.2.
HS CQI (Mean)	0 ... 30	–	The mean CQI value during the latest reporting period. Compare HS CQI (Max).
HS CQI (Min)	0 ... 30	–	The minimum CQI value during the latest reporting period. Compare HS CQI (Max).
HSDPA Category	Text	–	HSDPA Category which the UE reports support for. ► 3GPP 25.306, table 5.1a
HS-DSCH ACK Rate	0 ... 100 %	–	ACK / (NACK + ACK) ratio on the HS-DSCH.

IE Name	Range/Unit	Arg.	Description
HS-DSCH BLER	0 ... 100 %	–	Block error rate on the HS-DSCH for first transmission.
HS-DSCH DTX Rate	0 ... 100 %	–	DTX rate on the HS-DSCH: Percentage of TTIs estimated by the device as “not used” on downlink.
HS-DSCH NACK Rate	0 ... 100 %	–	NACK / (NACK + ACK) ratio on the HS-DSCH.
HS-DSCH Retrans-mission Rate	0 ... 100 %	–	Retransmission rate on the HS-DSCH.
HS MAC PDU Average Size	0 ... 1456 bytes	–	Average size of MAC-hs PDUs.
HS MAC PDU Discard Rate (%)	0 ... 100 %	–	Percentage of MAC-hs PDUs discarded.
HS MAC PDU Receive Rate (kbit/s)	0 ... 2500 kbit/s	–	MAC-hs PDU receive rate expressed in kbit/s.
HS-PDSCH IEs: General remark	All of these elements are calculated over the device’s latest reporting period.		
HS-PDSCH C/I Average (dB)	–30 ... 60 dB	–	Average C/I taken over all HS-PDSCHs (= all timeslots) in use.
HS-PDSCH C/I Best (dB)	–30 ... 60 dB	–	Best C/I among all HS-PDSCHs in use.
HS-PDSCH C/I Worst (dB)	–30 ... 60 dB	–	Worst C/I among all HS-PDSCHs in use.
HS-PDSCH Codes Used	0 ... 16	–	Average number of channelization codes used on the HS-DPSCH over the latest reporting period.
HS-PDSCH ISCP Average (dBm)	–116 ... –25 dBm	–	Average ISCP taken over all HS-PDSCHs (= all timeslots) in use.

IE Name	Range/Unit	Arg.	Description
HS-PDSCH ISCP Best (dBm)	–116 ... –25 dBm	–	Best ISCP among all HS-PDSCHs in use.
HS-PDSCH ISCP Worst (dBm)	–116 ... –25 dBm	–	Worst ISCP among all HS-PDSCHs in use.
HS-PDSCH RSCP Average (dBm)	–116 ... –25 dBm	–	Average RSCP taken over all HS-PDSCHs (= all timeslots) in use.
HS-PDSCH RSCP Best (dBm)	–116 ... –25 dBm	–	Best RSCP among all HS-PDSCHs in use.
HS-PDSCH RSCP Worst (dBm)	–116 ... –25 dBm	–	Worst RSCP among all HS-PDSCHs in use.
HS-PDSCH SIR (dB)	–20 ... –20 dB	–	HS-PDSCH signal-to-interference ratio. (Single value reported regardless of the number of HS-PDSCHs in use.)
HS-PDSCH Timeslots Used	0 ... 4	–	Number of timeslots occupied by an HS-PDSCH at least once during the latest reporting period.
HS QPSK Modulation Rate	0 ... 100 %	–	Use of QPSK as modulation method, expressed as a percentage of time.
HS-SCCH C/I (dB)	–30 ... 60 dB	–	C/I reported for HS-SCCH.
HS-SCCH ISCP (dBm)	–116 ... –25 dBm	–	ISCP reported for HS-SCCH.
HS-SCCH RSCP (dBm)	–116 ... –25 dBm	–	RSCP reported for HS-SCCH.
HS-SCCH SIR (dB)	–20 ... –20 dB	–	SIR reported for HS-SCCH.

IE Name	Range/Unit	Arg.	Description
HS Session	0 ... 1	–	Indicates whether or not HSPA is currently being used. 0: No 1: Yes
HS Session (Text)	Text	–	Same as HS Session but in text format.
HS Transport Block Count (Accu)	0 ... 65535	1 ... 254	Block counts for HSPA transport block sizes currently in use, accumulated over the current session. **Argument:** 1 represents the first TBS used (not TBS 1), etc.
HS Transport Block Count (Curr)	0 ... 65535	1 ... 254	Block counts for HSPA transport block sizes currently in use, collected over the latest report period. **Argument:** 1 represents the first TBS used (not TBS 1), etc.
HS Transport Block Size	0 ... 14043 bits	1 ... 254	Transport block sizes on the HS-DSCH. **Argument:** 1 represents the first TBS used (not TBS 1), etc.
HS Transport Block Sizes No Of	0 ... 254	–	Number of HSPA transport block sizes currently in use.
"HS UL" IEs: General remark	These elements pertain to HSUPA (EUL) and are updated primarily when that technology is in use. However, even if only HSDPA is available in the network, uplink activity occurring in the course of an HSDPA session may still cause some of the HS UL elements to be populated.		
HS UL 16-QAM Modulation Rate	0 ... 100 %	–	Use of 16-QAM as modulation method, expressed as a percentage of time.
HS UL E-AGCH Success Rate	0 ... 100 %	–	Percentage of TTIs where the UE received an absolute grant on the E-AGCH.

IE Name	Range/Unit	Arg.	Description
HS UL E-DCH Throughput (kbit/s)	0 ... 1000 kbit/s	–	Throughput on the E-DCH.
HS UL E-HICH RSCP (dBm)	–116 ... –25 dBm	–	Received signal code power on the E-HICH.
HS UL E-PUCH Successful First Tx Rate	0 ... 100 %	–	Percentage of transport blocks on the E-PUCH that were successfully transferred on first attempt.
HS UL E-PUCH Successful Other Tx Rate	0 ... 100 %	–	Percentage of transport blocks on the E-PUCH that were successfully transferred on third or later attempt.
HS UL E-PUCH Successful Second Tx Rate	0 ... 100 %	–	Percentage of transport blocks on the E-PUCH that were successfully transferred on second attempt.
HS UL E-PUCH Tx Power (dBm)	–50 ... 33 dBm	–	Transmit power used on the E-PUCH.
HS UL E-PUCH Unsuccessful Tx Rate	0 ... 100 %	–	Percentage of transport blocks on the E-PUCH that were not successfully transferred after the maximum number of attempts.
HS UL E-RUCCH Tx Power (dBm)	–50 ... 33 dBm	–	Transmit power used on the E-RUCCH.
HS UL Grant Rate	0 ... 100 %	–	Percentage of TTIs where the UE received a grant (i.e. was allowed to transmit).
HS UL QPSK Modulation Rate	0 ... 100 %	–	Use of QPSK as modulation method, expressed as a percentage of time.

IE Name	Range/Unit	Arg.	Description
IMEI	Text	–	International Mobile Equipment Identity, the unique equipment identity of the device. ▶ 3GPP 23.003
IMSI	Text	–	International Mobile Subscriber Identity, the unique identity of the SIM in the device. ▶ 3GPP 23.003
Latitude	–90 ... 90 degrees	–	Latitude recorded by positioning equipment.
Latitude (Text)	Text	–	Latitude as text. For the presentation format, see TR section 3.4.
Latitude Decimal Degrees (Text)	Text	–	Latitude in decimal degrees, presented as text.
Longitude	–180 ... 180 degrees	–	Longitude recorded by positioning equipment.
Longitude (Text)	Text	–	Longitude as text. For the presentation format, see TR section 3.4.
Longitude Decimal Degrees (Text)	Text	–	Longitude in decimal degrees, presented as text.
LTE Neighbor Cell Identity	0 ... 503	1 ... 16	Cell Identities (equal to 3 × PCIG + PCI) of measured LTE neighbors.
LTE Neighbor Cell RSRP	–140 ... 25 dBm	1 ... 16	RSRP of measured LTE neighbors.
LTE Neighbor Cell RSRQ	–40 ... 40 dB	1 ... 16	RSRQ of measured LTE neighbors.
LTE Neighbor Channel RSSI	–130 ... –20 dBm	1 ... 16	Channel RSSI of measured LTE neighbors.
LTE Neighbor Count	0 ... 16	–	Number of LTE neighbors measured.
LTE Neighbor EARFCN	0 ... 65535	1 ... 16	EARFCNs of measured LTE neighbors.

IE Name	Range/Unit	Arg.	Description
Mode	Text	–	Same as Mode (Num) but in text format.
Mode (Num)	1 ... 7	–	Relevant values: 2: Idle mode 3: Dedicated mode
Mode - System	1 ... 9	–	Relevant values: 2: GSM 8: TD-SCDMA For the full set of values, see the Mode - System element under WCDMA.
Mode - System (Text)	Text	–	Same as Mode - System but in text format.
Neighbor IEs: General remark	These elements pertain to neighbors of the current serving cell. **Argument:** The elements are sorted by descending RSCP. Argument 1 thus points to the strongest neighbor, etc.		
Neighbor Carrier RSSI	–131 ... 25 dBm	1 ... 32	Carrier RSSI for each neighbor.
Neighbor Cell Name	Text	1 ... 32	Name of each neighbor. Requires cell file.
Neighbor CPID	0 ... 127	1 ... 32	Cell Parameter Identity for each neighbor.
Neighbor Pathloss	46 ... 158 dB	1 ... 32	Pathloss for each neighbor.
Neighbor P-CCPCH Ec/No	–30 ... 0 dB	1 ... 32	P-CCPCH Ec/No for each neighbor.
Neighbor P-CCPCH RSCP	–116 ... –25 dBm	1 ... 32	P-CCPCH received signal code power for each neighbor.
Neighbor UARFCN	0 ... 16383 (frequency band dependent)	1 ... 32	Primary UARFCN of each neighbor.

IE Name	Range/Unit	Arg.	Description
PDP Context Completion Time (ms)	0 ... 60000 ms	1 ... 11	Time to complete establishment of PDP context, counted from the first Activate PDP Context Request message to Activate PDP Context Accept. **Argument:** PDP context index.
P-TMSI	0 ... $2^{32} - 1$	–	Packet TMSI (Temporary Mobile Subscriber Identity). ▶ 3GPP 23.003
P-TMSI (Hex)	Text	–	Packet TMSI in hexadecimal format.
RLC DL Throughput (kbit/s)	0 ... 2500 kbit/s	1 ... 32	RLC downlink throughput for each data bearer. **Argument:** RLC entity.
RLC UL Retrans-mission Ratio (%)	0 ... 100 %	1 ... 32	RLC uplink retransmission ratio for each data bearer. **Argument:** RLC entity.
RLC UL Throughput (kbit/s)	0 ... 1000 kbit/s	1 ... 32	RLC uplink throughput for each data bearer. **Argument:** RLC entity.
RRC State	Text	–	Same as RRC State (Num) but in text format.
RRC State (Num)	0 ... 5	–	State of RRC protocol: 0: No service 1: Idle mode 2: Connected_Cell_FACH 3: Connected_Cell_DCH 4: Connected_Cell_PCH 5: Connected_URA_PCH The state is set to idle when the UE registers, and the information element is then updated each time the state changes. ▶ 3GPP 25.331, chapter 7

IE Name	Range/Unit	Arg.	Description
“Sc <nth>” IEs: General remark	These elements contain pilot scan data from a particular UARFCN. The same family of elements are populated in the Midamble and Sync DL modes, though with certain differences of detail as noted below. **Argument:** The sorting order within each element depends on the General window setting: see UM section 20.3.		
Sc ... Cell Distance (m)	0 ... 1 · 10^5 m	1 ... 128	Distance to the cell in meters. Requires cell file and UE positioning data.
Sc ... Cell Name	Text	1 ... 128	Name of the cell site. Requires cell file.
Sc ... CPID	0 ... 127	1 ... 128	Cell Parameter Id of the cell.
Sc ... Ec/Io (dB)	–32 ... 0 dB	1 ... 128	The received energy per chip divided by the relevant measured power density (noise and signal) in the wide band. This is the primary measurement for pilot scanning. It is taken either over the Midamble for TS0 or over SyncDL, depending on the Measurement Mode setting; see UM section 20.3.
Sc ... Eps/Io (dB)	–32 ... 0 dB	1 ... 128	SyncDL Ec/Io measured over TS0: the received energy per chip divided by the relevant measured power density (noise and signal) in the wide band. Valid for Midamble measurement mode only; see UM section 20.3.
Sc ... Io (dBm)	–115 ... –25 dBm	1 ... 128	Wide-band channel power of the UARFCN.
Sc ... No Of CPID	0 ... 128	–	Number of cells detected on the UARFCN.
Sc ... SIR (dB)	–20 ... 20 dB	1 ... 128	Peak pilot signal-to-interference ratio. Antenna 1 radiation is used. Invalid if either pilot or interference is missing.

IE Name	Range/Unit	Arg.	Description
Sc ... Time Offset	0 ... 25599 chip/4	1 ... 128	Position of a selected CPID in quarters of chips from the internal 1/200th second time mark that is aligned with GPS time, if a GPS signal is present.
Sc ... UARFCN	0 ... 16383 (frequency band dependent)	1 ... 128	Scanned UARFCN.
"Sc Best" IEs	These elements combine cells from all scanned UARFCNs, sorted by descending Ec/Io. The sorting order of the "Best" elements is not affected by the settings in the General window (see UM section 20.3). Regarding pilot scanning in general, again see UM section 20.3. **Argument** (where present): 1 is the cell with the highest Ec/Io, etc.		
"Sc RSSI" IEs: General remark	These elements derive from RSSI scanning. The **argument**, where present, is a sequence number pointing to scanned frequencies as specified by the "Sc RSSI Frequency (MHz)" element, *unless* otherwise indicated.		
Sc RSSI (dBm)	–131 ... 25 dBm	1 ... 1500	RSSI for each scanned frequency.
Sc RSSI (dBm) [UARFCN]	–131 ... 25 dBm	0 ... 16383	RSSI for each scanned frequency. **Argument:** UARFCN.
Sc RSSI Band	Text	1 ... 1500	Band to which each scanned frequency belongs.
Sc RSSI Count	0 ... 1500	–	Number of frequencies scanned.
Sc RSSI Frequency (MHz)	0 ... 6000 MHz	1 ... 1500	Frequency scanned.
Sc RSSI UARFCN	0 ... 16383	1 ... 1500	UARFCN where each scanned frequency is located.

IE Name	Range/Unit	Arg.	Description
Serving IEs: General remark	These elements pertain to the current serving cell.		
Serving C/I	–30 ... 60 dB	–	C/I of serving cell. Calculated as Serving P-CCPCH RSCP – Timeslot ISCP (dBm) for timeslot 0 (the timeslot always used by the P-CCPCH). Valid only if Serving Current UARFCN = Serving Primary UARFCN.
Serving Carrier RSSI	–131 ... 25 dBm	–	Carrier RSSI for serving cell.
Serving Cell Id	0 ... 2^{28} – 1	–	Cell identity of serving cell.
Serving Cell Id (Dec)	Text	–	Cell identity of serving cell: text string in decimal format.
Serving Cell Id (Hex)	Text: “0000000” ... “FFFFFFF”	–	Cell identity of serving cell: text string in hexadecimal format.
Serving Cell Name	Text	–	Name of serving cell. Requires cell file.
Serving CPID	0 ... 127	–	Cell Parameter Identity of serving cell.
Serving Current UARFCN	0 ... 16383 (frequency band dependent)	–	UARFCN currently used by the serving cell: either the Primary UARFCN or a different UARFCN (the latter in dedicated mode only).
Serving DRX Coefficient	3 ... 9	–	DRX (Discontinuous Reception) coefficient for serving cell.
Serving LAC	0 ... 65535	–	LAC of serving cell.
Serving LAC (Hex)	Text: “0000” ... “FFFF”	–	LAC of serving cell in hexadecimal format.

IE Name	Range/Unit	Arg.	Description
Serving Max Allowed UL TxPower (dBm)	–50 ... 33 dBm	–	The maximum transmit power the terminal is allowed to use.
Serving MCC	000 ... 999	–	Mobile Country Code of serving cell.
Serving MNC	000 ... 999	–	Mobile Network Code of serving cell. May consist of two or three digits.
Serving Pathloss	46 ... 158 dB	–	Pathloss for serving cell.
Serving P-CCPCH Ec/No	–30 ... 0 dB	–	P-CCPCH Ec/No for the serving cell.
Serving P-CCPCH RSCP	–116 ... –25 dBm	–	P-CCPCH received signal code power for the serving cell.
Serving P-CCPCH SIR	–11 ... 20 dB	–	P-CCPCH signal-to-interference ratio for the serving cell.
Serving Primary UARFCN	0 ... 16383 (frequency band dependent)	–	UARFCN used for control signaling by the serving cell. This UARFCN may also be used for traffic.
Serving Q-hysteresis (dB)	0 ... 40 dB	–	Cell reselection parameter Qhyst1_s for serving cell: hysteresis value. ▶ 3GPP 25.304, section 5.2.6.1.5
Serving Q-rxlev-min (dBm)	–115 ... –25 dBm	–	Cell reselection parameter Qrxlevmin, specifying the minimum required RxLev in the serving cell. ▶ 3GPP 25.304, section 5.2.6.1.5
Serving S-intersearch Threshold	0 ... 91 dB	–	Cell reselection parameter $S_{intersearch}$ for serving cell: threshold for inter-frequency measurements. ▶ 3GPP 25.304, section 5.2.6.1.5
Serving S-intrasearch Threshold	0 ... 91 dB	–	Cell reselection parameter $S_{intrasearch}$ for serving cell: threshold for intra-frequency measurements. ▶ 3GPP 25.304, section 5.2.6.1.5

IE Name	Range/Unit	Arg.	Description
Serving T-reselection (s)	0 ... 31 s	–	Cell reselection timer value $Treselection_S$. ▶ 3GPP 25.304, section 5.2.6.1.5
Speed (km/h)	0 ... 250 km/h	–	Speed in km/h.
Speed (mph)	0 ... 155 mph	–	Speed in mph.
“Strongest Sc RSSI” IEs: General remark	These elements contain RSSI scan data. **Argument:** The frequencies are sorted by decreasing RSSI.		
Strongest Sc RSSI (dBm)	–131 ... 25 dBm	1 ... 32	Received signal strength.
Strongest Sc RSSI Band	Text	1 ... 32	Scanned frequency band.
Strongest Sc RSSI Frequency (MHz)	0 ... 6000 MHz	1 ... 32	Scanned frequency.
Strongest Sc RSSI UARFCN	0 ... 16383	1 ... 32	Scanned UARFCN.
T3212	0 ... 255 deci-hours	–	Value of timer T3212 controlling periodic location area updating. Given as raw value in deci-hours (0 means no periodic updates). ▶ 3GPP 24.008
Time	Text	–	Current time in text format: “hh:mm:ss.dd”, where “dd” = decimal seconds.
Time (ms)	0 ... 86,400,000 ms (= 24 h)	–	Current time in ms.

IE Name	Range/Unit	Arg.	Description
Timeslot IEs: General remark	The **argument** is equal to the timeslot index: 0 means TS 0, etc.		
Timeslot Code Count	0 ... 8	0 ... 6	Number of channelization codes in use for each timeslot during a non-HS session.
Timeslot Code Count HS-PDSCH	0 ... 16	0 ... 6	Number of channelization codes in use for each timeslot during an HS session.
Timeslot Code Spreading Factor	1 ... 16	0 ... 6	Spreading factor used for the channelization codes in each timeslot. Possible values are {1, 2, 4, 8, 16} on the uplink and {1, 16} on the downlink.
Timeslot Direction	Text	0 ... 6	Direction of transmission for each used timeslot: "UL" or "DL".
Timeslot DPCH RSCP (dBm)	–116 ... –25 dBm	0 ... 6	Dedicated Physical Channel received signal code power, measured and reported per timeslot.
Timeslot DPCH RSCP Sum (dBm)	–116 ... –25 dBm	–	Sum of DPCH received signal code powers for all reported timeslots. The summing is done in the mW domain.
Timeslot HS-PDSCH C/I (dB)	–30 ... 60 dB	0 ... 6	HS-PDSCH C/I, measured and reported per timeslot.
Timeslot HS-PDSCH ISCP (dBm)	–116 ... –25 dBm	0 ... 6	HS-PDSCH interference signal code power, measured and reported per timeslot.
Timeslot HS-PDSCH RSCP (dBm)	–116 ... –25 dBm	0 ... 6	HS-PDSCH received signal code power, measured and reported per timeslot.
Timeslot ISCP (dBm)	–116 ... –25 dBm	0 ... 6	Interference signal code power for each timeslot.
Timing Advance (chips)	–16 ... 240 chips	–	Timing Advance parameter stated in chip units.

IE Name	Range/Unit	Arg.	Description
TMSI	0 ... $2^{32} - 1$	–	Temporary Mobile Subscriber Identity; ▶ 3GPP 23.003
TMSI (Hex)	Text	–	TMSI in hexadecimal format.
TPC DL	–1, 0, 1	–	Inner loop power control indication pertaining to the downlink. Based on the recent history of power control decisions: • The value –1 means that the power has been adjusted predominantly downward. • The value 0 means that the upward and downward power adjustments have canceled out exactly. • The value +1 means that the power has been adjusted predominantly upward.
TPC UL	–1, 0, 1	–	Inner loop power control indication pertaining to the uplink. Works the same way as TPC DL, which see.
TPC Step (dB)	1 ... 3 dB	–	Transmit power control step size in dB.
Transport Channel BLER DL	0 ... 100 %	1 ... 32	Block error rate for each downlink transport channel. **Argument:** Transport channel index.
Transport Channel BLER Total DL	0 ... 100 %	–	Block error rate averaged over all downlink transport channels.
Transport Channel Count DL	0 ... 32	–	Number of downlink transport channels.
Transport Channel ID DL	1 ... 32	1 ... 32	Identity of each downlink transport channel. **Argument:** Transport channel index.

IE Name	Range/Unit	Arg.	Description
UE TxPower (dBm)	–50 ... 33 dBm	–	UE transmit power in dBm. Valid only in connected mode.
UpPCH TxPower (dBm)	–120 ... 30 dBm	–	Uplink pilot channel transmit power.
U-RNTI	0 ... 2^{32} – 1	–	UTRAN Radio Network Temporary Identity.
U-RNTI (Dec)	Text	–	UTRAN Radio Network Temporary Identity in decimal.
Voice Frame Error Rate (%)	0 ... 100 %	–	Frame error rate for voice service.

3.5. CDMA Information Elements

IE Name	Range/Unit	Arg.	Description
Access Channel Max Capsule Size	0 ... 7	–	Maximum number of Access Channel or Enhanced Access Channel frames in an Access Channel Message Capsule, less 3.
Access Channel Preamble Size	0 ... 255	–	Number of frames in the Access Channel or Enhanced Access Channel preamble, less 1.
Access Initial Power Offset	0 ... 255 dB	–	Initial power offset or adjustment used in the open loop power control procedure.
Access Max Req Seq	0 ... 15	–	Maximum number of access probe sequences for each 1x access attempt (used for regular MS origination).
Access Max Rsp Seq	0 ... 15	–	Maximum number of access probe sequences for each 1x access attempt (used in case of PACA origination).
Access Num Step	0 ... 15	–	Number of access probes in each 1x access probe sequence, less 1.
Access Power Increment	0 ... 255 dB	–	Open loop transmit power increment in units of 1 dB between successive access probes in an 1x access probe sequence.
Access Probe Number	0 ... 255	–	Sequence number of access probe sent during 1x access attempt.
Access Probe Sequence Number	0 ... 255	–	Sequence number of access probe sequence sent during 1x access attempt.
Active Set IEs: General remark	The **argument** points to the active set member index. In case of multicarrier operation, the IEs contain the six strongest active set members from all carriers taken together.		
Active Set Band Class	Text	1 ... 6	Frequency band class for each active set member. ► 3GPP2 C.S0057-B

IE Name	Range/Unit	Arg.	Description
Active Set Cell Name	Text	1 ... 6	Cell name for each active set member as defined in cell file (if available). Requires cell file.
Active Set Channel	0 ... 1199	1 ... 6	Channel number of RF channel used by each active set member.
Active Set Count	0 ... 24	–	The number of members in the active set, whether in idle or traffic mode. In the multicarrier case, the active set members on all carriers are counted, although only the six strongest of these appear in the other Active Set elements.
Active Set DCCH Code Channel	0 ... 2047	1 ... 6	DCCH code channel used by each active set member.
Active Set DCCH QOF Mask Id	0 ... 3	1 ... 6	DCCH QOF mask id used by each active set member.
Active Set Ec	–157 ... 10 dBm	1 ... 6	Received signal code power for each active set member.
Active Set Ec/Io	–32 ... 0 dB	1 ... 6	Signal-to-noise ratio (Ec/Io in dB) for each active set member.
Active Set Ec/Io Sum	–32 ... 0 dB	–	Total signal-to-noise ratio (Ec/Io in dB) for all active set members. The summing is done in the mW domain.
Active Set FCH Code Channel	0 ... 2047	1 ... 6	FCH code channel used by each active set member.
Active Set FCH QOF Mask Id	0 ... 3	1 ... 6	FCH QOF mask id used by each active set member.
Active Set PN	0 ... 511	1 ... 6	Pilot PN offset for each active set member.

IE Name	Range/Unit	Arg.	Description
Active Set SCH Code Channel	0 ... 2047	1 ... 6	SCH code channel used by each active set member.
Active Set SCH QOF Mask Id	0 ... 3	1 ... 6	SCH QOF mask id used by each active set member.
Active Set Serving Io	–125 ... –25 dBm	–	Total received signal power in the serving RF channel.
Altitude (ft)	–1312 ... 29028 ft	–	Height above sea level in feet. Reported by positioning equipment.
Altitude (m)	–400 ... 8848 m	–	Height above sea level in meters. Reported by positioning equipment.
Analog RSSI	–120 ... –30 dBm	–	Received signal strength indicator for AMPS.
Analog SCC	0 ... 255	–	AMPS Supplemental Code Channel.
Analog Tx Power Level	0 ... 7	–	Transmit power level in AMPS traffic state. See ► TIA/EIA-553-A, section 2.1.2.2; ERP levels in dBW are found in table 2.1.2-1.
Base ID	0 ... 65535	–	Base ID transmitted in Layer 3 message System Parameters.
Call Blocked Count	0 ... 1000	–	Number of Blocked Call events. Regarding this event, see section 8.3.
Call Dropped Count	0 ... 1000	–	Number of Dropped Call events. Regarding this event, see section 8.3.
Call Success Count	0 ... 1000	–	Number of Call End events. Regarding this event, see section 8.3.

IE Name	Range/Unit	Arg.	Description
Calls Blocked (%)	0 ... 100 %	–	Calculated as: # *blocks* / (# *blocks* + # *drops* + # *ends*) where *blocks* = Blocked Call events *drops* = Dropped Call events *ends* = Call End events Regarding the events, see section 8.3.
Calls Dropped (%)	0 ... 100 %	–	Calculated as: # *drops* / (# *blocks* + # *drops* + # *ends*) where *blocks* = Blocked Call events *drops* = Dropped Call events *ends* = Call End events Regarding the events, see section 8.3.
Candidate Set IEs: General remark	The **argument**, where present, points to the candidate set member index. In case of multicarrier operation, the IEs contain the six strongest candidate set members from all carriers taken together.		
Candidate Set Band Class	Text	1 ... 6	Frequency band class for each candidate set member. ▶ 3GPP2 C.S0057-B
Candidate Set Cell Name	Text	1 ... 6	Cell name for each candidate set member. Requires cell file.
Candidate Set Channel	0 ... 1023 (dependent on band class)	1 ... 6	Channel number of RF channel used by each candidate set member.

IE Name	Range/Unit	Arg.	Description
Candidate Set Count	0 ... 24	–	The number of candidate set members. In the multicarrier case, the candidate set members on all carriers are counted, although only the six strongest of these appear in the other Candidate Set elements.
Candidate Set Ec	–157 ... 10 dBm	1 ... 6	Received signal code power for each candidate set member.
Candidate Set Ec/Io	–32 ... 0 dB	1 ... 6	Signal-to-noise ratio (Ec/Io in dB) for each candidate set member.
Candidate Set PN	0 ... 511	1 ... 6	Pilot PN offset for each candidate set member.
CDMA Rx State	Text	–	One of: “Entering CDMA”, “Sync Channel”, “Paging Channel”, “Traffic Channel Initialization”, “Traffic Channel”, “Exit”.
Country ID	0 ... 999	–	MCC, Mobile Country Code.
Dialed Number	Text	–	The number dialed to initiate the current call. Valid only while a call is in progress.
DSC Channels	0 ... 8	0 ... 15	Data Source Control channel associated with each pilot in the Traffic Channel Assignment message. ► 3GPP2 C.S0024-A, section 8.7.6.2.2 **Argument:** Pilot PN index in Traffic Channel Assignment message.
EV-DO Access Failure Rate (%)	0 ... 100 %	–	Number of failed EV-DO access attempts divided by total number of EV-DO access attempts.
EV-DO Access Max Probe Seq	0 ... 255	–	Maximum number of access probe sequences per EV-DO access attempt.
EV-DO Access Probe Count	0 ... 255	–	Sequence number of access probe sent during EV-DO access attempt.

IE Name	Range/Unit	Arg.	Description
EV-DO Access Probe Num Step	0 ... 255	–	Number of access probes in each EV-DO access probe sequence.
EV-DO Access Probe Seq Count	0 ... 255	–	Sequence number of access probe sequence sent during EV-DO access attempt.
EV-DO Access Result	0 ... 3	–	Result of EV-DO access attempt: 0: ACAck not received 1: ACAck received 2: TCA message received 3: Probe interrupted
EV-DO Active Set IEs: General remark	The **argument**, where present, points to the active set member index. In case of multicarrier operation, the IEs contain the six strongest active set members from all carriers taken together.		
EV-DO Active Set DRC Cover	0 ... 7	1 ... 6	EV-DO: DRC cover for each active set member.
EV-DO Active Set DRC Lock	Text	1 ... 6	EV-DO: DRC lock status for each active set member: “Locked” or “Unlocked”.
EV-DO Active Set Drop Timer Active	0 ... 1	1 ... 6	EV-DO: Drop timer for each active set member. 0: Inactive 1: Active
EV-DO Active Set Drop Timer Expired	0 ... 1	1 ... 6	EV-DO: Drop timer status for each active set member. 0: Drop timer running 1: Drop timer expired
EV-DO Active Set MAC Index	0 ... 127	1 ... 6	EV-DO: The medium access control index associated with each active set member.
EV-DO Active Set Predicted DRC	0 ... 7	–	EV-DO: DRC cover for the active set pilot currently having the best predicted SINR.

IE Name	Range/Unit	Arg.	Description
EV-DO Active Set Predicted SINR	–30 ... 15 dB	–	EV-DO: Predicted SINR for the active set pilot currently having the best predicted SINR.
EV-DO Active Set RAB Offset	0 ... 255	1 ... 6	EV-DO: For each active set member, specifies the slots in which a new reverse activity bit can be transmitted. ▶ 3GPP2 C.S0024, section 9.3.1.3.2.2.3
EV-DO Active Set RAB Usage (%)	0 ... 100 %	1 ... 6	EV-DO: For each active set member, the rate of reverse activity bits during the last PN roll (16 slots), calculated as (number of ones) / 16.
EV-DO Active Set RPC Index	0 ... 15	1 ... 6	EV-DO: Reverse power control index for each active set member.
EV-DO Active Set RPC Indication	–1 ... 1	1 ... 6	EV-DO: For each active set member, a running average of the last 64 reverse power control bits, showing the recent trend of the power control. ▶ 3GPP2 C.S0024, section 9.2.1.2.4.2
EV-DO Active Set Serving DRC	0 ... 7	–	EV-DO: DRC cover for the current serving active set pilot.
EV-DO Active Set Serving PN	0 ... 511	–	EV-DO: PN offset for the current serving active set pilot.
EV-DO Active Set Serving RPC	0 ... 15	–	EV-DO: RPC index for the current serving active set pilot.
EV-DO Active Set Serving SINR	–30 ... 15 dB	–	EV-DO: SINR for the current serving active set pilot.
EV-DO Active Set SINR	–30 ... 15 dB	1 ... 6	EV-DO: Signal to interference-plus-noise ratio for each active set member.
EV-DO Active Set Window Center	0 ... 23768 chips	1 ... 6	EV-DO: Center of search window for each active set member. Given in chip units.

IE Name	Range/Unit	Arg.	Description
EV-DO Actual RRI (kbit/s)	0 ... 1800 kbit/s	–	EV-DO: RRI at which the reverse link packet was transmitted. This should be ≤ EV-DO Condition RRI (kbit/s); if Actual RRI < Condition RRI, then the reverse rate has been demoted, as there is not enough data to be sent.
EV-DO ALMP State (Num)	0 ... 5	–	EV-DO: Air Link Management Protocol state. 0: Inactive 1: Initialization 2: Idle 3: Connected
EV-DO ALMP State (Text)	Text	–	Same as EV-DO ALMP State (Num) but in text format.
EV-DO AT State (Num)	0 ... 5	–	EV-DO access terminal state. 0: Inactive (AT is switched to 1x or is in Deep Sleep) 1: Acquisition 2: Sync 3: Idle 4: Access 5: Connected
EV-DO AT State (Text)	Text	–	Same as EV-DO AT State (Num) but in text format.
EV-DO Attempt Duration	0 ... 65535 timeslots	–	Time (in slots) taken to complete the EV-DO access attempt.
EV-DO Attempt Transaction Id	0 ... 255	–	Transaction ID of EV-DO access attempt.
EV-DO Best Pilot PN	0 ... 511	–	EV-DO: PN offset for the active set pilot currently having the best predicted SINR.
EV-DO-DO Best SINR	–30 ... 15 dB	–	EV-DO: Predicted SINR for the active set pilot currently having the best predicted SINR.

IE Name	Range/Unit	Arg.	Description
EV-DO Candidate Set IEs: General remark	The **argument**, where present, points to the candidate set member index. In case of multicarrier operation, the IEs contain the six strongest candidate set members from all carriers taken together.		
EV-DO Candidate Set Drop Timer Active	0 ... 1	1 ... 6	EV-DO: Drop timer for each candidate set member. 0: Inactive 1: Active
EV-DO Candidate Set Drop Timer Expired	0 ... 1	1 ... 6	EV-DO: Status of drop timer for each candidate set member. 0: Drop timer running 1: Drop timer expired
EV-DO Candidate Set Window Center	0 ... 23768	1 ... 6	EV-DO: Center of search window for each candidate set member. Given in chip units.
EV-DO Color Code	0 ... 255	–	EV-DO base station color code.
EV-DO Condition RRI (kbit/s)	0 ... 1800 kbit/s	–	EV-DO reverse rate indication calculated according to the algorithm in ► 3GPP2 C.S0024, section 8.5.6.1.5.2. Compare EV-DO Actual RRI (kbit/s).
EV-DO Connected State (Num)	0 ... 5	–	EV-DO Connected state. 0: Inactive 1: Open
EV-DO Connected State (Text)	Text	–	Same as EV-DO Connected State (Num) but in text format.
EV-DO Connection Failure Rate (%)	0 ... 100 %	–	Number of failed EV-DO connection attempts divided by total number of EV-DO connection attempts.
EV-DO DRC Rate Received (kbit/s)	0 ... 4000 kbit/s	–	EV-DO received downlink data rate, instantaneous value.

IE Name	Range/Unit	Arg.	Description
EV-DO DRC Rate Received Average (kbit/s)	0 ... 4000 kbit/s	–	EV-DO received downlink data rate, running average.
EV-DO DRC Rate Requested (kbit/s)	0 ... 4000 kbit/s	–	EV-DO downlink data rate requested by terminal, instantaneous value.
EV-DO DRC Rate Requested Average (kbit/s)	0 ... 4000 kbit/s	–	EV-DO downlink data rate requested by terminal, running average.
EV-DO DRC State	Text	–	EV-DO DRC state: "Fixed" or "Dynamic".
EV-DO Finger IEs: General remark	The **argument** points to an EV-DO finger index.		
EV-DO Finger Antenna Selection	0 ... 1	1 ... 12	Antenna(s) selected for each EV-DO finger. Of interest only if the access terminal is equipped with two antennas and is enabled to use both. 0: Antenna 0 1: Antenna 1
EV-DO Finger C/I Antenna 0	–30 ... 15 dB	1 ... 12	EV-DO: When antenna diversity is enabled, for each finger, the cumulative energy of all search results for antenna 0.
EV-DO Finger C/I Antenna 1	–30 ... 15 dB	1 ... 12	EV-DO: When antenna diversity is enabled, for each finger, the cumulative energy of all search results for antenna 1.
EV-DO Finger Diversity Enabled	0 ... 1	1 ... 12	State of EV-DO antenna diversity. Relevant only if the access terminal is equipped with two antennas. 0: Not enabled 1: Enabled

IE Name	Range/Unit	Arg.	Description
EV-DO Finger Index	1 ... 12	1 ... 12	The index of the EV-DO finger.
EV-DO Finger MSTR	0 ... $2^{32} - 1$ chip/8	–	EV-DO Mobile Station Time Reference: the access terminal's current timing reference based on the sync channel time (in slots) and on the finger lock to the earliest arriving usable multipath of a pilot. Given in units of 1/8 chip.
EV-DO Finger MSTR Error	–32767 ... 32767 chip/8	1 ... 12	Finger delay for each EV-DO finger, expressed as an offset from the current MSTR. Given in units of 1/8 chip.
EV-DO Finger MSTR Pilot PN	0 ... 511	–	EV-DO: PN offset of pilot currently used as timing reference.
EV-DO Finger RPC Cell Index	1 ... 6	1 ... 12	EV-DO RPC Cell Index. Pilots that have the same RPC bit for the AT share the same value.
EV-DO FL IEs: General remark	The **argument**, where present, points to a DRC index. Arg. 0 = DRC index 0x1, etc.		
EV-DO FL Bad Packet Count	0 ... $2^{31} - 1$	0 ... 25	For each DRC index, the number of packets on the forward link received with bad CRC, accumulated over latest reporting period.
EV-DO FL Bad Packet Count (Total)	0 ... $2^{31} - 1$	0 ... 25	For each DRC index, the number of packets on the forward link received with bad CRC, accumulated from start.
EV-DO FL Bad Packet Rate	0 ... 100 %	0 ... 25	For each DRC index, the percentage of bad packets on the forward link. Given for the latest reporting period.
EV-DO FL Bad Packet Rate Multi User (Total)	0 ... 100 %	0 ... 25	For each DRC index, the percentage of bad multi-user packets on the forward link, accumulated from start.

IE Name	Range/Unit	Arg.	Description
EV-DO FL Good Packet Count	0 ... $2^{31} - 1$	0 ... 25	For each DRC index, the number of packets on the forward link received with good CRC, accumulated over latest reporting period.
EV-DO FL Good Packet Count (Total)	0 ... $2^{31} - 1$	0 ... 25	For each DRC index, the number of packets on the forward link received with good CRC, accumulated from start.
EV-DO FL Good Packet Rate	0 ... 100 %	0 ... 25	For each DRC index, the percentage of good packets on the forward link. Given for the latest reporting period.
EV-DO FL Multi Throughput (kbit/s)	0 ... 4000 kbit/s	–	Instantaneous EV-DO forward link throughput in the multi-user case.
EV-DO FL Packet Size	Text	0 ... 25	For each DRC index, the raw bit rate on the forward link (kbit/s).
EV-DO FL Throughput (kbit/s)	0 ... 4000 kbit/s	–	Instantaneous EV-DO forward link throughput.
EV-DO Hybrid Mode	Text	–	Tells whether the access terminal is in hybrid mode: "On" or "Off". A terminal in hybrid mode is monitoring both 1x and EV-DO paging channels in idle mode.
EV-DO Idle State (Num)	0 ... 5	–	EV-DO Idle state. 0: Inactive 1: Monitor 2: Sleep 3: Connection setup 4: Suspend
EV-DO Idle State (Text)	Text	–	Same as EV-DO Idle State (Num) but in text format.

IE Name	Range/Unit	Arg.	Description
EV-DO Init State (Num)	0 ... 5	–	EV-DO Init State. 0: Inactive 1: Network determination 2: Pilot acquisition 3: Sync
EV-DO Init State (Text)	Text	–	Same as EV-DO Init State (Num) but in text format.
EV-DO Multicarrier IEs: General remark	These elements are EV-DO Rev. B specific. The **argument** points to one of the carriers in use in the multicarrier configuration. In the EV-DO Rev. B specification, the use of up to three carriers is permitted; the reason for providing a fourth argument is that supported Qualcomm devices have the capability to handle four carriers (in anticipation of future EV-DO revisions).		
EV-DO Multicarrier Bad Packet Count	0 ... 16	1 ... 4	For each carrier, the number of packets on the forward link received with bad CRC, accumulated over latest reporting period.
EV-DO Multicarrier Band Class (Num)	0 ... 17	1 ... 4	Frequency band class for each carrier. ▶ 3GPP2 C.S0057-B
EV-DO Multicarrier Band Class (Text)	Text	1 ... 4	Same as EV-DO Multicarrier Band Class (Num) but in text format.
EV-DO Multicarrier Best Active Pilot PN	0 ... 511	1 ... 4	For each carrier, PN offset for the active set pilot currently having the best predicted SINR.
EV-DO Multicarrier Best SINR	–30 ... 15 dB	1 ... 4	For each carrier, predicted SINR for the active set pilot currently having the best predicted SINR.
EV-DO Multicarrier Channel Numbers	0 ... 1199	1 ... 4	RF channel number of each carrier.

IE Name	Range/Unit	Arg.	Description
EV-DO Multicarrier DRC Index (Num)	0 ... 15	1 ... 4	DRC index on each carrier.
EV-DO Multicarrier DRC Rate (Text)	Text	1 ... 4	For each carrier, DRC rate corresponding to the DRC index.
EV-DO Multicarrier PER Instantaneous (%)	0 ... 100 %	1 ... 4	Packet error rate, immediate value (no averaging).
EV-DO Multicarrier PER Long (%)	0 ... 100 %	1 ... 4	Packet error rate, running average over (approximately) 600 reports.
EV-DO Multicarrier PER Short (%)	0 ... 100 %	1 ... 4	Packet error rate, running average over (approximately) 60 reports.
EV-DO Neighbor Set IEs: General remark	The **argument**, where present, points to the neighbor set member index. In case of multicarrier operation, the IEs contain the strongest neighbors (up to 40) from all carriers taken together.		
EV-DO Neighbor Set Age	0 ... 65535	1 ... 40	EV-DO: Age counter for each neighbor set member. ▶ 3GPP2 C.S0024, section 6.6.6.1.2.7
EV-DO Neighbor Set Window Offset	0 ... 65535 chips	1 ... 40	EV-DO: Offset (from MSTR) of search window used for each neighbor set member.
EV-DO Neighbor Set Window Size	0 ... 65535 chips	1 ... 40	EV-DO: Size of search window used for each neighbor set member.
EV-DO Number Of Carriers	0 ... 4	–	EV-DO: Number of carriers in use. Greater than 1 in case of multicarrier operation.

IE Name	Range/Unit	Arg.	Description
EV-DO OVHD Message State (Num)	0 ... 5	–	EV-DO Overhead Message state. 0: Inactive 1: Process all messages 2: Sleep 3: Frequency change in progress 4: Access handoff in progress 5: Wait for link
EV-DO OVHD Message State (Text)	Text	–	Same as EV-DO OVHD Message State (Num) but in text format.
EV-DO PA State	Text	–	State of EV-DO power amplifier: "On" or "Off".
EV-DO PER Instantaneous (%)	0 ... 100 %	–	EV-DO packet error rate, immediate value (no averaging).
EV-DO PER Long (%)	0 ... 100 %	–	EV-DO packet error rate, running average over (approximately) 600 reports.
EV-DO PER Short (%)	0 ... 100 %	–	EV-DO packet error rate, running average over (approximately) 60 reports.
EV-DO Power Ratio ACK Pilot	–20 ... 20 dB	–	EV-DO: Offset between the ACK Channel and Pilot Channel output powers.
EV-DO Power Ratio Aux Pilot	–20 ... 20 dB	–	EV-DO: Offset between Aux Channel and Pilot Channel output powers.
EV-DO Power Ratio Data Pilot	–20 ... 20 dB	–	EV-DO: Offset between Data Channel and Pilot Channel output powers.
EV-DO Power Ratio DRC Pilot	–20 ... 20 dB	–	EV-DO: Offset between DRC Channel and Pilot Channel output powers.
EV-DO Power Ratio RRI Pilot	–20 ... 20 dB	–	EV-DO: Offset between RRI Channel and Pilot Channel output powers.

IE Name	Range/Unit	Arg.	Description
EV-DO Reverse Rate AN Limit	0 ... 1800 kbit/s	–	EV-DO reverse link data rate limit imposed by access network (AN).
EV-DO Reverse Rate Average (kbit/s)	0 ... 1800 kbit/s	–	EV-DO reverse link data rate, running average.
EV-DO Reverse Rate Current (kbit/s)	0 ... 1800 kbit/s	–	EV-DO reverse link data rate, instantaneous value.
EV-DO Reverse Rate PA Limit	0 ... 1800 kbit/s	–	EV-DO reverse link data rate limit imposed by power amplifier (PA).
EV-DO Revision	Text	–	EV-DO revision: one of "Rev 0", "Rev A", "Rev B".
EV-DO RL IEs: General remark	The **argument**, where present, points to a reverse link current rate index.		
EV-DO RL Max Traffic To Pilot	–20 ... 20 dB	–	EV-DO: Maximum offset between the Traffic Channel and Pilot Channel output powers.
EV-DO RL Packet Count (Total)	0 ... 2^{31} – 1	1 ... 5	For each RL current rate, the number of packets sent on the reverse link from start of logfile/since device activation.
EV-DO RL Packet Rate	0 ... 100 %	1 ... 5	Percentage distribution showing the current usage of the reverse link current rates. Based on latest report.
EV-DO RL Packet Size	Text	1 ... 5	For each RL current rate, the raw bit rate on the reverse link.
EV-DO RL Throughput (kbit/s)	0 ... 1800 kbit/s	–	Instantaneous EV-DO reverse link throughput.
EV-DO RLP RX Duplicate Bytes	0 ... 2^{32} – 1	–	EV-DO: Number of received duplicate frames.

IE Name	Range/Unit	Arg.	Description
EV-DO Route Update State (Num)	0 ... 4	–	EV-DO Route Update Protocol state. 0: Inactive 1: Idle 2: Connection setup 3: Connected 4: Synchronize connection setup
EV-DO Route Update State (Text)	Text	–	Same as EV-DO Route Update State (Num) but in text format.
EV-DO Session Failure Rate (%)	0 ... 100 %	–	Number of failed EV-DO session attempts divided by total number of EV-DO session attempts.
EV-DO Session Full UATI	Text	–	EV-DO: Full (128-bit) Unicast Access Terminal Identifier allocated to the access terminal.
EV-DO Session RATI	0 ... 255	–	EV-DO: Random Access Terminal Identifier allocated to the terminal.
EV-DO Session Result	0 ... 1	–	Success or failure of EV-DO session attempt, as indicated by the AN giving the AT a UATI assignment or not. 0: Failure 1: Success
EV-DO Session State (Num)	0 ... 5	–	EV-DO session state. 0: Closed 1: AMP setup 2: AT-initiated negotiation 3: AN-initiated negotiation 4: Open 5: Closing
EV-DO-DO Session State (Text)	Text	–	Same as EV-DO Session State (Num) but in text format.
EV-DO Session Transaction ID	0 ... 255	–	EV-DO: Transaction ID sent in UATIRequest message. ▶ 3GPP2 C.S0024, section 5.3.7.2.1

IE Name	Range/Unit	Arg.	Description
EV-DO Session UATI Color Code	0 ... 255	–	EV-DO: UATI Color Code sent in UATIAssignment message. The AN sets this field to the Color Code associated with the subnet to which the UATI belongs. ▶ 3GPP2 C.S0024, section 5.3.7.2.2
EV-DO UATI (Hex)	Text: "0000" ... "FFFF"	1 ... 8	EV-DO: List of active UATIs (Unicast Access Terminal Identifiers), given as 32-bit values (lowest 4 bytes of full UATI). **Argument:** Sequence number.
EV-DO UATI (Num)	0 ... 65535	1 ... 8	Same as EV-DO UATI (Hex) but in decimal format.
EV-DO UATI Count	0 ... 8	–	EV-DO: Number of active UATIs.
F-DCCH Bitrate (kbit/s)	0 ... 162600 kbit/s	–	Forward link DCCH bit rate configuration.
F-DCCH Enabled	Text	–	State of forward link DCCH: "Used" or "Not Used".
F-DCCH Frame Length (bits)	0 ... 65535 bits	–	Number of bits in a forward link DCCH physical layer frame.
F-DCCH Frame Size (ms)	Text	–	Forward link DCCH frame size in milliseconds.
F-DCCH MUX PDU	Text	–	Forward link DCCH MUX PDU type. ▶ 3GPP2 C.S0003-A, section 2.2.1.1
F-DCCH Radio Configuration	1 ... 9	–	Forward link DCCH Radio Configuration as specified in ▶ 3GPP2 C.S0002-A, table 3.1.3.1-1.
FER DCCH (%)	0 ... 100 %	–	Frame erasure rate on the DCCH (Digital Control Channel).
FER FCH (%)	0 ... 100 %	–	Frame erasure rate on the FCH (Fundamental Channel).

IE Name	Range/Unit	Arg.	Description
FER SCH0 (%)	0 ... 100 %	–	Frame erasure rate on the SCH0 (Supplemental Channel 0).
FER SCH1 (%)	0 ... 100 %	–	Frame erasure rate on the SCH1 (Supplemental Channel 1).
FER Total (%)	0 ... 100 %	–	Frame erasure rate calculated over all forward channels.
F-FCH Bitrate (kbit/s)	0 ... 162600 kbit/s	–	Forward link FCH bit rate configuration.
F-FCH Frame Length (bits)	0 ... 65535 bits	–	Number of bits in a forward link FCH physical layer frame.
F-FCH Frame Size (ms)	Text	–	Forward link FCH frame size in milliseconds.
F-FCH MUX PDU	Text	–	Forward link FCH MUX PDU type. ► 3GPP2 C.S0003-A, section 2.2.1.1
F-FCH Radio Configuration	1 ... 9	–	Forward link FCH radio configuration as specified in ► 3GPP2 C.S0002-A, table 3.1.3.1-1.
F-FCH Rate	0 ... 15	–	Forward link FCH rate bitmask. A combination of: 0x01 (Full Rate allowed), 0x02 (1/2 Rate allowed), 0x04 (1/4 Rate allowed), and 0x08 (1/8 Rate allowed)
F-FCH Traffic Type (Num)	0 ... 2	–	Forward link FCH traffic type; one of: 0: No forward traffic 1: Primary traffic 2: Secondary traffic
F-FCH Traffic Type (Text)	Text	–	Same as F-FCH Traffic Type (Num) but in text format.
Finger IEs: General remark	The **argument**, where present, points to a finger index.		
Finger Count	0 ... 12	–	Number of valid fingers.

IE Name	Range/Unit	Arg.	Description
Finger Delay Delta (chips)	2 ... 512 chips	1 ... 12	The position of each finger (in chips) relative to the earliest finger arrived.
Finger Delta (ms)	0 ... 65535 ms	1 ... 12	Time delta between the earliest finger and each of the other fingers.
Finger Energy (dB)	–32 ... 15 dB	1 ... 12	Signal-to-noise ratio for each finger: Ec/Io for 1x fingers, SINR for EV-DO fingers.
Finger Energy Sum (dB)	–64 ... 10 dB	–	Total signal-to-noise ratio for all fingers, instantaneous value: Ec/Io for 1x fingers, SINR for EV-DO fingers.
Finger Pilot PN	0 ... 511	1 ... 12	Pilot PN for each finger.
Finger Reference	1 ... 12	–	Index of the earliest finger.
Finger RTC Offset (1/8 chip)	0 ... 2^{32} – 1 chip/8	1 ... 12	Real Time Clock offset for each finger.
Finger Status	Text	1 ... 12	Status of each finger: a combination of “Reference”, “Locked”, and “Assigned”.
Firmware Version	Text	–	Version number of device firmware.
FPC F-DCCH Setpoint Avg	0 ... 255 dB/8	–	The current outer loop estimation Eb/Io setpoint of the forward link DCCH in units of 0.125 dB.
FPC F-FCH Setpoint Avg	0 ... 255 dB/8	–	The current outer loop estimation Eb/Io setpoint of the forward link FCH in units of 0.125 dB.
FPC F-SCH0 Setpoint Avg	0 ... 255 dB/8	–	The current outer loop estimation Eb/Io setpoint of the forward link SCH0 in units of 0.125 dB.
Frame Offset	0 ... 15 See Description	–	A time skewing of Traffic Channel frames from System Time in integer multiples of 1.25 ms. The maximum frame offset is 15 $\times$ 1.25 ms = 18.75 ms.

IE Name	Range/Unit	Arg.	Description
F-SCH Rate	0 ... 5	–	Forward link SCH rate. 0: 1X 1: 2X 2: 4X 3: 8X 4: 16X 5: 32X
F-SCH0 Bitrate (kbit/s)	0 ... 162600 kbit/s	–	F-SCH0 channel bit rate configuration.
F-SCH0 Enabled	Text	–	State of F-SCH0 channel: “Used” or “Not Used”.
F-SCH0 Frame Length (bits)	0 ... 65535 bits	–	Number of bits in an F-SCH0 physical layer frame.
F-SCH0 MUX PDU	Text	–	F-SCH0 MUX PDU type. ▶ 3GPP2 C.S0003-A, section 2.2.1.1
F-SCH0 Radio Configuration	1 ... 9	–	F-SCH0 Radio Configuration as specified in ▶ 3GPP2 C.S0002-A, table 3.1.3.1-1.
Hardware	Text	–	Device model.
Hardware ID	Text	–	ESN, Electronic Serial Number.
Heading (deg)	0 ... 360 degrees	–	Direction of travel measured in degrees clockwise from north. Reported by positioning equipment.
Latitude	–90 ... 90 degrees	–	Latitude recorded by positioning equipment.
Latitude (Text)	Text	–	Latitude as text. For the presentation format, see TR section 3.4.
Latitude Decimal Degrees (Text)	Text	–	Latitude in decimal degrees, presented as text.
Longitude	–180 ... 180 degrees	–	Longitude recorded by positioning equipment.

IE Name	Range/Unit	Arg.	Description
Longitude (Text)	Text	–	Longitude as text. For the presentation format, see TR section 3.4.
Longitude Decimal Degrees (Text)	Text	–	Longitude in decimal degrees, presented as text.
Missing Neighbor IEs: General remark	These elements are obtained when using a scanner in follow phone mode (see UM section 21.3). The **argument** points to a neighbor index.		
Missing Neighbor Cell Name	Text	1 ... 40	Cell name of each missing neighbor. Requires cell file.
Missing Neighbor Ec/Io	–32 ... 0 dB	1 ... 40	Signal-to-noise ratio for each missing neighbor.
Missing Neighbor PN	0 ... 511	1 ... 40	PN offset of each missing neighbor.
Mobile Identity Number	Text	–	Mobile Identity Number of the device.
Mode	Text	–	Same as "Mode (Num)" (which see) but in text format: "No service", etc.
Mode (Num)	1 ... 7	–	1: No service 2: Idle mode 3: Dedicated mode (4: Limited service mode) (5: Scan mode) 6: Packet mode (7: Packet Idle mode)
Mode - System	1 ... 9	–	Relevant values: 3: CDMA (1x) 4: 1xEV-DO 5: Analog For the full set of values, see the Mode - System element under WCDMA.
Mode - System (Text)	Text	–	Same as "Mode - System" but in text format.

IE Name	Range/Unit	Arg.	Description
MSM Revision	Text	–	Qualcomm chipset family (e.g. “MSM 7200”).
Neighbor Set IEs: General remark	The **argument**, where present, points to the neighbor set member index. In case of multicarrier operation, the IEs contain the strongest neighbors (up to 40) from all carriers taken together.		
Neighbor Set Band Class	Text	1 ... 40	Frequency band class for each neighbor set member. ▶ 3GPP2 C.S0057-B
Neighbor Set Cell Name	Text	1 ... 40	Cell name for each neighbor set member. Requires cell file.
Neighbor Set Channel	0 ... 1199	1 ... 40	Channel number of RF channel used by each neighbor set member.
Neighbor Set Count	0 ... 80	–	The number of neighbor set members. In the multicarrier case, the neighbor set members on all carriers are counted, although only the strongest of these (up to 40) appear in the other Neighbor Set elements.
Neighbor Set Ec	–157 ... 10 dBm	1 ... 40	Received signal code power for each neighbor set member.
Neighbor Set Ec/Io	–32 ... 0 dB	1 ... 40	Signal-to-noise ratio (Ec/Io in dB) for each neighbor set member.
Neighbor Set PN	0 ... 511	1 ... 40	Pilot PN offset for each neighbor set member.
Network ID	0 ... 65535	–	Network Identification (NID).
Network ID (Hex)	Text: “0000” ... “FFFF”	–	Same as Network ID but in hexadecimal format.
Number Of DSC Channels	0 ... 15	–	Number of DSC (Data Source Control) channels currently in use.
Pilot PN Increment	1 ... 15	–	Inter-sector pilot PN increment used by the AN in assigning PN offsets to sectors.

IE Name	Range/Unit	Arg.	Description
Pilot Set IEs: General remark	The **argument**, where present, points to the pilot set member index. In case of multicarrier operation, the IEs contain the strongest pilots (up to 52) from all carriers taken together.		
Pilot Set Band Class	Text	1 ... 52	Frequency band class for each pilot set member. ▶ 3GPP2 C.S0057-B
Pilot Set Cell Name	Text	1 ... 52	Cell name for each pilot set member. Requires cell file.
Pilot Set Cell Type	Text	1 ... 52	Type of pilot: "Active", "Candidate", or "Neighbor".
Pilot Set Channel	0 ... 1199	1 ... 52	Channel number of RF channel used by each pilot.
Pilot Set Count	0 ... 128	–	Total number of pilots in active, candidate, and neighbor sets. In the multicarrier case, the pilot set members on all carriers are counted (up to 6 [A] + 6 [C] + 20 [N] = 32 pilots on each carrier), although only the strongest of these (up to 52) appear in the other Pilot Set elements.
Pilot Set Ec	–157 ... 10 dBm	1 ... 52	Received signal code power for each pilot set member.
Pilot Set Ec/Io	–32 ... 0 dB	1 ... 52	Signal-to-noise ratio for each pilot set member.
Pilot Set PN	0 ... 511	1 ... 52	PN offset for each pilot set member.
"Polluters" IEs: General remark	These elements are obtained when using a scanner in follow phone mode: see UM, section 21.3. • "Current" refers to the polluter data derived from the latest scan report. • "Top List" refers to cumulative polluter statistics amassed since start of logfile/since device activation.		
Polluters Current Active Set	0 ... 511	1 ... 6	PN offset of each current active set member. **Argument:** Active set member index.

IE Name	Range/Unit	Arg.	Description
Polluters Current Cell Name	Text	1 ... 5	Cell name of each current polluter. Requires cell file. **Argument:** Rank of this polluter among current polluters.
Polluters Current Ec/Io	–32 ... 0 dB	1 ... 5	Signal-to-noise ratio for each current polluter. **Argument:** Rank of this polluter among current polluters.
Polluters Current Pilot PN	0 ... 511	1 ... 5	PN offset of each current polluter. **Argument:** Rank of this polluter among current polluters.
Polluters Top List Cell Name	Text	1 ... 5	Cell name of each polluter on the top list. Requires cell file. **Argument:** Rank on polluter top list.
Polluters Top List Channel	0 ... 1199	1 ... 5	RF channel number of each polluter on the top list. **Argument:** Rank on polluter top list.
Polluters Top List Pilot PN	0 ... 511	1 ... 5	PN offset of each polluter on the top list. **Argument:** Rank on polluter top list.
Protocol Revision - Base (Num)	0 ... 7	–	Base station protocol revision (P-Rev).
Protocol Revision - Base (Text)	Text	–	Same as "Protocol Revision - Base (Num)" but in text format.
Protocol Revision - Mobile (Num)	0 ... 7	–	Device protocol revision (P-Rev).
Protocol Revision - Mobile (Text)	Text	–	Same as "Protocol Revision - Mobile (Num)" but in text format.

IE Name	Range/Unit	Arg.	Description
Protocol Revision In Use (Num)	0 ... 7	–	Protocol revision (P-Rev) negotiated between phone and base station.
Protocol Revision In Use (Text)	Text	–	Same as "Protocol Revision In Use (Num)" but in text format.
R-DCCH Bitrate (kbit/s)	0 ... 162600 kbit/s	–	Reverse link DCCH bit rate configuration.
R-DCCH Enabled	Text	–	State of reverse link DCCH: "Used" or "Not Used".
R-DCCH Frame Length (bits)	0 ... 65535 bits	–	Number of bits in a reverse link DCCH physical layer frame.
R-DCCH MUX PDU	Text	–	Reverse link DCCH MUX PDU type. ▶ 3GPP2 C.S0003-A, section 2.2.1.1
R-DCCH Radio Configuration	1 ... 9	–	Reverse link DCCH radio configuration as specified in ▶ 3GPP2 C.S0002-A, table 3.1.3.1-1.
RF Mode	Text	–	For Analog and CDMA: "<technology> <phone state>", where • <technology> is one of "Analog", "CDMA", and • <phone state> is one of "Init", "Idle", "Access", "Traffic". For EV-DO: "<technology> <AT state>", where • <technology> = "1xEV-DO", and • <AT state> is one of "Inactive", "Acquisition", "Sync", "Idle", "Access", "Connected".

IE Name	Range/Unit	Arg.	Description
RF Mode (Num)	0 ... 13	–	RF Mode mapped to an integer. 0: Analog, Init 1: Analog, Idle 2: Analog, Access 3: Analog, Traffic 4: CDMA, Init 5: CDMA, Idle 6: CDMA, Access 7: CDMA, Traffic 8: EV-DO, Inactive 9: EV-DO, Acquisition 10: EV-DO, Sync 11: EV-DO, Idle 12: EV-DO, Access 13: EV-DO, Connected
R-FCH Bitrate (kbit/s)	0 ... 162600 kbit/s	–	Reverse link FCH bit rate configuration.
R-FCH Frame Length (bits)	0 ... 65535 bits	–	Number of bits in a reverse link FCH physical layer frame.
R-FCH MUX PDU	Text	–	Reverse link FCH MUX PDU type. ▶ 3GPP2 C.S0003-A, section 2.2.1.1
R-FCH Radio Configuration	1 ... 9	–	Reverse link FCH radio configuration as specified in ▶ 3GPP2 C.S0002-A, table 3.1.3.1-1.
R-FCH Rate	0 ... 15	–	Reverse link FCH rate bitmask. A combination of: 0x01 (Full Rate allowed), 0x02 (1/2 Rate allowed), 0x04 (1/4 Rate allowed), and 0x08 (1/8 Rate allowed)
R-FCH Traffic Type (Num)	0 ... 2	–	Reverse link FCH traffic type; one of: 0: No reverse traffic 1: Primary traffic 2: Secondary traffic
R-FCH Traffic Type (Text)	Text	–	Same as R-FCH Traffic Type (Num) but in text format.

IE Name	Range/Unit	Arg.	Description
RLP DL Avg. Throughput (kbit/s)	0 ... 14500 kbit/s	–	Averaged throughput on downlink at RLP level (16 s sliding window). Valid for both 1x and EV-DO.
RLP DL Throughput (kbit/s)	0 ... 14500 kbit/s	–	Instantaneous throughput on downlink at RLP level. Valid for both 1x and EV-DO.
RLP Erasure Rate (%)	0 ... 100 %	–	Erasure rate at RLP level.
RLP Retransmitted Frames Rx (%)	0 ... 100 %	–	Retransmitted frames on downlink at RLP level.
RLP Retransmitted Frames Tx (%)	0 ... 100 %	–	Retransmitted frames on uplink at RLP level.
RLP Rx Channel Rate (kbit/s)	0 ... 162600 kbit/s	0 ... 12	RLP downlink physical channel bit rate configuration. **Argument:** 0: FCH 1: DCCH 2: SCH0 3: SCH1 4: SCCH0 5: SCCH1 6: SCCH2 7: SCCH3 8: SCCH4 9: SCCH5 10: SCCH6 11: SCCH7 12: PDCH
RLP Total Bytes Rx	0 ... 2^{31} bytes	–	Total bytes transferred on downlink at RLP level.
RLP Total Bytes Tx	0 ... 2^{31} bytes	–	Total bytes transferred on uplink at RLP level.

IE Name	Range/Unit	Arg.	Description
RLP Tx Channel Rate (kbit/s)	0 ... 162600 kbit/s	0 ... 12	RLP uplink physical channel bit rate configuration. **Argument:** See RLP Rx Channel Rate (kbit/s).
RLP UL Avg. Throughput (kbit/s)	0 ... 2000 kbit/s	–	Averaged throughput on uplink at RLP level (16 s sliding window). Valid for both 1x and EV-DO.
RLP UL Throughput (kbit/s)	0 ... 2000 kbit/s	–	Instantaneous throughput on uplink at RLP level. Valid for both 1x and EV-DO.
R-SCH Rate	0 ... 5	–	Reverse link SCH rate. 0: 1X 1: 2X 2: 4X 3: 8X 4: 16X 5: 32X
R-SCH0 Bitrate (kbit/s)	0 ... 162600 kbit/s	–	Reverse link SCH0 bit rate configuration.
R-SCH0 Enabled	Text	–	State of reverse link SCH0: “Used” or “Not Used”.
R-SCH0 Frame Length (bits)	0 ... 65535 bits	–	Number of bits in a reverse link SCH0 physical layer frame.
R-SCH0 MUX PDU	Text	–	Reverse link SCH0 MUX PDU type. ▶ 3GPP2 C.S0003-A, section 2.2.1.1
R-SCH0 Radio Configuration	1 ... 9	–	Reverse link SCH0 Radio Configuration as specified in ▶ 3GPP2 C.S0002-A, table 3.1.3.1-1.
Rx Power	–120 ... 10 dBm	–	Received signal power. Valid for both 1x and EV-DO.

IE Name	Range/Unit	Arg.	Description
"Scanned 1st Freq." IEs	Pilot scanning: First scanned RF channel. **Argument:** The sorting order within each element depends on the setting in the General window: see UM section 21.3.6.1.		
Scanned 1st Freq. Band	Text	–	Band class for scanned RF channel. ▶ 3GPP2 C.S0057-B
Scanned 1st Freq. Cell Name	Text	1 ... 512	Cell name corresponding to each scanned pilot. Requires cell file.
Scanned 1st Freq. Channel	0 ... 1199	–	Channel number of scanned RF channel.
Scanned 1st Freq. Delay	–3 ... 60 chips	1 ... 512	Pilot delay in chips for each scanned pilot. See UM section 21.3.1.
Scanned 1st Freq. Delay Spread	0 ... 63 chips	1 ... 512	Delay spread in chips for each scanned pilot. See UM section 21.3.1.
Scanned 1st Freq. Ec	–157 ... –10 dBm	1 ... 512	Received signal code power of each scanned pilot.
Scanned 1st Freq. Ec/Io	–32 ... 0 dB	1 ... 512	Peak Ec/Io for each scanned pilot.
Scanned 1st Freq. Io	–125 ... –25 dBm	–	Total signal power in RF channel.
Scanned 1st Freq. Pilot PN	0 ... 511	1 ... 512	PN offset for each scanned pilot.
Scanned 1st Freq. Pilots Count	0 ... 512	–	Number of pilots scanned.
"Scanned 1st Freq. Strongest" IEs	Pilot scanning: First scanned RF channel. The strongest pilots are sorted by descending peak Ec/Io. **Argument** (1 ... 32): 1 means the pilot with highest peak Ec/Io, etc.		
"Scanned 2nd (etc.) Freq." IEs	Pilot scanning: Second (etc.) scanned RF channel. **Argument:** The sorting order within each element depends on the setting in the General window: see UM section 21.3.6.1.		

IE Name	Range/Unit	Arg.	Description
“Scanned 2nd (etc.) Freq. Strongest” IEs	Pilot scanning: Second (etc.) scanned RF channel. The strongest pilots are sorted by descending peak Ec/Io. **Argument** (1 ... 32): 1 means the pilot with highest peak Ec/Io, etc.		
Scanned Channel	0 ... 1199	1 ... 512	RSSI scanning: RF channel number of each RF channel scanned. **Argument:** 1 means the RF channel with the lowest number, etc.
Scanned Channels Count	0 ... 512	–	RSSI scanning: The number of RF channels scanned.
“Scanned Code Domain” IEs: General remark	These elements pertain to code domain scanning. A separate set of IEs is provided for each scanned pilot. The sets are distinguished by the ordinal “<*n*th>”, where *n* = 1 ... 12. **Argument** (1 ... 128): Points to a Walsh code.		
Scanned Code Domain Pilots Count	0 ... 12	–	Number of pilots scanned.
Scanned Code Domain <*n*th> Pilot Band	Text	–	Band class for scanned RF channel. ► 3GPP2 C.S0057-B
Scanned Code Domain <*n*th> Pilot Cell Name	Text	–	Cell name corresponding to scanned pilot. Requires cell file.
Scanned Code Domain <*n*th> Pilot Channel	0 ... 1199	–	Channel number of scanned RF channel.
Scanned Code Domain <*n*th> Pilot Code	0 ... 127	1 ... 128	Code number of each scanned Walsh code.
Scanned Code Domain <*n*th> Pilot Code Count	0 ... 128	–	Number of scanned Walsh codes.

IE Name	Range/Unit	Arg.	Description
Scanned Code Domain <*nth*> Pilot Code Ec	–157 ... –10 dBm	1 ... 128	Ec for each scanned Walsh code.
Scanned Code Domain <*nth*> Pilot Code Ec/Io	–32 ... 0 dB	1 ... 128	Ec/Io for each scanned Walsh code.
Scanned Code Domain <*nth*> Pilot Io	–125 ... –25 dBm	–	Total signal power in RF channel.
Scanned Code Domain <*nth*> Pilot PN	0 ... 511	1 ... 128	PN offset for scanned pilot.
Scanned RSSI	–120 ... –30 dBm	1 ... 512	RSSI scanning: RSSI for each RF channel. **Argument:** 1 means the RF channel with the lowest number, etc.
Scanned RSSI Average (dBm)	–120 ... –30 dBm	–	RSSI scanning: Average RSSI over all scanned RF channels.
“Scanned Strongest” IEs	These elements contain the strongest pilots irrespective of scanned RF channel. The pilots are sorted by descending peak Ec/Io. **Argument** (1 ... 32): 1 means the pilot with the highest peak Ec/Io, etc.		
Searcher State	Text	–	Searcher state, e.g. “Acquisition”, “TCH operation”. Valid for both 1x and EV-DO.
Searcher Window A	0 ... 15 See Description	–	Size of search window used for pilots in the active set. For the mapping to PN chip length, see ► IS-95, table 6.6.6.2.1-1.
Searcher Window N	0 ... 15	–	Size of search window used for pilots in the neighbor set.

IE Name	Range/Unit	Arg.	Description
Searcher Window R	0 ... 15	–	Size of search window used for pilots in the remaining set. ▶ 3GPP2 C.S0005-A, pages 1–18
Sector ID	Text	–	Hex string containing the 128-bit sector address of the serving sector. Format: “0011:2233:4455:6677:8899:AABB:CCDD:EEFF”
Service ID	0 ... 254	–	Radio Link Protocol service ID.
Service Option (Num)	0 ... 65535	–	Service Option for the current session. ▶ 3GPP2 C.R1001
Service Option (Text)	Text	–	Same as Service Option (Num) but in text format.
Slot Cycle Index	0 ... 7	–	Slot cycle index described in ▶ 3GPP2 C.S0005-A, section 2.6.2.1.1.3.
Soft Handoff State	Text	–	Soft handoff state. One of “No Soft Handoff”, “2-Way”, “3-Way”, “4-Way”, “5-Way”, “6-Way”. Derived from the information element Active Set Count.
“Spectr Ana” IEs: General remark	These elements are populated by spectrum analysis scanning. The **argument**, where present, is simply a sequence number pointing to scanned frequencies as indicated by the Spectr Ana Sc DL Freq element.		
Spectr Ana Sc DL Freq	870 ... 900 MHz	1 ... 2560	Scanned downlink frequencies in ascending order.
Spectr Ana Sc DL No Of Freq	0 ... 2560	–	The number of downlink frequencies swept by the scan.
Spectr Ana Sc DL RSSI	–130 ... –20 dBm	1 ... 2560	RSSI of downlink frequencies scanned.
Speed (km/h)	0 ... 250 km/h	–	Speed in km/h.
Speed (mph)	0 ... 160 mph	–	Speed in mph.

IE Name	Range/Unit	Arg.	Description
SQI MOS	1 ... 5 MOS	–	SQI expressed on the MOS scale. See UM chapter 42.
Station Class Mark (hex)	Text	–	Defined in ▶ 3GPP2 C.S0005-A, section 2.3.3.
Subnet Mask	0 ... 255	–	Sector subnet identifier.
System ID	0 ... 65535	–	System Identification (SID) in decimal format.
System ID (Hex)	Text: “0000” ... “FFFF”	–	System Identification (SID) in hexadecimal format.
T-Add (dB)	–32 ... 0 dB	–	Pilot detection threshold (sign reversed). ▶ 3GPP2 C.S0005-A, section 2.6.6.2.6.2
T-Add (Num)	–63 ... 0 See Description	–	Pilot detection threshold (expressed in units of 0.5 dB and sign reversed). ▶ 3GPP2 C.S0005-A, section 1.1.2.2
T-Comp (dB)	0 ... 8 dB	–	Active set versus candidate set comparison threshold. ▶ 3GPP2 C.S0005-A, section 2.6.6.2.5.2
T-Comp (Num)	0 ... 15 See Description	–	Active set versus candidate set comparison threshold (expressed in units of 0.5 dB).
T-Drop (dB)	–32 ... 0 dB	–	Pilot drop threshold (sign reversed). ▶ 3GPP2 C.S0005-A, section 2.6.6.2.3
T-Drop (Num)	–63 ... 0 See Description	–	Pilot drop threshold (expressed in units of 0.5 dB and sign reversed).
T-TDrop (Num)	0 ... 15 See Description	–	Drop timer value, mapped to an integer value according to ▶ 3GPP2 C.S0005-A v6.0, table 2.6.6.2.3-1.

IE Name	Range/Unit	Arg.	Description
T-TDrop (sec)	Text (“0.1 s”... “319 s”)	–	Drop timer value in seconds. ► 3GPP2 C.S0005-A v6.0, table 2.6.6.2.3-1
Tx Adjust	–128 ... 127 dB	–	Tx Adjust power control parameter. Valid for both 1x and EV-DO. Equal to Closed Loop Adjust parameter when in EV-DO mode.
Tx Open Loop Power	–127 ... 36 dBm	–	Tx Open Loop Power parameter. Valid for both 1x and EV-DO.
Tx Pilot Power	–127 ... 36 dBm	–	Tx Pilot Power parameter. Valid for both 1x and EV-DO.
Tx Power	–127 ... 36 dBm	–	Tx Power parameter. Valid for both 1x and EV-DO.

3.6. WiMAX Information Elements

3.6.1. General

3.6.1.1. Notes on CINR

The number of samples on which to base the CINR mean values and standard deviations is set in the WiMAX scan setup dialog (UM section 22.3.1, “Number of Samples for Stats”). However, this figure only serves as a guideline to the scanner; in practice the scanner may on some occasions use a lower number of samples as input to the statistics calculation. This number is reported in the “Samples Taken” elements (see below).

Note that as power level fluctuations become minute, the standard deviation likewise approaches zero and hence tends towards negative infinity when expressed in dB. A large negative number has been used as the lower endpoint for the standard deviation range.

3.6.2. Information Element Table

IE Name	Range/Unit	Arg.	Description
Altitude (ft)	–1312 ... 29028 ft	–	Height above sea level in feet. Reported by positioning equipment.
Altitude (m)	–400 ... 8848 m	–	Height above sea level in meters. Reported by positioning equipment.
Firmware Version	Text	–	Version number of device firmware.
Hardware	Text	–	Scanner model.
Hardware ID	Text	–	Hardware identification string.
Heading (deg)	0 ... 360 degrees	–	Direction of travel measured in degrees clockwise from north. Reported by positioning equipment.
Latitude	–90 ... 90 degrees	–	Latitude recorded by positioning equipment.

IE Name	Range/Unit	Arg.	Description
Latitude (Text)	Text	–	Latitude as text. For the presentation format, see TR section 3.4.
Latitude Decimal Degrees (Text)	Text	–	Latitude in decimal degrees, presented as text.
Longitude	–180 ... 180 degrees	–	Longitude recorded by positioning equipment.
Longitude (Text)	Text	–	Longitude as text. For the presentation format, see TR section 3.4.
Longitude Decimal Degrees (Text)	Text	–	Longitude in decimal degrees, presented as text.
Mode	Text	–	Not used.
Mode (Num)	1 ... 7	–	Not used.
Mode - System	1 ... 9	–	Not used.
Mode - System (Text)	Text	–	Not used.
“Sc Channel” IEs: General remark	These elements are obtained from preamble scanning. The **argument**, where present, points to the position of the channel in the list of scanned channels.		
Sc Channel [indx]	0 ... 1580	0 ... 1499	RF channel number of each channel scanned. See ► WiMAX Forum Mobile System Profile version 1.4, table 130.
Sc Channel Count	0 ... 1500	–	The number of channels scanned.
Sc Channel Profile (Text) [indx]	Text	0 ... 1499	The WiMAX RF profile to which each scanned channel belongs.
Sc Channel RSSI (dBm) [indx]	–140 ... 20 dBm	0 ... 1499	The total power in all the allowed preamble subcarriers of the WiMAX signal, gated during the preamble symbol time. This is the sum of all three segment powers.

IE Name	Range/Unit	Arg.	Description
Sc Channel RSSI Mean (dBm) [indx]	–140 ... 20 dBm	0 ... 1499	Running mean value of channel RSSI.
Sc Channel RSSI Samples Taken [indx]	0 ... 32	0 ... 1499	Number of samples used to calculate RSSI statistics (mean, standard deviation).
Sc Channel RSSI Std. Dev. (dB) [indx]	–200 ... 20 dB	0 ... 1499	Running standard deviation for channel RSSI.
Sc Channel Segment 0 Power (dBm) [indx]	–140 ... 20 dBm	0 ... 1499	The total power in the preamble subcarriers allocated to segment 0, gated during the preamble symbol time.
Sc Channel Segment 1 Power (dBm) [indx]	–140 ... 20 dBm	0 ... 1499	The total power in the preamble subcarriers allocated to segment 1, gated during the preamble symbol time.
Sc Channel Segment 2 Power (dBm) [indx]	–140 ... 20 dBm	0 ... 1499	The total power in the preamble subcarriers allocated to segment 2, gated during the preamble symbol time.
“Sc Preamble” IEs: General remark	These elements are obtained from preamble scanning. The **argument**, where present, indicates the position of the preamble in the list of detected preambles.		
Sc Preamble Center Frequency Offset (Hz) [indx]	–10000 ... 10000 Hz	0 ... 99	The center frequency offset of the channel on which each preamble was detected.
Sc Preamble Cha-PI (Text) [indx]	Text	0 ... 99	For each preamble detected, a text string containing RF channel number and preamble index.
Sc Preamble Channel [indx]	0 ... 1580	0 ... 99	Channel number for each preamble detected.

IE Name	Range/Unit	Arg.	Description
Sc Preamble CINR (dB) [indx]	–37 ... 60 dB	0 ... 99	Carrier to interference-plus-noise ratio (CINR) for each preamble detected.
Sc Preamble CINR Mean (dB) [indx]	–37 ... 60 dB	0 ... 99	Running mean value of carrier to interference-plus-noise ratio (CINR) for each preamble detected.
Sc Preamble CINR Samples Taken [indx]	0 ... 32	0 ... 99	Number of samples used to calculate CINR statistics (mean, standard deviation).
Sc Preamble CINR Std. Dev. (dB) [indx]	–100 ... 60 dB	0 ... 99	Running standard deviation of carrier to interference-plus-noise ratio (CINR) for each preamble detected.
Sc Preamble Count	0 ... 100	–	The number of preambles detected.
Sc Preamble Index [indx]	0 ... 113	0 ... 99	Index of each detected preamble as defined in the tables in ▶ IEEE 802.16e, section 8.4.6.1.1.
Sc Preamble Operator ID [indx]	Text	0 ... 99	Operator ID for each detected preamble.
Sc Preamble Power (dBm) [indx]	–140 ... 20 dBm	0 ... 99	RSSI of each detected preamble.
Sc Preamble Profile (Text) [indx]	Text	0 ... 99	The WiMAX RF profile to which each detected preamble belongs.
Sc Preamble Sector ID [indx]	Text	0 ... 99	Sector ID for each detected preamble.
Sc Preamble Segment Index [indx]	0 ... 2	0 ... 99	Segment index for each detected preamble.

IE Name	Range/Unit	Arg.	Description
“Sc RSSI” IEs: General remark	These elements are obtained from RSSI scanning. The **argument**, where present, points to the position of the channel in the list of scanned channels.		
Sc RSSI (dBm)	–140 ... 20 dBm	0 ... 1499	RSSI for each scanned channel.
Sc RSSI Bandwidth (kHz)	Text	–	The bandwidth scanned around the center frequency of each channel.
Sc RSSI Channel	0 ... 1580	0 ... 1499	Channel number of each channel scanned. See ▶ WiMAX Forum Mobile System Profile version 1.4, table 130.
Sc RSSI Channel Count	0 ... 1500	–	The number of channels scanned.
Sc RSSI Frequency (MHz)	0 ... 6000 MHz	0 ... 1499	Frequency of each scanned channel.
Sc RSSI Profile (Text)	Text	0 ... 1499	The WiMAX RF Profile to which each scanned channel belongs.
“Sc Strongest Channel” IEs: General remark	Preamble scanning. Information element components sorted by decreasing channel RSSI. **Argument:** 1 = channel with highest RSSI, etc.		
Sc Strongest Channel	0 ... 1580	1 ... 32	RF channel number.
Sc Strongest Channel Profile (Text)	Text	1 ... 32	WiMAX RF Profile.
Sc Strongest Channel RSSI (dBm)	–140 ... 20 dBm	1 ... 32	Channel RSSI.
Sc Strongest Channel RSSI Mean (dBm)	–140 ... 20 dBm	1 ... 32	Running mean value of channel RSSI.

IE Name	Range/Unit	Arg.	Description
Sc Strongest Channel RSSI Samples Taken	–140 ... 20 dBm	1 ... 32	Number of samples used to calculate channel RSSI statistics (mean, standard deviation).
Sc Strongest Channel RSSI Std. Dev. (dB)	–200 ... 20 dB	1 ... 32	Running standard deviation of channel RSSI.
Sc Strongest Channel Segment 0 Power (dBm)	–140 ... 20 dBm	1 ... 32	The total power in the preamble subcarriers allocated to segment 0, gated during the preamble symbol time.
Sc Strongest Channel Segment 1 Power (dBm)	–140 ... 20 dBm	1 ... 32	The total power in the preamble subcarriers allocated to segment 1, gated during the preamble symbol time.
Sc Strongest Channel Segment 2 Power (dBm)	–140 ... 20 dBm	1 ... 32	The total power in the preamble subcarriers allocated to segment 2, gated during the preamble symbol time.
"Sc Strongest (CINR)" IEs: General remark	Preamble scanning. Information element components sorted by decreasing preamble CINR. **Argument:** 1 = preamble with highest CINR, etc.		
Sc Strongest (CINR) Cha-PI (Text)	Text	1 ... 32	Text string containing RF channel number and preamble index.
Sc Strongest (CINR) Channel	0 ... 1580	1 ... 32	RF channel number.
Sc Strongest (CINR) CINR	–37 ... 60 dB	1 ... 32	CINR.
Sc Strongest (CINR) Preamble Index	0 ... 113	1 ... 32	Preamble index.

IE Name	Range/Unit	Arg.	Description
"Sc Strongest RSSI" IEs: General remark	RSSI scanning. Information element components sorted by decreasing RSSI. **Argument:** 1 = channel with highest RSSI, etc.		
Sc Strongest RSSI (dBm)	–140 ... 20 dBm	1 ... 32	RSSI of each channel included in RSSI scan.
Sc Strongest RSSI Channel	0 ... 1580	1 ... 32	RF channel number of each RSSI scanned channel.
Sc Strongest RSSI Frequency (MHz)	0 ... 6000 MHz	1 ... 32	Frequency of each RSSI scanned channel.
Sc Strongest RSSI Profile (Text)	Text	1 ... 32	RF Profile to which each RSSI scanned channel belongs.
"Sc Strongest (Preamble Power)" IEs: General remark	Preamble scanning. Information element components sorted by decreasing preamble RSSI. **Argument:** 1 = preamble with highest RSSI, etc.		
Sc Strongest (Preamble Power) Cha-PI (Text)	Text	1 ... 32	Text string containing RF channel number and preamble index.
Sc Strongest (Preamble Power) Channel	0 ... 1580	1 ... 32	RF channel number.
Sc Strongest (Preamble Power) CINR	–37 ... 60 dB	1 ... 32	CINR.
Sc Strongest (Preamble Power) Preamble Index	0 ... 113	1 ... 32	Preamble index.

IE Name	Range/Unit	Arg.	Description
"Spectr Ana" IEs: General remark	These elements are populated by spectrum analysis scanning. The **argument**, where present, is simply a sequence number pointing to scanned frequencies as indicated by the "Spectr Ana Sc DL Freq (MHz)" element.		
Spectr Ana Sc DL Freq (MHz)	0 ... $6 \cdot 10^6$ MHz	1 ... 3001	Scanned frequencies on downlink in ascending order.
Spectr Ana Sc DL No Of Freq	0 ... 3001	–	The number of downlink frequencies swept by the scan.
Spectr Ana Sc DL RSSI (dBm)	–140 ... 20 dBm	1 ... 3001	RSSI of downlink frequencies scanned.
Speed (km/h)	0 ... 250 km/h	–	Speed in km/h.
Speed (mph)	0 ... 160 mph	–	Speed in mph.
Time	Text	–	Current time in text format: "hh:mm:ss.dd", where "dd" = decimal seconds.
Time (ms)	0 ... 86,400,000 ms (= 24 h)	–	Current time in ms.

3.7. Position Information Elements

3.7.1. General

These elements originate from positioning equipment. It should be noted that similar elements also appear in the various cellular technology categories.

3.7.2. Information Element Table

IE Name	Range/Unit	Arg.	Description
Altitude	–400 ... 8848 m	–	Height above sea level in meters.
GPS UTC Date	Text	–	UTC date from GPS.
GPS UTC Time	Text	–	UTC time from GPS.
Geographical Position	Text	–	Latitude, longitude, and altitude presented as string “Lat: <lat>, Lon: <lon>, Alt: <alt>”.
Heading	0 ... 360 degrees	–	Direction of travel measured in degrees clockwise from north.
Horizontal Dilution Of Precision	0 ... 100	–	Horizontal dilution of precision, HDOP, as defined in ▶ NMEA-0183.
Latitude	–90 ... 90 degrees	–	Latitude in degrees.
Longitude	–180 ... 180 degrees	–	Longitude in degrees.
Number Of Satellites	0 ... 12	–	Number of GPS satellites used to calculate position.
Position Fix Indicator	Text	–	Indicates type of fix (two- or three-dimensional).

IE Name	Range/Unit	Arg.	Description
Position Quality Indicator	Text	–	Indicates position quality, e.g.: GPS fix (SPS, Standard Positioning Service) Differential GPS fix (DGPS) PPS fix (Precise Positioning Service) Real Time Kinematic Estimated (dead reckoning) Manual input mode (set when pinpointing on map) Simulation mode Calculated value Interpolated
Positional Dilution Of Precision	0 ... 100	–	Positional dilution of precision, PDOP, as defined in ▶ NMEA-0183.
Speed	0 ... 360 km/h	–	Speed in km/h.
Vertical Dilution Of Precision	0 ... 100	–	Vertical dilution of precision, VDOP, as defined in ▶ NMEA-0183.

3.8. Data Service Testing Information Elements

3.8.1. General

This section lists the information elements in the **Data** category, i.e. those obtained when performing data service testing. The Data category contains the following kinds of elements:

- *Application-level data service measurements:* These reflect the performance experienced directly by the user of the service, as opposed to the performance at lower levels in the protocol hierarchy (RLC, LLC, RLP, etc.). The latter is indicated mostly by information elements in other categories such as **GSM** and **WCDMA**. Compare, however, the remaining bullets below.
- *Transport layer measurements:* UDP elements.
- *Link layer measurements.*

Throughput elements in the Data category are either *instantaneous* or *averages* taken over the entire duration of the network connection. These elements contrast with the throughputs reported in KPI events (see section 8.4), which are measured over the period defined in each KPI, as described in the Technical Reference, chapter 11. **All KPI data is furnished by these events; no KPIs are based on the information elements in the Data category.**

The Data category information elements are independent of the bearer service used (packet-switched or circuit-switched).

3.8.2. Updating of Data Service Testing IEs

The following applies:

1. General application throughput elements (those beginning with “Application Layer Throughput”) are updated once every second.
2. Instantaneous throughput elements for individual services apply to the latest reporting period, unless otherwise indicated.
3. Transfer times indicate elapsed time for a currently active data transfer (e.g. an FTP download). They are incremented every second and are reset after the data transfer has concluded.
4. Unless otherwise indicated, average throughputs, byte counts, and all percentages apply to the period following the latest network connect

(triggering of Network Connect event) and are reset at network disconnect (when the Network Disconnect activity has completed).

3.8.3. Information Element Table

IE Name	Range/Unit	Arg.	Description
ABM (Available Bandwidth Measurement) IEs: Test setup in UM section 12.20.3.10 The **argument** points to an ABM server. Each of arguments 1 ... 4 represents a fixed server, while argument 0 points to the server for which values were last reported. All numeric ABM IEs are updated for each new ABM pulse train, which means once every second.			
ABM Downlink Trip Time	0 ... 10000 ms	0 ... 4	Average time taken by ABM packets to travel from the ABM server to the UE.
ABM Packet Loss Downlink	0 ... 100 %	0 ... 4	Percentage of ABM packets that were lost on the way from the ABM server to the UE.
ABM Packet Loss Uplink	0 ... 100 %	0 ... 4	Percentage of ABM packets that were lost on the way from the UE to the ABM server.
ABM Round Trip Time	0 ... 20000 ms	0 ... 4	Average time taken by ABM packets to travel from the UE to the ABM server and back.
ABM Server	Text	0 ... 4 (see Descr.)	IP address of ABM server. **Note:** Argument 0 is not valid for this element.
ABM Through-put Downlink (kbit/s)	0 ... 350000 kbit/s	0 ... 4	Throughput achieved when sending ABM packets from the ABM server to the UE.
ABM Throughput Uplink (kbit/s)	0 ... 350000 kbit/s	0 ... 4	Throughput achieved when sending ABM packets from the UE to the ABM server.
ABM Uplink Trip Time	0 ... 10000 ms	0 ... 4	Average time taken by ABM packets to travel from the UE to the ABM server.

IE Name	Range/Unit	Arg.	Description
AMR codec IEs			
AMR Codec Usage Downlink	0 ... 100 %	1 ... 17	AMR codec usage on downlink for VoIP. Same structure and argument meanings as for the WCDMA element AMR Codec Usage (DL).
AMR Codec Usage Uplink	0 ... 100 %	1 ... 17	AMR codec usage on uplink for VoIP. Same structure and argument meanings as for the WCDMA element AMR Codec Usage (UL).
Application layer IEs: See also section 6.1.			
Application Layer Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received at the application level since network connect. Login information is included in this byte count.
Application Layer Sent	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes sent at the application level since network connect, including login information.
Application Layer Throughput Downlink	0 ... 350000 kbit/s	–	Current throughput for data received at the application level.
Application Layer Throughput Uplink	0 ... 350000 kbit/s	–	Current throughput for data sent at the application level.
Connection IEs			
Connection Duration	Text hh:mm:ss	–	Time since network connect. Given in hours, minutes, and seconds.
Email receive IEs: Test setup in UM section 12.20.4.2			
Email Receive Average Throughput	0 ... 350000 kbit/s	–	Average throughput for receiving of email.
Email Receive Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received over email.

IE Name	Range/Unit	Arg.	Description
Email Receive Throughput	0 ... 350000 kbit/s	–	Instantaneous email receive throughput.
Email Receive Transfer Time	0 ... 172800 s (= 48 h)	–	Elapsed time for current email receive session.
Email send IEs: Test setup in UM section 12.20.4.1			
Email Send Average Throughput	0 ... 350000 kbit/s	–	Average throughput for sending of email.
Email Send Sent	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes sent over email.
Email Send Throughput	0 ... 350000 kbit/s	–	Instantaneous email send throughput.
Email Send Transfer Time	0 ... 172800 s	–	Elapsed time for current email send session.
FTP download IEs: Test setup in UM section 12.20.3.11			
FTP Download Average Throughput	0 ... 350000 kbit/s	–	Average throughput for FTP download.
FTP Download Data Transfer Cut-off Ratio	0 ... 100 %	–	Percentage of FTP downloads that could not be completed although they were started successfully.
FTP Download IP Service Access Failure Ratio	0 ... 100 %	–	Percentage of FTP download attempts where, after successful PDP context activation, the FTP service itself could not be accessed. (This IE is meaningful only for UMTS.)
FTP Download Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received over FTP.

IE Name	Range/Unit	Arg.	Description
FTP Download Service Non-Accessibility	0 ... 100 %	–	Percentage of FTP download attempts where the FTP service could not be accessed, due to a failure that occurred either during PDP context activation or during the service access procedure itself. (This IE is meaningful only for UMTS.)
FTP Download Throughput	0 ... 350000 kbit/s	–	Instantaneous FTP download throughput.
FTP Download Transfer Time	0 ... 172800 s	–	Elapsed time for current FTP download session.
FTP upload IEs: Test setup in UM section 12.20.3.12			
FTP Upload Average Throughput	0 ... 350000 kbit/s	–	Average throughput for FTP upload.
FTP Upload Data Transfer Cut-off Ratio	0 ... 100 %	–	Percentage of FTP uploads that could not be completed although they were started successfully.
FTP Upload IP Service Access Failure Ratio	0 ... 100 %	–	Percentage of FTP upload attempts where, after successful PDP context activation, the FTP service itself could not be accessed. (This IE is meaningful only for UMTS.)
FTP Upload Sent	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes sent over FTP.
FTP Upload Service Non-Accessibility	0 ... 100 %	–	Percentage of FTP upload attempts where the FTP service could not be accessed, due to a failure that occurred either during PDP context activation or during the service access procedure itself. (This IE is meaningful only for UMTS.)
FTP Upload Throughput	0 ... 350000 kbit/s	–	Instantaneous FTP upload throughput.
FTP Upload Transfer Time	0 ... 172800 s	–	Elapsed time for current FTP upload session.

IE Name	Range/Unit	Arg.	Description
HTTP Get IEs: Test setup in UM section 12.20.3.13			
HTTP Average Throughput	0 ... 350000 kbit/s	–	Average throughput for HTTP download.
HTTP Data Transfer Cut-off Ratio	0 ... 100 %	–	Percentage of HTTP downloads that could not be completed although they were started successfully.
HTTP IP Service Access Failure Ratio	0 ... 100 %	–	Percentage of HTTP download attempts where, after successful PDP context activation, the HTTP service itself could not be accessed. (This IE is meaningful only for UMTS.)
HTTP Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received over HTTP.
HTTP Service Non-Accessibility	0 ... 100 %	–	Percentage of HTTP download attempts where the HTTP service could not be accessed, due to a failure that occurred either during PDP context activation or during the service access procedure itself. (This IE is meaningful only for UMTS.)
HTTP Throughput	0 ... 350000 kbit/s	–	Instantaneous HTTP download throughput.
HTTP Transfer Time	0 ... 172800 s	–	Elapsed time for current HTTP download session.
HTTP Post IEs: Test setup in UM section 12.20.3.14			
HTTP Post Average Throughput	0 ... 350000 kbit/s	–	Average throughput for HTTP upload.
HTTP Post File Size Sent	0 ... $2 \cdot 10^6$ kbyte	–	Size of file uploaded over HTTP.
HTTP Post File Transfer Time	0 ... 172800 s	–	Time taken by the browser to complete the HTTP upload.
HTTP Post Throughput	0 ... 350000 kbit/s	–	Instantaneous HTTP upload throughput.

IE Name	Range/Unit	Arg.	Description
Link layer IEs			
Link Layer Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received in the link layer.
Link Layer Sent	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes sent in the link layer.
Link Layer Throughput Downlink	0 ... 350000 kbit/s	–	Instantaneous link layer downlink throughput.
Link Layer Throughput Uplink	0 ... 350000 kbit/s	–	Instantaneous link layer uplink throughput.
Local IP address IEs			
Local IP Address	Text	–	Local IP address assigned to device.
MMS receive IEs: Test setup in UM section 12.20.4.4			
MMS Retrieval Failure Ratio	0 ... 100 %	–	Percentage of MMS messages that could not be downloaded by the receiving party's device, although the latter did receive an MMS notification.
MMS send IEs: Test setup in UM section 12.20.4.3			
MMS Send Failure Ratio	0 ... 100 %	–	Percentage of MMS message send attempts that failed.
Social network testing IEs: Test setup in UM section 12.20.3.20			
Social Network Logon Attempt Count	0 ... 100	–	Number of attempts made to log on to the social network.
Social Network Logon Success Count	0 ... 100	–	Number of successful logons to the social network.
Social Network Weibo Attempt Count	0 ... 100	–	Number of Weibo status updates posted.

IE Name	Range/Unit	Arg.	Description
Social Network Weibo Success Count	0 ... 100	–	Number of successful Weibo test cycles, where the master successfully posted a status update and the slave successfully downloaded the update, responding with an “all OK” comment to acknowledge this fact.
Social Network Weibo Failure Count	0 ... 100	–	Number of failed Weibo test cycles. Two cases: 1) The master’s status update post failed; 2) The master’s status update post succeeded, but the slave failed to download it and responded with an “error” comment to report this.
Social Network Weibo Timeout Count	0 ... 100	–	Number of Weibo test cycles that timed out. This means that the master successfully posted a status update, but the slave did not return any comment on the update within 20 s of its being posted.
Social Network Weibo Total Duration	0 ... 172,800,000 ms (= 48 h)	–	Total duration of all successful Weibo test cycles added together.

IE Name	Range/Unit	Arg.	Description
Streaming IEs: Test setup in UM sections 12.20.6.4, 12.20.6.5 Most of these are valid for HTTP streaming only, while a smaller set is valid for RTP streaming only. The latter set is tagged with "**RTP**" in the list that follows. IEs that are updated for both types of streaming are tagged "**RTP and HTTP**". HTTP-only IEs are left untagged. Player session related IEs are updated once when the SWF player has finished loading. Streaming session metrics are updated for each new set of intermediate scores that is output from VQmon, provided that the video buffering proceeds successfully. (If the player is unable to buffer any video, VQmon will not produce any results.) All HTTP streaming IEs are reset at the start of a new streaming session. For more detail on certain HTTP streaming metrics, see UM chapter 46. Regarding limitations on the population of HTTP streaming IEs, see section 6.3.			
Streaming Absolute MOS-V	0 ... 5 MOS	–	Average absolute video MOS for the stream. Regarding "absolute", see UM section 46.1.1.
Streaming Audio Bit Rate	0 ... 350000 kbit/s	–	Bit rate at which the audio is intended to be replayed.
Streaming Audio Codec Type	Text	–	Audio codec type used for the audio stream: e.g. "MPEG-4 AAC", "AC-3".
Streaming Audio Packet Corrected Rate	0 ... 100 %	–	Percentage of audio packets received with errors, but corrected using error correction algorithms.
Streaming Audio Packet Discarded Rate	0 ... 100 %	–	Percentage of audio packets discarded by the receiving jitter buffer.
Streaming Audio Packet Out Of Sequence Rate	0 ... 100 %	–	Percentage of audio packets identified as out-of-sequence, possibly due to high jitter levels or the use of load-sharing devices.
Streaming Audio Stream Count	Text	–	Same as Streaming Video Stream Count.

IE Name	Range/Unit	Arg.	Description
Streaming Average Audio Effective Packet Loss Rate	0 ... 100 %	–	Percentage of audio packets lost or discarded (minus those corrected).
Streaming Average Audio Received Bandwidth	0 ... 350000 kbit/s	–	Average audio bandwidth excluding transport packet overhead, FEC, and retransmissions.
Streaming Average Video Effective Packet Loss Rate	0 ... 100 %	–	Percentage of video packets lost or discarded (minus those corrected).
Streaming Average Video Received Bandwidth	0 ... 350000 kbit/s	–	Average bandwidth for video transport packets, excluding IP overhead, FEC, and retransmissions.
Streaming Bit Rate Change	Text	–	Number of video codec bit rate changes that have occurred.
Streaming Duration	0 ... 172800 s	–	Elapsed time for current streaming session. **RTP**
Streaming Effective Throughput	0 ... 350000 kbit/s	–	Throughput excluding duplicate packets.
Streaming Frame Height	Text	–	Image height in pixels.
Streaming Frame Rate	Text	–	Video frame rate, given as number of frames per 1000 seconds (e.g. “29,970” equaling 29.97 frames per second).
Streaming Frame Width	Text	–	Image width in pixels.
Streaming GOP Length	Text	–	Number of frames in a Group of Pictures.

IE Name	Range/Unit	Arg.	Description
Streaming Instantaneous Absolute MOS-V	0 ... 5 MOS	–	Instantaneous absolute video MOS for the stream. Regarding “absolute”, see UM section 46.1.1.
Streaming Instantaneous MOS-A	0 ... 5 MOS	–	Instantaneous absolute audio MOS for the stream.
Streaming Instantaneous MOS-AV	0 ... 5 MOS	–	Instantaneous absolute audio–video MOS for the stream.
Streaming Instantaneous Relative MOS-V	0 ... 5 MOS	–	Instantaneous relative video MOS for the stream. Regarding “relative”, see UM section 46.1.1.
Streaming MOS-A	0 ... 5 MOS	–	Average audio MOS for the stream.
Streaming MOS-AV	0 ... 5 MOS	–	Average audio–video MOS for the stream.
Streaming MTQI	0 ... 5 MOS	–	Mobile TV quality index for streaming. Realtime score which is regularly updated during the streaming session. See UM chapter 45. **RTP**
Streaming Packet Loss	0 ... 100 %	–	Percentage of streaming packets that were lost. **RTP**
Streaming Player Download Data Transfer Failure Ratio	0 ... 100 %	–	Percentage of attempts to download the streaming player that failed at the data transfer stage (after receipt of first packet and before receipt of last packet).
Streaming Player Download Data Transfer Time	0 ... 172800 s	–	Time taken to download the streaming player (from receipt of first packet to receipt of last packet).

IE Name	Range/Unit	Arg.	Description
Streaming Player Service IP Access Failure Ratio	0 ... 100 %	–	Percentage of attempts to download the streaming player that failed before the first packet of the download was received (IP access failure).
Streaming Player Service IP Access Time	0 ... 172800 s	–	Time taken for IP access when downloading the streaming player (from user request to receipt of first packet).
Streaming Player Session Failure Ratio	0 ... 100 %	–	Percentage of attempts to download the streaming player that failed at some stage (IP access or data transfer).
Streaming Player Session Time	0 ... 172800 s	–	Total session time for streaming player download (from user request to receipt of last packet).
Streaming Playout Buffer Delta Rate	0 ... 350000 kbit/s	–	Equal to Streaming Playout Buffer Empty Rate minus Streaming Playout Buffer Fill Rate.
Streaming Playout Buffer Empty Proportion	0 ... 100 %	–	Percentage of the total session time during which the playout buffer was empty.
Streaming Playout Buffer Empty Rate	0 ... 350000 kbit/s	–	Rate at which data is emptied from the streaming player's playout buffer.
Streaming Playout Buffer Fill Rate	0 ... 350000 kbit/s	–	Rate at which the streaming player's playout buffer is filled with new data.
Streaming Playout Buffer Rebuffering Proportion	0 ... 100 %	–	Percentage of the total session time that was spent rebuffering.
Streaming Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received over a streaming connection. **RTP**

IE Name	Range/Unit	Arg.	Description
Streaming Relative MOS-V	0 ... 5 MOS	–	Average relative video MOS for the stream. Regarding “relative”, see UM section 46.1.1.
Streaming Reproduction Cut-off Ratio	0 ... 100 %	–	Percentage of successfully started stream reproductions that were ended by a cause other than intentional termination by the user. **RTP**
Streaming Reproduction Start Failure Ratio	0 ... 100 %	–	Percentage of unsuccessful stream reproductions. **RTP**
Streaming Service Non-Accessibility	0 ... 100 %	–	Percentage of instances where the first RTP data packet of the stream could not be received by the device when requested by the user. **RTP**
Streaming TCP Window Size	0 ... $2 \cdot 10^6$ byte	–	TCP window size used in the streaming session.
Streaming Throughput (kbit/s)	0 ... 350000 kbit/s	–	Instantaneous streaming throughput. **RTP and HTTP**
Streaming VSQI	0 ... 5 MOS	–	Video Streaming Quality Index (realtime score which is regularly updated during the streaming session, unlike the overall VSQI score for an entire session, which is indicated by the event Streaming Quality VSQI). See UM chapter 44. **RTP**
Streaming VSTQ	Text	–	Video Service Transmission Quality score. See UM section 46.2.
Streaming Video Bit Rate	0 ... 350000 kbit/s	–	Same as Streaming Playout Buffer Empty Rate.
Streaming Video Codec Type	Text	–	Video codec type used for the audio stream: e.g., “MPEG-2”, “H.264”.

IE Name	Range/Unit	Arg.	Description
Streaming Video Inter-ruption Count	Text	–	Number of times the video stream replay was interrupted for rebuffering.
Streaming Video Interruption Duration	0 ... 172800 s	–	Total duration of video stream replay interruptions for reasons of rebuffering.
Streaming Video Packet Corrected Rate	0 ... 100 %	–	Percentage of video packets received with errors, but corrected using error correction algorithms.
Streaming Video Packet Discarded Rate	0 ... 100 %	–	Percentage of video packets discarded by the receiving jitter buffer.
Streaming Video Packet Out Of Sequence Rate	0 ... 100 %	–	Percentage of video packets identified as out-of-sequence, possibly due to high jitter levels or the use of load-sharing devices.
Streaming Video Play Start Failure Ratio	0 ... 100 %	–	Percentage of attempts to start streaming video replay that failed (playing never started).
Streaming Video Play Start Time	0 ... 172800 s	–	Time from user video replay request until playing started.
Streaming Video Session Failure Ratio	0 ... 100 %	–	Percentage of streaming video replay session that failed at some point before the last video packet was received.
Streaming Video Session Time	0 ... 172800 s	–	Total time of streaming video replay session from user request to receipt of last video packet.
Streaming Video Stream Count	Text	–	Number of “chunks” or file segments in the video stream.

IE Name	Range/Unit	Arg.	Description
TCP download IEs: Test setup in UM section 12.20.3.19			
TCP Download Average Throughput (kbit/s)	0 ... 350000 kbit/s	–	Average throughput for TCP download.
TCP Download Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received over TCP.
TCP Download Throughput (kbit/s)	0 ... 350000 kbit/s	–	Instantaneous TCP download throughput. See also section 6.2.
TCP Download Transfer Time	0 ... 172800 s	–	Elapsed time for current TCP download session.
TCP Packet Loss	0 ... 100 %	–	Retransmissions (in percent) on the downlink over the TCP protocol during the last second. **Note:** For this percentage to be correct, IP sniffing must not be set to “Optimized Performance”. See UM section 12.20.3.8.
TCP upload IEs: Test setup in UM section 12.20.3.19			
TCP Upload Average Throughput (kbit/s)	0 ... 350000 kbit/s	–	Average throughput for TCP upload.
TCP Upload Sent	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes sent over TCP.
TCP Upload Throughput (kbit/s)	0 ... 350000 kbit/s	–	Instantaneous TCP upload throughput. See also section 6.2.
TCP Upload Transfer Time	0 ... 172800 s	–	Elapsed time for current TCP upload session.

IE Name	Range/Unit	Arg.	Description
UDP download IEs: Test setup in UM sections 12.20.3.18, 12.20.3.19			
UDP Download Average Throughput	0 ... 350000 kbit/s	–	Average throughput for UDP download.
UDP Download Jitter	Text	–	UDP jitter: the mean deviation (in ms) of the difference in packet spacing at the receiver compared to the sender, for a pair of packets.
UDP Download Packet Loss	0 ... 100 %	–	Retransmissions (in percent) on the downlink over the UDP protocol. For the UDP activity, this measurement is obtained once for each session, at the end of the session. For the Network Bandwidth (Iperf Testing) activity, this measurement is obtained once every second.
UDP Download Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received over UDP.
UDP Download Throughput	0 ... 350000 kbit/s	–	Instantaneous UDP download throughput. See also section 6.2.
UDP Download Transfer Time	0 ... 172800 s	–	Elapsed time for current UDP download session.
UDP upload IEs: Test setup in UM sections 12.20.3.18, 12.20.3.19			
UDP Upload Average Throughput	0 ... 350000 kbit/s	–	Average throughput for UDP upload.
UDP Upload Sent	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes sent over UDP.
UDP Upload Throughput	0 ... 350000 kbit/s	–	Instantaneous UDP upload throughput. See also section 6.2.
UDP Upload Transfer Time	0 ... 172800 s	–	Elapsed time for current UDP upload session.

IE Name	Range/Unit	Arg.	Description
UTRAN speech codec IEs			
UTRAN Speech Codec	Text	–	Currently used speech codec in a VoIP call taking place in UTRAN.
VoIP IEs: For VoIP speech quality IEs, see the Media Quality category, section 3.9. Test setup in UM sections 12.20.7.1–12.20.7.5			
VoIP Decoding Errors (%)	0 ... 100 %	–	Percentage of VoIP audio frames that could not be decoded by the speech codec. Updated once every second.
VoIP FER Combined Packet Loss (%)	0 ... 100 %	–	VoIP: Total percentage of packet loss that affects the reproduction of the audio. Encompasses decoding errors, underruns, and jitter buffer size increases. Should in general correlate closely to PESQ and POLQA. Updated once every second.
VoIP Jitter Buffer Lost Packets (%)	0 ... 100 %	–	VoIP: Percentage of packets that were missing from the audio reproduction because they were not delivered from the jitter buffer to the decoder in timely fashion. Note that the packet need not have been lost on the way to the receiving party; it may just have been delayed too long, so that it was discarded by the jitter buffer. Updated once every second.
VoIP Jitter Buffer Overruns (%)	0 ... 100 %	–	VoIP: Percentage of audio frames with overruns. The VoIP client tries to keep the delays caused by the jitter buffer reasonably low. When the client decides the buffer is too long, it will throw away received packets to decrease the buffer size. This is referred to as overruns, and it affects the audio reproduction. Updated once every second.

IE Name	Range/Unit	Arg.	Description
VoIP Jitter Buffer Playout Delay Average (ms)	0 ... 172800 ms	–	VoIP: Average playout delay in ms: that is, the average time the voice packets were held by the jitter buffer. Updated once every second.
VoIP Jitter Buffer Playout Delay Maximum (ms)	0 ... 172800 ms	–	VoIP: Maximum playout delay in ms. Updated once every second.
VoIP Jitter Buffer Playout Delay Minimum (ms)	0 ... 172800 ms	–	VoIP: Minimum playout delay in ms. Updated once every second.
VoIP Jitter Buffer Size Increase (%)	0 ... 100 %	–	Percentage of audio frames where the VoIP client decided to increase the jitter buffer size (because the jitter was found to be too high). This procedure results in a period of silence in the audio reproduction as the jitter buffer accumulates packets without releasing any. Updated once every second.
VoIP Jitter Buffer Underruns (%)	0 ... 100 %	–	VoIP: Percentage of audio frames where the jitter buffer was empty and had no packets to deliver to the speech decoder. Updated once every second.
VoIP RFC 1889 Jitter (ms)	0 ... 172800 ms	–	VoIP: Packet jitter or delay variation as defined in ▶ IETF RFC 1889, section 6.3.1. A smoothed value is presented which is updated once every second.
VoIP Speech Codec	Text	–	VoIP: Speech codec selected for the VoIP client in the governing script (see UM sections 12.20.7.1, 12.20.7.2).
WAP IEs: Test setup in UM section 12.20.3.15			
WAP Activation Failure Ratio	0 ... 100 %	–	Percentage of instances where the WAP session could not be activated.

IE Name	Range/Unit	Arg.	Description
WAP Average Throughput	0 ... 350000 kbit/s	–	Average throughput for WAP download.
WAP Page Data Transfer Cut-off Ratio	0 ... 100 %	–	Percentage of WAP page downloads that could not be completed although they were started successfully.
WAP Page Request Failure Ratio	0 ... 100 %	–	Percentage of WAP page requests that were unsuccessful.
WAP Received	0 ... $2 \cdot 10^6$ kbyte	–	Number of bytes received over WAP.
WAP Throughput	0 ... 350000 kbit/s	–	Instantaneous WAP download throughput.
WAP Transfer Time	0 ... 172800 s	–	Elapsed time for current WAP download session.

3.9. Media Quality Information Elements

3.9.1. General

This category holds information elements related to quality measurement for various media.

Currently, this category is limited to AQM (PESQ/POLQA with ancillary data such as volume measurements). It does not incorporate quality measures that are not produced in connection with AQM, such as SQI.

It is useful to recapitulate the meaning of the “uplink” elements:

- In the ACU R2 setup, the uplink elements are populated in the mobile-to-fixed configuration, where they are calculated by the CallGenerator. In the other configurations, the uplink elements are not populated; but the uplink measurements are identical to the downlink measurements for the other phone in the pair.
- In the ACU TerraTec setup, the uplink elements are populated with copies of the downlink measurements for the other phone in the pair.
- In the AQM module based setup, uplink measurements are those performed by the CallGenerator. If an MRU is used instead, no uplink measurements are made, and the uplink information elements are not populated.
- In the VoIP setups and in on-device measurement regardless of bearer, uplink measurements do not exist, and the uplink information elements are not populated.

3.9.2. Information Element Table

IE Name	Range/Unit	Arg.	Description
AQM Algorithm Downlink	Text	–	AQM algorithm used to produce downlink speech quality scores. One of “PESQ”, “P.OLQA NB”, “P.OLQA SWB”.
AQM Algorithm Uplink	Text	–	AQM algorithm used to produce uplink speech quality scores.

IE Name	Range/Unit	Arg.	Description
AQM Audio Channel Type Downlink	Text	–	Type of audio channel used for the speech serving as input to downlink AQM: "CS" or "IP".
AQM Echo Attenuation	0 ... 100 dB	–	Echo attenuation on downlink.
AQM Echo Correlation	0 ... 5	–	Echo correlation on downlink.
AQM Echo Delay	0 ... 1000 ms	–	Echo delay on downlink.
AQM Echo Power	0 ... 100 dB	–	Echo power on downlink.
AQM Sentence Downlink	Text	–	Name of audio file containing the downlink AQM sentence.
AQM Sentence Uplink	Text	–	Name of audio file containing the uplink AQM sentence.
AQM Source Downlink	Text	–	Source of the audio input to downlink AQM, for example: "ACU R2", "Terratec", "F3607", "PJSIP", "ODM".
AQM Source Uplink	Text	–	Source of the audio input to uplink AQM.
AQM Volume Downlink	–100 ... 20 dB	–	Volume on downlink. Obtained with PESQ only.
AQM Volume Uplink	–100 ... 20 dB	–	Volume on uplink. Obtained with PESQ only.
Frequent AQM IEs: General remark	When a mobile-to-fixed configuration is used, these elements (uplink *and downlink* scores) only appear in merged logfiles; see UM section 10.7.		
Frequent AQM Score Downlink	1 ... 5 MOS	–	Frequent AQM score for last speech sentence played on the downlink.
Frequent AQM Score Uplink	1 ... 5 MOS	–	Frequent AQM score for last speech sentence played on the uplink.

IE Name	Range/Unit	Arg.	Description
PESQ and POLQA IEs: General remark	The **argument** has the following significance: 0: The score is updated independently of AQM Audio Channel Type Downlink. 1: The score is updated only if the audio channel type is CS. 2: The score is updated only if the audio channel type is IP. The update interval is 11 s.		
PESQ Score Downlink	1 ... 5 MOS	0 ... 2	Downlink PESQ score.
PESQ Score Uplink	1 ... 5 MOS	0 ... 2	Uplink PESQ score.
POLQA NB Score Downlink	1 ... 5 MOS	0 ... 2	Downlink POLQA score for narrowband speech.
POLQA NB Score Uplink	1 ... 5 MOS	0 ... 2	Uplink POLQA score for narrowband speech.
POLQA SWB Score Downlink	1 ... 5 MOS	0 ... 2	Downlink POLQA score for super-wideband speech.
POLQA SWB Score Uplink	1 ... 5 MOS	0 ... 2	Uplink POLQA score for super-wideband speech.
Speech Interruption Downlink	Text	–	Indicates silence on the downlink when speech should be present by the value “Silence detected”. When speech is transmitted normally, the value is “Voice detected”.
Speech Path Delay (RTT)	–2000 ... 2000 ms	–	The length of time it takes for the speech to travel from the receiving party to the calling party (this device) and back to the receiving party again. In a mobile-to-mobile configuration, this element is obtained on the MT side. In a mobile-to-fixed configuration, the element is calculated by the CallGenerator and only appears in merged logfiles (see UM section 10.7).

3.10. Uplink (MTR) Information Elements

3.10.1. General

This section lists the information elements in the **GSM Uplink** category. These originate from MTR (Mobile Traffic Recording) files, which can be recorded in GSM cellular networks using infrastructure from Ericsson and contain event data produced in the Base Station Controller (BSC), as well as measurement data from the BTS and from the mobile device itself.

Pre-14.0 versions of TEMS Investigation had a function for merging MTR data into TEMS Investigation logfiles. This function has been removed, but the GSM Uplink information elements are retained to preserve compatibility.

The GSM Uplink category includes further elements besides those listed, including RxLev and RxQual (Full and Sub) for both uplink and downlink. All such elements have precisely the same ranges and meanings as the corresponding elements in section 3.1, and so they have been omitted here.

No uplink information elements are valid when running GPRS/EGPRS.

3.10.2. Information Element Table

IE Name	Range/Unit	Arg.	Description
BCCH Allocation Used	Text	–	BCCH Allocation (BS) list currently used by the mobile device.
DTX DL Used	Text: “YES”/“NO”	–	Use of DTX on downlink.
DTX UL Used	Text: “YES”/“NO”	–	Use of DTX on uplink.
Neighbor CI	0 ... 65535	1 ... 6	Cell Identity of neighbor cell. **Argument:** Indicates neighbor ranking: 1 gives the neighbor with the highest rank, etc.

IE Name	Range/Unit	Arg.	Description
Neighbor Ranking Type	Text	1 ... 6	Indicates the algorithm used to compute the ranking value. One of: "Undefined", "K-value", "L-value", "High signal cell", "Low signal cell". **Argument:** Indicates neighbor ranking: 1 gives the neighbor with the highest rank, etc.
Neighbor Ranking Value	–127 ... 128	1 ... 6	This value is usually negative. A higher value means a higher ranking. If a ranking value of a neighbor becomes positive, this neighbor probably soon will become the serving cell. **Argument:** Indicates neighbor ranking: 1 gives the neighbor with the highest rank, etc.
Path Loss Full	47 ... 190 dB	–	Pathloss, Full value.
Path Loss Sub	47 ... 190 dB	–	Pathloss, Sub value.
Power Level BS	0 ... 15 See Description	–	Base station transmit power. Regarding the value range, see ▶ 3GPP 45.005, section 4.1.2. Valid only in dedicated mode.
Power Level MS	0 ... 31 See Description	–	Mobile device transmit power (compare MS Power Control Level in section 3.1). Regarding the value range, see ▶ 3GPP 45.005, section 4.1.1. Valid only in dedicated mode.
Power Level MS (dBm)	0 ... 31 dBm		Mobile device transmit power in dBm (compare MS Tx Power (dBm) in section 3.1). Valid only in dedicated mode.
SQI	–40 ... 50 dBQ	–	Uplink Speech Quality Index.

IE Name	Range/Unit	Arg.	Description
TA Actual	0 ... 219 See Description	–	Extended Timing Advance. Valid only in dedicated mode. For the significance of the parameter value, see ▶ 3GPP 45.010.

3.11. Wi-Fi Information Elements

3.11.1. General

This category contains information elements derived from Wi-Fi measurements in TEMS Investigation or from Wi-Fi scanning recorded in TEMS Pocket logfiles.

The **argument**, where present, points to one Wi-Fi access point (with its unique BSSID) among those detected.

3.11.2. Information Element Table

IE Name	Range/Unit	Arg.	Description
BSSID	Text	1 ... 32	MAC address of Wi-Fi access point, given in hexadecimal format: "12:34:56:78:90:ab".
Capabilities	Text	1 ... 32	This element usually indicates the security protocol setting in the Wi-Fi network, e.g. "WPA-PSK-CCMP".
Channel	1 ... 196	1 ... 32	Channel number according to ► IEEE 802.11b/g/n.
Frequency	0 ... 6000 MHz	1 ... 32	Channel center frequency.
Link Speed	0 ... $1 \cdot 10^6$ kbit/s	–	Maximum speed (as dictated by network settings) of the currently serving Wi-Fi access point.
RSSI	–120 ... 0 dBm	1 ... 32	Received Signal Strength.
SSID	Text	1 ... 32	Name of Wi-Fi network.

4. Information Element Support in Devices

This chapter details which devices support which information elements, for all cellular technologies where this is non-trivial.

Elements derived from positioning equipment are not included in the tables.

In the Information Elements column, <*string*>* means all IEs beginning with <*string*>. The asterisk (*) sometimes appears as a wildcard also in other positions.

A *gray* checkmark means that the IE support is restricted to a subset of the devices in the column, or that only part of the IE data is obtained for these devices. See the accompanying footnote for details.

The tables include certain devices/chipsets that are no longer connectable in this version of TEMS Investigation; these are printed in non-boldface. They are retained here since old logfiles recorded with the devices in question can still be loaded in the application. There also exist information elements which are unique to one or more of these devices.

4.1. GSM Information Elements

- Sony Ericsson Xperia arc and X10 are covered by the Qualcomm “HSPA, HSPA+” column.
- Sony Ericsson Xperia arc S LT18a/i and Sony Xperia V LT25i, Xperia T LT30a have their own column under “Sony/Sony Er.”.
- The “Sony/Sony Er.” column containing W995 is also valid for TM506 and W760i as well as for Samsung Galaxy S 4G and Infuse 4G, except where otherwise noted.
- Scanning elements supported by the SRU are the same as those supported by the Sony Ericsson W995 phones.
- The Nokia column containing C5/C7 is also valid for N75, N80, 6720, 7376.

Information Elements	Sony/Sony Er.					Motorola			Nokia			Qualc.			D.	Sc
	Xperia arc S, LT25i, LT30a	**W995, C905, C702, Z750i**	**K600i, K800i**	**W600i, K790**	V800, Z800	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	A835, A845	**C5/C7, 6120/6121, N95/N96**	6086, 6125, 6230/6230i, 6280	6630, 6680	**HSPA, HSPA+**	**HSDPA**	WCDMA	**Datang LC8130E**	**PCTel Scanners**
Adjacent RxLev*		✓	✓	✓												
Adjacent Scan		✓	✓	✓												
AMR Active Set*	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓		
AMR C/I*		✓	✓	✓												
AMR Codec*	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓		
AMR Hysteresis	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓		
AMR Threshold	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓		
ARFCN TCH	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
ARFCN *(others)*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Attach Time	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Band Control	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
BER*		✓	✓	✓												
BLER/Timeslot		✓	✓	✓												
BSIC* [1]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
C Value	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		
C/A* [2]		✓	✓	✓												
C/I Absolute, Best, Best: ARFCN, Worst, Worst: ARFCN [3 4 5]	✓	✓	✓	✓					✓	✓	✓					
C/I* *(others)* [4 5]	✓	✓	✓	✓												
C1	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
C2	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
C31	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓		
C32	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓		
Cell EGPRS Support		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Cell GPRS Support		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Cell Id*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Cell Name*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CGI*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Channel*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Ciphering Algorithm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

Information Elements	Sony/Sony Er.					Motorola			Nokia			Qualc.			D.	Sc
	Xperia arc S, LT25i, LT30a	**W995, C905, C702, Z750i**	**K600i, K800i**	**W600i, K790**	V800, Z800	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	A835, A845	**C5/C7, 6120/6121, N95/N96**	6086, 6125, 6230/6230i, 6280	6630, 6680	**HSPA, HSPA+**	**HSDPA**	WCDMA	**Datang LC8130E**	**PCTel Scanners**
Coding Scheme DL	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓			
Coding Scheme UL	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
CS-* DL Usage...	✓	✓	✓	✓		✓						✓	✓			
Current CS*	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
Current MCS*		✓		✓					✓	✓	✓					
Data Mode*	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		
Disable Handover [6]		✓														
Downlink Sign. Ctr Curr.		✓	✓	✓	✓				✓	✓	✓				✓	
Downlink Sign. Ctr Max		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
DTX Rate DL		✓	✓	✓												
EGPRS BEP (*)		✓		✓					✓	✓	✓					
EGPRS BEP Total (*)		✓		✓												
EGPRS Link Q. Ctrl UL		✓		✓					✓	✓	✓					
EGPRS Window Size*	✓	✓		✓		✓			✓	✓	✓	✓	✓			
FER*		✓	✓	✓					✓	✓	✓					
Firmware Version	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Frequency Band*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
GA-RC*, GAN*, GANC* [7]										✓						
GMM State		✓	✓	✓	✓				✓	✓	✓					
GRR State	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Hardware	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hardware ID	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hopping*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
HSN	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Ignore Cell Barred	✓	✓	✓	✓					✓	✓	✓					
Interference*																
Internal GPS* [8]		✓														
LAC*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
LLC BLER DL		✓	✓	✓		✓			✓	✓	✓					
LLC BLER UL		✓	✓	✓		✓			✓	✓	✓					

Information Elements	Sony/Sony Er.					Motorola			Nokia			Qualc.			D.	Sc
	Xperia arc S, LT25i, LT30a	**W995, C905, C702, Z750i**	**K600i, K800i**	**W600i, K790**	V800, Z800	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	A835, A845	**C5/C7, 6120/6121, N95/N96**	6086, 6125, 6230/6230i, 6280	6630, 6680	**HSPA, HSPA+**	**HSDPA**	WCDMA	**Datang LC8130E**	**PCTel Scanners**
LLC Bytes*		✓	✓	✓					✓	✓	✓					
LLC Throughput*		✓	✓	✓		✓			✓	✓	✓					
LLC Window Size*		✓	✓	✓					✓	✓	✓					
MAC Mode*	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		
MAIO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
MCC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
MCS-* DL Usage...	✓	✓		✓								✓	✓			
Message Hex Dump...	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
MNC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Mode*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Modulation* [9]	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓		
MS Behavior Modified	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
MS Power Control Level	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	
MS Tx Power	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	
Neighbor ARFCN*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Neighbor BSIC*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Neighbor C1*	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Neighbor C2*	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Neighbor C31*	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓		
Neighbor C32*	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓		
Neighbor Cell*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Neighbor LAC*		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Neighbor RxLev*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Neighbor (SI) ARFCN																✓
Network Control Order		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Network Mode Of Oper.		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Number Of Hopp. Freq.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Number Of Used T'slots*	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	
PBCCH Timeslot		✓	✓	✓	✓				✓	✓	✓					
PDCH Utilization*	✓	✓	✓	✓		✓										

Information Elements	Sony/Sony Er.					Motorola			Nokia			Qualc.			D.	Sc
	Xperia arc S, LT25i, LT30a	**W995, C905, C702, Z750i**	**K600i, K800i**	**W600i, K790**	V800, Z800	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	A835, A845	**C5/C7, 6120/6121, N95/N96**	6086, 6125, 6230/6230i, 6280	6630, 6680	**HSPA, HSPA+**	**HSDPA**	WCDMA	**Datang LC8130E**	**PCTel Scanners**
PDP*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Preferred GAN Mode [7]										✓						
Prevent*	✓	✓	✓	✓												
Q Search Power [10]	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
RAC*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Radio Link Timeout Curr.	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	
Radio Link Timeout Max	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
RLA_P*		✓	✓	✓					✓	✓	✓					
RLC BLER*		✓	✓	✓	✓	✓			✓	✓	✓					
RLC Block*		✓	✓	✓	✓											
RLC Bytes*	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		
RLC Thr'put DL (%)	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
RLC Thr'put DL (kbit/s)	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	
RLC Thr'put UL (%) [11]	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓			
RLC Thr'put UL (kbit/s)	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	
RLP*									✓	✓	✓					
RxLev*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
RxQual*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Scanned Adjacent*		✓	✓	✓												
Scanned ARFCN		✓	✓	✓												
Scanned Band		✓	✓	✓												
Scanned BSIC		✓	✓	✓												
Scanned C/A*		✓	✓	✓												
Scanned C/I																✓
Scanned Cell Name		✓	✓	✓												✓
Scanned Channels No of		✓	✓	✓												✓
Scanned RxLev*		✓	✓	✓												✓
Serving Cell List Active	✓	✓	✓	✓												
Signal Str. Hopping List	only Sony Ericsson T610 and similar models															
Signal Str. On BCCH Carr.		✓	✓	✓												

Information Elements	Sony/Sony Er.					Motorola			Nokia			Qualc.			D.	Sc
	Xperia arc S, LT25i, LT30a	**W995, C905, C702, Z750i**	**K600i, K800i**	**W600i, K790**	V800, Z800	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	A835, A845	**C5/C7, 6120/6121, N95/N96**	6086, 6125, 6230/6230i, 6280	6630, 6680	**HSPA, HSPA+**	**HSDPA**	WCDMA	**Datang LC8130E**	**PCTel Scanners**
SNDCP BLER*		✓	✓	✓					✓	✓	✓					
SNDCP Bytes*		✓	✓	✓					✓	✓	✓					
SNDCP Throughput DL		✓	✓	✓					✓	✓	✓					
SNDCP Throughput UL		✓	✓	✓					✓	✓	✓					
Speech Codec	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
SQI* [12]		✓	✓	✓												
Strongest Sc. C/I																✓
Strongest Sc.* *(others)*		✓	✓	✓												✓
Sub Channel Number	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
TA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Target Handover	✓	✓	✓	✓												
TD-SCDMA Neighbor*															✓	
TFI*	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	
Time	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Timeslot	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Timeslot Channel Type*	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	
Timeslot Used*	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	
TLLI*	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
Training Sequence Code	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		
Uplink State Flag		✓	✓	✓												
WCDMA Neighbor*	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓		
Weakest Sc. C/I																✓
Weakest Sc.* *(others)*		✓	✓	✓												✓

1. Regarding BSIC decoding with PCTel scanners, see UM section 17.2.3.
2. Option must be turned on in phone's Properties dialog: see UM section 14.3.2.4.
3. For PCTel scanners this requires the C/I measurement option: see UM section 17.2.3.

4. Not supported by Sony Xperia LT25i/LT30a, nor by Samsung Galaxy S 4G or Infuse 4G.
5. For Xperia arc S, the “GSM C/I” log must be turned on; see UM section 14.5.1. With this device, C/I is obtained only for circuit-switched.
6. Supported by C702, C905, W760i, and W995.
7. Supported by Nokia 6086 only.
8. Supported only by devices that are equipped with an internal GPS.
9. Supported by K800i but not by K600i.
10. Supported by K790 but not by W600i.
11. Supported by K790 and K800i but not by W600i and K600i.
12. Not supported by Samsung Galaxy S 4G or Infuse 4G.

4.2. WCDMA Information Elements

- Sony Ericsson Xperia arc and X10 are covered by the Qualcomm “HSPA” column.
- Sony Ericsson Xperia arc S LT18a/i and Sony Xperia V LT25i, Xperia T LT30a have their own column under “Sony/Sony Er.”.
- The “Sony/Sony Er.” W995 column is also valid for Samsung Galaxy S 4G and Infuse 4G, except where otherwise noted.
- The “Sony/Sony Er.” column containing Z750i is also valid for Sony Ericsson TM506.
- Scanning elements supported by the SRU are the same as those supported by the Sony Ericsson W995 phones.

Information Elements	Sony/Sony Er.					Mot.		Nokia			Qualcomm				Scan.		
	Xperia arc S, LT25i, LT30a	**W995**	**Z750i, C905, C702, W760i**	**K800i**	**K600i**	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	**C5/C7, 6720**	**6120/6121, N95/N96**	6280, 7376, N80	**HSPA+**	**HSPA**	**HSDPA**	WCDMA	**Anritsu ML8780A**	**PCTel SeeGull**	**R&S TSMW**
AMR* [1]	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓				
AS ... RSCP Sum/Ant.*											✓						
AS*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Averaged BER								✓	✓	✓							
BLER Target Control*	✓	✓	✓	✓													
Call Event Success Rate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Cell Barred Control*	✓	✓	✓	✓													
Compressed Mode	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
CW*																✓	
Det Neigh * Sum/Ant.*											✓						
Det Neigh CPICH Tx Pwr		✓	✓	✓	✓	✓	✓										
Det Neigh Pathloss		✓	✓	✓	✓	✓	✓										
Det Neigh* *(others)*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
DPCCH Power UL		✓															
DTX Rate DL		✓	✓	✓	✓												
DVB-H*	LG U960 only																

Information Elements	Sony/Sony Er.					Mot.		Nokia			Qualcomm				Scan.		
	Xperia arc S, LT25i, LT30a	**W995**	**Z750i, C905, C702, W760i**	**K800i**	**K600i**	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	**C5/C7, 6720**	**6120/6121, N95/N96**	6280, 7376, N80	**HSPA+**	**HSPA**	**HSDPA**	WCDMA	**Anritsu ML8780A**	**PCTel SeeGull**	**R&S TSMW**
Finger 1st* [2] [3]	✓	✓	✓	✓		✓	✓				✓	✓	✓	✓	✓		
Finger 2nd* ... 8th* [2]		✓	✓												✓		
Finger 9th* ... 12th*		✓	✓														
Firmware Version	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GSM Neigh*	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓			
Hardware	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
HO Event Type*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
HS elements: See also the catch-all row "HS* (others)" below*																	
HS 64-QAM Mod. Rate											✓						
HS MIMO*											✓						
HS Phy*	✓	✓	✓					✓	✓		✓	✓	✓				
HS UL Average*	✓							✓			✓	✓					
HS UL BLER 1st	✓							✓			✓	✓					
HS UL BLER Residual	✓										✓	✓					
HS UL Buffer Limited Tx	✓										✓	✓					
HS UL DTX Rate	✓							✓			✓	✓					
HS UL E-DCH Thr'put	✓										✓	✓					
HS UL E-DCH TTI	✓	✓	✓	✓	✓			✓			✓	✓					
HS UL E-DPCCH Power		✓															
HS UL E-DPDCH Power		✓															
HS UL Error Blocks*	✓							✓			✓	✓					
HS UL Error Blocks Res.	✓										✓	✓					
HS UL E-TFC*		✓						✓									
HS UL Happy Rate	✓							✓			✓	✓					
HS UL HICH*	✓							✓			✓	✓					
HS UL New Trans. Rate	✓							✓			✓	✓					
HS UL Non-Serving*	✓							✓			✓	✓					
HS UL Number of TTIs	✓							✓			✓	✓					
HS UL Power Limited Tx	✓										✓	✓					
HS UL Retransm. Rate	✓							✓			✓	✓					

Information Elements	Sony/Sony Er.					Mot.		Nokia			Qualcomm				Scan.		
	Xperia arc S, LT25i, LT30a	**W995**	**Z750i, C905, C702, W760i**	**K800i**	**K600i**	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	**C5/C7, 6720**	**6120/6121, N95/N96**	6280, 7376, N80	**HSPA+**	**HSPA**	**HSDPA**	WCDMA	**Anritsu ML8780A**	**PCTel SeeGull**	**R&S TSMW**
HS UL S. G. Limited Tx	✓										✓	✓					
HS UL Succ. E-AGCH R.	✓							✓			✓	✓					
HS UL Succ. First Tx R.	✓							✓			✓	✓					
HS UL Transm. Distr.* [4]		✓						✓									
HS UL UE Tr. Pwr Headr.		✓															
HS* *(others)*	✓	✓	✓			✓			✓		✓	✓	✓				
HS-DSCH HARQ Proc...	✓	✓	✓			✓					✓	✓	✓				
HS-DSCH Post Rate											✓						
HS-DSCH Pre Rate											✓						
HS-DSCH Throughput	✓	✓	✓			✓					✓	✓	✓				
HS-DSCH * Per Process	✓	✓	✓						✓		✓	✓	✓				
HS-DSCH* *(others)*	✓	✓	✓			✓			✓		✓	✓	✓				
HS-SCCH*	✓	✓	✓			✓			✓		✓	✓	✓				
IMEI	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Inter-freq*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Internal GPS* [5]		✓															
Inter-RAT*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Intra-freq*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
MCC	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Message Hex Dump...	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
MNC	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Mode*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Mon Neigh * Sum/Ant.*											✓						
Mon Neigh* *(others)*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
MS Behavior Modified	✓	✓	✓	✓	✓	✓	✓		✓	✓							
Network Search*		✓	✓														
Other/Own*		✓	✓												✓	✓	✓
PDP*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Poss No ... AS M. 1–8		✓	✓												✓	✓	✓
Poss No ... AS M. 9–12		✓	✓													✓	✓

Information Elements	Sony/Sony Er.					Mot.		Nokia			Qualcomm				Scan.		
	Xperia arc S, LT25i, LT30a	**W995**	**Z750i, C905, C702, W760i**	**K800i**	**K600i**	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	**C5/C7, 6720**	**6120/6121, N95/N96**	6280, 7376, N80	**HSPA+**	**HSPA**	**HSDPA**	WCDMA	**Anritsu ML8780A**	**PCTel SeeGull**	**R&S TSMW**
Power Control Indic.* [6]	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
RACH Initial TX						✓	✓		✓								
RACH Max Preambles	✓	✓	✓	✓	✓						✓	✓	✓	✓			
RACH Message TX	✓					✓	✓				✓	✓	✓	✓			
RACH Transm. Preamb.	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
RAT Control*	✓	✓	✓	✓	✓	✓	✓		✓	✓							
RB Setup UL DPCH SC	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
RLC AM*	✓										✓	✓	✓	✓			
RLC DL Ent. Data Mode	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓			
RLC DL Throughput	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
RLC No Of Entities	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
RLC UL Ent. Data Mode	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓			
RLC UL Throughput	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
RLC/Trsp DL Thr’put	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
RLC/Trsp UL Thr’put	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
RRC State*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
SAN URA Id	✓										✓	✓	✓	✓			
SAN* *(others)*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Sc [1st–4th] Aggr Eb/Io															✓	✓	✓
Sc [1st–4th] Aggr Ec		✓	✓												✓	✓	✓
Sc [1st–4th] Aggr Ec/Io		✓	✓												✓	✓	✓
Sc [1st–4th] Ag–Pk Ec															✓	✓	✓
Sc [1st–4th] Cell*		✓	✓												✓	✓	✓
Sc [1st–4th] Delay Spr.															✓	✓	✓
Sc [1st–4th] Intra-fr. C. [7]		✓	✓												✓	✓	✓
Sc [1st–4th] Io		✓	✓												✓	✓	✓
Sc [1st–4th] No Of SCs		✓	✓												✓	✓	✓
Sc [1st–4th] Peak*															✓	✓	✓
Sc [1st–4th] P-SCH*															✓	✓	✓
Sc [1st–4th] Rake F. C.															✓	✓	

Information Elements	Sony/Sony Er.					Mot.		Nokia			Qualcomm				Scan.		
	Xperia arc S, LT25i, LT30a	**W995**	**Z750i, C905, C702, W760i**	**K800i**	**K600i**	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	**C5/C7, 6720**	**6120/6121, N95/N96**	6280, 7376, N80	**HSPA+**	**HSPA**	**HSDPA**	WCDMA	**Anritsu ML8780A**	**PCTel SeeGull**	**R&S TSMW**
Sc [1st–4th] SC		✓	✓												✓	✓	✓
Sc [1st–4th] SC Group															✓	✓	✓
Sc [1st–4th] SIR															✓	✓	✓
Sc [1st–4th] S-SCH*															✓	✓	✓
Sc [1st–4th] Time Offset															✓	✓	✓
Sc [1st–4th] T.O. Slot Pos																✓	✓
Sc [1st–4th] UARFCN		✓	✓												✓	✓	✓
Sc [1st–4th] UL Interf.		✓	✓												✓	✓	
Sc [5th–8th]*		✓	✓												✓	✓	✓
Sc [9th–12th]*		✓	✓													✓	✓
Sc Best*: *same as* Sc [1st–4th]*, *see above*																	
SCH TS Sc*																✓	
Sector Control	✓					✓	✓		✓	✓							
Serving * Sum/per Ant.											✓						
Serving Cell LAC*	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
Serving Cell RAC*	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
Serving CPICH Tx Pwr	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
Serving URA Id	✓										✓	✓	✓	✓			
Serving* *(others)*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
SF*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
SHO*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
SIR	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓			
SIR Target [8]	✓	✓	✓	✓	✓	✓	✓		✓	✓							
Spectr Ana DL*																✓	
Spectr Ana UL*																	
SQI* [9]		✓	✓	✓	✓												
Str Neigh * Sum/Ant.*											✓						
Str Neigh* *(others)*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
Time	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Trsp Ch BLER*	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			

Information Elements	Sony/Sony Er.					Mot.		Nokia			Qualcomm				Scan.		
	Xperia arc S, LT25i, LT30a	W995	Z750i, C905, C702, W760i	K800i	K600i	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	C5/C7, 6720	6120/6121, N95/N96	6280, 7376, N80	HSPA+	HSPA	HSDPA	WCDMA	Anritsu ML8780A	PCTel SeeGull	R&S TSMW
Trsp Ch Id DL	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓			
Trsp Ch No Of DL	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓			
Trsp Ch No Of Error Blks	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓			
Trsp Ch No Of UL	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓			
Trsp Ch Throughput*		✓	✓	✓	✓												
Trsp Ch Type*	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓			
UE Initial Transmit Pwr	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
UE Tx Power	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
UL Interference Serving	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
UTRA Carrier RSSI	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			
UTRA Ca. RSSI per Ant.											✓						
UTRA Ca. RSSI Sum											✓						
VTQI [10] [11] [12]	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			

1. Supported by N96 only.
2. Anritsu: Finger ... Slot and Finger Position ... Slot are not obtained. Same remark applies to 2nd and further scanned UARFCNs.
3. A mode report must be turned on in certain Sony/Sony Ericsson phones; see UM section 14.3.1.
4. The residual percentage is not obtained from the Nokia phones.
5. Supported only by devices that are equipped with an internal GPS.
6. A mode report must be turned on in certain Sony/Sony Ericsson phones; see UM section 14.3.1.
7. Not supported by PCTel SeeGull LX.
8. The “WCDMA SIR Target” log must be turned on; see UM section 14.5.1.
9. Not supported by Samsung Galaxy S 4G or Infuse 4G.
10. Note that in practice, VTQI naturally also requires that the device be equipped with a front camera. There exist connectable devices, such as the Sony Ericsson Xperia arc S, which support the VTQI information element but do not have a front camera.

11. Not supported by Sony Ericsson W760i.
12. Note on Nokia phones: VTQI is based on transport channel BLER. Nokia phones do not report BLER for individual transport channels but only an average over all channels (see “Trsp Ch BLER, DL (Log)”). This means that VTQI scores based on Nokia reports will not be accurate if further transport channels are used in parallel with the one used for the video call.

4.3. LTE Information Elements

Information Elements	UE Chipsets								Scanners					
	Altair (TDD)	Hisilicon Balong 710	Hisilicon Balong 700	LG	Qualcomm	Qualcomm TDD	Samsung	Sequans	Andrew	DRT	PCTel SeeGull EX	PCTel SeeGull MX	R&S TSMW	Transcom
AFC*		✓												
ANR*	✓	✓	✓	✓	✓	✓	✓	✓						
Antenna Correlation		✓												
Bearer Def. EPS B'r ID		✓	✓		✓	✓								
Bearer* *(others)*	✓	✓	✓	✓	✓	✓	✓	✓						
Cell Allowed Meas. B'w.*		✓	✓	✓	✓	✓	✓	✓						
Cell DL EARFCN Inter F.		✓	✓	✓	✓	✓		✓						
Cell GERAN ARFCN		✓	✓	✓	✓	✓	✓	✓						
Cell Q-*		✓	✓	✓	✓	✓	✓	✓						
Cell Reselection Priority*		✓	✓	✓	✓	✓	✓	✓						
Cell T-Reselection*		✓	✓	✓	✓	✓	✓	✓						
Cell Threshold*		✓	✓	✓	✓	✓	✓	✓						
Cell List Type	✓	✓	✓	✓	✓	✓	✓	✓						
Cell List* *(others): Same as corresponding Serving Cell and Neighbor IEs*														
CQI Code Word*	✓	✓	✓	✓	✓	✓	✓	✓						
CQI Periodicity		✓												
CQI Report Mode		✓												
CQI Sub-band Code W.*		✓	✓		✓	✓								
Cyclic Prefix					✓	✓		✓						
DRX Cycle Type		✓												
DRX Enabled*		✓												
DRX Inact. Timer		✓	✓	✓	✓	✓	✓	✓						
DRX Inact. Timer Enabl.		✓												
DRX Long Cycle		✓	✓	✓	✓	✓	✓	✓						
DRX On Dur. Timer		✓	✓	✓	✓	✓	✓	✓						
DRX On Dur. Timer Enbl.		✓												
DRX Retransm. Timer		✓	✓	✓	✓	✓	✓	✓						
DRX Short Cycle		✓	✓	✓	✓	✓	✓	✓						
DRX Short Cycle Enbl.		✓												
DRX Short Cycle Timer		✓	✓	✓	✓	✓	✓	✓						

Information Elements	UE Chipsets								Scanners					
	Altair (TDD)	**Hisilicon Balong 710**	Hisilicon Balong 700	**LG**	**Qualcomm**	**Qualcomm TDD**	**Samsung**	**Sequans**	**Andrew**	**DRT**	**PCTel SeeGull EX**	**PCTel SeeGull MX**	**R&S TSMW**	**Transcom**
DRX Start Offset		✓	✓	✓	✓	✓	✓	✓						
Duplex Mode*		✓	✓			✓		✓						✓
EMM State	✓	✓			✓	✓	✓	✓						
EMM Substate		✓												
EPower*											✓	✓		
Equipment Time		✓			✓	✓								
ESM State [1]														
Firmware Version	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Hardware*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
IMSI		✓												
MAC BLER*				✓										
MAC DL PDU HO Int. T.		✓		✓	✓	✓								
MAC DL Throughput		✓	✓	✓				✓						
MAC Random Access*		✓												
MAC UL PDU HO Int. T.		✓												
MAC UL Throughput		✓	✓	✓				✓						
Message Hex Dump...	✓	✓	✓	✓	✓	✓	✓	✓						
MME*		✓		✓	✓	✓	✓	✓						
Mode - System		✓	✓	✓	✓	✓	✓	✓						✓
MTMSI		✓												
Neigh. C. Channel RSSI	✓	✓	✓	✓	✓	✓	✓							
Neigh. C. Frame Timing*					✓	✓								
Neigh. C. Identity	✓	✓	✓	✓	✓	✓	✓	✓						
Neigh. C. RSRP	✓	✓	✓	✓	✓	✓	✓	✓						
Neigh. C. RSRP Tx1 Rx*					✓	✓	✓							
Neigh. C. RSRP Tx2 Rx*							✓							
Neigh. C. RSRQ	✓	✓	✓	✓	✓	✓	✓	✓						
Neigh. C. RSRQ Tx1 Rx*					✓	✓	✓							
Neigh. C. RSRQ Tx2 Rx*							✓							
Neigh. C.* *(others)*		✓	✓	✓	✓	✓	✓	✓						
PBCH BLER*				✓	✓	✓								
PCFICH CFI Information		✓		✓	✓	✓								

Information Elements	UE Chipsets								Scanners					
	Altair (TDD)	Hisilicon Balong 710	Hisilicon Balong 700	LG	Qualcomm	Qualcomm TDD	Samsung	Sequans	Andrew	DRT	PCTel SeeGull EX	PCTel SeeGull MX	R&S TSMW	Transcom
PDCCH CCE*		✓												
PDCCH DCI Format*		✓			✓	✓								
PDCCH DL Grant Count*		✓												
PDCCH UL Grant Count*		✓												
PDCP DL PDU HO Int. T.		✓												
PDCP DL RB Thr'put	✓			✓	✓	✓								
PDCP DL Thr'put	✓	✓	✓	✓	✓	✓								
PDCP UL PDU HO Int. T.		✓												
PDCP UL RB Thr'put	✓			✓	✓	✓								
PDCP UL Thr'put	✓	✓	✓	✓	✓	✓								
PDN Connection*	✓	✓	✓	✓	✓	✓	✓	✓						
PDSCH BLER	✓	✓		✓	✓	✓	✓	✓						
PDSCH BLER TB*	✓	✓		✓	✓	✓	✓	✓						
PDSCH MCS*	✓	✓		✓	✓	✓	✓	✓						
PDSCH Modulation*	✓	✓		✓	✓	✓	✓							
PDSCH No. of Used TBs	✓			✓	✓	✓	✓							
PDSCH Phy Th'put	✓	✓	✓	✓	✓	✓	✓							
PDSCH Phy Th'put CW*		✓												
PDSCH Res. Block Start		✓												
PDSCH Res. Blocks	✓	✓		✓	✓	✓	✓							
PDSCH Res. Blocks (%)	✓	✓		✓	✓	✓								
PDSCH Trsm. Distr.* (%)		✓		✓	✓	✓		✓						
PDSCH Trsm. Distr.* Cnt		✓												
PMI	✓	✓		✓	✓	✓	✓	✓						
Protocol Version		✓	✓	✓	✓	✓	✓	✓						
PUSCH BLER		✓		✓	✓	✓	✓							
PUSCH BLER * No. Of	✓	✓		✓	✓	✓	✓	✓						
PUSCH HARQ Max Trsm		✓												
PUSCH MCS		✓		✓	✓	✓	✓	✓						
PUSCH Modulation*	✓	✓		✓	✓	✓	✓							
PUSCH Phy Throughput	✓	✓	✓	✓	✓	✓	✓							
PUSCH Res. Block Start		✓												

Information Elements	UE Chipsets								Scanners					
	Altair (TDD)	Hisilicon Balong 710	Hisilicon Balong 700	LG	Qualcomm	Qualcomm TDD	Samsung	Sequans	Andrew	DRT	PCTel SeeGull EX	PCTel SeeGull MX	R&S TSMW	Transcom
PUSCH Res. Blocks	✓	✓		✓	✓	✓	✓							
PUSCH Res. Blocks (%)				✓	✓	✓								
PUSCH Transm. Distr.*		✓												
RACH Cont. Res. T.	✓	✓	✓	✓	✓	✓	✓	✓						
RACH Current Tx Power	✓	✓		✓	✓	✓								
RACH Initial Tx Power	✓	✓		✓	✓	✓								
RACH Latency				✓	✓	✓								
RACH Max Preamb. Pwr		✓		✓	✓	✓	✓	✓						
RACH Max Preambles		✓		✓				✓						
RACH No. of Transmits		✓		✓	✓	✓								
RACH Preamble Resp...					✓	✓								
RACH Preamble Step		✓			✓	✓								
RACH Reason					✓	✓								
RACH Result					✓	✓								
RACH RNTI		✓												
RACH Signature		✓												
RACH Type		✓			✓	✓								
Random Access Period		✓												
RI	✓	✓		✓	✓	✓	✓	✓						
RI * Number Of	✓	✓		✓	✓	✓	✓	✓						
RLC DL PDU HO Int. T.		✓												
RLC DL RB*		✓		✓	✓	✓								
RLC DL State		✓		✓	✓	✓								
RLC DL Throughput		✓	✓	✓	✓	✓								
RLC UL PDU HO Int. T.		✓												
RLC UL RB*		✓		✓	✓	✓								
RLC UL State		✓		✓	✓	✓								
RLC UL Throughput		✓	✓	✓	✓	✓								
Roaming Status		✓												
RRC State	✓	✓	✓	✓	✓	✓	✓	✓						
“Sc ...”: IEs from Reference Signal scanning														
Sc ... BCH RSSI									✓	✓			✓	✓

Information Elements	UE Chipsets								Scanners					
	Altair (TDD)	Hisilicon Balong 710	Hisilicon Balong 700	LG	Qualcomm	Qualcomm TDD	Samsung	Sequans	Andrew	DRT	PCTel SeeGull EX	PCTel SeeGull MX	R&S TSMW	Transcom
Sc ... Cell Distance									✓	✓	✓	✓	✓	
Sc ... Cell Identity									✓	✓	✓	✓	✓	✓
Sc ... Cell Name									✓	✓	✓	✓	✓	✓
Sc ... CFO									✓	✓			✓	
Sc ... Channel RSSI											✓	✓		✓
Sc ... Delay Spread											✓	✓	✓	
Sc ... EARFCN									✓	✓	✓	✓	✓	✓
Sc ... MIMO*												✓		
Sc ... No Of Cell Id's									✓	✓	✓	✓	✓	✓
Sc ... No Of Rx Antennas												✓		
Sc ... No Of Tx Antennas												✓		
Sc ... P-SCH RP									✓	✓	✓	✓	✓	✓
Sc ... RS CINR									✓	✓	✓	✓	✓	✓
Sc ... RSRP									✓	✓	✓	✓	✓	✓
Sc ... RSRP Rx1 Tx*									✓	✓	✓	✓		✓
Sc ... RSRP Rx2 Tx*												✓		
Sc ... RSRQ									✓	✓	✓	✓	✓	✓
Sc ... RSRQ Rx1 Tx*									✓	✓	✓	✓		✓
Sc ... RSRQ Rx2 Tx*												✓		
Sc ... SCH CINR										✓	✓	✓	✓	✓
Sc ... SCH RQ									✓	✓	✓	✓	✓	✓
Sc ... S-SCH RP									✓	✓	✓	✓	✓	✓
Sc ... Time Offset									✓	✓	✓	✓		
Sc RSSI*										✓	✓	✓		✓
Schedule Req. Status		✓												
Serv. C. Channel RSSI	✓	✓		✓	✓	✓	✓	✓						
Serv. C. Distance		✓	✓	✓	✓	✓	✓	✓						
Serv. C. DL Bandwidth	✓	✓	✓	✓	✓	✓	✓	✓						
Serv. C. DL EARFCN	✓	✓	✓	✓	✓	✓	✓	✓						
Serv. C. DL Frequency		✓	✓											
Serv. C. DL Pathloss		✓	✓	✓	✓	✓	✓	✓						
Serv. C. Frame Timing*					✓	✓								

Information Elements	UE Chipsets								Scanners					
	Altair (TDD)	**Hisilicon Balong 710**	Hisilicon Balong 700	**LG**	**Qualcomm**	**Qualcomm TDD**	**Samsung**	**Sequans**	**Andrew**	**DRT**	**PCTel SeeGull EX**	**PCTel SeeGull MX**	**R&S TSMW**	**Transcom**
Serv. C. Identity	✓	✓	✓	✓	✓	✓	✓	✓						
Serv. C. MCC		✓	✓	✓	✓	✓	✓	✓						
Serv. C. MNC		✓	✓	✓	✓	✓	✓	✓						
Serv. C. Name		✓	✓	✓	✓	✓	✓	✓						
Serv. C. PLMN		✓	✓											
Serv. C. RRC Identity		✓		✓	✓	✓	✓	✓						
Serv. C. RS CINR		✓	✓	✓	✓	✓	✓	✓						
Serv. C. RSRP	✓	✓	✓	✓	✓	✓	✓	✓						
Serv. C. RSRP Tx1 Rx*		✓	✓		✓	✓	✓							
Serv. C. RSRP Tx2 Rx*							✓							
Serv. C. RSRP-DRS		✓												
Serv. C. RSRQ	✓	✓	✓	✓	✓	✓	✓	✓						
Serv. C. RSRQ Tx1 Rx*					✓	✓	✓							
Serv. C. RSRQ Tx2 Rx*							✓							
Serv. C. SINR-DRS		✓												
Serv. C. TAC		✓	✓	✓	✓	✓	✓	✓						
Serv. C. Total RS Power		✓	✓	✓	✓	✓	✓	✓						
Serv. C. Tx1-Tx2 Per ...[2]					✓	✓								
Serv. C. UL EARFCN		✓	✓		✓	✓	✓							
Serv. C. UL Frequency		✓	✓											
Spectr Ana*									✓	✓	✓	✓		✓
SRS TX Power	✓	✓			✓	✓								
SRS Usage Rate					✓	✓								
Strongest*										✓	✓	✓		✓
TDD Special Subfr. Cfg.		✓	✓			✓								
TDD UL/DL Config.*		✓	✓			✓		✓						
TDD* *(others)*						✓								
TD-SCDMA Neighbor*		✓												
Time*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Timing Advance*		✓			✓	✓								
Transmission Mode	✓	✓		✓	✓	✓	✓	✓						
UE Category	✓	✓	✓	✓	✓	✓	✓	✓						

Information Elements	UE Chipsets								Scanners					
	Altair (TDD)	**Hisilicon Balong 710**	Hisilicon Balong 700	**LG**	**Qualcomm**	**Qualcomm TDD**	**Samsung**	**Sequans**	**Andrew**	**DRT**	**PCTel SeeGull EX**	**PCTel SeeGull MX**	**R&S TSMW**	**Transcom**
UE PUCCH Tx Power	✓	✓		✓	✓	✓		✓						
UE PUSCH Tx Power	✓	✓		✓	✓	✓		✓						
UE Tx Power	✓			✓			✓	✓						

1. Currently not obtained with any supported devices.
2. The “LL1 CRS TXRX Power Report” log must be turned on; see UM section 14.5.

4.4. TD-SCDMA Information Elements

The LTE Neighbor elements are supported by Hisilicon Balong 710 chipset devices only.

All other elements are supported by all connectable TD-SCDMA capable devices.

4.5. CDMA Information Elements

Information Elements	UE Chipsets						Scan.		
	LG (LTE/EV-DO)	Qualc. EV-DO Rev. B	Qualc. EV-DO Rev. A	Qualc. EV-DO Rel. 0	Qualc. CDMA (1x)	Via	Andrew	PCTel SeeGull LX, EX	PCTel SeeGull MX
Access*	✓	✓	✓	✓	✓				
Active Set Band Class	✓	✓	✓	✓	✓	✓			
Active Set Cell Name	✓	✓	✓	✓	✓				
Active Set Channel	✓	✓	✓	✓	✓	✓			
Active Set Count	✓	✓	✓	✓	✓				
Active Set DCCH*	✓	✓	✓	✓	✓				
Active Set Ec	✓		✓	✓	✓				
Active Set Ec/Io	✓	✓	✓	✓	✓	✓			
Active Set Ec/Io Sum	✓		✓	✓	✓				
Active Set FCH*	✓		✓	✓	✓				
Active Set PN	✓	✓	✓	✓	✓	✓			
Active Set SCH*	✓		✓	✓	✓				
Active Set Serving Io	✓		✓	✓	✓				
Analog*	✓		✓	✓	✓				
Base ID	✓		✓	✓	✓				
Cand. Set Band Class	✓	✓	✓	✓	✓	✓			
Cand. Set Cell Name	✓	✓	✓	✓	✓				
Cand. Set Channel	✓	✓	✓	✓	✓	✓			
Cand. Set Count	✓	✓	✓	✓	✓				
Cand. Set Ec	✓		✓	✓	✓				
Cand. Set Ec/Io	✓	✓	✓	✓	✓	✓			
Cand. Set PN	✓	✓	✓	✓	✓	✓			
CDMA Rx State	✓		✓	✓	✓				

Information Elements	UE Chipsets						Scan.		
	LG (LTE/EV-DO)	Qualc. EV-DO Rev. B	Qualc. EV-DO Rev. A	Qualc. EV-DO Rel. 0	Qualc. CDMA (1x)	Via	Andrew	PCTel SeeGull LX, EX	PCTel SeeGull MX
Country ID	✓		✓	✓	✓				
Dialed Number	✓		✓	✓	✓				
DSC Channels	✓		✓	✓	✓				
EV-DO Access*	✓		✓	✓					
EV-DO Act. S. DRC Cov.	✓	✓	✓	✓					
EV-DO Act. S. DRC Lk	✓		✓	✓					
EV-DO Act. S. Drop T.*	✓		✓	✓					
EV-DO Act. S. MAC Idx	✓		✓	✓					
EV-DO Act. S. Pred.*	✓		✓	✓					
EV-DO Act. S. RAB*	✓		✓	✓					
EV-DO Act. S. RPC*	✓	✓	✓	✓					
EV-DO Act. S. Srv. DRC	✓		✓	✓					
EV-DO Act. S. Srv. PN	✓		✓	✓		✓			
EV-DO Act. S. Srv. RPC	✓		✓	✓					
EV-DO Act. S. Srv. SINR	✓		✓	✓					
EV-DO Act. S. SINR	✓		✓	✓					
EV-DO Act. S. Win. Ctr	✓		✓	✓					
EV-DO Actual RRI	✓		✓	✓					
EV-DO ALMP State	✓		✓	✓		✓			
EV-DO AT State	✓		✓	✓		✓			
EV-DO Attempt*	✓		✓	✓					
EV-DO Best Pilot PN	✓		✓	✓		✓			
EV-DO Best SINR	✓		✓	✓					
EV-DO Cand. Set*	✓		✓	✓					
EV-DO Color Code	✓		✓	✓	✓				
EV-DO Condition RRI	✓		✓	✓					
EV-DO Connected State	✓		✓	✓		✓			
EV-DO Conn. Fail. Rate	✓		✓	✓					
EV-DO Drop Timer*	✓		✓	✓					
EV-DO DRC*	✓		✓	✓					
EV-DO Finger MSTR	✓		✓	✓		✓			
EV-DO Finger* *(others)*	✓		✓	✓					

Information Elements	UE Chipsets						Scan.		
	LG (LTE/EV-DO)	Qualc. EV-DO Rev. B	Qualc. EV-DO Rev. A	Qualc. EV-DO Rel. 0	Qualc. CDMA (1x)	Via	Andrew	PCTel SeeGull LX, EX	PCTel SeeGull MX
EV-DO FL Throughput	✓		✓	✓		✓			
EV-DO FL* *(others)*	✓		✓	✓					
EV-DO Hybrid Mode	✓		✓	✓		✓			
EV-DO Idle State	✓		✓	✓		✓			
EV-DO Init State	✓		✓	✓		✓			
EV-DO Multicarrier*		✓							
EV-DO Neighbor Set*	✓	✓	✓	✓					
EV-DO No. Of Carriers	✓	✓	✓	✓					
EV-DO OVHD Msg. State	✓		✓	✓		✓			
EV-DO PA State	✓		✓	✓					
EV-DO PER*	✓		✓	✓					
EV-DO Power Ratio*	✓		✓	✓					
EV-DO Reverse Rate*	✓		✓	✓					
EV-DO Revision	✓	✓	✓	✓					
EV-DO RL Throughput	✓		✓	✓		✓			
EV-DO RL* *(others)*	✓		✓	✓					
EV-DO RLP*	✓		✓	✓					
EV-DO Route Upd. State	✓		✓	✓		✓			
EV-DO Session State	✓		✓	✓		✓			
EV-DO Session* *(others)*	✓		✓	✓					
EV-DO UATI*	✓		✓	✓					
F-DCCH*	✓		✓	✓	✓				
FER*	✓		✓	✓	✓				
F-FCH*	✓		✓	✓	✓				
Finger Pilot PN	✓		✓	✓	✓	✓			
Finger* *(others)*	✓		✓	✓	✓				
Firmware Version	✓		✓	✓	✓				
FPC*	✓		✓	✓	✓				
Frame Offset*	✓		✓	✓	✓				
F-SCH Rate	✓		✓	✓	✓				
F-SCH0*	✓		✓	✓	✓				
Hardware*	✓		✓	✓	✓				

Information Elements	UE Chipsets						Scan.		
	LG (LTE/EV-DO)	Qualc. EV-DO Rev. B	Qualc. EV-DO Rev. A	Qualc. EV-DO Rel. 0	Qualc. CDMA (1x)	Via	Andrew	PCTel SeeGull LX, EX	PCTel SeeGull MX
Missing Neighbor*							✓	✓	
Mobile Identity Number	✓		✓	✓	✓				
MSM Revision	✓		✓	✓	✓				
Neighbor Set Band Class	✓	✓	✓	✓	✓	✓			
Neighbor Set Cell Name	✓		✓	✓	✓				
Neighbor Set Channel	✓	✓	✓	✓	✓	✓			
Neighbor Set Count	✓	✓	✓	✓	✓				
Neighbor Set Ec	✓		✓	✓	✓				
Neighbor Set Ec/Io	✓	✓	✓	✓	✓	✓			
Neighbor Set PN	✓	✓	✓	✓	✓	✓			
Network ID	✓		✓	✓	✓	✓			
Number Of DSC Ch’s	✓		✓	✓	✓				
Phone State	✓		✓	✓	✓				
Pilot PN Increment	✓	✓	✓	✓	✓				
Pilot Set Band Class	✓	✓	✓	✓	✓				
Pilot Set Cell Name	✓	✓	✓	✓	✓				
Pilot Set Cell Type	✓	✓	✓	✓	✓				
Pilot Set Channel	✓	✓	✓	✓	✓				
Pilot Set Count	✓	✓	✓	✓	✓				
Pilot Set Ec/Io	✓	✓	✓	✓	✓				
Pilot Set PN	✓	✓	✓	✓	✓				
Polluters*							✓	✓	
Protocol Revision*	✓		✓	✓	✓	✓			
R-DCCH*	✓		✓	✓	✓				
RF Band	✓		✓	✓	✓				
RF Channel	✓		✓	✓	✓	✓			
RF Mode	✓		✓	✓	✓				
R-FCH*	✓		✓	✓	✓				
RLP DL Avg Throughput	✓	✓	✓	✓	✓				
RLP DL Throughput	✓	✓	✓	✓	✓	✓			
RLP Total Bytes*	✓	✓	✓	✓	✓				
RLP UL Avg Throughput	✓	✓	✓	✓	✓				

Information Elements	UE Chipsets						Scan.		
	LG (LTE/EV-DO)	Qualc. EV-DO Rev. B	Qualc. EV-DO Rev. A	Qualc. EV-DO Rel. 0	Qualc. CDMA (1x)	Via	Andrew	PCTel SeeGull LX, EX	PCTel SeeGull MX
RLP UL Throughput	✓	✓	✓	✓	✓	✓			
RLP* *(others)*	✓		✓	✓	✓				
R-SCH Rate	✓		✓	✓	✓				
R-SCH0*	✓		✓	✓	✓				
Rx Power	✓		✓	✓	✓	✓			
Scanned RSSI Average								✓	
Scanned* *(others)*							✓	✓	✓
Searcher*	✓		✓	✓	✓				
Sector ID	✓		✓	✓		✓			
Service Option	✓		✓	✓	✓				
Slot Cycle Index	✓		✓	✓	✓				
Soft Handoff State	✓		✓	✓	✓				
Spectr Ana*							✓	✓	
SQI MOS	✓		✓	✓	✓				
Station Class Mark	✓		✓	✓	✓				
Subnet Mask	✓		✓	✓					
System ID	✓		✓	✓	✓	✓			
T-Add	✓		✓	✓	✓				
T-Comp	✓		✓	✓	✓				
T-Drop	✓		✓	✓	✓				
T-TDrop	✓		✓	✓	✓				
Tx Adjust	✓		✓	✓	✓				
Tx Open Loop Power	✓		✓	✓					
Tx Pilot Power	✓		✓	✓					
Tx Power	✓		✓	✓	✓	✓			

4.6. Media Quality Information Elements

For circuit-switched, Media Quality information elements are populated by AQM-capable devices; these are listed in the Device Configuration Guide, section 2.4. In the course of VoIP testing, Media Quality information elements can be populated by any device used for that purpose (that is, almost any device that can be used for data transfer).

The precise set of Media Quality elements that is obtained depends on the AQM testing configuration and, in some of these configurations, on what hardware is used at the other end. For full details, see chapter 5.

One further limitation is that during CS voice testing, PESQ is not computed for the AMR-WB speech codec. This limitation does not apply to VoIP.

5. Support for Media Quality Information Elements in AQM Solutions

Which Media Quality information elements are obtained differs between the various AQM solutions offered by TEMS Investigation. This chapter provides full detail in this regard. (TEMS Automatic logfiles recorded by RTUs are also covered here.)

Regarding device-related limitations, see section 4.6.

Information Element	ACU R2	ACU TerraTec	AQM mod., analog CG	AQM mod., digital CG	AQM mod., MRU	VoIP, PJSIP	VoIP, ODM MTSI	ODM Call Ctrl, CS/VoIP	TA, CallGen., analog	TA, CallGen., digital	TA, mobile to mobile
UM chapter reference	38	39	40	40	40	41	41	41	–	–	–
AQM Algorithm DL	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AQM Algorithm UL	CG	✓	✓	✓			✓		✓	✓	✓
AQM Audio Ch. Type DL	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AQM Echo Attenuation			✓						✓		
AQM Echo Correlation			✓								
AQM Echo Delay			✓						✓		
AQM Echo Power			✓								
AQM Sentence DL	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AQM Sentence UL	CG	✓	✓	✓			✓		✓	✓	✓
AQM Source DL	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AQM Source UL	CG	✓	✓	✓			✓		✓	✓	✓
AQM Volume DL		✓	✓	✓	✓				✓	✓	✓
AQM Volume UL		✓	✓	✓					✓	✓	✓
Frequent AQM Score DL	✓		✓	✓	✓		R2		✓	✓	✓
Frequent AQM Score UL	CG		✓	✓					✓	✓	✓

Information Element	ACU R2	ACU TerraTec	AQM mod., analog CG	AQM mod., digital CG	AQM mod., MRU	VoIP, PJSIP	VoIP, ODM MTSI	ODM Call Ctrl, CS/VoIP	TA, CallGen., analog	TA, CallGen., digital	TA, mobile to mobile
PESQ Score DL	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
PESQ Score UL	CG	✓	✓	✓			✓		✓	✓	✓
POLQA NB Score DL	✓	✓				✓	✓	✓			✓
POLQA NB Score UL	CG	✓					✓				✓
POLQA SWB Score DL	✓	✓				✓	✓	✓			✓
POLQA SWB Score UL	CG	✓					✓				✓
Speech Interruption DL	✓							✓			
Speech Path Delay	✓		✓	✓					✓	✓	✓

In the **ACU R2** column, “CG” means that the information element is obtained only in the mobile-to-fixed configuration, where calls are made to a CallGenerator.

In the **VoIP, ODM MTSI** column, “R2” means that the information element is obtained only if the devices are connected to the PC via an ACU R2 box.

The TEMS Automatic (“**TA**”) columns are to be interpreted as follows:

- **TA, CallGen., analog:** TEMS Automatic, RTUs (Remote Test Units) engaging CallGenerator with analog calling card
- **TA, CallGen., digital:** TEMS Automatic, RTUs engaging CallGenerator with digital calling card
- **TA, mobile to mobile:** TEMS Automatic, RTUs engaging Mobile CallGenerator (MCG)

6. Notes on Data Service Testing Elements

6.1. Application Layer Throughput

At high throughput rates, the application layer throughput as presented in TEMS Investigation is more spiky and unstable than the throughput in lower protocol layers. Most probably, this phenomenon is caused by the buffering in the third-party FTP client used by TEMS Investigation. By contrast, CPU load or buffering capacity are unlikely causes of the application throughput fluctuations.

6.2. Network Bandwidth (Iperf)

The waveform in Network Bandwidth line charts will be jagged and not smooth, due to the low resolution of the Iperf process.

6.3. Streaming over HTTP

The “Streaming Player” and “Streaming Playout” information elements may not be populated in certain configurations:

- When the DASH (Dynamic Adaptive Streaming over HTTP) protocol is used in conjunction with ActionScript 3.x player.
- When the HTML5 player is used.

Another limitation is that the ActionScript 2.x player only supports HTTPS (not HTTP) URLs.

7. Notes on Plain-text Decoding of Mode Reports

7.1. TPC Info per Cell (Sony Ericsson)

While in WCDMA soft handover, the UE is power controlled jointly by all members of the active set. Power control commands are received on the DPCCH.

Certain Sony Ericsson UEs deliver two mode reports that are relevant in this context, “TPC Info” and “DPCCH DL”. TPC Info shows the power control commands from each cell in the active set separately, whereas the DPCCH DL report gives the final power control decision obtained by combining and weighting the input from all active set members.

The plain-text decoding of the TPC Info mode report represents the power control commands from each cell by a string of letters as follows:

- Q = Not valid: The cell was not part of the active set at this time.
- U = Up: The cell ordered the UE to raise the power.
- D = Down: The cell ordered the UE to lower the power.
- C = Skip: The UE was in compressed mode at this time, measuring on a different UARFCN or on GSM.
- N = No change: No power control command, power unchanged.

Since the power control frequency is 1500 Hz, each letter in the string represents 1/1500 of a second.

8. Predefined Events

Here all predefined events are listed and explained, along with any extra information provided in the application (see section 10.9). All cause values are decoded into plain-text format in the presentation. Not all of the extra information listed in the table is necessarily included every time the event occurs.

The descriptions of how events are triggered are not always exhaustive. In exceptional cases, an event may be triggered by a message not mentioned here.

Event symbols shown are default symbols; they can be changed in line charts (UM section 31.4.3) and maps (UM section 33.2.4).

Events are mostly device-independent and are generated for all devices supporting the relevant radio access technology or technologies. Exceptions are noted in the tables.

8.1. General Events

Under this heading have been collected events that do not result from interaction with a cellular network.

Event Name	Symbol	Description/Extra Information
Activated	 (green)	The device was activated in TEMS Investigation.
Deactivated	 (red)	The device was deactivated in TEMS Investigation.
Filemark		A filemark was encountered in the logfile.

Event Name	Symbol	Description/Extra Information
GPS Position Invalid	 (red triangle)	Positions reported by the GPS unit became invalid (GPS coverage lost).
GPS Position Valid	 (dark green circle)	GPS positions are once again valid (GPS coverage regained). Reported after a GPS Position Invalid event has occurred.
No Reported Data		The device stopped reporting data.
Pinpoint Added		During pinpointing in the Map window: A waypoint was added. While walking a planned route in the Pinpoint Window: A waypoint was committed.
Recording Paused		The recording of a logfile was paused.[1]
Recording Resumed		The recording of a logfile was resumed.[1]
Wi-Fi Scan State		The PC Wi-Fi network card or some other Wi-Fi adapter was activated in TEMS Investigation.

1. The “pause recording” and “resume recording” functions were removed in TEMS Investigation 14.0. However, the corresponding events may appear in the presentation of older logfiles and are therefore retained.

8.2. GSM/WCDMA/LTE/TD-SCDMA Events

Events in this category are generated by devices supporting at least one of the technologies GSM, WCDMA, LTE, and TD-SCDMA.

The following is to be noted:

- For TD-SCDMA devices a subset of the listed events can be generated (in both TD-SCDMA and GSM mode). The extra information given in the table is rarely provided with events originating from TD-SCDMA devices. There are also a number of TD-SCDMA specific events.

The asterisk column uses the following codes:

Code	Meaning
c	Requires that a cell file has been loaded.
e	Generated in EDGE mode.
g	Generated in GSM mode.
ga	Generated by GAN-capable device interacting with a GANC.
lte	Generated in LTE mode.
sg	Generated during GSM scanning.
sw	Generated during WCDMA scanning.
td	Generated in TD-SCDMA mode (and unique to that mode).
w	Generated in WCDMA mode.

Event List

Event Name	Symbol	*	Description/Extra Information
Authentication Failure		g w	The authentication or ciphering failed. Can be generated for both packet-switched and circuit-switched. **Extra information:** GMM/MM cause (if available).
Baton Handover		td	Successful baton handover in TD-SCDMA.

Event Name	Symbol	*	Description/Extra Information
Baton Handover Failure		td	An attempted baton handover in TD-SCDMA failed.
Blocked Call	 (red)	g w ga	*GSM/WCDMA/TD-SCDMA:* Call abnormally ended prior to Call Established event (for example because all traffic channels were busy). *GAN:* Layer 3 message Activate Channel Failure received prior to Call Established. **Extra information:** • Block type • CC cause • RR cause • Call time (time since Call Initiation event)
Call Attempt	 (gray)	g w ga	*GSM:* A traffic channel was requested (through the Layer 3 message Channel Request). (Note that the request could also be for a signaling channel, in which case no call is actually attempted; the two types of request cannot be distinguished.) *WCDMA/TD-SCDMA:* An RRC Connection Request was sent following initiation of an MO or MT call. *GAN:* • (MO call) GAN Layer 3 message Request sent with establishment cause 64 (TCH/H sufficient) or 224 (TCH/F needed). • (MT call) GAN Layer 3 message Paging Request received.
Call Attempt Retry	 (gray)	g w	A call attempt (see the event Call Attempt) was repeated. Triggered by Channel Request/RRC Connection Request.

Event Name	Symbol	*	Description/Extra Information
Call End		g w	A call was terminated. This event is normally triggered by the CC message Release. **Extra information:** • Call end cause (usually one of "MS initiated release", "NW initiated release", "User busy") • Call duration
Call Established	(green)	g w ga	A call was established. The event is triggered by • (*GSM/WCDMA/TD-SCDMA:*) the Layer 3 message Connect (MO call) or Connect Acknowledge (MT call) • (*GAN:*) the Layer 3 message Activate Channel Complete.
Call Initiation		g w	An MO call was initiated by a script (the equivalent of the "call" command being given in the handset GUI). This event is normally triggered by a report from the PC communication protocol, never by a Layer 3 message. This event precedes Call Attempt.
Call Re-established	(green)	g w	Following a radio link failure, a call was re-established (a drop thus being prevented). Technology-specific details: *GSM:* New traffic channel assigned within 20 s. ▶ 3GPP 45.008, section 6.7.2 *WCDMA:* New traffic channel assigned before T314 timer expired. ▶ 3GPP 25.331, section 8.3.1.13 This event can occur only if call re-establishment is enabled in the network. If it is not, a call will be automatically dropped in this situation.

Event Name	Symbol	*	Description/Extra Information
Call Setup		g w ga	A call was set up by the device. The event is triggered by • (*GSM/WCDMA/TD-SCDMA:*) one of the Layer 3 messages Alerting or Connect • (*GAN:*) the GAN Layer 3 message Activate Channel. **Extra information:** • Call direction (MO/MT) • Call setup time (measured from Call Attempt, i.e. the *first* call attempt) • User setup time (measured from Call Initiation, thus more accurately reflecting the user-perceived setup time; obtained only for MO calls in scripts)
Cell Change Order From UTRAN		g	Successful cell change order: handover from UTRAN to GSM packet data channel. Generated after entering GSM mode. Only occurs when the change takes place from Cell_DCH mode. If it takes place from a Common channel, the event Cell Reselection From UTRAN is generated instead.
Cell Change Order From UTRAN Failure		w	Cell change order from UTRAN failed.
Cell Reselection		g w	Cell reselection within GSM or within UTRAN (intra-frequency). **Extra information** (GSM): BCCH ARFCN and BSIC of new cell.
Cell Reselection From UTRAN		g	Cell reselection from UTRAN to GSM. Generated after entering GSM mode.

Event Name	Symbol	*	Description/Extra Information
Cell Reselection To EUTRAN		lte	Cell reselection from UTRAN or GSM to EUTRAN. Generated after entering LTE mode. **Extra information:** • New cell EARFCN and PCI • Old cell UARFCN and SC (WCDMA) or ARFCN and BSIC (GSM)
Cell Reselection To UTRAN		w	Cell reselection from GSM to UTRAN. Generated after entering WCDMA mode.
Channel Switch From HSDPA		w td	Successful switch from HS-PDSCH to DPCH.
Channel Switch From HSDPA Failure		w td	Switch from HS-PDSCH to DPCH failed.
Channel Switch To HSDPA		w td	Successful switch from DPCH (3GPP Release 99) to HS-PDSCH.
Channel Switch To HSDPA Failure		w td	Switch from DPCH to HS-PDSCH failed.
Compressed Mode Entered		w	The device entered compressed mode.
Compressed Mode Exited		w	The device left compressed mode.
CS Call Initiated on IP Call Request (Incoming)		g w	A VoIP (IP) call was requested by the user, but instead a CS voice call was initiated by the UE.
CS Call Initiated on IP Call Request (Outgoing)		g w	Answering of a VoIP (IP) call was intended by the user, but instead the UE answered it by initiating a CS voice call.

Event Name	Symbol	*	Description/Extra Information
CSFB Blocked Call	(red)	g w lte	A CS fallback call was blocked. This can happen in several ways: • The Extended Service Request timed out without any response from network, or the network responded with Service Reject. In this case the CS fallback procedure never reaches the RAT change stage. • RAT change to UTRAN/GERAN failed, as indicated by the event EUTRAN RRC Connection Release Redirected Failure. • After successful RAT change to UTRAN/GERAN, the CS call setup failed (CS Blocked Call event generated). **Extra information:** • Call direction (MO/MT) • Block type Regarding CS fallback in general, see ▶ 3GPP 23.272.
CSFB Call Attempt	(gray)	lte	A CS fallback call attempt was made. Triggered by the Layer 3 message NAS Extended Service Request. **Extra information:** • Call direction (MO/MT)
CSFB Call Established	(green)	g w	A CS fallback call was established. Triggered by the Layer 3 message Connect (MO call) or Connect Acknowledge (MT call). **Extra information:** • Call direction (MO/MT) • Target technology (WCDMA/GSM)

Event Name	Symbol	*	Description/Extra Information
CSFB Call Initiation		lte	A CS fallback call was initiated by a Service Control script. This event is normally triggered by a report from the PC communication protocol, never by a Layer 3 message. This event is generated if the device has previously performed Combined EPS/IMSI Attach, thereby notifying the network that it desires to be able to make CS fallback calls. If no such attach command has been observed, the event is not generated.
CSFB Call Setup		g w	A CS fallback call was set up. Triggered by the Layer 3 message Alerting. **Extra information:** • Call direction (MO/MT) • Target technology (WCDMA/GSM) • Call setup time (measured from CSFB Call Attempt, i.e. the *first* call attempt) • User setup time (measured from CSFB Call Initiation, thus more accurately reflecting the user-perceived setup time. Obtained only for MO calls in scripts. If no CSFB Call Initiation event was generated, the user setup time cannot be computed.)
CSFB During IP Call Setup		g w	The call setup procedure was initiated as a VoIP (IP) call, but before the call setup was completed, the call setup procedure was handed over to the CS domain.
Datalink Failure		g	Datalink failure caused by unsolicited Disconnected Mode response or sequence error.
Dedicated Mode		g	The device entered dedicated mode. **Extra information:** BCCH ARFCN and BSIC.

Event Name	Symbol	*	Description/Extra Information
Dropped Call		g w	Call abnormally ended after Call Established event. **Extra information:** • Drop type • Cause • CC cause • Call duration (time since Call Established event)
EGPRS MS Out Of Memory		e	The device’s status buffer filled up, so that the device was no longer able to use Incremental Redundancy on the downlink for link quality control. Consequently it was forced to switch to using Link Adaptation.
Emergency Call Failure		g w	This event is generated for an emergency call (after call end) if its duration was shorter than 35 s. The call is then regarded as failed because it is not certain that a position fix was obtained within such a short time. Detailed trigger conditions: Step 1 as for Emergency Call Success, but duration criteron *not* satisfied in step 2.

Event Name	Symbol	*	Description/Extra Information
Emergency Call Success		g w	This event is generated for an emergency call (after call end) if it had a duration of at least 35 s. It can then be regarded as certain that a position fix was obtained. Detailed trigger conditions: *GSM:* 1 CM Service Request sent with Service Type = 2 (“Emergency call establishment”). 2 Call successfully set up and maintained for at least 35 s (counting from step 1) with TCH available without a break throughout this time. *WCDMA:* 1 RRC Connection Request sent with establishment cause = “Emergency call”. 2 Call successfully set up and maintained for at least 35 s (counting from step 1) with TCH available without a break throughout this time.
EPS events: Some of these, tagged “**lg**” below, are unique to LG chipset devices.			
EPS NAS Signaling Failure		lte **lg**	EPS NAS signaling failed. **Extra information:** Details the nature of the failure, e.g.: “Release with cause Load Balancing TAU Required by network” “Release with cause Redirection by network” “Data transmission failure caused by RRC mobility” “Service loss”
EPS NAS Timer Expiry		lte **lg**	An EPS NAS timer expired. **Extra information:** “Timer T<nnnn> expired”, where <nnnn> = 3411, 3402, etc.

Event Name	Symbol	*	Description/Extra Information
EPS RACH Failure		lte **lg**	An EPS random access procedure failed.
EPS RACH Success		lte **lg**	An EPS random access procedure succeeded.
EPS Radio Problem		lte **lg**	An EPS NAS radio problem occurred. This event partially overlaps with EPS RRC Timer Expiry. **Extra information:** Problem cause, e.g.: "MAC out of sync" "RLC max RETX" "Integrity failure" "Timer T300 expired"
EPS RRC Timer Expiry		lte **lg**	An EPS RRC timer expired. **Extra information:** "Timer T<nnn> expired", where <nnn> = 300, 301, 304, etc.
EPS TDD UL/DL Configuration Changed		lte	TDD subframe configuration changed. ▶ 3GPP 36.211, table 4.2-1 **Extra information:** • Old subframe configuration • New subframe configuration Each subframe configuration is represented as a string where U = uplink, D = downlink, and S = special subframe. Example: "D:S:U:U:U:D:S".
EPS Transmission Mode Changed		lte	Change of EPS transmission mode. Compare the LTE information element Transmission Mode.

Event Name	Symbol	*	Description/Extra Information
EUTRAN ANR Neighbor Reported		lte	The device reported CGI for a cell identified as a missing neighbor by the Automatic Neighbor Relation mechanism. ▶ 3GPP 36.300, sections 22.3.2a, 22.3.3–22.3.4; 3GPP 36.331, section 5.5 **Extra information:** Type of ANR neighbor: intra-frequency, inter-frequency, or Inter-RAT.
EUTRAN Attach Complete		lte	The device successfully attached to EUTRAN. Triggered by EPS Attach Complete. **Extra information:** • Attach type: EPS attach result in Attach Accept message • Attach time: Time from Attach Request to Attach Complete
EUTRAN Attach Failure		lte	Attach to EUTRAN failed. Triggered by Attach Reject or timeout. **Extra information:** • Attach type • Failure cause
EUTRAN Detach Accept		lte	The device successfully detached from EUTRAN. Triggered by EPS Detach Accept. **Extra information:** • Attach type detached from • Detach time: Time from Detach Request to Detach Accept

Event Name	Symbol	*	Description/Extra Information
EUTRAN Inter-frequency Handover		lte	Intra-RAT, inter-frequency handover signaled by the eNodeB. ▶ 3GPP 36.331, section 5.3.5.4 Triggered by the Layer 3 message RRC Connection Reconfiguration with *targetPhyCellId* differing from serving cell ID, and on different EARFCN. **Extra information:** • Old EARFCN, new EARFCN • Old cell ID, new cell ID • Handover interruption time
EUTRAN Inter-frequency Handover Failed		lte	Intra-RAT, inter-frequency handover failed. Triggered by expiry of the T304 timer configured in the RRC Connection Reconfiguration message. ▶ 3GPP 36.331, section 5.3.5.6 **Extra information:** • Old EARFCN, new EARFCN • Old cell ID, new cell ID • Handover interruption time
EUTRAN Intra-frequency Handover		lte	Intra-RAT, intra-frequency handover signaled by the eNodeB. ▶ 3GPP 36.331, section 5.3.5.4 Triggered by the Layer 3 message RRC Connection Reconfiguration with *targetPhyCellId* differing from serving cell ID, but on same EARFCN. **Extra information:** • EARFCN • Old cell ID, new cell ID • Handover interruption time

Event Name	Symbol	*	Description/Extra Information
EUTRAN Intra-frequency Handover Failed		lte	Intra-RAT, intra-frequency handover failed. Triggered by expiry of the T304 timer configured in RRC Connection Reconfiguration message. ▶ 3GPP 36.331, section 5.3.5.6 **Extra information:** • EARFCN • Old cell ID, new cell ID • Handover interruption time
EUTRAN Reselection Time After CSFB Call		lte	This event carries performance information on the switch back to LTE after hangup of a CS fallback call. **Extra information:** • Idle to LTE time: Time in seconds from entering idle mode (in UMTS) to reception of System Information Block on LTE. • SIB 19 to LTE time: Time in seconds from reception of System Information Block Type 19 (UMTS) to reception of System Information Block on LTE.
EUTRAN RRC A1 Event		lte	Measurement Report containing A1 event sent from device: serving cell is better than *threshold*. ▶ 3GPP 36.331, section 5.5.4.2 **Extra information:** Serving cell readings.
EUTRAN RRC A2 Event		lte	Measurement Report containing A2 event sent from device: serving cell is worse than *threshold*. ▶ 3GPP 36.331, section 5.5.4.3 **Extra information:** Serving cell readings.
EUTRAN RRC A3 Event		lte	Measurement Report containing A3 event sent from device: neighbor is *offset* better than serving cell. ▶ 3GPP 36.331, section 5.5.4.4 **Extra information:** Serving cell and neighbor readings.

Event Name	Symbol	*	Description/Extra Information
EUTRAN RRC A4 Event		lte	Measurement Report containing A4 event sent from device: neighbor is better than *threshold*. ▶ 3GPP 36.331, section 5.5.4.5 **Extra information:** Neighbor readings.
EUTRAN RRC A5 Event		lte	Measurement Report containing A5 event sent from device: serving cell is worse than *threshold1* and neighbor is better than *threshold2*. ▶ 3GPP 36.331, section 5.5.4.6 **Extra information:** Serving cell and neighbor readings.
EUTRAN RRC Connection Reject		lte	An RRC connection was rejected.
EUTRAN RRC Connection Release Redirected Attempt		lte	An RRC connection was redirected. Triggered by EPS RRC Connection Release message with redirection flag. **Extra information:** Redirection control information from RRC Connection Release message.
EUTRAN RRC Connection Release Redirected Failure		lte	Redirection of RRC connection failed; the device returned to EUTRAN without successful new connection setup.

Event Name	Symbol	*	Description/Extra Information
EUTRAN RRC Connection Release Redirected Success		ltewg[1]	Successful new connection setup following EPS RRC Connection Release message with redirection flag. Triggered by one these messages: • *WCDMA:* RRC Connection Setup Complete • *GSM:* Immediate Assignment • *GPRS/EDGE:* Packet Uplink/Downlink Assignment • *EV-DO:* Traffic Channel Complete • *1x:* Service Connect **Extra information:** • Technology and cell to which the device was redirected. • Redirection control information from RRC Connection Release message. • RRC Reconnect Time, measured from RRC Connection Release to the relevant message above.
EUTRAN RRC Established	 (green)	lte	An RRC connection was established. Triggered by RRC Connection Setup Complete message. **Extra information:** Establishment cause.
Handover		g	Successful inter-cell handover in GSM.
Handover Failure		g	Inter-cell handover in GSM failed.

Event Name	Symbol	*	Description/Extra Information
Handover From EUTRAN		w	Successful handover from EUTRAN to UTRAN. Generated after entering WCDMA mode. **Extra information:** • Handover type: PS or SRVCC • Source RAT, target RAT • Handover interruption time, measured from Mobility From EUTRA Command (with Handover To UTRAN indication) to Handover To UTRAN Complete.
Handover From EUTRAN Failure		lte	Handover from EUTRAN to UTRAN failed.
Handover From GAN		ga	Successful handover from GAN to GERAN (GSM). Triggered by the GAN Layer 3 message Handover Command if followed by Deregister or if a period of 2 s passes without Handover Failure being received.
Handover From GAN Failure		ga	Handover from GAN to GERAN (GSM) failed. Triggered by the GAN Layer 3 message Handover Failure.
Handover From UTRAN		g	Successful handover from UTRAN to GSM. Generated after entering GSM mode.
Handover From UTRAN Failure		w	Handover from UTRAN to GSM failed.
Handover Intracell		g	Successful intra-cell handover in GSM.
Handover Intracell Failure		g	Intra-cell handover in GSM failed.

Event Name	Symbol	*	Description/Extra Information
Handover To EUTRAN		lte	Successful handover from UTRAN to EUTRAN. Generated after entering LTE mode. **Extra information:** Handover interruption time, measured from “Handover From UTRAN Command-EUTRA” to “RRC Reconfiguration Complete”.
Handover To EUTRAN Failure		w	Handover from UTRAN to EUTRAN failed.
Handover To GAN		ga	Successful handover from GERAN (GSM) to GAN. Triggered by the GAN Layer 3 message Handover Complete.
Handover To GAN Failure		ga	Handover from GERAN (GSM) to GAN failed. Triggered if TU3920 timer expires after Handover Access without Handover Complete being received. TU3920 is a timer included in the Register Accept message sent from the GANC.
Handover To UTRAN		w	Successful handover from GSM to UTRAN. Generated after entering WCDMA mode.
Handover To UTRAN Failure		g	Handover from GSM to UTRAN failed.
HS Serving Cell HO		w	Successful HSPA serving cell handover. The same symbol is used as for Inter-frequency Handover, since HSPA serving cell handover is handled in a similar way (and differently from UMTS soft handover).
HS Serving Cell HO Failure		w	HSPA serving cell handover failed. The same symbol is used as for Inter-frequency Handover Failure (compare HS Serving Cell HO).

Event Name	Symbol	*	Description/Extra Information
Idle Mode		g	The device entered idle mode. **Extra information:** BCCH ARFCN and BSIC.
Inter-frequency Cell Reselection		w	Successful WCDMA inter-frequency cell reselection. **Extra information:** New UARFCN; new SC.
Inter-frequency Handover		w td	Successful inter-frequency handover in WCDMA or TD-SCDMA. **Extra information:** New UARFCN.
Inter-frequency Handover Failure		w td	Inter-frequency handover in WCDMA or TD-SCDMA failed.
Intra-frequency Hard Handover		w td	Successful intra-frequency hard handover in WCDMA or TD-SCDMA.
Intra-frequency Hard Handover Failure		w td	Intra-frequency hard handover in WCDMA or TD-SCDMA failed.
Limited Service Mode		g	The GSM device entered limited service mode (emergency calls only).
Location Area Update		g w	The device changed location areas. **Extra information:** Location update type (LUT).
Location Area Update Failure		g w	The device failed in changing its location area. **Extra information:** Cause; location update type (LUT).
Measurement Report 1		w	Intra-frequency measurement report sent from device (UMTS reporting events “1A”, “1B”, etc.). ► 3GPP 25.331, section 14.1 **Extra information:** Type of UMTS event.
Measurement Report 2		w	Inter-frequency measurement report sent from device (UMTS reporting events “2A”, “2B”, etc.). ► 3GPP 25.331, section 14.2 **Extra information:** Type of UMTS event.

Event Name	Symbol	*	Description/Extra Information
Measurement Report 3		w	Inter-RAT measurement report sent from device (UMTS reporting events “3A”, “3B”, etc.). ▶ 3GPP 25.331, section 14.3 **Extra information:** Type of UMTS event.
Measurement Report 4		w	Traffic volume measurement report sent from device (UMTS reporting events “4A”, “4B”). ▶ 3GPP 25.331, section 14.4 **Extra information:** Type of UMTS event.
Measurement Report 5		w	Quality measurement report sent from device (UMTS reporting event “5A”). ▶ 3GPP 25.331, section 14.5 **Extra information:** Type of UMTS event.
Measurement Report 6		w	UE-internal measurement report sent from device (UMTS reporting events “6A”, “6B”, etc.). ▶ 3GPP 25.331, section 14.6 **Extra information:** Type of UMTS event.
Measurement Report 7		w	UE positioning measurement report sent from device (UMTS reporting events “7A”, “7B”, etc.). ▶ 3GPP 25.331, section 14.7 **Extra information:** Type of UMTS event.

Event Name	Symbol	*	Description/Extra Information
Missing GSM Neighbor	 (yellow bar on the right)	sg	This is a GSM event based on scan data that includes decoded BSIC and System Information. The event does not require a cell file. It is assumed that the strongest cell with decoded BSIC is the serving cell. Among other cells with decoded BSIC, the six strongest ones are looked up in the strongest cell’s neighbor list (which is extracted from System Information messages). For each cell that is not in the neighbor list, an instance of this event is generated. The event is only generated once for each combination of assumed serving cell (ARFCN + BSIC) and missing neighbor (ARFCN). **Extra information:** BCCH ARFCN and BSIC of serving cell; ARFCN, BSIC, and signal strength (in dBm) of missing neighbor.
Missing GSM Neighbor, GSM Symmetry	 (yellow bar on the right)	g	This is a GSM event based on UE data. It does not require a cell file. Triggered in when the source cell of a handover is not in the target cell’s neighbor list. Cells are compared with respect to ARFCN and BSIC. If BSIC is not available, the event will not be triggered. The event triggering is delayed two seconds after the handover to ensure that the entire neighbor list of the target cell has been received. **Extra information:** Serving cell ARFCN and BSIC (i.e. new serving cell after handover); missing neighbor ARFCN and BSIC (i.e. old serving cell prior to handover).

Event Name	Symbol	*	Description/Extra Information
Missing LTE Neighbor	 (yellow bar on the right)		This event is based on LTE scan data. It requires that a cell file is loaded and that the currently strongest cell has a neighbor list defined in that file. Triggered in the following cases: 1 A cell not defined as a neighbor of the strongest cell is more than *n* dB stronger than at least one neighbor of the strongest cell. The margin *n* dB is set in the **General** window under **LTE**. 2 A cell not defined as a neighbor of the strongest cell is within *n* dB of the strongest cell. (The event is then triggered regardless of the strength of defined neighbors.) 3 No cell from the strongest cell's neighbor list is detected, but at least one cell is detected besides the strongest cell. (The event is then triggered regardless of the strength of that cell.) The signal power measure used in the comparisons is RSRQ. **Extra information:** EARFCN plus the following (different for each of the three cases listed above): • Case 1: Defined neighbor Cell Identity and RSRQ; missing neighbor Cell Identity and RSRQ. • Case 2: Strongest cell Cell Identity; missing neighbor Cell Identity and RSRQ. • Case 3: Strongest cell Cell Identity; missing neighbor Cell Identity.

Event Name	Symbol	*	Description/Extra Information
Missing TD-SCDMA Neighbor	 (yellow bar on the right)		This event is based on TD-SCDMA scan data. It requires that a cell file is loaded and that the currently strongest cell has a neighbor list defined in that file. Triggered in the following cases: 1 A cell not defined as a neighbor of the strongest cell is more than *n* dB stronger than at least one neighbor of the strongest cell. The margin *n* dB is set in the **General** window under **TD-SCDMA**. 2 A cell not defined as a neighbor of the strongest cell is within *n* dB of the strongest cell. (The event is then triggered regardless of the strength of defined neighbors.) 3 No cell from the strongest cell's neighbor list is detected, but at least one cell is detected besides the strongest cell. (The event is then triggered regardless of the strength of that cell.) The signal power measure used in the comparisons is Ec/Io. **Extra information:** UARFCN plus the following (different for each of the three cases listed above): • Case 1: Defined neighbor CPID and Ec/Io; missing neighbor CPID and Ec/Io. • Case 2: Strongest cell CPID; missing neighbor CPID and Ec/Io. • Case 3: Strongest cell CPID; missing neighbor CPID.

Event Name	Symbol	*	Description/Extra Information
Missing WCDMA Intra-frequency Neighbor	 (yellow bar on the right)	w	This is a WCDMA event based on UE data. The event does not require a cell file. Triggered in the following cases: 1 The strongest active set member lies between –18 dB and –12 dB, and the strongest detected neighbor is stronger than –12 dB. 2 The strongest active set member is stronger than –12 dB, and the strongest detected neighbor is stronger than –12 dB. 3 A detected neighbor exists, although no active set member or monitored neighbor exists. The signal strength measure used in the comparisons is CPICH Ec/No. **Extra information:** • Cases 1 and 2 above: Priority (“1” and “2” respectively); strongest active set member SC and Ec/No; missing neighbor SC and Ec/No. • Case 3: Missing neighbor SC and Ec/No.

Event Name	Symbol	*	Description/Extra Information
Missing WCDMA Neighbor	 (yellow bar on the right)	(c) sw	This event is based on WCDMA scan data. It requires either • that the scan data includes decoded SIBs, or • that a cell file is loaded and that the currently strongest cell has a neighbor list defined in that file. If both SIB and cell file data are available, the SIBs are used and the cell file is ignored. Triggered in the following cases: 1 A cell not defined as a neighbor of the strongest cell is more than *n* dB stronger than at least one neighbor of the strongest cell. The margin *n* dB is set in the **General** window under **WCDMA**. 2 A cell not defined as a neighbor of the strongest cell is within *n* dB of the strongest cell. (The event is then triggered regardless of the strength of defined neighbors.) 3 No cell from the strongest cell's neighbor list is detected, but at least one cell is detected besides the strongest cell. (The event is then triggered regardless of the strength of that cell.) The signal power measure used in the comparisons is Aggr Ec. **Extra information:** UARFCN plus the following (different for each of the three cases listed above): • Case 1: Defined neighbor SC and Ec/Io; missing neighbor SC and Ec/Io. • Case 2: Strongest cell SC; missing neighbor SC and Ec/Io. • Case 3: Strongest cell SC; missing neighbor SC.

Event Name	Symbol	*	Description/Extra Information
More Than 3 Strong SCs	(red bar on the right)	sw	This event is based on WCDMA scan data. The information element Poss No of AS Members (with argument = power threshold *n* dB governed by the **Missing Neighbor Margin** setting in the **General** window under **WCDMA**) is larger than 3, and all the detected scrambling codes are stronger than –100 dBm. **Extra information:** UARFCN.
No Service Mode		g	The device entered no service mode, since it could not find a control channel.
Packet Mode		g	The device entered packet mode (switched to a PDCH). **Extra information:** BCCH ARFCN and BSIC.
PDP Context Activation [2]		g w	A PDP context was successfully activated. **Extra information:** • Setup time, counted from the first RRC Connection Request message to Activate PDP Context Accept. • PDP context completion time, counted from the first Activate PDP Context Request message to Activate PDP Context Accept.
PDP Context Activation Failure [2]		g w	Activation of a PDP context failed. **Extra information:** Failure cause.
PDP Context Deactivation [2]		g w	An active PDP context was deactivated.
PDU Error		g	Protocol Data Unit error caused by syntax error in a Layer 3 message.
PS Attach [2]		g w	The device successfully attached to the packet service. **Extra information:** Attach type; attach completion time.

Event Name	Symbol	*	Description/Extra Information
PS Attach Failure [2]		g w	The device failed to attach to the packet service. **Extra information:** Attach type; failure cause.
PS Channel Type Switch Complete		w	A switch between a dedicated data channel and a common data channel succeeded. **Extra information:** Direction of switch: “Dedicated to Common” or “Common to Dedicated”.
PS Channel Type Switch Failure		w	A switch between a dedicated data channel and a common data channel failed. **Extra information:** Direction of switch: “Dedicated to Common” or “Common to Dedicated”.
PS Data Interruption Time Due To CSFB		g w	This event reports the IP interruption time during RAT change to UTRAN/GERAN due to initiation of a CS fallback call. Always generated in conjunction with the IP Interruption Time event. **Extra information:** Interruption time in ms. Measured from last received IP packet in EUTRAN to first received IP packet in UTRAN/GERAN.
PS Detach		g w	The device successfully detached from the packet service.
PS RAB Channel Rate Switch Complete		w	The spreading factor, and hence the data rate, was changed successfully for the radio access bearer. **Extra information:** Uplink and downlink spreading factors.
PS RAB Channel Rate Switch Failure		w	A change of spreading factor failed for the radio access bearer. **Extra information:** Uplink and downlink spreading factors.

Event Name	Symbol	*	Description/Extra Information
Radio Bearer Reconfiguration Failure		w	The device could not reconfigure the radio bearer. **Extra information:** Cause value.
Radio Bearer Setup Failure		w	The device could not set up the radio bearer. **Extra information:** Cause value.
Radio Link Addition		w	One or several radio links were added. **Extra information:** Added scrambling codes; soft handover type; event type.
Radio Link Addition Failure		w	Addition of one or several radio links failed. **Extra information:** Failure cause.
Radio Link Removal		w	One or several radio links were removed. **Extra information:** Removed scrambling codes; event type.
Radio Link Removal Failure		w	Removal of one or several radio links failed. **Extra information:** Failure cause.
Radio Link Replacement		w	Combined addition and removal of radio links. **Extra information:** Added scrambling codes; removed scrambling codes; soft handover type; event type.
Radio Link Replacement Failure		w	Addition or removal of one or several radio links failed. **Extra information:** Failure cause.
Ringing		g	The GSM device started emitting a ringing signal.
Routing Area Update		g w	The device changed routing areas.

Event Name	Symbol	*	Description/Extra Information
Routing Area Update Failure		g w	The device failed in changing its routing area. **Extra information:** Failure cause.
Rove In To GAN		ga	Successful reselection from GSM to GAN. Triggered by the GAN Layer 3 message Register Accept.
Rove In To GAN Failure		ga	Reselection from GSM to GAN failed. Triggered by the GAN Layer 3 message Register Reject or by the TU3904 timer expiring after Register Request is sent. **Extra information:** Failure cause.
Rove In To GAN Redirect		ga	When reselecting from GSM to GAN, the device was redirected from the default GANC to a different GANC. Triggered by the GAN Layer 3 message Register Redirect.
Rove Out From GAN		ga	Successful reselection from GAN to GSM. Triggered by the GAN Layer 3 message Deregister.
Rove Out From GAN Failure		ga	Reselection from GAN to GSM failed. Triggered when GA-RC/ GA-CSR State switches to Deregistered without Deregister message being received.
RRC Connection Abnormal Release		w	An RRC connection was abnormally released. **Extra information:** Failure cause.
RRC Connection Reject		w	An RRC connection was rejected. **Extra information:** Failure cause. ▶ 3GPP 25.331, section 10.3.3.31
RRC Established	(green)	w	An RRC connection was established. Triggered by the message RRC Connection Setup Complete. **Extra information:** Establishment cause.

Event Name	Symbol	*	Description/Extra Information
RRC Protocol Error	 (red)	w	An RRC protocol error occurred. **Extra information:** Failure cause.
Scanning Mode		sg	The GSM device entered scanning mode, i.e. it started some type of scanning.
Security Mode Failure		w	A security mode command failed. **Extra information:** Cause value.
SHO Procedure Complete		w	Soft handover: Active set update procedure completed with Measurement Control message.
SHO Procedure Complete Without Measurement Control		w	Soft handover: Active set update procedure completed without a Measurement Control message (because another soft handover procedure started). **Extra information:** One of "Addition", "Removal", "Replacement".
Silent Call		g w	A silent call was detected by the AQM algorithm: all system signaling was OK, but the audio was not transferred in both directions. The event is triggered 27.5 s after the last Stop DTMF Acknowledge message. See the document "AQM in TEMS Products".
SMS Error		g w	Transfer of an SMS message failed (during either sending or receiving).
SMS Received		g w	An SMS message was successfully received.
SMS Sent		g w	Sending of an SMS message was successfully competed.
VCC Handover From EUTRAN		w g 1	Voice Call Continuity handover of VoLTE call from EUTRAN to UTRAN/GERAN. **Extra information:** Handover type: SRVCC (Single Radio VCC) or DRVCC (Dual Radio VCC).

1. Also occurs in 1x and EV-DO in case of redirection to either of these technologies.
2. Retained here although a similar event exists in the Data category. The latter (only) is used as input to KPIs.

8.3. CDMA Events

Event Name	Symbol	Description/Extra Information
Blocked Call	 (red)	Unexpected change to idle or init state before Call Established, or Order (PCH) Message received with one of the order codes “Reorder”, “Intercept”, “Registration Reject”, or “Release”.
Call Attempt	 (gray)	*MO call:* Origination (ACH) message sent with a voice Service Option. *MT call:* Page Response (ACH) message received with a voice Service Option.
Call Attempt Retry	 (gray)	A call attempt (see Call Attempt) was repeated.
Call End		Triggered by Order (RTCH) Message or Order (FTCH) Message with order code “Release”.
Call Established	 (green)	*MO call:* Triggered by Service Connect Completion (RTCH) Message. *MT call:* Order (RTCH) Message with order code “Connect”.
Call Initiation		Triggered by Protocol Report containing dialed number.
Call Setup		A call was set up by the device. Triggered by Service Connect Completion (RTCH) Message.
Dedicated Mode		The device is in traffic state.
Dropped Call		Unexpected change to idle or init state after Call Established.
EV-DO 1x Tune-away		The device suspended the EV-DO service to look for 1x paging. Triggered by EV-DO Tuneaway Information Report.
EV-DO Access Failure		An EV-DO access attempt failed. Triggered by EV-DO Access Attempt Report.

Event Name	Symbol	Description/Extra Information
EV-DO Access Success		An EV-DO access attempt completed successfully. Triggered by EV-DO Access Attempt Report.
EV-DO Connection Failure		An EV-DO connection attempt failed. Triggered by EV-DO Connection Attempt Report.
EV-DO Connection Success		An EV-DO connection attempt completed successfully. Triggered by EV-DO Connection Attempt Report.
EV-DO Dynamic Rate		The device switched back from fixed rate to dynamic rate during an EV-DO session. Triggered by occurrence of fixed rate end time (see EV-DO Fixed Rate).
EV-DO Fixed Rate		The device entered fixed rate mode for a period of time during an EV-DO session. Triggered by receipt of Fixed Mode Enable Message (containing a given end time).
EV-DO Handoff 1 Active		The EV-DO active set was reduced to a single pilot. **Extra information:** • *EV-DO Rev. A:* PN offset of each active pilot. • *EV-DO Rev. B:* RF channel(s) and PN offset of each active pilot (to one pilot PN may correspond multiple RF channels: <Channel 1>-<PN 1>, <Channel 2>-<PN 1>, ...)
EV-DO Handoff 2 Actives		Handoff in EV-DO traffic mode, two pilots in active set. **Extra information:** See EV-DO Handoff 1 Active.

Event Name	Symbol	Description/Extra Information
EV-DO Handoff 3 Actives		Handoff in EV-DO traffic mode, three pilots in active set. **Extra information:** See EV-DO Handoff 1 Active.
EV-DO Handoff 4 Actives		Handoff in EV-DO traffic mode, four pilots in active set. **Extra information:** See EV-DO Handoff 1 Active.
EV-DO Handoff 5 Actives		Handoff in EV-DO traffic mode, five pilots in active set. **Extra information:** See EV-DO Handoff 1 Active.
EV-DO Handoff 6 Actives		Handoff in EV-DO traffic mode, six pilots in active set. **Extra information:** See EV-DO Handoff 1 Active.
EV-DO Island		There is only a single active EV-DO pilot and no candidates. Triggered by EV-DO Pilot Sets Ver2 Report.
EV-DO Session Failure		An EV-DO session attempt failed. Triggered by EV-DO Session Attempt Ver2 Report.
EV-DO Session Success		An EV-DO session attempt completed successfully. Triggered by EV-DO Session Attempt Ver2 Report.

Event Name	Symbol	Description/Extra Information
Hard Handoff		Handoff in traffic state to another frequency, a different band, a different pilot set, or another frame offset, or a combination of these. Triggered by Active Set Change. **Extra information:** • *If band changed:* RF mode (EV-DO or 1x); new band; new RF channel; new top pilot PN. • *If only channel changed:* RF mode; new RF channel.
Idle Handoff		Idle handoff 1x to 1x or EV-DO to EV-DO. Triggered by Active Set Change. **Extra information:** • *If band changed:* RF mode (EV-DO or 1x); new band; new RF channel; new top pilot PN. • *If only channel changed:* RF mode; new RF channel.
Idle Handoff To Analog		System change from 1x or EV-DO to Analog in idle mode. Triggered by System Determination Last Main Action Report.
Idle Handoff To CDMA		System change from Analog or EV-DO to 1x in idle mode. Triggered by System Determination Last Main Action Report. **Extra information:** New RF channel.
Idle Handoff To EV-DO		System change from 1x to EV-DO in idle mode. Triggered by System Determination Last Main Action Report. **Extra information:** New RF channel.
Idle Mode		The device is in init state or entered idle mode.

Event Name	Symbol	Description/Extra Information
Missing CDMA Neighbor	 (olive green bar on the right)	See algorithm description in section 8.3.1.
Narrowband Interference		Generated in the course of narrowband interference scanning: see UM section 21.6. Triggered when an in-band RF channel has a strength exceeding the average in-band RSSI by an amount at least equal to Interference Offset. The latter margin is set in the General window: see UM section 21.6.1. The event is generated only once for a given interferer in the course of a scan. Furthermore, if interference is detected on several contiguous RF channels, only one event is reported for all of these channels.
No Service Mode		The mobile is searching for serving network, or is in sleep mode.
Packet Mode		The device entered data traffic mode.
Polluter	 (red bar on the right)	See algorithm description in section 8.3.1.
Soft Handoff 2-Way		Soft handoff in 1x traffic mode, two pilots in active set.
Soft Handoff 3-Way		Soft handoff in 1x traffic mode, three pilots in active set.
Soft Handoff 4-Way		Soft handoff in 1x traffic mode, four pilots in active set.
Soft Handoff 5-Way		Soft handoff in 1x traffic mode, five pilots in active set.

Event Name	Symbol	Description/Extra Information
Soft Handoff 6-Way		Soft handoff in 1x traffic mode, six pilots in active set.
Soft Handoff Complete		Active set in 1x reduced to a single pilot.
Traffic Handoff To Analog		System change from 1x to Analog during traffic. Triggered by System Determination Last Main Action Report.
Traffic Handoff To CDMA		System change from Analog or EV-DO to 1x during traffic. Triggered by System Determination Last Main Action Report.
Traffic Handoff To EV-DO		System change from 1x to EV-DO during traffic. Triggered by System Determination Last Main Action Report.

8.3.1. Algorithm for Pilot Pollution and Missing Neighbor Detection in CDMA

1. Order all pilot responses $P_1, P_2, \ldots$ by descending E_c/I_0. Discard pilots that lie below the noise floor (which is technology and frequency band dependent).
2. Identify all M pilots whose strength exceeds R, where

$$R = \frac{1}{2}(\text{T-Add} + \text{T-Drop}).$$

3. Let $M' = min(N, M)$, where N is the maximum number of fingers that a receiver can demodulate.
4. For $k = 2, \ldots, M$, check whether the $k\text{th}$ strongest pilot is in the neighbor list. Any pilot not in the neighbor list is flagged as a missing neighbor.
5. Calculate

$$S_1 = \sum_{k=1}^{M'} 10^{(E_c/I_0)_k/10}$$

6. Calculate

$$S_2 = \sum_{k=M'+1}^{L} 10^{(E_c/I_0)_k/10}$$

   where L is the largest integer such that

$$(E_c/I_0)_L \geq (E_c/I_0)_{M'} - 10 \text{ dB}.$$

7. Calculate the percentage of useful energy $d = S_1/(S_1 + S_2)$.
8. If $d \geq 0.85$, there is no pilot pollution.
9. If $d < 0.85$, then each pilot P_k such that $(E_c/I_0)_k \geq S_1 - 10 \text{ dB}$ is a polluter.

8.4. Data Events

8.4.1. General

These events are generated in the course of PS data service testing. Many of them serve as input to the computation of data service KPI statistics in TEMS Discovery; all of these appear in the window Events Of KPI Type in TEMS Investigation. All KPIs are defined in the Technical Reference volume, chapter 11, “KPI Definitions”. Individual KPIs in that chapter are referred to in the table in section 8.4.4. Further technical detail on KPIs is provided in a separate document “KPI Definitions in TEMS Products”, which is included in the TEMS Investigation documentation package.

All data service KPIs are based on the “Data” events; note that no KPIs are based on the (somewhat similar) “Data” category information elements in section 3.8.

KPIs for CS voice and video telephony are of course not derived from “Data” events but rather from information logged during the CS sessions. For details, again please refer to the document “KPI Definitions in TEMS Products”.

Certain events in the Data category have nothing to do with KPIs: chiefly, those consisting of a service designation plus one of the suffixes “Start”, “End”, or “Error”. These events signify simply that a data service session has started, ended, or aborted because of an error (of whatever kind; the cause is specified in the extra information).

8.4.2. Notes on KPIs for Particular Data Services

- MMS Notification and MMS End-to-end KPIs (TR sections 11.2.6.3–11.2.6.4 and 11.2.6.7–11.2.6.8) are based on multiple KPI events; this is not indicated in the table below.
- No KPI events exist for email because of the ubiquitous use of encryption in connection with that service, which makes it impossible to obtain many of the measurements that would be required for KPI calculation.
- No KPI events exist for SMS. The SMS events in section 8.2 are unrelated to KPI computation.

8.4.3. Notes on KPI Definitions in ETSI Specification

The ETSI KPI specification (▶ ETSI TS 102 250-2) describes two slightly different methods of KPI measurement, called “Method A” and “Method B” respectively.[1] TEMS Investigation supports both of these; measurements according to Methods A and B may be delivered in two separate instances of the event, or they may both be given in the same event instance.

1. ▶ ETSI TS 102 250-2 V1.4.1, section 4.2:
"Currently two main views about the best way to reflect the user's experience are in place: One preferring the payload throughput philosophy and the other preferring the transaction throughput philosophy:
Method A [...] defines trigger points which are as independent as possible from the service used, therefore representing a more generic view (payload throughput)
Method B [...] defines trigger points on application layer, therefore representing a more service oriented view (transaction throughput)."

8.4.4. Event List

Event Name	Symb.	Extra Info	Associated KPI (or Description)
ABM events: Test setup in UM section 12.20.3.10			
ABM Error		Cause	–
ABM Start		For each ABM server: Server ID; Server IP address; Server port	–
ABM Stop		–	–
AQM events (VoIP): Test setup in UM section 12.20.7.4			
AQM Session Complete		Phone number; synch time	–
AQM Session Failure		Phone number; synch time	–
AQM Session Start		–	–
Attach events			
Attach Failure		–	Attach Failure Ratio (%)
Attach Setup Time		Time in ms	Attach Setup Time (s)
DNS events			
DNS Host Name Resolution Failure		Domain name(s); DNS server address	–
DNS Host Name Resolution Time		Domain name(s); DNS server address; Resolution time in seconds	–

Event Name	Symb.	Extra Info	Associated KPI (or Description)
Email receive events: Test setup in UM section 12.20.4.2			
Email Receive End		Outcome	– (No KPIs defined for email)
Email Receive Error		Cause	
Email Receive Start		POP3 server IP address or host name	
Email send events: Test setup in UM section 12.20.4.1			
Email Send End		Outcome	– (No KPIs defined for email)
Email Send Error		Cause	
Email Send Start		SMTP server IP address or host name	
FTP download events: Test setup in UM section 12.20.3.11. Not obtained for SFTP.			
FTP Download Data Transfer Cutoff		Cutoff point	Data Transfer Cut-off Ratio (%)
FTP Download Data Transfer Time		Time in seconds	Data Transfer Time (s)
FTP Download End		Outcome	–
FTP Download Error		Cause	–
FTP Download IP Service Access Failure		Details of failure	IP Service Access Failure Ratio (%)
FTP Download IP Service Setup Time		Time in seconds	IP Service Setup Time (s)
FTP Download Mean Data Rate		Data rate in kbit/s	Mean Data Rate (kbit/s)

Event Name	Symb.	Extra Info	Associated KPI (or Description)
FTP Download Service Not Accessible		Details of failure	Service Non-Accessibility (%)
FTP Download Setup Time		Time in seconds	Setup Time (s)
FTP Download Start		File path and name	–
FTP upload events: Test setup in UM section 12.20.3.12. Not obtained for SFTP.			
FTP Upload Data Transfer Cutoff		Cutoff point	Data Transfer Cut-off Ratio (%)
FTP Upload Data Transfer Time		Time in seconds	Data Transfer Time (s)
FTP Upload End		Outcome	–
FTP Upload Error		Cause	–
FTP Upload IP Service Access Failure		Details of failure	IP Service Access Failure Ratio (%)
FTP Upload IP Service Setup Time		Time in seconds	IP Service Setup Time (s)
FTP Upload Mean Data Rate		Data rate in kbit/s	Mean Data Rate (kbit/s)
FTP Upload Service Not Accessible		Details of failure	Service Non-Accessibility (%)
FTP Upload Setup Time		Time in seconds	Setup Time (s)
FTP Upload Start		File path and name	–
HTTP events, general			
HTTP Service Not Accessible		Details of failure	Service Non-Accessibility (%)
HTTP Setup Time		Time in seconds	Setup Time (s)

Event Name	Symb.	Extra Info	Associated KPI (or Description)
HTTP events, Get: Test setup in UM section 12.20.3.13			
HTTP Data Transfer Cutoff		Cutoff point	Data Transfer Cut-off Ratio (%)
HTTP Data Transfer Time		Time in seconds	Data Transfer Time (s)
HTTP End		Outcome	–
HTTP Error		Cause	–
HTTP IP Service Access Failure		Details of failure	IP Service Access Failure Ratio (%)
HTTP IP Service Setup Time		Time in seconds	IP Service Setup Time (s)
HTTP Mean Data Rate		Data rate in kbit/s	Mean Data Rate (kbit/s)
HTTP Start		IP address or host name	–
HTTP events, Post: Test setup in UM section 12.20.3.14			
HTTP Post Data Transfer Cutoff		Cutoff point	Data Transfer Cut-off Ratio (%)
HTTP Post Data Transfer Time		Time in seconds	Data Transfer Time (s)
HTTP Post End		Outcome	–
HTTP Post Error		Cause	–
HTTP Post IP Service Access Failure		Details of failure	IP Service Access Failure Ratio (%)
HTTP Post IP Service Setup Time		Time in seconds	IP Service Setup Time (s)

Event Name	Symb.	Extra Info	Associated KPI (or Description)
HTTP Post Mean Data Rate		Data rate in kbit/s	Mean Data Rate (kbit/s)
HTTP Post Start		HTTP server script URL	–
IP events			
IP Interruption Time		Time in seconds	– (unrelated to KPIs) Generated on handover and indicates time gap between last IP packet in old cell and first IP packet in new cell.[1] **Note:** For this time to be correct, IP sniffing must not be configured for “Optimized Performance”. See UM section 12.20.3.8.
MMS receive events: Test setup in UM section 12.20.4.4			
MMS Receive Data Transfer Cutoff		–	Data Transfer Cut-off Ratio (%)
MMS Receive Data Transfer Time		Time in seconds	Data Transfer Time (s)
MMS Receive End		Outcome	–
MMS Receive Error		Cause	–
MMS Receive Start		–	–
MMS Retrieval Failure		–	MMS Retrieval Failure Ratio (MT) (%)
MMS Retrieval Time		Time in seconds	MMS Retrieval Time (MT) (s)

Event Name	Symb.	Extra Info	Associated KPI (or Description)
MMS send events: Test setup in UM section 12.20.4.3			
MMS Send Data Transfer Cutoff		–	Data Transfer Cut-off Ratio (%)
MMS Send Data Transfer Time		Time in seconds	Data Transfer Time (s)
MMS Send End		Outcome	–
MMS Send Error		Cause	–
MMS Send Failure		–	MMS Send Failure Ratio (MO) (%)
MMS Send Start		–	–
MMS Send Time		Time in seconds	MMS Send Time (MO) (s)
MTSI events: Test setup in UM sections 12.20.7.1–12.20.7.5			
MTSI Registration Failure		–	MTSI Registration Failure Ratio (%)
MTSI Registration Time		Time in seconds	MTSI Registration Time (s)
MTSI Session Completion Failure		–	MTSI Session Completion Failure Ratio (%)
MTSI Session Completion Time		Time in seconds	–
MTSI Session Setup Failure		–	MTSI Session Setup Failure Ratio (%)
MTSI Session Setup Time		Time in seconds	MTSI Session Setup Time (s)

Event Name	Symb.	Extra Info	Associated KPI (or Description)
Network connect events: Test setup in UM sections 12.20.3.2–12.20.3.3			
Network Connect		Connection type (NDIS/RAS); IP address	Network Unavailability (%)
Network Connect Attempt		Connection type (NDIS/RAS)	– (unrelated to KPIs) Triggered when a Network Connect activity starts executing.
Network Connect Error		Cause	Network Unavailability (%)
Network Connection Lost		–	– (unrelated to KPIs) Triggered when the operational state of the .NET network interface changes to Down for a device to which Network Connect was previously applied.[2] Generated only for NDIS connections.
Network Disconnect		–	–
PDP context events			
PDP Context Activation Time		Time in ms	PDP Context Activation Time (s)
PDP Context Cutoff		–	PDP Context Cut-off Ratio (%)
Ping events: Test setup in UM section 12.20.3.16			
Ping End		Max. delay; Min. delay; Avg. delay; Success count; Failed count	–

Event Name	Symb.	Extra Info	Associated KPI (or Description)
Ping Error		Cause	–
Ping Roundtrip Time		Time in seconds; Ping size; IP address	Ping Roundtrip Time (ms)
Ping Start		IP address or host name	–
Ping Timeout		–	–
Social network testing events: Test setup in UM section 12.20.3.20			
Social Network Logon Rate		Logon Success Count / Logon Attempt Count × 100 (%)	– These events report percentages/averages aggregated over the whole execution of a Social Network activity rather than single instances of success/ failure or elapsed time.
Social Network Weibo Average Time		Weibo Total Duration / Weibo Success Count × 100 (%)	
Social Network Weibo Failure Rate		Weibo Failure Count / (Weibo Attempt Count – Weibo Timeout Count) × 100 (%) (timeouts are disregarded in this calculation)	
Social Network Weibo Success Rate		Weibo Success Count / Weibo Attempt Count × 100 (%)	

Event Name	Symb.	Extra Info	Associated KPI (or Description)
SRVCC events			
SRVCC Handover Interruption Time (User Plane)		Time in ms	– Time from last RTP report on LTE to first UMTS DL Vocoder report on UTRAN/ GERAN.
Streaming events, common to HTTP and RTP: Test setup in UM section 12.20.6.4			
Streaming End		Outcome	–
Streaming Start		HTTP: File URL RTP: File path and name	–
Streaming events: HTTP-specific			
Streaming Quality MOS		Avg. audio MOS; Avg. absolute video MOS; Avg. relative video MOS; Avg. audio–video MOS	– (No KPI defined) Event gives overall VQmon scores for an entire streaming session. See UM chapter 46.
Streaming events: RTP-specific			
Streaming Error		Cause	–
Streaming Intermediate VSQI		MOS value	Streaming Quality (MOS-VSQI) Event gives average of the latest 30 values of Streaming VSQI. See UM chapter 44.

Event Name	Symb.	Extra Info	Associated KPI (or Description)
Streaming Quality MTQI		MOS value	– (No KPI defined) Event gives overall MTQI score for an entire streaming session. See UM chapter 45.
Streaming Quality VSQI		MOS value	Streaming Quality (MOS-VSQI) Event gives overall VSQI score for an entire streaming session. See UM chapter 44.
Streaming Reproduction Cutoff		–	Reproduction Cut-off Ratio (%)
Streaming Reproduction Start Delay		Time in seconds	Reproduction Start Delay (s)
Streaming Reproduction Start Failure		–	Reproduction Start Failure Ratio (%)
Streaming Service Access Time		Time in seconds	Service Access Time (s)
Streaming Service Not Accessible		–	Service Non-Accessibility (%)
Streaming Session Cutoff		–	Streaming Session Cut-off Ratio (%)
Streaming State		State of RTP streaming video client: one of "Connecting", "Negotiating", "Prebuffering", "Reproducing", "Rebuffering", "Finished"	–

Event Name	Symb.	Extra Info	Associated KPI (or Description)
TCP events: Test setup in UM section 12.20.3.19			
TCP Download End		Outcome	– (No KPIs defined for TCP)
TCP Download Error		Cause	
TCP Download Start		IP address	
TCP Handshake Time		IP address; Time in seconds	
TCP Upload End		Outcome	
TCP Upload Error		Cause	
TCP Upload Start		IP address	
Trace Route events: Test setup in UM section 12.20.3.17			
Trace Route End		Destination; Reached (True/ False)	– (No KPIs defined for Trace Route)
Trace Route Hop		Hop sequence no.; IP address reached; Hop time	
Trace Route Start		Destination	
Trace Route Timeout		Hop sequence no.; IP address targeted	

Event Name	Symb.	Extra Info	Associated KPI (or Description)
UDP events: Test setup in UM sections 12.20.3.18, 12.20.3.19			
UDP Download End		Outcome	– (No KPIs defined for UDP)
UDP Download Error		Cause	
UDP Download Packet Loss		Packet loss in %	
UDP Download Start		IP address	
UDP Upload End		Outcome	
UDP Upload Error		Cause	
UDP Upload Packet Loss		Packet loss in %	
UDP Upload Start		IP address	
VoIP events: Test setup in UM sections 12.20.7.1–12.20.7.5			
VoIP End		Outcome	– (KPIs based on “MTSI” events, which see)
VoIP Error		Cause	
VoIP Start		Cause (e.g. “A-Party calling”); Client used	
WAP events: Test setup in UM section 12.20.3.15			
WAP Activation Failure		–	WAP Activation Failure Ratio (%)
WAP Activation Time		Time in ms	WAP Activation Time (ms)
WAP End		Outcome	–

Event Name	Symb.	Extra Info	Associated KPI (or Description)
WAP Error		Cause	–
WAP Page Data Transfer Cutoff		–	Data Transfer Cut-off Ratio (%)
WAP Page Data Transfer Time		Time in seconds	Data Transfer Time (s)
WAP Page Mean Data Rate		Data rate in kbit/s	Mean Data Rate (kbit/s)
WAP Page Request Failure		–	WAP Page Request Failure Ratio (%)
WAP Page Request Time		Time in seconds	WAP Page Request Time (s)
WAP Portal Access Time		Time in seconds	WAP Portal Access Time (s)
WAP Portal Not Accessible		–	WAP Portal Non-accessibility (%)
WAP Site Access Time		Time in seconds	WAP Site Access Time (s)
WAP Site Not Accessible		–	WAP Site Non-accessibility (%)
WAP Start		URL; Connection method	–

1. This event is currently generated only when an LTE network is involved in the handover.
2. Reference: ▶ msdn.microsoft.com/en-us/library/system.net.networkinformation.operationalstatus.aspx

8.5. Media Quality Events

Under this heading are collected events pertaining to audio quality measurement and audio perception.

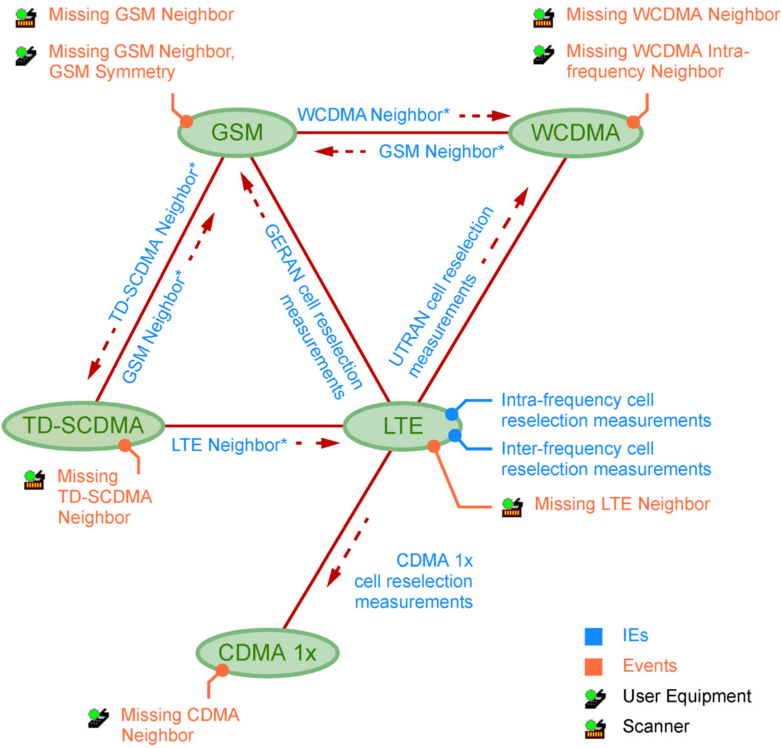
Event Name	Symbol	Description/Extra Information
AQM Out of Synch		The synchronization between the AQM module and the CallGenerator was lost. See the document “AQM in TEMS Products”.
AQM Session Complete		The device completed a Voice Quality activity normally. **Extra information:** Phone number; synch time.
AQM Session Failure		The device aborted a Voice Activity abnormally because of an error. **Extra information:** Phone number; synch time.
AQM Session Start		The device started executing a Voice Quality activity.
AQM Sync Failure		Synchronization was never achieved within the duration of the (intended) audio quality measurement. As a consequence, no AQM output was obtained.
AQM Synched		The synchronization between the AQM module and the CallGenerator was re-established. See the document “AQM in TEMS Products”.
Handover Speech Interruption Downlink		The information element Speech Interruption Downlink took on the value “Silence detected” at some point in connection with a handover. **Extra information:** Length of silent period; type of handover.

Event Name	Symbol	Description/Extra Information
Speech Interruption Time Downlink		The information element Speech Interruption Downlink had the value "Silence detected" for at least 100 ms. **Extra information:** Length of silent period.

9. Overviews of Selected IE and Event Families

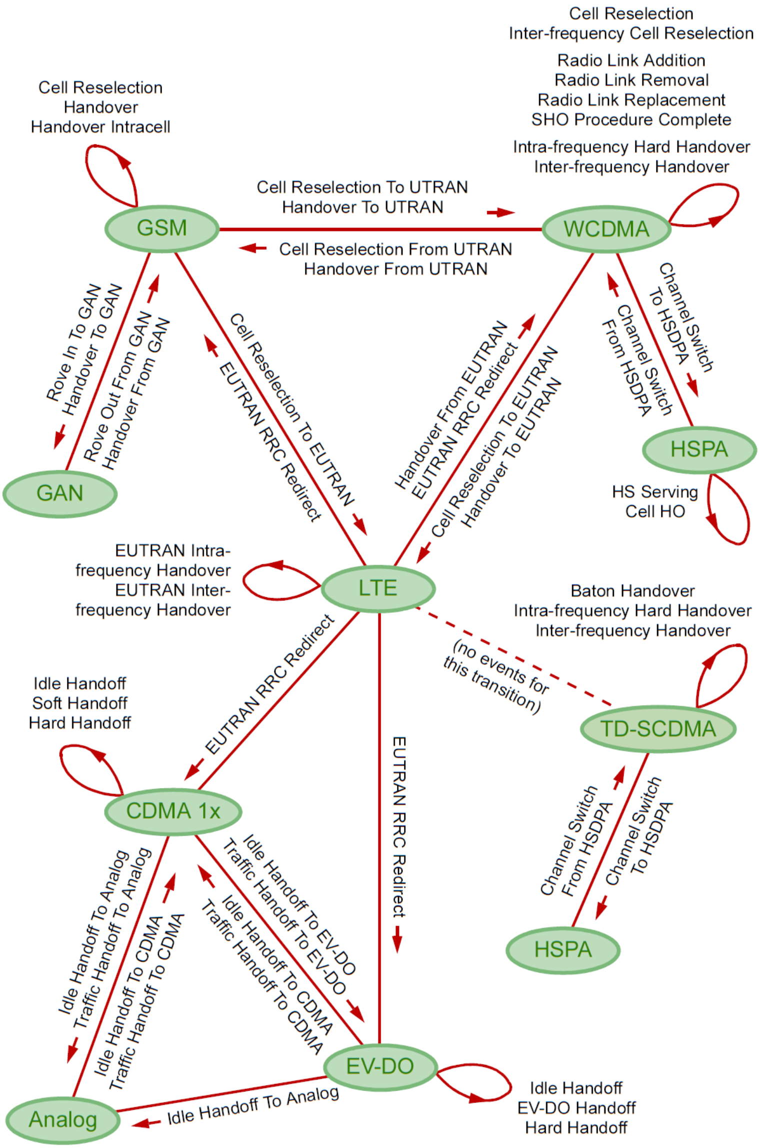
This chapter serves as a complement to the listings in chapters 3 and 8.

9.1. Cell Reselection/Neighbor Measurements



Cell reselection and inter-RAT neighbor measurements; missing neighbor events.

9.2. RAT Transition Events



RAT transition events; handover/handoff, cell reselection, and others.

10. Overview of Preconfigured Presentation Windows

This chapter explains the purpose of each window found on the **Menu** tab of the Navigator.

Note that only windows covered by your license will show up in the application. For example, if your license does not cover CDMA or EV-DO, all windows containing CDMA and/or EV-DO data will be hidden.

10.1. GSM Presentation Windows

For particulars of GSM information elements displayed, see section 3.1.

10.1.1. General Presentation Windows

Window Name	Description
AMR Call Average	Shows the distribution of AMR speech codec usage for the whole of the call currently in progress.
AMR Cell Average	Shows the distribution of AMR speech codec usage for the time spent in the current serving cell.
AMR Codec Usage	Shows the most recent distribution of AMR speech codec usage (exact updating frequency for these statistics may vary between devices).

Window Name	Description
AMR Settings	Shows the current active set of AMR speech coders on the uplink and downlink respectively, along with hysteresis and threshold values governing AMR mode switches (changes from one coder to another).
Current Channel	Shows information elements relating to the channel currently used. It also shows current time.
GAN Status	Shows measurements and network parameters relating to the GAN as well as to the GERAN.
Hopping Channels	Shows ARFCN, RxLev and C/I for all channels currently in the hopping list. **Note:** RxLev is not obtainable with any currently connectable phones.
Modified MS Behavior	Shows the current state of the user-configurable GSM properties for the device: see UM chapter 14.
Radio Parameters	Shows a collection of vital data about the status of the radio link (current BCCH, signal strength, speech quality, and more).
Serving + Neighbors	Shows BSIC, ARFCN, RxLev, and some further parameters for the serving cell and its neighboring cells, with the serving cell on top and the neighbors below it, sorted by signal strength in descending order.
Serving + Neighbors By Band	Similar to Serving + Neighbors except that the cells are sorted first by frequency band and then by signal strength in descending order.
Speech Quality	Shows SQI, PESQ/POLQA, and Frequent AQM. See UM chapters 37 and 42.

Window Name	Description
GAN WLAN Quality Line Chart	Tracks signal strength and quality level in a WLAN.
GSM Line Chart	Tracks the signal strength of the serving cell and neighbors. Shows call and handover events.
Radio Quality Bar Chart	Shows GSM radio parameters.

10.1.2. Data Service Presentation Windows

The information in these windows is obtained when running GPRS, EDGE, or HSCSD. Some of the information is only shown when a data testing script is being executed or its execution is analyzed.

For particulars of technology-independent data service testing information elements, see section 3.8.

Window Name	Description
Data Bytes Sent/Received	Shows the total number of data bytes sent and received at various protocol levels.
Data Throughput	Shows throughput and decode error/ retransmission rates for GPRS/EGPRS.
Data Timeslots	Shows the timeslots currently used on the uplink and downlink for GPRS/EGPRS or HSCSD, as well as the utilization, performance, and channel coding/ modulation coding scheme usage for each timeslot.
EGPRS Status	Shows the state and performance of the EGPRS connection.
GPRS Status	Shows the state and performance of the GPRS connection.
HSCSD Throughput	Shows throughput and error/retrans- mission rates for HSCSD.

Window Name	Description
PDP Context	Shows PDP context data for GPRS/ EGPRS, including quality-of-service requirements specified in the subscription.
EGPRS Line Chart	Tracks EGPRS performance, including throughput and BEP. Shows data service testing events.
GPRS Line Chart	Tracks GPRS performance, including throughput. Shows data service testing events.
Video Streaming Line Chart	Tracks the performance of a video streaming session, including VQmon metrics. (This line chart looks the same for GSM, WCDMA, LTE, and CDMA.)
Video Monitor	See UM chapter 30.

10.1.3. Scanning Presentation Windows

Window Name	Description
RSSI Scan Bar Chart	Shows output from an RSSI scan. See UM section 17.2.5.
Spectrum Analysis Bar Chart	Shows the result of a spectrum scan.

10.1.4. Interference Presentation Windows

Window Name	Description
C/A	Shows the interference from adjacent channels.

Window Name	Description
C/I	Shows the carrier-over-interference ratio, i.e. the ratio between the signal strength of the current serving cell and the signal strength of interfering signal components. If frequency hopping is used, the window shows the entire hopping list sorted by ascending C/I: the currently worst channel is at the top. The C/I measure is discussed in UM chapter 47.
Interference Line Chart	This is a “shotgun chart”, intended for presentation of interference scan data (from old logfiles).
Adjacent Bar Chart	Shows C/A measurements. Channels are drawn in groups of five, each consisting of one C_0 frequency surrounded by four adjacent channels (–2, –1, +1, +2).
Compact Adjacent Bar Chart	Shows C/A measurements. Same data as in the Adjacent Bar Chart, but here a parallel coordinates presentation is used where all C_0 channels are connected by one line, all “+1” adjacent channels by another, etc.
Interference Bar Chart	Shows GSM interference scan data (from old logfiles).

10.1.5. GSM Uplink Presentation Windows

Regarding MTR files (Ericsson Mobile Traffic Recordings), see section 3.10.

Window Name	Description
Uplink Neighbors	These windows present various categories of information from MTR files.
Uplink Radio Parameters	
Uplink Serving Cell	
Ericsson MTR Records	Lists messages from MTR files.
Uplink Line Chart	Presents data from MTR files (signal strength and power level).

10.2. WCDMA Presentation Windows

For particulars of WCDMA information elements displayed, see section 3.2.

10.2.1. General Presentation Windows

Window Name	Description
AMR Codecs	Shows the distribution of AMR speech codec usage on uplink and downlink.
GSM Neighbors	Shows measurements of GSM neighbors performed in WCDMA mode.
Handover	Shows information on handovers: indication of handover type (hard, soft, softer) and real-time statistics on handover frequency, success rate, and distribution across soft handover types.

Window Name	Description
Inter-Freq Meas Ctrl Events, Inter-RAT Meas Ctrl Events, Intra-Freq Meas Ctrl Events	These windows give the essentials of Measurement Control reports, which tell the UE what should trigger the sending of a measurement report to the network. Separate windows are provided for intra-frequency, inter-frequency, and inter-RAT criteria.
Modified MS Behavior	Shows the current state of the user-configurable WCDMA properties for the device: see UM chapter 14.
RACH Analysis	Shows information on the number of RACH preambles and their transmit power.
Radio Parameters	Shows a collection of information elements describing the status of the radio link and some more general radio conditions. “RAT State” shows which radio access technology is currently used: GSM or WCDMA.
Serving/Active Set + Neighbors	Shows data on the serving cell/active set and on the monitored neighboring cells.
Speech Quality	Shows SQI, PESQ/POLQA, and Frequent AQM. See UM chapters 42 and 37.
Transport Channels	Shows data on each transport channel in use.
WCDMA Line Chart	Tracks CPICH and GSM neighbor signal strength, UE transmit power, and SQI.
WCDMA Two Antenna Line Chart	Tracks CPICH signal strength readings for each antenna used in MIMO.
WCDMA/GSM Line Chart	Similar to WCDMA Line Chart, but also tracks GSM serving cell readings.
Radio Parameters Bar Chart	Shows WCDMA radio parameters.

Window Name	Description
Radio Parameters Parallel Bar Chart	Shows WCDMA radio parameters. See the example in UM section 32.5.

10.2.2. Data Service Presentation Windows

For particulars of technology-independent data service testing information elements, see section 3.8.

Window Name	Description
DVB-H Analysis	Shows information elements related to DVB-H.
HSDPA Analysis	Shows information elements related to HSDPA (single-antenna case).
HSDPA Analysis Dual Cell	Similar to the HSDPA Analysis window but for dual cell (dual carrier).
HSDPA Analysis MIMO	Similar to the HSDPA Analysis window but for MIMO. The data is given for each antenna separately.
HSDPA Analysis Per Process	Shows HS information elements that are differentiated with respect to HARQ processes.
HSUPA Analysis	Shows information elements related to HSUPA.
PDP Context	Shows PDP context data for WCDMA, including quality-of-service requirements specified in the subscription.
VoIP AMR Codecs	Shows the distribution of AMR speech codec usage on uplink and downlink for VoIP.
VoIP Quality	Shows a collection of VoIP-related data: PESQ/POLQA, jitter, and jitter buffer metrics.

Window Name	Description
DVB-H Stats Line Chart	Tracks DVB-H performance.
HS UL Output Power	Tracks DPCCH, E-DPCCH, and E-DPDCH transmit power.
Trsp Ch Throughput Line Chart: Sony Ericsson	Tracks transport channel throughput as reported by Sony Ericsson UEs.
Video Streaming Line Chart	Tracks the performance of a video streaming session, including VQmon metrics. (This line chart looks the same for GSM, WCDMA, LTE, and CDMA.)
VoIP Quality Line Chart	Tracks VoIP performance in terms of PESQ/POLQA and jitter/packet loss metrics.
WCDMA HSPA/GSM Data Line Chart	Tracks data service performance for HSPA and (E)GPRS, including application and RLC layer throughput as well as data service testing events.
WCDMA Rel. 99/GSM Data Line Chart	Tracks data service performance for WCDMA R99 and (E)GPRS, including application and RLC layer throughput as well as data service testing events.
WCDMA RLC Data Line Chart	Tracks data service performance for WCDMA R99, including application and RLC layer throughput as well as data service testing events.
HS UL E-TFC Accumulated: Sony Ericsson	Shows retransmission rate and usage for each E-TFC (Transport Format Combination), averaged over the current session. Specific to Sony Ericsson devices.
HS UL E-TFC Current: Sony Ericsson	Shows current retransmission rate and usage for each E-TFC (Transport Format Combination). Specific to Sony Ericsson devices.

Window Name	Description
HS UL Transmission Distribution Accumulated: Sony Ericsson	Shows the distribution of transmission attempts with respect to the sequence number of the attempt (1st, 2nd, etc.). Applies to the whole of the current session.
HS UL Transmission Distribution Current: Sony Ericsson	Shows the distribution of transmission attempts with respect to the sequence number of the attempt (1st, 2nd, etc.). Applies to the device’s latest reporting period.
HSDPA MIMO Transport Block Size Primary Cell Bar Chart	Shows HSDPA transport block size usage (MIMO, primary cell).
HSDPA MIMO Transport Block Size Secondary Cell Bar Chart	Shows HSDPA transport block size usage (MIMO, secondary cell).
HSDPA PDSCH Codes Primary Cell Bar Chart	Shows codes used on the HS-PDSCH (MIMO, primary cell).
HSDPA PDSCH Codes Secondary Cell Bar Chart	Shows codes used on the HS-PDSCH (MIMO, secondary cell).
HSDPA Transport Block Size Primary Cell Bar Chart	Shows HSDPA transport block size usage (single antenna, primary cell).
HSDPA Transport Block Size Secondary Cell Bar Chart	Shows HSDPA transport block size usage (single antenna, secondary cell).
Video Monitor	See UM chapter 30.

10.2.3. Scanning Presentation Windows

Window Name	Description
CPICH Best UARFCN Data	Shows pilot scan data for the strongest scrambling codes, regardless of UARFCN. See UM section 18.2.9.
CPICH Data	Shows pilot scan data for the strongest scrambling codes on each UARFCN. See UM section 18.2.9.
Network Search	Shows the outcome of network search scanning (UARFCNs and scrambling codes found). See UM section 18.6.2.
Synch Channel Data	Shows scan data on the synchronization channels P-SCH and S-SCH, obtained with the Pilot scanning method. All UARFCNs are covered in the same window. See UM section 18.2.11.
CPICH Scan 1st *(etc.)* UARFCN Line Chart	These charts track scanned scrambling code signal strength on the CPICH for one UARFCN. See UM section 18.2.9.
CPICH Scan 1st *(etc.)* UARFCN Bar Chart	These charts show scanned scrambling code signal strength on the CPICH for one UARFCN. See UM section 18.2.7.
RSSI Scan Bar Chart	Shows output from an RSSI scan. See UM section 18.4.2.
SCH Timeslot Scan Bar Chart	Shows output from an SCH timeslot scan. See UM section 18.3.2.
Spectrum Analysis Bar Chart	Shows output from a downlink spectrum scan. See UM section 18.5.2.
Spectrum Analysis Uplink Bar Chart	Shows output from an uplink spectrum scan. See UM section 18.5.2.

10.2.4. Finger Info Presentation Windows

Window Name	Description
Finger Info 1st *(etc.)* UARFCN	These windows show Rake finger information (obtained from either UEs or scanners) for one UARFCN. See UM section 18.2.12.

10.3. LTE Presentation Windows

For particulars of LTE information elements displayed, see section 3.3.

For particulars of technology-independent data service testing information elements, see section 3.8.

10.3.1. General Presentation Windows

Window Name	Description
ABM Information	Shows output from available bandwidth measurements. See UM chapter 48.
ANR Information	Shows information on ANR (Automatic Neighbor Relation) parameters and measurements.
DRX Parameters	Shows parameters related to the DRX (Discontinuous Reception) mechanism.
EPS Bearer	Shows information on each EPS bearer in use.
Equipment Information	Shows information on firmware and hardware as well as other device-related information.
NAS Status	Shows Non-Access Stratum status.

Window Name	Description
PCFICH/CFI Info	Shows the distribution of the number of OFDM symbols allocated for the PDCCH (control signaling), as indicated by the CFI value on the PCFICH.
PDN Connection	Shows information on current packet data network connections.
RACH Analysis	Shows RACH settings and the outcome of RACH procedures.
Radio Parameters	Shows a collection of vital data about the status of the radio link, including transmission mode, modulation on PDSCH/PUSCH, RI, and PMI. The all-time-high and all-time-low indicators are turned on for UE Tx Power: see UM section 27.2.
RLC DL Radio Bearer	Shows configuration of and throughput on current downlink RLC radio bearers.
RLC UL Radio Bearer	Shows configuration of and throughput on current uplink RLC radio bearers.
RRC/RLC Status	Shows a variety of RRC and RLC states.
Serving Cell	Shows serving cell and MME parameters.
Serving/Neighbor Cell	Shows EARFCN, CI, RSRP, and RSRQ for the serving cell and its neighboring cells, with the serving cell on top and the neighbors below it, sorted by signal strength in descending order.
Serving/Neighbor Cell Frame Timing	Shows EARFCN, CI, and cell frame timing for the serving cell and its neighboring cells. For neighbors, cell frame timing offsets are also shown. The serving cell is on top with the neighbors below it, sorted by signal strength in descending order.

Window Name	Description
TDD Information	Shows TD-LTE parameters.
VoIP AMR Codecs	Shows the distribution of AMR speech codec usage on uplink and downlink for VoIP.
VoIP Quality	Shows a collection of VoIP-related data: PESQ/POLQA, jitter, and jitter buffer metrics.
Downlink Line Chart	Tracks RSRP, RSRQ and RS CINR for serving cell, CQI, and PDSCH data.
LTE/EV-DO Line Chart	Tracks a mix of LTE and EV-DO measurements. Intended for dual mode LTE/EV-DO devices.
LTE/EV-DO Throughput Line Chart	Tracks LTE and EV-DO throughput at various levels. Intended for dual mode LTE/EV-DO devices.
LTE/WCDMA/GSM Line Chart	Tracks a mix of LTE and WCDMA/GSM measurements. Intended for dual mode LTE/WCDMA devices.
LTE/WCDMA/GSM Throughput Line Chart	Tracks LTE and WCDMA/GSM throughput at various levels. Intended for dual mode LTE/WCDMA devices.
Serving/Neighbor Cell Line Chart	Tracks LTE serving cell RSRP and RSRQ.
Throughput Line Chart	Tracks LTE throughput at various protocol levels: application layer, RLC, PDCP, MAC, PDSCH Phy. Also exists in a version with Mbit/s as unit.
Uplink Line Chart	Tracks UE Tx Power and PUSCH Phy throughput.

Window Name	Description
Video Streaming Line Chart	Tracks the performance of a video streaming session, including VQmon metrics. (This line chart looks the same for GSM, WCDMA, LTE, and CDMA.)
VoIP Quality Line Chart	Tracks VoIP performance in terms of PESQ/POLQA and jitter/packet loss metrics.
PDCCH DCI Format Usage Distribution Bar Chart	Shows the distribution of DCI format usage on the PDCCH: 1) for the latest reporting period and 2) accumulated from the start of the session.
PDSCH Transmission Distribution Accumulated Bar Chart	Shows the distribution of transmissions on the PDSCH (first transmission, first retransmission, second, third, etc.), accumulated from the start of the session.
PDSCH Transmission Distribution Current Bar Chart	Shows the distribution of transmissions on the PDSCH for the latest reporting period.
Serving/Neighbor Cells Bar Chart	Shows RSRP and RSRQ for serving and neighbor cells.
TDD N_p Distribution Bar Chart	See the information element TDD N_p Distribution (%) for an explanation.
TDD Position Of Minimum k Distribution Bar Chart	See the information element TDD Position Of Minimum k Distribution (%) for an explanation.

10.3.2. “Cell Search Parameters” Presentation Windows

Window Name	Description
Cell Search Parameters (CDMA)	Shows parameter settings for CDMA2000 inter-RAT cell reselection.

Window Name	Description
Cell Search Parameters (GSM)	Shows parameter settings for GSM (GERAN) inter-RAT cell reselection.
Cell Search Parameters (LTE)	Shows parameter settings for LTE intra-frequency and inter-frequency cell reselection.
Cell Search Parameters (UTRA-FDD)	Shows parameter settings for UTRA inter-RAT cell reselection from FDD LTE.
Cell Search Parameters (UTRA-TDD)	Shows parameter settings for UTRA inter-RAT cell reselection from TDD LTE.

10.3.3. Scanning Presentation Windows

Window Name	Description
Scanned Cells	Shows various data for each LTE cell subject to a Reference Signal Scan: EARFCN, CI, RSRP, and RSRQ.
RS 1st *(etc.)* EARFCN Line Chart	These charts track LTE RSRP and RSRQ on a particular EARFCN subject to a Reference Signal scan. See UM section 19.2.7.
RSSI Scan Line Chart	Tracks the strongest LTE frequencies found during RSSI scanning. See UM section 19.3.5.
Enhanced Power Scan Bar Chart	Shows RSSI for frequencies measured during an enhanced power scan. See UM section 19.5.3.
RS 1st *(etc.)* EARFCN Bar Chart	These charts show RSRQ for cells on a particular EARFCN subject to a Reference Signal scan. See UM section 19.2.7.
RSSI Scan Bar Chart	Shows the result of an RSSI scan. See UM section 19.3.5.

Window Name	Description
Spectrum Analysis Bar Chart	Shows the result of a spectrum scan.

10.4. TD-SCDMA Presentation Windows

For particulars of TD-SCDMA information elements displayed, see section 3.4.

10.4.1. General Presentation Windows

Window Name	Description
Cell Reselection	Shows the values of cell search and reselection related parameters.
Current Channel	Shows information elements relating to the channel currently used. It also shows current time.
Radio Parameters	Shows a collection of vital data about the status of the radio link, including serving cell P-CCPCH RSCP, serving cell carrier RSSI, and TxPower levels.
Serving + Neighbor	Shows UARFCN, CPID, and signal strength readings for the serving cell and its neighboring cells, with the serving cell on top and the neighbors below it, sorted by signal strength in descending order.
TD-SCDMA Physical Channel Monitor	Regarding this specially designed window, see UM section 27.6.1.
Timeslots	Shows timeslot usage as well as per-timeslot RSCP, ISCP, and C/I readings.
Transport Channels	Shows data on each transport channel in use.
UE Identities	Shows UE identification strings such as C-RNTI/H-RNTI/U-RNTI.

Window Name	Description
TD-SCDMA Line Chart	Tracks serving and neighbor signal strength as well as UE transmit power.
TD-SCDMA/GSM Line Chart	Tracks serving and neighbor signal strength for both TD-SCDMA and GSM.

10.4.2. Data Service Presentation Windows

For particulars of technology-independent data service testing information elements, see section 3.8.

Window Name	Description
HSDPA Radio	Shows HSDPA radio parameters.
HSDPA QoS	Shows HSDPA quality-of-service parameters.
PDP Context	Shows PDP context data for TD-SCDMA.
TD-SCDMA HS/GSM Data Line Chart	Tracks data service performance for TD-SCDMA and (E)GPRS, including application and RLC layer throughput as well as data service testing events.
TD-SCDMA RLC Data Line Chart	Tracks data service performance for TD-SCDMA, including application and RLC layer throughput as well as data service testing events.

10.4.3. Scanning Presentation Windows

Window Name	Description
Scanned Cells	Shows various data for each TD-SCDMA cell subject to pilot scan, including UARFCN, CPID, Ec/Io, Eps/Io, and SIR. See UM section 20.3.2.

Window Name	Description
CPID Scan 1st *(etc.)* RF Line Chart	These charts track scanned CPID signal strength, obtained during pilot scanning, on one UARFCN. See UM section 20.3.2.
RSSI Scan Line Chart	Tracks the strongest TD-SCDMA frequencies found during RSSI scanning. See UM section 20.4.2.
CPID Scan 1st *(etc.)* RF Bar Chart	These charts show Ec/Io on a particular UARFCN during pilot scanning. See UM section 20.3.2.
RSSI Scan Bar Chart	Shows the result of an RSSI scan. See UM section 20.4.2.

10.5. CDMA Presentation Windows

For particulars of CDMA information elements displayed, see section 3.5.

10.5.1. General Presentation Windows

Window Name	Description
A/C/N Sets	Shows properties of all cells in the CDMA active, candidate, and neighbor sets.
Active Set	Shows properties of the cells in the CDMA active set.
Candidate Set	Shows properties of the cells in the CDMA candidate set.
Finger Info	Shows data on Rake fingers. Includes special features for graphical presentation of the T-Add and T-Drop thresholds; see UM section 27.6.2.
Neighbor Set	Shows properties of the cells in the CDMA neighbor set.

Window Name	Description
Radio Parameters	Shows a collection of vital data about the status of the radio link. The same window covers both 1x and EV-DO. Among the data shown is signal strength, FER/PER, and Tx/Rx Power.
Serving	Shows various IDs, states, and parameter settings of the current serving cell.
Speech Quality	Shows FER, PESQ (including PESQ for VoIP), and Frequent AQM. See UM chapter 37.
CDMA Line Chart	Tracks the signal strength of active set and candidate set members. Shows call events.
CDMA Bar Chart	Shows signal power, FER, and PER.

10.5.2. Data Service Presentation Windows

For particulars of technology-independent data service testing information elements, see section 3.8.

Window Name	Description
Data Bytes Sent/Received	Shows the total number of data bytes sent and received at various protocol levels.
EV-DO Forward Link Packets	Shows statistics on good and bad packets for each forward link data rate.
EV-DO Multicarrier Overview	Shows data by carrier for multicarrier EV-DO.
EV-DO Overview	Shows data that is relevant to EV-DO, including PER and RLP layer performance.
EV-DO Reverse Link Packets	Shows statistics on good and bad packets for each reverse link data rate.

Window Name	Description
EV-DO Status	Shows a variety of EV-DO state values.
VoIP AMR Codecs	Shows the distribution of AMR speech codec usage on uplink and downlink for VoIP.
VoIP Quality	Shows a collection of VoIP-related data: PESQ/POLQA, jitter, and jitter buffer metrics.
CDMA Data Line Chart	Tracks data service performance (1x and EV-DO). Shows data service testing events.
Video Streaming Line Chart	Tracks the performance of a video streaming session, including VQmon metrics. (This line chart looks the same for GSM, WCDMA, LTE, and CDMA.)
VoIP Quality Line Chart	Tracks VoIP performance in terms of PESQ/POLQA and jitter/packet loss metrics.
Video Monitor	See UM chapter 30.

10.5.3. Scanning Presentation Windows

Window Name	Description
Code Domain Scan 1st *(etc.)* PN Line Chart	These charts track Walsh code powers for a given PN offset.
PN Scan 1st *(etc.)* RF Line Chart	These charts track the strongest scanned pilots on a particular RF channel.
Code Domain Scan 1st *(etc.)* PN Bar Chart	These charts show code powers for the entire Walsh code range for a given PN offset.
Narrowband Interference Scan Bar Chart	Shows the result of a narrowband interference scan. See UM section 21.6.2.

Window Name	Description
PN Scan 1st *(etc.)* RF Bar Chart	These charts show the strongest scanned pilots on a particular RF channel. See UM section 21.3.
Polluters Bar Chart	Shows the polluter top list, obtained when scanning in “follow phone” mode. See UM section 21.3.1.
RSSI Scan Bar Chart	Shows the result of an RSSI scan. See UM section 21.5.
Spectrum Analysis Bar Chart	Shows the result of a spectrum scan. See UM section 21.7.
Strongest Scanned PN Bar Chart	Shows the strongest pilots among all scanned RF channels. See UM section 21.3.

10.6. WiMAX Presentation Windows

For particulars of WiMAX information elements displayed, see section 3.6.

10.6.1. Scanning Presentation Windows

Regarding WiMAX scanning, see UM chapter 22.

Window Name	Description
Scanned Preamble Index	Shows data on all preambles detected during a preamble scan, including power and CINR.
Channel RSSI Line Chart	Tracks the strongest WiMAX channels found during preamble scanning.
RSSI Scan Line Chart	Tracks the strongest channels found during RSSI scanning.
Channel RSSI Bar Chart	Shows channel power for all scanned channels.

Window Name	Description
Preamble Power Group Bar Chart	Shows power of detected preambles sorted by channel.
RSSI Scan Bar Chart	Shows power readings for the entire spectrum scanned.
Segment Power Group Bar Chart	Shows power for all segments of all scanned channels.
Spectrum Analysis Bar Chart	Shows the result of a spectrum scan.
Strongest CINR Bar Chart	Shows detected preambles ranked by decreasing CINR.
Strongest Preamble Power Bar Chart	Shows detected preambles ranked by decreasing power.
Strongest Preamble Power Group Bar Chart	Shows detected preambles grouped by channel. Channels are ranked by total preamble power.
Strongest Segment Power (Cha Sort) Bar Chart	Shows segments grouped by channel. Channels are ranked according to the power of their strongest segment.
Strongest Segment Power (Segment Pwr Sort) Bar Chart	Shows segments ranked by decreasing power, regardless of channel.
Weakest CINR Bar Chart	Shows detected preambles ranked by increasing CINR.
Weakest Preamble Power Bar Chart	Shows detected preambles ranked by increasing power.

10.7. Wi-Fi Presentation Windows

For particulars of Wi-Fi information elements displayed, see section 3.11.

Window Name	Description
Wi-Fi Cell List	Shows detected Wi-Fi cells (access points).
Wi-Fi Throughput Line Chart	Tracks application layer throughput for data transfer over Wi-Fi.

10.8. Analysis Presentation Windows

These are found in the **Analysis** folder.

For particulars of the events displayed, see chapter 8.

Window Name	Description
Call Analysis	Lists events pertaining to calls and handovers (for multiple cellular technologies).
Missing Neighbor	Lists missing neighbor events (for multiple cellular technologies).
WCDMA Handover Analysis	Lists RRC messages that concern the DCCH as well as the “SHO” (soft handover) events.
Event Counter	A preconfigured Event Counter window is found here. Regarding Event Counter windows in general, see UM chapter 28.

10.9. Signaling Presentation Windows

Regarding message windows in general, see UM chapter 29.

Window Name	Description
Data Reports	Lists messages pertaining to data service testing. Also lists H.245 and IP protocol reports.
Error Reports	Lists reports from the external device concerning malfunctions and received corrupt messages. The **Events** and **Columns** tabs are absent from the properties dialog of this window (UM sections 29.1.3–29.1.4).
Events	Lists all events that occur, both predefined and user-defined, with the exception of KPI-related events. All predefined events are listed in chapter 8 of this volume; how to create user-defined events is covered in UM section 24.3. As in other message windows, you can double-click an event in the Events windows to view details on the event in a separate plain-text window. For certain events, extra information is provided. The contents of this extra information are detailed in chapter 8.
Events Of KPI Type	Lists all events underlying the computation of KPI statistics in TEMS Discovery. See section 8.4.

Window Name	Description
IP Protocol Reports	Lists all air interface message traffic occurring over the protocols in the Internet protocol suite: • Application layer: BOOTP, DNS, FTP, FTP-DATA, HTTP, NBDS, NBNS, RTCP, RTP, RTSP, SNMP • Transport layer: TCP, UDP • Network layer: ICMP, IPv4, IPv6 • Data link layer: PPP CC, PPP CHAP, PPP IPCP, PPP LCP, PPP PAP Regarding IP sniffing, see UM sections 12.20.3.2, 12.20.3.8, 12.20.3.9.
Layer 2 Messages	Lists Layer 2 messages. By default this window also shows certain events, the emphasis being on call, handover, and failure events: see chapter 8.
Layer 3 Messages	Lists Layer 3 messages. By default this window also shows certain events, the emphasis being on call, handover, and failure events: see chapter 8.
Mode Reports	Lists (vendor-specific) reports from external devices concerning their status. By default this window also shows certain events, the emphasis being on call, handover, and failure events: see chapter 8.

10.10. Positioning Presentation Windows

Window Name	Description
Map	Map window preconfigured with some basic GSM, WCDMA, LTE, TD-SCDMA, and CDMA data. Regarding Map windows in general, see UM chapter 33.
GPS	See UM chapter 34.

10.11. Media Quality Presentation Windows

Window Name	Description
Speech Quality	Shows information elements in the Media Quality category.

10.12. Presentation Window Templates

The Template folder in the Navigator contains blank templates for:

- status windows
- message windows
- line charts
- bar charts
- Event Counter windows.

These templates contain no data; you customize their contents from scratch.

Appendix A. Abbreviations

ABM	Available Bandwidth Measurements
ACR	Absolute Category Rating
ACU	Audio Capturing Unit
AFC	Automatic Frequency Control
AG	Absolute Grant
AGC	Automatic Gain Control
ALMP	Air Link Management Protocol
AM	Acknowledged Mode
AMBR	Aggregate Maximum Bit Rate
AMR	Adaptive Multi Rate
AMR-NB	Adaptive Multi Rate Narrowband
AMR-WB	Adaptive Multi Rate Wideband
ANR	Automatic Neighbor Relation (detection)
APK	Application Package File
AQM	Audio Quality Measurement
ARFCN	Absolute Radio Frequency Channel Number
AS	Active Set
ASP	Active Set Pilot
AT	Access Terminal
BCC	Base station Colour Code
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
BEP	Bit Error Probability
BER	Bit Error Rate
BLEP	Block Error Probability
BLER	Block Error Rate
BOOTP	Bootstrap Protocol
BSIC	Base Station Identity Code
BSN	Block Sequence Number
BSSID	Basic Service Set Identifier
C/A	Carrier to Adjacent (ratio)
C/I	Carrier to Interference (ratio)
C/N	Carrier to Noise (ratio)
CA	Carrier Aggregation
CBCH	Cell Broadcast Channel

CCE	Control Channel Element
CDD	Cyclic Delay Diversity
CDMA	Code Division Multiple Access
CFI	Control Format Indicator
CFO	Carrier Frequency Offset
CGI	Cell Global Identity
CHAP	Challenge Handshake Authentication Protocol
CI	Cell Identity
CID	Connection Identifier
CINR	Carrier to Interference-plus-Noise Ratio
CPICH	Common Pilot Channel
CPID	Cell Parameter Identity
CQI	Channel Quality Indicator
CRC	Cyclic Redundancy Check
C-RNTI	Cell Radio Network Temporary Identity
CS	Coding Scheme
CS	Circuit-Switched
CSV	Comma-Separated Values
CW	Code Word *(LTE)*
CW	Continuous Wave
DCCH	Digital Control Channel
DCD	Downlink Channel Descriptor
DCH	Dedicated Channel
DCI	Downlink Control Information
DGPS	Differential GPS
DL	Downlink
DLFP	Downlink Frame Prefix
DN	Detected Neighbor
DNS	Domain Name System (Service, Server)
DPCCH	Dedicated Physical Control Channel
DPCH	Dedicated Physical Channel
DR	Dead Reckoning
DRC	Data Rate Control
DRS	Dedicated Reference Signal
DRVCC	Dual Radio Voice Call Continuity
DRX	Discontinuous Reception
DSC	Data Source Control *(CDMA)*
DSC	Downlink Signalling Counter *(GSM)*
DSCH	Downlink Shared Channel
DTX	Discontinuous Transmission
DVB-H	Digital Video Broadcasting – Handheld
DwPTS	Downlink Pilot Timeslot

E-AGCH	E-DCH Absolute Grant Channel
EARFCN	E-UTRA ARFCN
ECI	E-UTRAN Cell Identifier
ECP	Extended Cyclic Prefix
E-DCH	E- (Enhanced) Dedicated Channel
EDGE	Enhanced Data Rates for GSM Evolution (= EGPRS)
E-DPCCH	E-DCH Dedicated Physical Control Channel
E-DPDCH	E-DCH Dedicated Physical Data Channel
EFR	Enhanced Full Rate
EGPRS	Enhanced GPRS (= EDGE)
E-HICH	E-DCH HARQ Indicator Channel
eHRPD	Enhanced High Rate Packet Data
EIRP	Effective Isotropic Radiated Power
EMM	EPS Mobility Management
eNB-ID	eNode B Identifier
EPS	Evolved Packet System
E-PUCH	E-DCH Physical Uplink Channel
E-RGCH	E-DCH Relative Grant Channel
E-RUCCH	E-DCH Random Access Uplink Control Channel
ESM	EPS Session Management
ESN	Electronic Serial Number
ESS	Extended Service Set
E-TFC	E- (Enhanced) Transport Format Combination
E-TFCI	E- (Enhanced) Transport Format Combination Indicator
EV-DO (1xEV-DO)	1x Evolution – Data Optimized
EVRC	Enhanced Variable Rate Codec
FACCH	Fast Associated Control Channel
FACH	Forward Access Channel
FCH	Fundamental Channel
FDD	Frequency Division Duplex
FEC	Forward Error Correction
FER	Frame Erasure Rate
FL	Forward Link
FPC	Forward Power Control
FR	Full Rate
FTP	File Transfer Protocol
FWT	Fixed Wireless Terminal
GA-CSR	Generic Access Circuit Switched Resources
GAN	Generic Access Network
GANC	Generic Access Network Controller
GA-RC	Generic Access Resource Control
GBR	Guaranteed Bit Rate

GERAN	GSM EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GMM	GPRS Mobility Management
GOP	Group Of Pictures
GP	Guard Period
GPRS	General Packet Radio Service
GPS	Global Positioning System
GPX	GPS Exchange Format
GRR	GPRS Radio Resource
GSM	Global System for Mobile Communication
HARQ	Hybrid Automatic Repeat Request
HDOP	Horizontal Dilution Of Precision
HO	Handover
HR	Half Rate
H-RNTI	HS-DSCH Radio Network Temporary Identity
HRPD	High Rate Packet Data
HSCSD	High Speed Circuit-Switched Data
HSDPA	High Speed Downlink Packet Access
HS-DSCH	High Speed Downlink Shared Channel
HSN	Hopping Sequence Number
HSPA	High Speed Packet Access
HS-PDSCH	High Speed Physical Downlink Shared Channel
HS-SCCH	High Speed Shared Control Channel
HSUPA	High Speed Uplink Packet Access
HTTP	Hypertext Transfer Protocol
ICMP	Internet Control Message Protocol
IE	Information Element
IMAP	Internet Message Access Protocol
IMEI	International Mobile Equipment Identity
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
IPCP	Internet Protocol Control Protocol
ISCP	Interference Signal Code Power
JPEG	Joint Photographic Expert Group
KPI	Key Performance Indicator
LA	Location Area
LAC	Location Area Code
LAT	Latitude
LCP	Link Control Protocol
LLC	Logical Link Control
LON	Longitude

LTE	Long Term Evolution
LUT	Location Update Type
M2M	Mobile-To-Mobile
MAC	Medium Access Control
MBR	Maximum Bit Rate
MCC	Mobile Country Code
MCS	Modulation Coding Scheme
MD5	Message-Digest algorithm 5
MDM	Mobile Diagnostic Monitor
MEID	Mobile Equipment Identity
MFER	Frame Error Rate after MPE-FEC decoding
MIMO	Multiple Input Multiple Output
MIN	Mobile Identity Number
MISO	Multiple Input Single Output
MM	Mobility Management
MME	Mobility Management Entity
MMS	Multimedia Messaging Service
MMSC	MMS Center
MN	Monitored Neighbor
MNC	Mobile Network Code
MO	Mobile-Originated
MOS	Mean Opinion Score
MOS-A	Mean Opinion Score – Audio
MOS-AV	Mean Opinion Score – Audio and Video
MOS-V	Mean Opinion Score – Video
MRU	Mobile Receiving Unit
MS	Mobile Station (may represent UE or scanner)
MSM	Mobile Station Modem
MSTR	Mobile Station Time Reference
MT	Mobile-Terminated
M-TMSI	M-Temporary Mobile Subscriber Identity
MTQI	Mobile TV Quality Index
MTR	Mobile Traffic Recording
MTSI	Multimedia Telephony Service for IMS
MTU	Mobile Test Unit
MU-MIMO	Multi-User MIMO
MuxPDU	Multiplex Sublayer Protocol Data Unit
NAS	Non-Access Stratum
NBDS	NetBIOS Datagram Service
NBNS	NetBIOS Name Service
NCC	Network Colour Code
NDIS	Network Driver Interface Specification

NID	Network Identification
NMEA	National Marine Electronics Association
NMO	Network Mode of Operation
NSAPI	Network Service Access Point Identifier
NV	Non-Volatile
ODM	On-Device Measurement
OFDM	Orthogonal Frequency-Division Multiplexing
OVHD	Overhead
PA	Power Amplifier
PACA	Priority Access and Channel Assignment
PAP	Password Authentication Protocol
PBCCH	Packet Broadcast Control Channel
PBCH	Physical Broadcast Channel
PCCCH	Packet Common Control Channel
P-CCPCH	Primary Common Control Physical Channel
PCFICH	Physical Control Format Indicator Channel
PCH	Paging Channel
PCI	Physical layer Cell Identity
PCIG	Physical layer Cell Identity Group
PCS	Personal Communications Service
PDCCH	Packet Data Control Channel
PDCH	Packet Data Channel
PDCP	Packet Data Convergence Protocol
PDN	Packet Data Network
PDOP	Positional Dilution Of Precision
PDP	Packet Data Protocol
PDSCH	Physical Downlink Shared Channel
PDU	Protocol Data Unit
PER	Packet Error Rate
PESQ	Perceptual Evaluation of Speech Quality
PI	Preamble Index
PLMN	Public Land Mobile Network
PMI	Precoding Matrix Indicator
PN	Pseudo Noise
POLQA	Perceptual Objective Listening Quality Assessment
POP3	Post Office Protocol version 3
PPCH	Packet Paging Channel
PPP	Point-to-Point Protocol
PPS	Precise Positioning Service
P-SCH	Primary Synchronization Channel
PSS	Primary Synchronization Signal
PSTN	Public Switched Telephone Network

P-TMSI	Packet Temporary Mobile Subscriber Identity
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel
QAM	Quadrature Amplitude Modulation
QCELP	Qualcomm Code Excited Linear Prediction
QCI	Quality-of-service Class Identifier
QOF	Quasi-Orthogonal Function
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RA	Routing Area
RAB	Reverse Activity Bit
RAC	Routing Area Code
RACH	Random Access Channel
RAN	Radio Access Network
RAS	Remote Access Service
RAT	Radio Access Technology
RATI	Random Access Terminal Identifier
RB	Radio Bearer
RF	Radio Frequency
RI	Rank Indication
RL	Reverse Link
RLA	Received Level Average
RLC	Radio Link Control
RLP	Radio Link Protocol
RNC	Radio Network Controller
RNDIS	Remote Network Driver Interface Specification
RNTI	Radio Network Temporary Identity
RP	Received Power
RPC	Reverse Power Control
RQ	Received Quality
RR	Radio Resource (Management)
RRC	Radio Resource Control
RRI	Reverse Rate Indication
RS	Reference Signal
RSCP	Received Signal Code Power
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
RSSI	Received Signal Strength Indicator
RTC	Real-Time Clock
RTCP	Real-Time Control Protocol
RTP	Real-Time Transport Protocol
RTSP	Real-Time Streaming Protocol

SACCH	Slow Associated Control Channel
SAN	Serving/Active Set + Neighbors
SAPI	Service Access Point Identifier
SC	Scrambling Code
SCC	Supplemental Code Channel
SCH	Supplemental Channel *(CDMA)*
SCH	Synchronization Channel *(UMTS)*
SDCCH	Stand-alone Dedicated Control Channel
SDP	Session Description Protocol
SDU	Signaling Data Unit
SEGW	Security Gateway
SF	Spreading Factor
SFBC	Space-Frequency Block Coding
SFTP	SSH File Transfer Protocol (“Secure FTP”)
SG	Serving Grant
SGSN	Serving GPRS Support Node
SGW	Security Gateway
SHO	Soft Handover
SIB	System Information Block
SID	Silence Descriptor *(UMTS)*
SID	System Identification *(CDMA)*
SIM	Subscriber Identity Module
SIMO	Single Input Multiple Output
SINR	Signal to Interference-plus-Noise Ratio
SIP	Session Initiation Protocol
SIR	Signal to Interference Ratio
SISO	Single Input Single Output
SM	Spatial Multiplexing
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SMV	Selectable Mode Vocoder
SNDCP	Subnetwork Dependent Convergence Protocol
SNR	Signal to Noise Ratio
SPS	Standard Positioning Service
SQE	Speech Quality Estimate
SQI	Speech Quality Index
SRS	Sounding Reference Signal
SRU	Scanning Receiver Unit
SRVCC	Single Radio Voice Call Continuity
SS	Signal Strength
SS	Synchronization Signal
S-SCH	Secondary Synchronization Channel

SSH	Secure Shell
SSID	Service Set Identifier
SSL	Secure Sockets Layer
SSS	Secondary Synchronization Signal
STBC	Space-Time Block Coding
TA	Timing Advance
TAB	*(umbrella term for various MapInfo file types)*
TAC	Tracking Area Code
TB	Transport Block
TBS	Transport Block Size
TCA	Traffic Channel Assignment
TCH	Traffic Channel
TCP	Transmission Control Protocol
TDD	Time Division Duplex
TD-LTE	Time Division LTE
TDMA	Time Division Multiple Access
TD-SCDMA	Time Division Synchronous Code Division Multiple Access
TFI	Temporary Flow Id
TIF	Tag Image File
TLLI	Temporary Logical Link Identifier
TLS	Transport Layer Security
TM	Transparent Mode
TMSI	Temporary Mobile Subscriber Identity
TPC	Transmit Power Control
TRP	TEMS Route Persistence
TS	Timeslot
TSC	Training Sequence Code
TTI	Transmission Time Interval
TWAMP	Two-Way Active Measurement Protocol
UARFCN	UMTS Absolute Radio Frequency Channel Number
UATI	Unicast Access Terminal Identifier
UCD	Uplink Channel Descriptor
UCS	Universal Character Set
UDP	User Datagram Protocol
UE	User Equipment
UL	Uplink
UM	Unacknowledged Mode
UMA	Unlicensed Mobile Access
UMTS	Universal Mobile Telecommunications System
UpPCH	Uplink Pilot Channel
URA	UTRAN Registration Area
URL	Uniform Resource Locator

U-RNTI	UTRAN Radio Network Temporary Identity
USB	Universal Serial Bus
UTC	Universal Time – Coordinated
UTF	UCS Transformation Format
UTM	Universal Transverse Mercator
UTRAN	UMTS Terrestrial Radio Access Network
VCC	Voice Call Continuity
VDOP	Vertical Dilution Of Precision
VMR-WB	Variable Multi Rate Wideband
VoIP	Voice over IP
VoLTE	Voice over LTE
VPLMN	Visited Public Land Mobile Network
VSQI	Video Streaming Quality Index
VSTQ	Video Service Transmission Quality
VTQI	Video Telephony Quality Index
WAP	Wireless Application Protocol
WCDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WSP	Wireless Session Protocol
XML	Extensible Markup Language

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Technical Reference

Contents

1. What’s In This Manual

This book covers various technical aspects of TEMS Investigation 15.3, including:

- Supported cellular system versions
- File formats
- File export formats
- Report formats
- Descriptions of various algorithms used in the application.

2. Supported Cellular System Versions

For details on frequency bands and references to specifications, consult section 4.6.1 (where all bands are listed, not just those supported in TEMS Investigation).

2.1. 3GPP

TEMS Investigation 15.3 is 3GPP Release 8 compliant. Within 3GPP, the following bands are supported:

- GSM/GPRS/EGPRS
  - GSM 850 MHz
  - GSM E-900 MHz
  - GSM 1800 MHz
  - GSM 1900 MHz
- WCDMA/HSPA
  - Bands I–VI
  - Band VIII
  - Band IX
  - Band XI
- LTE (with Rohde & Schwarz TSMW, any LTE band can be scanned)
  - (FDD) Bands I–XIV (1–14), XVII–XXI (17–21)
  - (TDD) Bands XXXIII–XLI (33–41).

2.2. CDMA

CDMA standards are supported by TEMS Investigation 15.3 as follows:

- cdmaOne (IS-95)
- cdma2000 (IS-2000)/EV-DO (IS-856) Rel. 0/Rev. A/Rev. B

on the following bands:

- 450 MHz
- 800 MHz
- 1900 MHz
- 2100/1700 MHz AWS

2.3. TD-SCDMA

The TD-SCDMA 2010–2025 MHz band is supported.

2.4. WiMAX

WiMAX (802.16e) scanning can be done on the 2.3, 2.5 and 3.5 GHz bands.

The following RF Profiles are supported:

- Prof1.B 2.3-5
- Prof1.B 2.3-10
- Prof2.A 2.305
- Prof2.B 2.305
- Prof2.C 2.305
- Prof3.A 2.496-5
- Prof3.A 2.496-10
- Prof4.A 3.3
- Prof4.B 3.3
- Prof4.C 3.3
- Prof5.A 3.4
- Prof5.B 3.4
- Prof5.C 3.4

3. Format of CEL File (UMTS)

In the current version of the CEL file, columns from the older GSM- and WCDMA-specific versions of the CEL format may be freely combined, with partly different columns being filled in for GSM and WCDMA cells.

3.1. General

The file is in ASCII format with tab-delimited data. There is no restriction on the number of cells in the file, but very large cell files will slow the application down noticeably. The default file extension is .cel.

3.2. File Header

The cell file header, which takes up the first line of the file, consists of a revision number and an identification string:

<Rev> TEMS_-_Cell_names

where <Rev> is a revision number.

3.3. Column Headers

The second line in the cell file is the column header line. It consists of tab-separated strings, each of which identifies a category of data. The set of column headers used appears from the table in section 3.4 below; columns can be arranged in any order as long as their headers are valid.

3.4. Data

The remainder of the cell file contains data. Each data line represents one cell name entry and is stored in ASCII as:

data1<HT>data2<HT>data3<HT>...<HT>dataN<CR><NL>

The table below describes the format of the data in each column:

3.4.1. General Data

Column Header	Data Content and Format
Cell	Cell name. Text string.
NETWORK_ CELLID	Free text field describing the cell. Text string.
Lat, Lon	Latitude and longitude. Text string. The input format must be one of the following, where H is one of {N, n, S, s, W, w, E, e, +, -}, “+” representing N or E, d = degree digit, m = minute digit, s = second digit, * = degree sign, one of {*, ¤, o, O, ^, °}: • H dddmm.mmmm (decimal minutes). Here, minutes must be written with two and degrees with at least two digits. Thus, when entering N 4° 2.86´, the degrees and minutes must be written 0402. • H ddd* mm.mmmm’ (decimal minutes). This format, unlike the previous one, does not require padding zeroes in the ddd* mm segment. • H ddd* mm’ ss” (degrees, minutes and seconds; the sign for seconds must be a double quote, ASCII 0x22 – it cannot be replaced by two single quotes). • H ddd* mm’ ss.ssss” (degrees, minutes and decimal seconds). • H ddd.dddd* (decimal degrees). In all formats, the number of decimals is unlimited. The presentation format is H dddmm.mmmm, i.e. decimal minutes rounded off to four decimal places. This gives a resolution of about 20 cm, so that the error is negligible compared to other sources of error.

Column Header	Data Content and Format
MCC	Mobile Country Code. Integer, base 10 representation.
MNC	Mobile Network Code. Integer, base 10 representation.
LAC	Location Area Code. Integer, base 10 or (with prefix 0x) hexadecimal representation.
RA	Routing Area Code. Integer, base 10 representation.
CI	The Cell Identity reported in System Information. For WCDMA, this is the same as UC-Id = RNC-Id + C-Id in ▶ 3GPP 25.401, section 6.1.5. Integer, base 10 or (with prefix 0x) hexadecimal representation.
CI_N_n	Cell Identity of neighbor n of this cell. Same format as for CI.
ANT_ DIRECTION	Antenna direction in degrees clockwise from north. Decimal number. (Alternative name: ANT_ ORIENTATION)
ANT_BEAM_ WIDTH	Antenna beam width in degrees. Integer.
ANT_TYPE	Antenna type. Text string.
ANT_HEIGHT	Antenna height in meters. Decimal number.
ANT_TILT	Antenna tilt in degrees. Decimal number.
CELL_TYPE	Cell type (e.g. “Macro”, “Micro”, “Pico”). Text string.

3.4.2. GSM-specific Data

Column Header	Data Content and Format
ARFCN	ARFCN. Mandatory for GSM cells. Integer.
BSIC	BSIC. Integer in the range 00 ... 77 (octal).
TCH_ARFCN_n	ARFCN of TCH no. n used by this cell. Integer.
LAC_N_n	LAC for neighbor n of this cell. Same format as for LAC.

3.4.3. WCDMA-specific Data

Column Header	Data Content and Format
UARFCN	UARFCN. Mandatory for WCDMA cells. Integer.
SC	Scrambling code. Integer.
RNC-ID	Radio Network Controller ID. Equal to the 12-bit RNC-Id in ▶ 3GPP 25.401, section 6.1.5. Integer, base 10 or (with prefix 0x) hexadecimal representation.
RNC-ID_N_n	Radio Network Controller ID of neighbor n of this cell. Same format as for RNC-ID.
C-ID	Cell Identity. Equal to the 16-bit C-Id in ▶ 3GPP 25.401, section 6.1.5. Integer, base 10 or (with prefix 0x) hexadecimal representation. The 28-bit Cell Identity ("UC-Id" in 3GPP) is a concatenation of RNC-ID (see above) and C-ID.
C-ID_N_n	Cell Identity of neighbor n of this cell. Same format as for C-ID.
URA	UTRAN Registration Area. Integer.
TIME_OFFSET	Time offset of P-SCH synchronization signal in chips. Integer.

Column Header	Data Content and Format
CPICH_POWER	Power (in dBm) on P-CPICH control channel. Decimal number.
MAX_TX_POWER	Maximum transmit power (in dBm) for the cell. Decimal number.
NODE_B	Node B identity assigned by the operator. Text string.
NODE_B_STATUS	Node B status (e.g. “Operational”, “Phase 3”). Text string.

3.5. Comment Lines

A comment line starts with an exclamation mark ‘!’.

Comment lines are ignored when the cell file is imported.

3.6. Neighbor Identification

In GSM, the following parameters are used to identify neighbors: CI, CI_N_n, LAC, LAC_N_n.

In WCDMA, the following parameters are used to identify neighbors: either {CI, CI_N_n} or {C-ID, C-ID_N_n, RNC-ID, RNC-ID_N_n}.

3.7. Example

Below is a sample cell file. The data columns are split into sections here for obvious reasons of presentation; the actual file has one single row of data columns below the header.

Cells no. 1–2 are WCDMA cells, while cells no. 3–4 are GSM cells.

55 TEMS_-_Cell_names

Cell	ARFCN	BSIC	UARFCN	SC	Lat	Lon
1			10714	32	N 47.719283	W 27.293849
2			10714	16	N 47.719283	W 27.293849
3	617	21			N 46.571874	W 26.979771
4	592	20			N 46.571874	W 27.293849

MCC	MNC	LAC	CI	LAC_N_1	CI_N_1
147	2	201			
147	2	201			
147	93	76	32500	76	32501
147	93	76	32501	76	32500

RNC-ID	C-ID	RNC-ID_N_1	C-ID_N_1
687	3756	687	3757
687	3757	687	3756

ANT_DIRECTION	ANT_BEAM_WIDTH	ANT_TYPE	ANT_HEIGHT
156.2	90	Kath1	15.1
228.4	90	Kath1	13.7
73.1	45	Kath2	8.8
147.8	45	Kath2	9.1

ANT_TILT	CELL_TYPE	NODE_B	NODE_B_STATUS
0.0	Macro	RBS Teleby	Operational
7.8	Macro	RBS Teleby	Not Operational
4.4	Macro		
14.2	Macro		

RA	URA	TIME_OFFSET	CPICH_POWER	MAX_TX_POWER
1	4	9442	33	45.5
1	4	22156	33	45.5
1				
1				

4. Format of XML Cell File

The XML cell file format is used for representing (primarily) cell and site information and for interchanging such information between products in the TEMS portfolio.

4.1. Scope of XML Format

The XML format incorporates cell and site data for GSM, WCDMA, LTE, TD-SCDMA, CDMA (1x as well as EV-DO), and WiMAX. It also includes Wi-Fi access point data, which is of interest for GAN-capable user terminals.

4.2. Relation to CEL Format

No formal mapping exists from the older *.cel format (chapter 3) to the XML format, but the correspondences are obvious throughout. All column headings in the *.cel file have their counterparts in XML file elements; in addition, the XML file contains further data. Just note that in the *.cel file, neighbors are indicated by their CIs, whereas in the XML file, cell names are used to identify neighbors.

4.3. Relation to TEMS Investigation CDMA CSV Format

The CSV cell file format used in TEMS Investigation CDMA can be converted to the XML format using TEMS Discovery. Please consult the documentation for that product.

Please note that the CSV format lacks certain items of information that are present in the XML format. For example, the band class is lacking in CSV but is mandatory in XML (see sections 4.7.12.3, 4.7.13). This information must be entered manually in the XML files.

4.4. Schemas

The XML-format cell file is based on two XML schemas:

- The schema TEMSDataTypes.xsd defines TEMS-specific XML data types, derived from the fundamental data types set down in the XML specification. See section 4.6.
- The schema TEMSCell.xsd defines XML attributes and elements that embody cell and site data, relying on the data types in TEMSDataTypes.xsd. See section 4.7.

The schemas are found in the directory XMLSchema beneath the TEMS Investigation installation directory. The syntax laid down in the schemas should always be followed when composing XML cell files.

4.5. General Remarks on Format

The file format should generally follow the recommendation for XML 1.0. See the World Wide Web Consortium recommendation at ▶ www.w3.org/TR/REC-xml.

Files should be encoded in Unicode UTF-8 (▶ IETF RFC 2279). They therefore need to begin with:

```
<?xml version="1.0" encoding="UTF-8"?>
```

When composing XML files it is a good idea to use an XML-capable editor or other tool with XML support. To ensure that language-specific characters are handled correctly, any tool used needs to support the UTF-8 encoding. UTF-8 allows a set of more than $2^8 = 256$ characters to be mapped into 8-bit symbols, by using two-byte sequences for certain characters. For example, Swedish Å needs to be encoded as Ä_ in the XML file. Tools with UTF-8 support normally handle this automatically.

The file should have extension .xml.

Free text comments must be formatted like this:

```
<!-- Comment goes here -->
```

4.6. TEMS-specific Data Types

To facilitate handling of data, a number of TEMS-specific data types are defined. They are collected in the schema TEMSDataTypes.xsd. The definition of custom data types enables range checks and validation of cell data. The data types are used in defining the elements and attributes of the XML cell file, as described in section 4.7.

All TEMS-specific data types are derived from basic (generic) XML schema data types with additional constraints on value ranges or enumeration. It should be noted that these data types do not compare directly to their counterparts in programming languages. For example, it does not follow automatically that the “Long” data types found below should always be represented by a “long” data type in a programming language.

Full information on the basic set of XML schema data types, including definitions of int, long, float, double, and string, is found at ▶ www.w3.org/TR/xmlschema-2/.

Value ranges below are given in the form of inclusive minimum and maximum values, that is, the endpoints of the ranges are valid values.

The TEMS-specific data types are as follows:

Data Type	Range/Description
Double90_90	–90.0 ... 90.0
Double180_180	–180.0 ... 180.0
Double5000	0.0 ... 5000.0
Float90	0.0 ... 90.0
Float90_90	–90.0 ... 90.0
Float100	1.0 ... 100.0
Float180_180	–180.0 ... 180.0
Float360	0.0 ... 360.0
Float_LteBandwidth	{1.4, 3, 5, 10, 15, 20}
Int2To3	2, 3
Long2	0, ..., 2
Long7, Long9, etc.	(analogous to Long2)
LongPositive	0, ..., 9,223,372,036,854,775,807
String128	String with max 128 characters
String128_Collapse	String with max 128 characters, collapsed white spaces[1]

Data Type	Range/Description
String_GeodeticDatum	String indicating geodetic datum; one of “WGS84”, “Bessel 1841”, “Krasovsky”, “Clarke 1880”
String_OperatingBand	String; for values see section 4.6.1
String_SystemType	String equal to one of the following: “GSM”, “WCDMA”, “LTE”, “TD-SCDMA”, “CDMA”, “EV-DO”, “WIMAX”, “WIFI”

1. Any leading and trailing spaces are removed when the file is read. Also, any sequences of spaces inside the string are replaced by single spaces. More about white space handling is found at ▶ www.w3.org/TR/xmlschema-2/#rf-whiteSpace.

4.6.1. String_OperatingBand

A string of type String_OperatingBand can have the following values:

4.6.1.1. GSM Bands

For full details see ▶ 3GPP 45.005.

Band	Description
GSM	Unspecified GSM band. Can be used when the frequency band is not known or not defined.
GSM 450, GSM 480, GSM 850, GSM 900, E-GSM 900, R-GSM 900, GSM 1800, GSM 1900	E-GSM = Extended GSM R-GSM = Railway GSM The rest is self-explanatory.

4.6.1.2. WCDMA Bands

For full details see ▶ 3GPP 25.101, chapter 5.

Band	Description
W-CDMA	Unspecified WCDMA band. Can be used when the frequency band is not known or not defined.
W-CDMA 850	Band V, AM/China
W-CDMA 850 JP	Band VI, JP
W-CDMA 900	Band VIII, EU (GSM)
W-CDMA 1800	Band III, EU/JP/APAC
W-CDMA 1800 JP	Band IX, JP
W-CDMA 1900	Band II, AM
W-CDMA 2100	Band I, EU/JP/APAC
W-CDMA 2100 AM	Band IV, AM
W-CDMA 2500	Band VII, Global

4.6.1.3. LTE Bands

For full details see ▶ 3GPP 36.101, tables 5.5-1 “E-UTRA Operating Bands” and 5.6.1-1 “E-UTRA Channel Bandwidth”.

Band	Description
EUTRA Generic	Unspecified E-UTRA band. Can be used when the frequency band is not known or not defined.
FDD bands	
EUTRA 1	Band I, UMTS IMT 2100 MHz
EUTRA 2	Band II, PCS 1900 MHz
EUTRA 3	Band III, DCS 1800 MHz
EUTRA 4	Band IV, AWS 1700/2100 MHz
EUTRA 5	Band V, Cellular 850 MHz, UMTS 850 MHz
EUTRA 6	Band VI, UMTS 800 MHz
EUTRA 7	Band VII, IMT-E 2600 MHz

Band	Description
EUTRA 8	Band VIII, GSM, UMTS 900 MHz, E-GSM 900 MHz
EUTRA 9	Band IX, UMTS 1700 MHz
EUTRA 10	Band X, UMTS IMT-2000, 1700/2100 MHz
EUTRA 11	Band XI, PDC 1500 MHz
EUTRA 12	Band XII, Lower SMH Blocks A/B/C, 700 MHz
EUTRA 13	Band XIII, Upper SMH Block C, 700 MHz
EUTRA 14	Band XIV, Upper SMH Block D, 700 MHz
EUTRA 17	Band XVII, 700 MHz
EUTRA 18	Band XVIII, 800 MHz
EUTRA 19	Band XIX, 800 MHz
EUTRA 20	Band XX, EU Digital Dividend 800 MHz
EUTRA 21	Band XXI, 1400 MHz
EUTRA 22	Band XXII, 3400/3500 MHz
EUTRA 23	Band XXIII, 2000/2100 MHz
EUTRA 24	Band XXIV, 1600/1500 MHz
EUTRA 25	Band XXV, 1800/1900 MHz
TDD bands	
EUTRA 33	Band XXXIII, 1900 to 1920 MHz
EUTRA 34	Band XXXIV, 2010 to 2025 MHz
EUTRA 35	Band XXXV, 1850 to 1910 MHz
EUTRA 36	Band XXXVI, 1930 to 1990 MHz
EUTRA 37	Band XXXVII, 1910 to 1930 MHz
EUTRA 38	Band XXXVIII, 2570 to 2620 MHz
EUTRA 39	Band XXXIX, 1880 to 1920 MHz
EUTRA 40	Band XL, IMT-2000, 2300 to 2400 MHz
EUTRA 41	Band XLI, 2496 to 2690 MHz
EUTRA 42	Band XLII, 3400 to 3600 MHz
EUTRA 43	Band XLIII, 3600 to 3800 MHz

4.6.1.4. TD-SCDMA Bands

TD-SCDMA bands are not represented in the cell file. (The UARFCN uniquely identifies the band.)

4.6.1.5. CDMA Bands

The CDMA band definitions are from ▶ 3GPP2 C.S0057-B, version 1.0.

Band	Description
CDMA	Unspecified CDMA band. Can be used when the frequency band is not known or not defined.
CDMA 800	Band 0, 800 MHz cellular
CDMA 1900	Band 1, 1.8 to 2.0 GHz PCS
CDMA TACS	Band 2, 872 to 960 MHz TACS
CDMA JTACS	Band 3, 832 to 925 MHz JTACS
CDMA PCS KR	Band 4, 1.75 to 1.87 GHz Korean PCS
CDMA 450	Band 5, 450 MHz NMT
CDMA 2GHz	Band 6, 2 GHz IMT-2000
CDMA 700	Band 7, 700 MHz
CDMA 1800	Band 8, 1800 MHz
CDMA 900	Band 9, 900 MHz
CDMA 800 2nd	Band 10, Secondary 800 MHz
CDMA 400 PAMR EU	Band 11, 400 MHz European PAMR
CDMA 800 PAMR	Band 12, 800 MHz PAMR
CDMA 2.5GHz IMT2000	Band 13, 2.5 GHz IMT-2000 Extension band
CDMA 1900 PCS US	Band 14, US PCS 1.9 GHz
CDMA AWS	Band 15, AWS (US)
CDMA 2.5GHz US	Band 16, US 2.5 GHz
CDMA 2.5GHz US FW LO	Band 17, US 2.5 GHz Forward Link Only

4.6.1.6. WiMAX Bands

The WiMAX bands are as defined in the document ▶ “WiMAX Forum Mobile System Profile Release 1.0 Approved Specification”, Revision 1.7.0.

Band
WIMAX (Unspecified WiMAX band. Can be used when the frequency band is not known or not defined.)
WIMAX 2300-1.A (8.75 MHz)
WIMAX 2300-1.B (5 MHz)
WIMAX 2300-1.B (10 MHz)
WIMAX 2300-2.A1 (3.5 MHz)
WIMAX 2300-2.A2 (3.5 MHz)
WIMAX 2300-2.B1 (5 MHz)
WIMAX 2300-2.B2 (5 MHz)
WIMAX 2300-2.C1 (10 MHz)
WIMAX 2300-2.C2 (10 MHz)
WIMAX 2500 (5 MHz)
WIMAX 2500 (10 MHz)
WIMAX 2500-3.A (5 MHz)
WIMAX 2500-3.A (10 MHz)
WIMAX 2500-BRS.AB (10 MHz)
WIMAX 2500-BRS.BC (10 MHz)
WIMAX 2500-BRS.CD (10 MHz)
WIMAX 2500-BRS.EF (10 MHz)
WIMAX 2500-BRS.FH (10 MHz)
WIMAX 2500-BRS.HG (10 MHz)
WIMAX 2600 (5 MHz)
WIMAX 2600 (10 MHz)
WIMAX 3300-4.A (5 MHz)
WIMAX 3300-4.B (7 MHz)

Band
WIMAX 3300-4.C (10 MHz)
WIMAX 3500-4.B (7 MHz)
WIMAX 3500-5.A (5 MHz)
WIMAX 3500-5.AL (5 MHz)
WIMAX 3500-5.AH (5 MHz)
WIMAX 3500-5.B (7 MHz)
WIMAX 3500-5.BL (7 MHz)
WIMAX 3500-5.BH (7 MHz
WIMAX 3500-5.C (10 MHz)
WIMAX 3500-5.CL (10 MHz)
WIMAX 3500-5.CH (10 MHz)

4.6.1.7. Wi-Fi Bands

Wi-Fi uses unlicensed (ISM) frequency bands as specified in IEEE 802.11. These bands are not represented in the XML cell file.

4.7. Structure of Cell File

4.7.1. Diagram Conventions

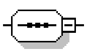
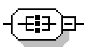
In this section, the structure of the XML cell file is illustrated using tree diagrams. A few conventions in these diagrams need explaining:

<table>
<tr><th>Graphic</th><th>Explanations</th></tr>
<tr><td>
</td><td>

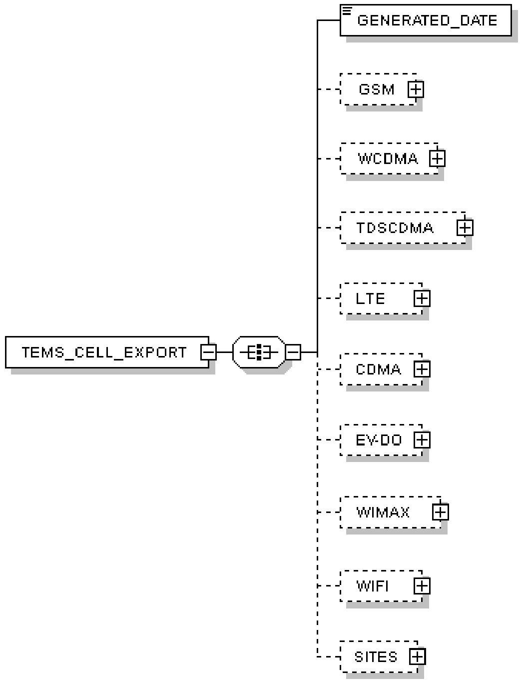
Solid line box: The element is mandatory.
Lines in upper left corner: The element is “atomic”, i.e. it is fully defined in itself and does not contain other elements. Non-atomic elements are drawn without these lines.
Arrow: The element type is global. Global element types are ones that are reused multiple times in the file structure, for instance because they are needed for all technologies (e.g. CELLNAME, ANTENNA). The element type is defined only once in the schema file, and all occurrences of the element type refer to that definition. An element without the arrow is local and has a definition of its own.
</td></tr>
<tr><td>
</td><td>

Dashed line box: The element is optional.
</td></tr>
<tr><td>


</td><td>

Plus sign: The entity in the diagram contains other elements within it. The subordinate structure is collapsed in this case.
Minus sign: The subordinate structure is expanded.
Stacked boxes: Several instances of the element may occur. The permitted number of instances is indicated by a range; in this case, there must be at least one CELL_LIST, but there is no fixed upper limit on the number of such elements.
</td></tr>
<tr><td></td><td>The element on the left must precede the element on the right.</td></tr>
<tr><td></td><td>The element on the left must precede the elements on the right; but the latter may come in arbitrary order.</td></tr>
</table>

4.7.2. Overall File Structure



Nearly every piece of data in an XML cell file will be described as an element or attribute. The main root element is TEMS_CELL_EXPORT; it has a mandatory attribute VERSION which indicates the version of the cell file format.

The GENERATED_DATE element, also mandatory, indicates when the cell file was generated.

A number of further, standard attributes need to be included in the cell file to enable schema validation (checking of element names, value ranges, etc.):

xmlns:dataType="http://www.ascom.com/networktesting/dataTypes"

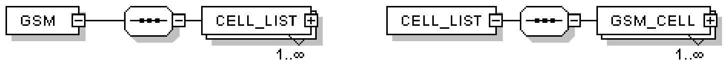
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:noNamespaceSchemaLocation="TEMSCell.xsd" VERSION="1.2"

Please note that no path should be given to TEMSCell.xsd.

4.7.3. GSM Cell Data

GSM cell data is organized as follows:

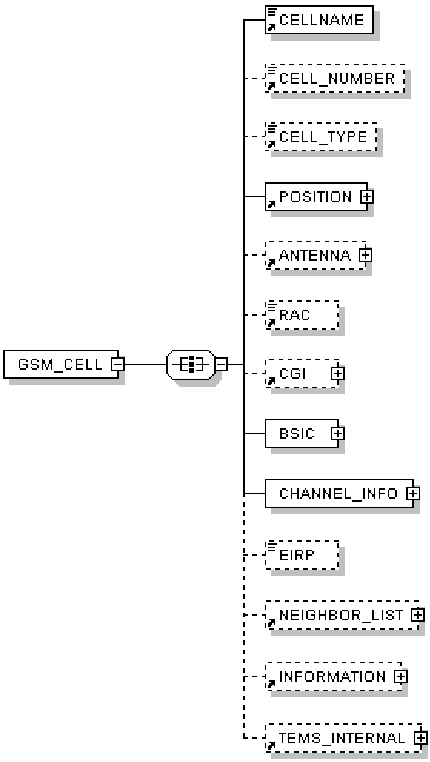


The “GSM” element contains at least one and optionally several CELL_LIST elements. Cell lists are intended to be used to distinguish operators. Each cell list element contains at least one GSM cell. There is no limit to the number of either cells or cell lists.

Like the main root element, the “GSM” element has a mandatory VERSION attribute stating the version of the GSM cell data structure.

CELL_LIST elements have one mandatory attribute, NET_OPERATOR.

For each GSM cell the following elements are specified:

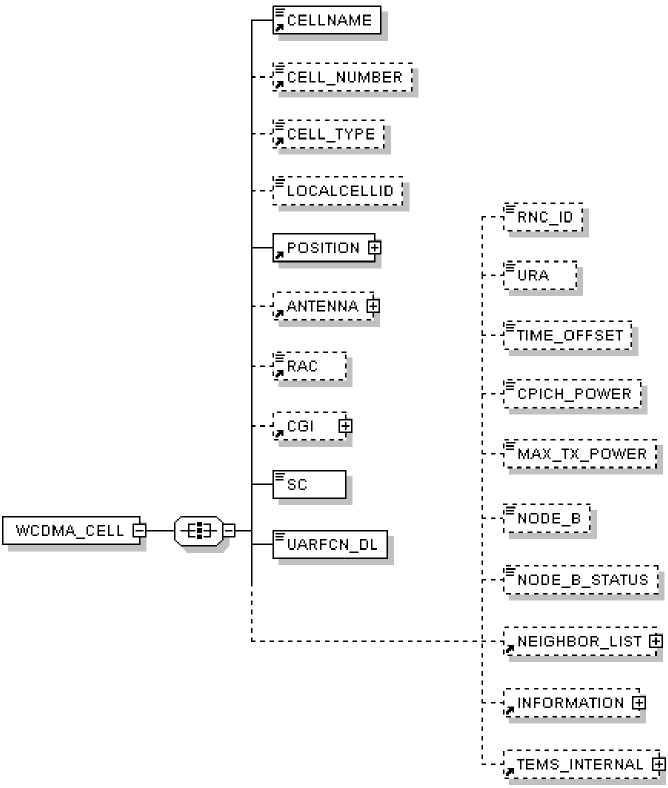


Each cell element is a container that holds multiple subordinate elements. As can be seen in the diagram, only a few of these are mandatory. One is CELLNAME, whose value must be unique in the entire file. CELLNAME has SYSTEM_TYPE as attribute; if this attribute is not set, it is implicitly assumed that this cell belongs to the system (the communications technology) in whose structure it is found, e.g. GSM.

4.7.4. WCDMA Cell Data

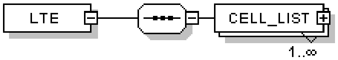
WCDMA cell data is organized like GSM cell data; compare section 4.7.3.

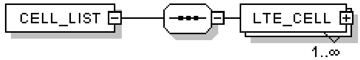
For each WCDMA cell the following elements are specified:



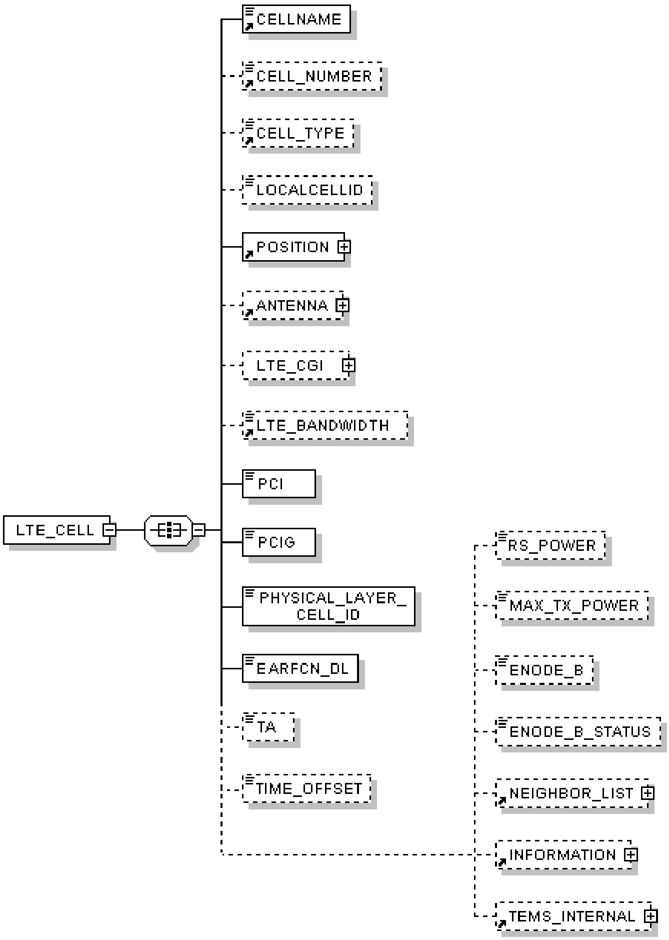
4.7.5. LTE Cell Data

LTE cell data is organized like GSM cell data; compare section 4.7.3.





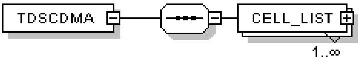
For each LTE cell the following elements are specified:

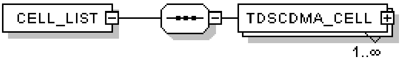


Either {PCI, PCIG} or PHYSICAL_LAYER_CELL_ID is used (not both).

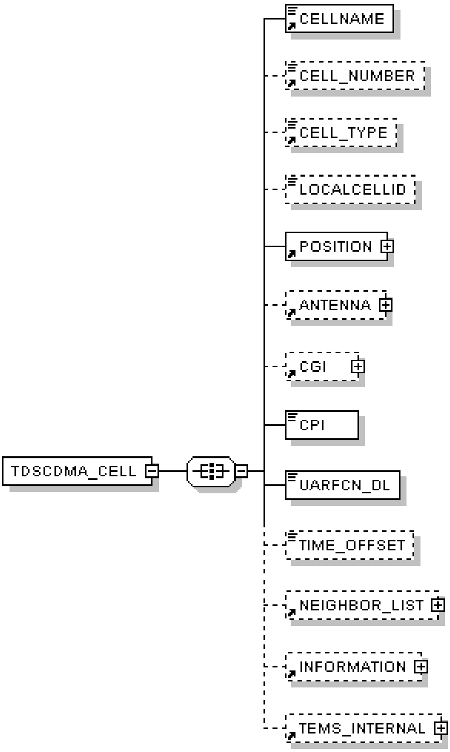
4.7.6. TD-SCDMA Cell Data

TD-SCDMA cell data is organized like GSM cell data; compare section 4.7.3.





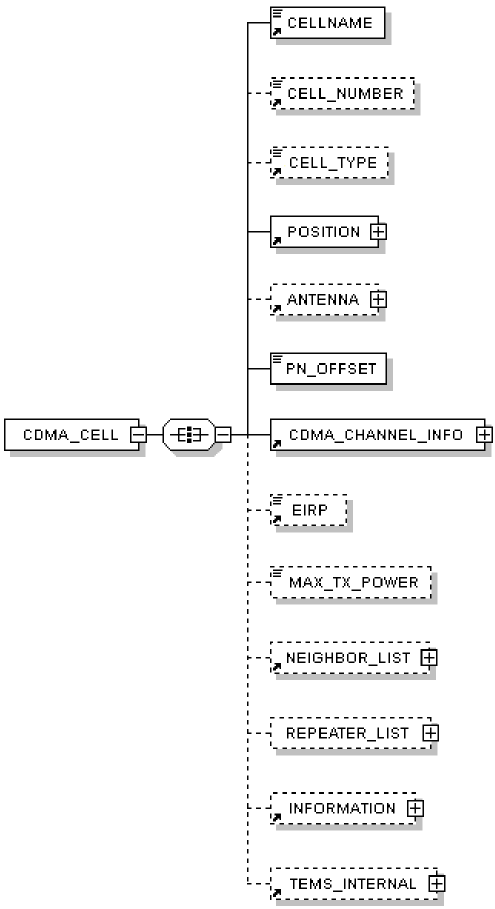
For each TD-SCDMA cell the following elements are specified:



4.7.7. CDMA Cell Data

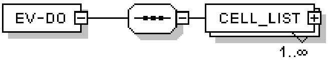
CDMA cell data is organized like GSM cell data; compare section 4.7.3.

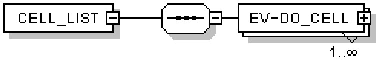
For each CDMA cell the following elements are specified:



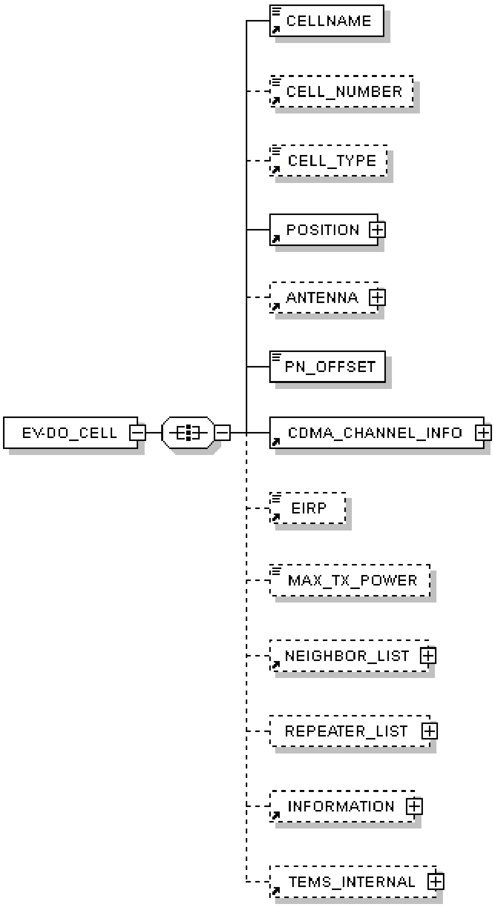
4.7.8. EV-DO Cell Data

EV-DO cell data is organized like GSM cell data; compare section 4.7.3.



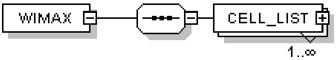


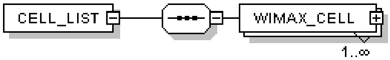
For each EV-DO cell the following elements are specified:



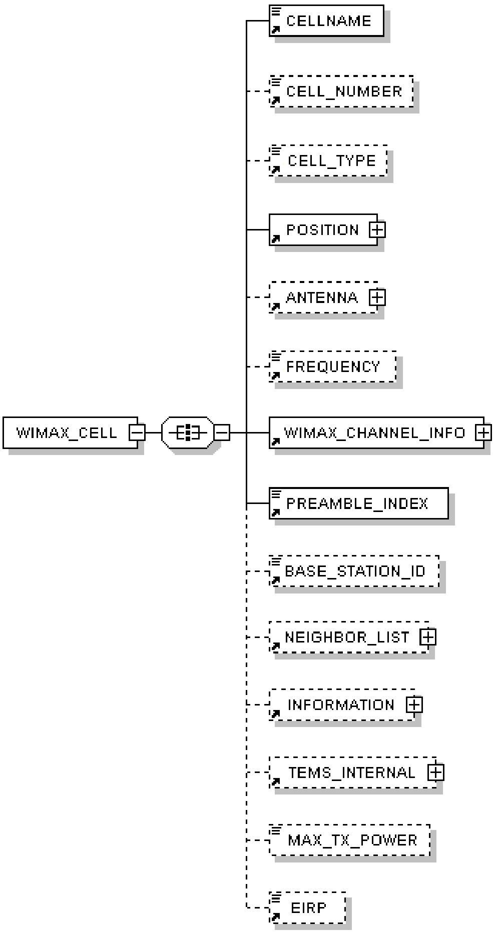
4.7.9. WiMAX Cell Data

WiMAX cell data is organized like GSM cell data; compare section 4.7.3.



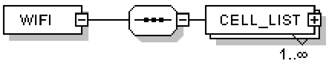


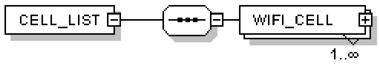
For each WiMAX cell the following elements are specified:



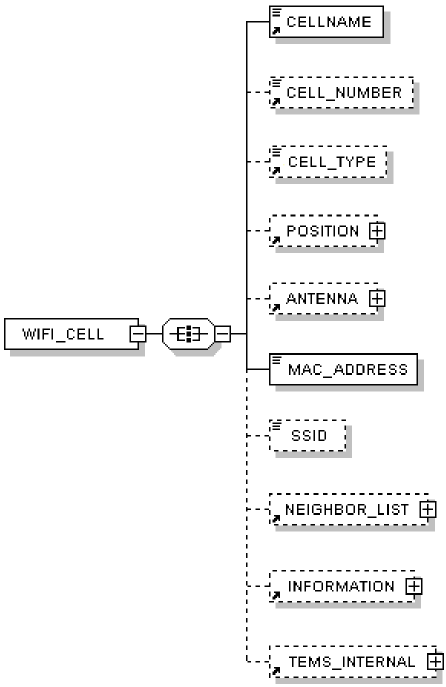
4.7.10. Wi-Fi Access Point Data

Wi-Fi access point data is organized like GSM cell data; see section 4.7.3.[1]





For each Wi-Fi access point the following elements are specified:



1. For simplicity, the term “CELL” has been retained in the Wi-Fi data structure, although Wi-Fi access points are not in fact cells in a cellular network in the way that (e.g.) GSM cells are.

4.7.11. Site Data

The “SITES” data structure allows grouping of cells. However, this structure is not used by the present version of TEMS Investigation, and therefore no detailed description of it is provided here.

4.7.12. Container Elements

This section lists all remaining elements that contain other elements as components. The “atomic” elements follow in section 4.7.13.

Mandatory components and global ones are indicated as such below. For components whose number may vary, the range of that number is given; “∞” means that there is no fixed upper limit.

4.7.12.1. ANTENNA

DIRECTION *(mandatory)*
BEAM_WIDTH
GAIN
HEIGHT
POLARIZATION
ELECTRICAL_TILT
MECHANICAL_TILT
TYPE
INFORMATION *(global)*

4.7.12.2. BSIC

NCC *(mandatory)*
BCC *(mandatory)*

4.7.12.3. CDMA_CHANNEL_INFO

BAND *(mandatory, global)*
CHANNEL *(mandatory, global)*

4.7.12.4. CGI

MCC
MNC_LENGTH
MNC
LAC
CI

4.7.12.5. CHANNEL_INFO

BCCH *(mandatory; this element contains:)* • ARFCN *(mandatory, global)* • BAND *(global)*
TCH [0 ... ∞] *(this element contains:)* • ARFCN *(global)* • BAND *(global)*

4.7.12.6. INFORMATION[1]

INFO [0 ... ∞]

4.7.12.7. LTE_CGI

MCC
MNC_LENGTH
MNC
TAC
CI

1. This element also has the attribute INFO_CATEGORY (section 4.7.14).

4.7.12.8. NEIGHBOR_LIST

CELLNAME [1 ... ∞] *(mandatory, global)*

4.7.12.9. POSITION

GEODETIC_DATUM *(mandatory)*
LATITUDE *(mandatory)*
LONGITUDE *(mandatory)*
ALTITUDE

4.7.12.10. REPEATER_LIST

REPEATER [0 ... ∞] *(this element contains:)* • POSITION *(mandatory, global)* • ANTENNA *(global)*

4.7.12.11. TEMS_INTERNAL

This is data used internally by TEMS products.

4.7.12.12. WIMAX_CHANNEL_INFO

BAND *(mandatory, global)*
CHANNEL *(mandatory, global)*

4.7.13. "Atomic" Elements

Under this heading, finally, are listed all elements which do not contain smaller elements as components. Global elements and local technology-specific elements are collected in a single list.

Element	Description	Data Type
ALTITUDE	Ground height in meters above mean sea level.	double

Element	Description	Data Type
ARFCN	Absolute Radio Frequency Channel Number.	Long1023
BAND	Operating band used for the cell.	String_ OperatingBand
BASE_STATION_ID	WiMAX Base Station Id. Most significant 24 bits are Operator Id. Least significant 24 bits are Sector Id.	LongPositive
BCC	Base Station Colour Code.	Long7
BEAM_WIDTH	Width of antenna beam in degrees.	Float360
CELL_NUMBER	Unique numeric ID for the cell (must be unique in the entire file).	LongPositive
CELL_TYPE	Type of the cell, e.g. “Macro”, “Micro”, “Pico”.	String128
CELLNAME	Text label for cell; must be unique in the entire cell file. This element has the attribute SYSTEM_TYPE (section 4.7.14).	string
CHANNEL	The CDMA RF channel number.	Long1023
CI	GSM, WCDMA: Cell Identity. Equal to the 16-bit C-Id in ▶ 3GPP 25.401, section 6.1.5. The 28-bit Cell Identity (“UC-Id” in 3GPP) is a concatenation of RNC_ID and CI. LTE: ECI, E-UTRAN Cell Identifier. Used to identify a cell uniquely within a PLMN. Length: 28 bits. Contains the eNode B Identifier (eNB-ID) and can address from 1 up to 256 cells per eNode B, depending on the length of the eNB-ID. ▶ 3GPP 36.300, section 8.2	Long268435455
CPI	Cell Parameter ID.	Long127
CPICH_POWER	Primary CPICH power in dBm.	double

Element	Description	Data Type
DIRECTION	Direction of the antenna beam in degrees clockwise from north.	Float360
EARFCN_DL	Downlink EARFCN.	Long65535
EIRP	Effective Isotropic Radiated Power: the apparent power (in W) transmitted towards the receiver.	double
ELECTRICAL_TILT	Electrical tilt in degrees.	Float90
ENODE_B	Name of eNode B.	String128_ Collapse
ENODE_B_STATUS	Status of eNode B (e.g. "Operational").	String128_ Collapse
FREQUENCY	Center frequency in Hz.	LongPositive
GAIN	Antenna gain in dB.	float
GENERATED_DATE	Date and time of XML file generation: "YYYY-MM-DD". **Note:** Other date formats (e.g. "MM/DD/YYYY") are not allowed.	string
GEODETIC_DATUM	Reference ellipsoid used by the GPS to calculate coordinates. The default GPS ellipsoid is WGS84. (Note that this element does *not* indicate the projection.)	String_ GeodeticDatum
HEIGHT	Height above ground of antenna in meters.	double
INFO	Arbitrary additional information.	String128
LAC	Location Area Code.	Long65535
LATITUDE	Latitude in decimal degrees.	Double90_90

Element	Description	Data Type
LOCALCELLID	WCDMA: 28-bit identifier used to uniquely identify the set of resources within a Node B required to support a cell (as identified by a C-Id). ▶ 3GPP 25.401, section 6.1.6 LTE: ECI, E-UTRAN Cell Identifier. Used to identify a cell uniquely within a PLMN. Length: 28 bits. Contains the eNode B Identifier (eNB-ID) and can address from 1 up to 256 cells per eNode B, depending on the length of the eNB-ID. ▶ 3GPP 36.300, section 8.2	Long268435455
LONGITUDE	Longitude in decimal degrees.	Double180_180
LTE_BANDWIDTH	Bandwidth in LTE cell.	Float_ LteBandwidth
MAC_ADDRESS	MAC address of connected WLAN access point (BSSID in IEEE 802.11 standard).	String128_ Collapse
MAX_TX_POWER	Maximum transmission power (in dBm) for all downlink channels added together.	Double5000
MECHANICAL_TILT	Mechanical tilt in degrees.	Float90
MCC	Mobile Country Code.	Long999
MNC	Mobile Network Code.	Long999
MNC_LENGTH	Number of digits in MNC.	Int2To3
NCC	Network Colour Code.	Long7
NODE_B	Name of Node B.	String128_ Collapse
NODE_B_STATUS	Status of Node B (e.g. “Operational”).	String128_ Collapse
PCI	Physical Cell Identity. Can be obtained as PHYSICAL_LAYER_CELL_ID **mod** 3.	Long2

Element	Description	Data Type
PCIG	Physical Cell Identity Group. Can be obtained as PHYSICAL_LAYER_ CELL_ID **div** 3.	Long167
PHYSICAL_LAYER_ CELL_ID	Physical Layer Cell Id, equal to 3 × PCIG + PCI. Optionally used instead of {PCI, PCIG}.	Long511
POLARIZATION	Polarization of antenna (vertical, horizontal, or circular).	String128
PREAMBLE_INDEX	WiMAX preamble index.	Long113
RAC	Routing Area Code.	Long255
RNC_ID	Radio Network Controller ID. Equal to the 12-bit RNC-Id in ▶ 3GPP 25.401, section 6.1.5. The 28-bit Cell Identity (“UC-Id” in 3GPP) is a concatenation of RNC_ID and CI.	Long4096
RS_POWER	Transmitted Reference Signal RSSI.	double
SC	Primary downlink scrambling code to be used in the cell.	Long511
SSID	Service Set Identifier of connected WLAN access point.	String128
TA	E-UTRAN Tracking Area. *Same as* TAC; please use TAC instead.	Long65535
TAC	E-UTRAN Tracking Area Code.	Long65535
TIME_OFFSET	Time offsets used in various contexts, for example in WCDMA to define the starting point of scrambling codes on the CPICH, SCH, etc. Express as a multiple of 256 chips.	Long9
TYPE	Type of antenna used.	String128
UARFCN_DL	Downlink UARFCN.	Long16383
URA	UTRAN Registration Area.	Long65535

4.7.14. Attributes

Element	Description	Data Type
INFO_CATEGORY	Associated with the INFORMATION element (section 4.7.12.6). Allows categorization of the data put into this element.	String128_ Collapse
NET_OPERATOR	Associated with the CELL_LIST element (sections 4.7.3–4.7.8). Consists of a string indicating the name of the network operator.	String128_ Collapse
SYSTEM_TYPE	Associated with the CELLNAME element (see section 4.7.13). Consists of a string indicating the type of network.	String_ SystemType
VERSION	Associated with • the file as a whole (main root element, TEMS_CELL_EXPORT: section 4.7.2) • with the elements denoting a communications technology (sections 4.7.3–4.7.8). Separate version numbering is applied to each of these entities.	Float100

4.8. Example of XML Cell File: UMTS, LTE, Wi-Fi

This example shows what an XML cell file with UMTS and Wi-Fi data may look like. Certain parts which merely repeat previously shown structures are left out; such omissions are indicated by "...".

A complete file can be found in the directory XMLSchema beneath the TEMS Investigation installation directory.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Sample XML file: TEMS XML Cell Export File Format v. 1.2 -->
<TEMS_CELL_EXPORT xmlns:dataType="http://www.ascom.com/networktesting/
dataTypes" xmlns:xsi= "http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="TEMSCell.xsd" VERSION="1.2">
  <GENERATED_DATE>2006-11-28</GENERATED_DATE>
```

```xml
<GSM VERSION="1.1">
  <CELL_LIST NET_OPERATOR="Operator 1">
    <GSM_CELL>
      <CELLNAME SYSTEM_TYPE="GSM">GSM Cell 1</CELLNAME>
      <CELL_NUMBER>0</CELL_NUMBER>
      <CELL_TYPE>Macro</CELL_TYPE>
      <POSITION>
        <GEODETIC_DATUM>WGS84</GEODETIC_DATUM>
        <LATITUDE>90.0</LATITUDE>
        <LONGITUDE>180.0</LONGITUDE>
        <ALTITUDE>3.14159265358979</ALTITUDE>
      </POSITION>
      <ANTENNA>
        <DIRECTION>360.0</DIRECTION>
        <BEAM_WIDTH>360.0</BEAM_WIDTH>
        <GAIN>3.14159</GAIN>
        <HEIGHT>3.14159265358979</HEIGHT>
        <POLARIZATION>Vertical</POLARIZATION>
        <ELECTRICAL_TILT>90.0</ELECTRICAL_TILT>
        <MECHANICAL_TILT>90.0</MECHANICAL_TILT>
        <TYPE>Antenna Type 1</TYPE>
        <INFORMATION>
          <INFO INFO_CATEGORY="String">Antenna Info 1</INFO>
          <INFO INFO_CATEGORY="String">Antenna Info 2</INFO>
        </INFORMATION>
      </ANTENNA>
      <RAC>255</RAC>
      <CGI>
        <MCC>999</MCC>
        <MNC_LENGTH>3</MNC_LENGTH>
        <MNC>999</MNC>
        <LAC>65535</LAC>
        <CI>65535</CI>
      </CGI>
      <BSIC>
        <NCC>7</NCC>
        <BCC>7</BCC>
      </BSIC>
      <CHANNEL_INFO>
        <BCCH>
          <ARFCN>1023</ARFCN>
          <BAND>GSM 900</BAND>
        </BCCH>
        <TCH>
          <ARFCN>1023</ARFCN>
          <BAND>GSM 900</BAND>
        </TCH>
```

```
          <TCH>
            <ARFCN>1023</ARFCN>
            <BAND>GSM 900</BAND>
          </TCH>
        </CHANNEL_INFO>
        <EIRP>3.14159265358979</EIRP>
        <NEIGHBOR_LIST>
          <CELLNAME SYSTEM_TYPE="GSM">GSM Cell 2</CELLNAME>
          <CELLNAME SYSTEM_TYPE="GSM">GSM Cell 3</CELLNAME>
        </NEIGHBOR_LIST>
      </GSM_CELL>
      <GSM_CELL>
        <CELLNAME SYSTEM_TYPE="GSM">GSM Cell 2</CELLNAME>
...
      </GSM_CELL>
      <GSM_CELL>
        <CELLNAME SYSTEM_TYPE="GSM">GSM Cell 3</CELLNAME>
...
      </GSM_CELL>
...
    </CELL_LIST>
    <CELL_LIST NET_OPERATOR="Operator 2">
      <GSM_CELL>
...
      </GSM_CELL>
      <GSM_CELL>
...
      </GSM_CELL>
...
    </CELL_LIST>
  </GSM>

  <WCDMA VERSION="1.1">
    <CELL_LIST NET_OPERATOR="Operator 1">
      <WCDMA_CELL>
        <CELLNAME SYSTEM_TYPE="WCDMA">WCDMA Cell 1</CELLNAME>
        <CELL_NUMBER>0</CELL_NUMBER>
        <CELL_TYPE>String</CELL_TYPE>
        <LOCALCELLID>268435455</LOCALCELLID>
        <POSITION>
...
        </POSITION>
        <ANTENNA>
...
        </ANTENNA>
        <RAC>255</RAC>
        <CGI>
```

```
...
        </CGI>
        <SC>511</SC>
        <UARFCN_DL>16383</UARFCN_DL>
        <RNC_ID>4096</RNC_ID>
        <URA>65535</URA>
        <TIME_OFFSET>9</TIME_OFFSET>
        <CPICH_POWER>3.14159265358979</CPICH_POWER>
        <MAX_TX_POWER>5000</MAX_TX_POWER>
        <NODE_B>Base Station 1</NODE_B>
        <NODE_B_STATUS>Operational</NODE_B_STATUS>
        <NEIGHBOR_LIST>
          <CELLNAME SYSTEM_TYPE="GSM">WCDMA Cell 2</CELLNAME>
          <CELLNAME SYSTEM_TYPE="GSM">WCDMA Cell 3</CELLNAME>
        </NEIGHBOR_LIST>
      </WCDMA_CELL>
      <WCDMA_CELL>
        <CELLNAME SYSTEM_TYPE="WCDMA">WCDMA Cell 2</CELLNAME>
...
      </WCDMA_CELL>
      <WCDMA_CELL>
        <CELLNAME SYSTEM_TYPE="WCDMA">WCDMA Cell 3</CELLNAME>
...
      </WCDMA_CELL>
...
    </CELL_LIST>
    <CELL_LIST NET_OPERATOR="Operator 2">
      <WCDMA_CELL>
...
      </WCDMA_CELL>
      <WCDMA_CELL>
...
      </WCDMA_CELL>
...
    </CELL_LIST>
  </WCDMA>

  <LTE>
    <CELL_LIST NET_OPERATOR="Operator 1">
      <LTE_CELL>
        <CELLNAME SYSTEM_TYPE="LTE">LTE Cell 1</CELLNAME>
        <EARFCN_DL>5206</EARFCN_DL>
        <POSITION>
          <GEODETIC_DATUM>WGS84</GEODETIC_DATUM>
          <LATITUDE>51.137990700</LATITUDE>
          <LONGITUDE>-9.943741439</LONGITUDE>
        </POSITION>
```

```
      <PCI>1</PCI>
      <PCIG>10</PCIG>
      <LTE_CGI>
        <MCC>193</MCC>
        <MNC>11</MNC>
        <TAC>18</TAC>
        <CI>123456789</CI>
      </LTE_CGI>
    </LTE_CELL>
  </CELL_LIST>
</LTE>

<WIFI VERSION="1.0">
  <CELL_LIST NET_OPERATOR="Operator 1">
    <WIFI_CELL>
      <CELLNAME SYSTEM_TYPE="WIFI">Wi-Fi AP 1</CELLNAME>
      <CELL_NUMBER>0</CELL_NUMBER>
      <CELL_TYPE>String</CELL_TYPE>
      <LOCALCELLID>268435455</LOCALCELLID>
      <ANTENNA>
...
      </ANTENNA>
      <MAC_ADDRESS>00-00-00-00-00-00</MAC_ADDRESS>
      <SSID>MyESS</SSID>
      <NEIGHBOR_LIST>
        <CELLNAME SYSTEM_TYPE="WIFI">Wi-Fi AP 2</CELLNAME>
        <CELLNAME SYSTEM_TYPE="WIFI">Wi-Fi AP 3</CELLNAME>
      </NEIGHBOR_LIST>
    </WIFI_CELL>
    <WIFI_CELL>
      <CELLNAME SYSTEM_TYPE="WIFI">Wi-Fi AP 2</CELLNAME>
...
    </WIFI_CELL>
    <WIFI_CELL>
      <CELLNAME SYSTEM_TYPE="WIFI">Wi-Fi AP 3</CELLNAME>
...
    </WIFI_CELL>
...
  </CELL_LIST>
  <CELL_LIST NET_OPERATOR="Operator 2">
    <WIFI_CELL>
...
    </WIFI_CELL>
    <WIFI_CELL>
...
    </WIFI_CELL>
...
```

```
    </CELL_LIST>
  </WIFI>

</TEMS_CELL_EXPORT>
```

4.9. Example of XML Cell File: CDMA, EV-DO

Below is an example showing an XML cell file with CDMA and EV-DO data. Again, some parts which repeat previously shown structures are left out; omissions are indicated by “...”. See also section 4.8.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Sample XML file: TEMS XML Cell Export File Format v. 1.2 -->
<TEMS_CELL_EXPORT xmlns:dataType="http://www.ascom.com/networktesting/
dataTypes" xmlns:xsi= "http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="TEMSCell.xsd" VERSION="1.2">
  <GENERATED_DATE>2006-11-28</GENERATED_DATE>

  <CDMA VERSION="1.0">
    <CELL_LIST NET_OPERATOR="Operator 1">
      <CDMA_CELL>
        <CELLNAME SYSTEM_TYPE="CDMA">CDMA Cell 1</CELLNAME>
        <CELL_NUMBER>0</CELL_NUMBER>
        <CELL_TYPE>Macro</CELL_TYPE>
        <POSITION>
...
        </POSITION>
        <ANTENNA>
...
        </ANTENNA>
        <PN_OFFSET>147</PN_OFFSET>
        <CDMA_CHANNEL_INFO>
          <BAND>CDMA 450</BAND>
          <CHANNEL>23</CHANNEL>
        </CDMA_CHANNEL_INFO>
        <EIRP>3.14159265358979</EIRP>
        <MAX_TX_POWER>2.71828182845904</MAX_TX_POWER>
        <NEIGHBOR_LIST>
          <CELLNAME SYSTEM_TYPE="CDMA">CDMA Cell 2</CELLNAME>
          <CELLNAME SYSTEM_TYPE="CDMA">CDMA Cell 3</CELLNAME>
        </NEIGHBOR_LIST>
      </CDMA_CELL>
      <CDMA_CELL>
        <CELLNAME SYSTEM_TYPE="CDMA">CDMA Cell 2</CELLNAME>
...
      </CDMA_CELL>
```

```
        <CDMA_CELL>
          <CELLNAME SYSTEM_TYPE="CDMA">CDMA Cell 3</CELLNAME>
...
        </CDMA_CELL>
...
      </CELL_LIST>
      <CELL_LIST NET_OPERATOR="Operator 2">
        <CDMA_CELL>
...
        </CDMA_CELL>
        <CDMA_CELL>
...
        </CDMA_CELL>
...
      </CELL_LIST>
    </CDMA>

    <EV-DO VERSION="1.0">
      <CELL_LIST NET_OPERATOR="Operator 1">
        <EV-DO_CELL>
          <CELLNAME SYSTEM_TYPE="EV-DO">EV-DO Cell 1</CELLNAME>
...
        </EV-DO_CELL>
        <EV-DO_CELL>
...
        </EV-DO_CELL>
...
      </CELL_LIST>
      <CELL_LIST NET_OPERATOR="Operator_2">
...
      </CELL_LIST>
    </EV-DO>

  </TEMS_CELL_EXPORT>
```

5. Cell Identification

This chapter describes the algorithms used to identify in the cell file those cells that a device interacts with or scans.

5.1. Cell Identification in GSM

For the cell file formats, see chapter 3 (CEL format) and chapter 4 (XML format).

The CGI step in the algorithms below can be performed only with devices capable of obtaining CGI data. With other devices, this step is skipped. Compare the descriptions of the information elements Cell Name Algorithm and Neighbor Cell Name Algorithm: see Information Elements and Events, section 3.1.

5.1.1. Serving Cell

The following procedure is used to find a matching cell:

1. If CGI (MCC, MNC, LAC, CI) is available, look up the cell in the cell file.
2. Otherwise, try to match the ARFCN and BSIC in the cell file, also considering the geographical position of the sample. A position is considered valid if the distance to the cell is less than 35 km. If multiple matches are found within a 35 km radius, the closest cell is picked. If the position is invalid, no result is returned unless a unique match is found in the cell file.

5.1.2. Neighbors

The following procedure is used to find a matching cell:

1. If CGI (MCC, MNC, LAC, CI) is available, look up the cell in the cell file.
2. Otherwise, if the current serving cell is known, search that cell’s neighbor list as defined in the cell file for a neighbor with matching ARFCN and BSIC.

3 If the current serving cell is not known, search the entire cell file for cells with matching ARFCN and BSIC, also considering the geographical position of the sample. A position is considered valid if the distance to the cell is less than 35 km. If multiple matches are found within a 35 km radius, the closest cell is picked. If the position is invalid, no result is returned unless a unique match is found in the cell file.

5.2. Cell Identification in WCDMA

For the cell file formats, see chapter 3 (CEL format) and chapter 4 (XML format). Note the following:

- CEL format: CI must be the full 28-bit Cell Id (see section 3.4).
- XML format: Both CI and RNC_ID must be set (see section 4.7.13).

The following procedure is used to find a matching cell:

1 If a valid 28-bit Cell Id is available for the SAN (Serving/Active set/ Neighbors) constellation, look up the cell in the cell file. This is possible in idle mode only, because only then can the Cell Id be obtained.

2 Otherwise, try to match the UARFCN and SC in the cell file, also considering the geographical position of the sample. A position is considered valid if the distance to the cell is less than 200 km. If multiple matches are found within a 200 km radius, the closest cell is picked. If the position is invalid, no result is returned unless a unique match is found in the cell file.

Step 1 is possible only with a UE. With a scanner, only step 2 is performed.

5.3. Cell Identification in LTE

For the cell file format, see chapter 4 (XML format).

The following procedure is used to find a matching cell:

1 If a valid 28-bit Cell Id is available for the SAN (Serving/Active set/ Neighbors) constellation, look up the cell in the cell file. This is possible in idle mode only, because only then can the Cell Id be obtained.

2 Otherwise, try to match the EARFCN and Physical Layer Cell ID (= PCI + 3 × PCIG) in the cell file, also considering the geographical position of the sample. A position is considered valid if the distance to the cell is less than 50 km. If multiple matches are found within a 50 km radius,

the closest cell is picked. If the position is invalid, no result is returned unless a unique match is found in the cell file.

Step 1 is possible only with a UE. With a scanner, only step 2 is performed.

5.4. Cell Identification in CDMA

For the cell file format, see chapter 4 (XML format).

The following procedure is used to find a matching cell:

- Try to match the sample's system type (CDMA/EV-DO), frequency band, RF channel and PN offset in the cell file, also considering the geographical position of the sample. A position is considered valid if the distance to the cell is less than 100 km. If multiple matches are found within a 100 km radius, the closest cell is picked. If the position is invalid, no result is returned unless a unique match is found in the cell file.

5.5. Cell Identification in WiMAX

For the cell file format, see chapter 4 (XML format).

The following procedure is used to find a matching cell:

- Try to match the sample's system frequency band, RF channel and Preamble Index in the cell file, also considering the geographical position of the sample. A position is considered valid if the distance to the cell is less than 50 km. If multiple matches are found within a 50 km radius, *no* cell is picked. If the position is invalid, no result is returned unless a unique match is found in the cell file.

6. Format of Cell Whitelists Underlying User-defined Events

This chapter describes the format of cell whitelists, which are composed in the Cell Whitelist Generator of the Event Definition window and converted by TEMS Investigation into a user-defined event. See the User's Manual, section 24.4.

6.1. Format Description

Overall Structure

The basic structure of the whitelist is as follows:

$<RAT>
#<MCC>,<MNC>
[<LAC$_1$>],<CI$_1$>
[<LAC$_2$>],<CI$_2$>
...
[<LAC$_n$>],<CI$_n$>

An arbitrary number of cells (LAC/CI lines) can be listed. The RAT, MCC, and MNC apply to all of these cells.

The above structure can be iterated in the following ways:

- Under one RAT, multiple "#<MCC>,<MNC>" sections can be entered, each with a separate list of cells.
- Multiple $<RAT> sections can be entered, each containing the above structure in its entirety.

Radio Access Technology

<RAT> is one of {GSM, WCDMA}.

Information Elements Used for GSM

- <MCC> = MCC, Mobile Country Code.
- <MNC> = MNC, Mobile Network Code.
- <LAC> = LAC, serving cell Location Area Code in decimal format. This is optional and will be left out of the event expression if not specified.
- <CI> = Cell Id, Cell Identity of serving cell in decimal format.

Information Elements Used for WCDMA

- <MCC> = MCC, Mobile Country Code.
- <MNC> = MNC, Mobile Network Code.
- <LAC> = Serving Cell LAC, serving cell Location Area Code in decimal format. This is optional and will be left out of the event expression if not specified.
- <CI> = Serving Cell Id (CI Part), serving cell C-ID (16 bits) in decimal format.

Spaces and empty lines are ignored throughout.

6.2. Example

Below is an example of a valid whitelist. Spaces and newlines have been inserted for readability.

Note that in the WCDMA section, the LAC has been omitted throughout.

```
$GSM

#240, 05
4301, 31501
4301, 31502
4301, 31574
7849, 29361
7849, 29362

#240, 07
2605, 18975
2605, 18978
```

$WCDMA

#240, 01
, 49017
, 49018
, 49019

6.3. Conversion to Event Expression

For a given RAT, each #<MCC>,<MNC> section is transformed into a logical expression of this form:

MCC = <MCC>
AND
MNC = <MNC>
AND
(
    (LAC = <LAC_1>) AND (CI = <CI_1>)
    OR
    (LAC = <LAC_2>) AND (CI = <CI_2>)
    OR
    ...
    OR
    (LAC = <LAC_n>) AND (CI = <CI_n>)
)

If some LAC_i is omitted, the *i*th member of the OR expression simplifies to CI = <CI_i>.

If there are multiple #<MCC>,<MNC> sections, they are joined by OR at the top level.

7. Data Session Error Messages

Below are listed error messages that may occur when doing data service testing, whether manually (see the User's Manual, section 7.3) or in automated fashion using Service Control scripts (see the User's Manual, chapter 12).

7.1. General Data Service Error Messages

Message	Explanation
Bad hostname	An attempt was made to use an APN without web services.
Connection failed	A failure occurred in connecting to the server.
Connection terminated	The connection was terminated (most likely by the server) before completion.
Connection timeout	A timeout occurred while the client was attempting to establish a connection to the server. Possible causes: • Use of incorrect port number. • *(FTP)* URL or IP address put into FTP Account field instead of Remote Address field.
Failed to start IP sniffer	Start-up of the IP sniffing function in TEMS Investigation failed.
Session aborted by user	The user aborted the session for some reason.
Socket already open or in use	An attempt was made to use a socket that is already opened or already in use.

Message	Explanation
Socket creation failed	An attempt to create a socket was unsuccessful.
Socket error	Socket binding to local port failed, or receiving of data from the socket failed. Possible causes: • The socket already exists when attempting a dial-up. Try disconnecting the data session (icon in system tray). • The phone has been deactivated in TEMS Investigation. Try reactivating the phone. • *(FTP)* Use of leading slash for root-located file.
The address is not valid	Possible causes: • Use of non-existent URL or IP address as remote address. • The DNS lookup of the host name failed. • *(FTP)* Path appended to the URL or IP address under Remote Address (not allowed: see the User's Manual, sections 12.20.3.11, 12.20.3.12).
Timeout	A connection to the server was successfully established, but a timeout occurred at a later time. (Compare Connection timeout above.)
Unknown error	A failure occurred in decoding a message from the server. Possible causes: • Use of forward slashes in the Target File (local) path. • Phone disconnected from TEMS Investigation. Reconnect the phone.

7.2. RAS Error Messages

Message	Explanation
Internal error	An invalid APN was used.
No answer	The remote computer did not respond.
The PPP link control protocol terminated	Possible causes: • PDP Context Activation failure. See the Activate PDP Context Reject message in the Layer 3 Messages window for the cause value. • The phone lacks an APN for the network. Try setting the APN by sending the following command to the phone: AT+CGDCONT=1, "IP","my_server.com" (replace the final string by the correct URL).
The request has timed out	A subsequent error occurred after an initial PDP Context Activation error. Action: Stop, reload, and restart the script.
Unknown error	Possible cause: Use of *99****n*# as access phone number (where *n* indicates the *n*th APN entry in the phone). Some phones do not accept this syntax.

7.3. NDIS Error Messages

Message	Explanation
NDIS device not connected. IP address not assigned to network adapter	No connect operation has been performed in the phone-specific software application. See the User’s Manual, section 12.20.3.2.

7.4. FTP Error Messages

Message	Explanation
Account not accepted	The FTP account was invalid.
Cannot transfer without valid account	The user lacked a valid account for logging in to the FTP server.
Data port could not be opened	The server failed to connect on the FTP data port. (FTP utilizes two ports, a data port and a command port.)
File access denied	The user did not have permission to access the file on the server.
File not found	The file to upload or download was not found. Possible causes (download): • The file was not in the remote directory. • The file was in the remote directory, but the user lacked read permission for that directory.
Local directory error	• *(FTP DL)* The target file directory did not exist, and an attempt to create it failed. • *(FTP UL)* The source file directory did not exist.
Not able to open file for writing	The specified file is read-only.
Password not accepted	The password was invalid.
Port command failed	Something went wrong when non-passive mode was used. This could happen if the client is behind a firewall.
The RETR command failed	A failure occurred when trying to retrieve a file from the server.
Unsufficient storage space	There was not enough disk space available to download the file.

Message	Explanation
User not accepted	The user name was invalid.

7.5. Email Error Messages

Message	Explanation
Failed to add attachment to the message	Adding an attachment failed.
HELLO command was rejected or not responded to by the server	The client attempted to initiate a connection with the email server, but the server did not respond.
Invalid values of parameters	Typically reported when the email message body or receiver/sender is missing.
Password command timed out or rejected	Sending the password to the server failed.
The DATA command failed	Sending the email message body to the recipient failed.
The message body is too big	(The maximum message body size is 32 kB.)
The RETR command failed	An attempt to retrieve a file from the server failed.
The user command has timed out or rejected	Sending the user name failed.
There was a problem with the server with respect to the RCPT command	The email server could not resolve the identity of the message recipient.
There was no response from the server	The client attempted to retrieve the response code from the server, but the server did not respond to the client’s request.

7.6. Video Streaming Error Messages

Message	Explanation
Connection failed	A failure occurred in the RTSP protocol when the streaming client was trying to initiate a connection with the streaming server.
Data timeout	The streaming client did not receive any data within the specified timeout period.
File not found	The requested file was not found on the streaming server.
Host could not be resolved	The streaming server with the specified remote address could not be found.
Invalid parameter	Some parameters in the script setup are incorrect.
Live measurement mode required	(Live measurement mode is required when specifying an SDP file as source file.)
Stream setup failed	The streaming client did not succeed in setting up the video/audio streams.
Streaming client initialization failed	A failure occurred related to adding or connecting video/audio filters.
Streaming client internal error	This message is usually reported due to a failure in the RTSP communication with the streaming server.
Unsupported payload	An attempt was made to use an unsupported video or audio codec.

7.7. MMS Error Messages

Message	Explanation
Message not found on MMSC	The message could not be located on the MMSC.

Message	Explanation
MMS receive failure	A failure occurred when retrieving the MMS from the MMSC.
MMS send failure	This error message has many possible causes. They are listed in section 7.7.1.
MMSC redirect not supported	The MMSC reply is a redirection request.
MMSC request error	A failure occurred following a request to the MMSC.
MMSC unexpected reply	A reply was received in a format other than an MMS message.
Received MMS is corrupt	The received MMS is corrupt.

7.7.1. MMS Send Failure Causes

- An unspecified error occurred during the processing or reception of the corresponding request.
- The client did not have permission or funds to perform the requested operation.
- An inconsistency with the message format was detected when the corresponding request was parsed.
- There was no MMS address (From:, To:, Cc:, Bcc:) in a proper format, or none of the addresses belonged to the MMSC.
- The MMSC was not able to accept the corresponding request due to capacity overload.
- The MMSC does not support the corresponding request abstract message.
- The corresponding M-Send.req as received was valid and understood by the MMS Proxy-Relay, but some temporary condition or event caused an error to occur.
- The MMS Proxy-Relay was not able to handle the corresponding M-Send.req due to an unspecified error on the transport layer or due to capacity overload.

- An unspecified permanent error occurred during the processing or reception of the corresponding M-Send.req.
- The corresponding M-Send.req was rejected due to failure of authentication or authorization of the originating MMS client.
- An inconsistency in the formats of optional or mandatory header fields or an error in header field values was detected when the corresponding M-Send.req was parsed.
- The MMS Proxy-Relay was not able to resolve the insert-address-token into a valid sending address.
- The MM content in the M-Send.req was not accepted due to size, media type, copyrights, or for some other reason.
- The corresponding request contained a reply MM that was too large, not within the reply charging deadline, and/or contained non-text media elements although only text was allowed.
- The M-Send.req contained an XMms-Reply-Charging header field with the value “Accepted” or “Accepted text only”.
- The MMS Proxy-Relay does not support reply charging. The corresponding M-Send.req contained reply charging parameters and was thus rejected.
- The MMS Proxy-Relay does not support address hiding. The corresponding M-Send.req had XMms-Sender-Visibility set to “Hide” and was thus rejected.

7.8. WAP Error Messages

Message	Explanation
Failed to create WAP stack	Something went wrong when creating the WAP stack.
Failed to disconnect	An error occurred when disconnecting from the server.
The GET command failed	The requested data source could not be retrieved.

8. Text Export Format for Logfiles

8.1. General

The text export format for logfiles uses an ASCII representation with tab delimited data. The default file extension is .fmt.

8.2. File Header

The first line in the file contains column headers. Headers marked * are or can be excluded from the reduced version of the text export file (see the User's Manual, section 10.6.2.2):

- Time
- MS
- Frame Number *
- Direction
- Message Type
- Message ID *
- Hexadecimal String *
- Event
- Event Info *
- One header for each information element component exported, composed of: the device designation (or All, if the data is exported for all devices), the name of the information element, and the argument, if there is one. Examples:
  - *(GSM)* All-RxLev Full, MS1-Neighbor BSIC [1]
  - *(WCDMA)* All-RRC State, MS1-AS CPICH Ec/No [1]
  - *(CDMA)* All-CDMA Rx State, MS1-Neighbor Set PN [2]

Note that positioning data, too, is exported as ordinary information element columns.

8.3. Data

The remainder of the export file contains logfile data. Each line of data represents one message. The table below describes the format of the data in each column:

Column Header	Description/Format
Time	Current time: hh:mm:ss:dd, where dd = decimal seconds.
MS	Device designation: MSn or DCn (n is an integer).
Frame Number	Frame number of the TDMA frame. Integer in the range 0 ... 2715648. (Valid only for GSM messages; “Not Valid” for WCDMA and CDMA messages.)
Direction	Direction of the message: UL, DL, or Internal.
Message Type	Type of message, e.g. • *(GSM)* Paging Request Type 1, Synch Channel Information • *(WCDMA)* System Information Block, UE Intra-Freq Report • *(CDMA)* EV-DO Power, Pilot Sets, Searcher General Status
Message ID	Integer denoting message type.
Hexadecimal String	The message expressed as a string of hexadecimal digits in groups of two, e.g. F6 96 01 00 ...
Event	Event(s) triggered by the message, if any. If there are multiple events, semicolons (;) are used to separate them.

Column Header	Description/Format
Event Info	Event parameters, if any. Example (WCDMA, Radio Link Addition): SC added: 1, SHO type: unknown, Event type: e1a. If there are multiple events, semicolons (;) are used to separate event parameter strings. If an event has no parameters, it is still represented by a semicolon so that consistency is maintained with the Event string. For example, if the Event string is of the form <event_1>;<event_2>;<event_3>, and events 1 and 3 have parameters while event 2 does not, then the Event Info string takes the form <event_1_info>;;<event_3_info>.
Information element columns	Value of information element component.

9. Notes on Third-party Logfile Export Formats

Compare the User's Manual, section 10.6 on logfile export.

9.1. Export to MapInfo

For both Interchange and Tab format, "Version 300" is exported.

Exported files for each logfile (Interchange):

- *.mif – graphics data in ASCII (e.g. format version, symbol information)
- *.mid – textual data in ASCII (e.g. MS information, event/message texts)

Exported files for each logfile (Tab):

- *.tab – table structure in ASCII (e.g. format version, field definitions)
- *.dat – table date storage in binary format (e.g. message information)
- *.map – storage of map objects in binary format
- *.id – links to the *.map file in binary format

9.2. Export to ArcView

ArcView 3.2 for Windows was used to verify the export function. The export file format itself is based on the document "ESRI Shapefile Technical Description" (ESRI White Paper, July 1998), available on the Web at ► www.esri.com/library/whitepapers/pdfs/shapefile.pdf.

Exported files for each logfile:

- *.shp – main file in binary format, containing header, symbol, and data related information in records
- *.shx – binary format index file for the *.shp file
- *.dbf – dBase table file with message information in attribute records (events, messages, MS indication, etc.)

9.3. Export to Marconi Planet

The specification adhered to in this case is “Planet DMS Test Mobile Generic File Format”, with “Version” set to “1.0” by TEMS Investigation.

Exported file for each logfile:

- *.txt – ASCII format file with data in “header”, “definition”, and “main” sections (as defined by the above-mentioned specification)

9.4. Export to Ethereal (Wireshark)

Exported file for each logfile:

- *.eth – Ethereal format file

9.5. Export to MDM

Normally, one MDM file is exported for each device channel found in the logfile. For example, if the logfile contains MS1, MS2, and MS3, the export will produce three files named

<original logfile name>_MSn_<mdm name>

where n = 1, 2, 3, and <mdm name> is given in a format which can be exemplified by:

m0108371.411

This is interpreted as follows:

m	01	08	37	1.4	11
	days	hours	minutes	seconds (14)	two final digits of the phone’s MIN

If a device was deactivated in TEMS Investigation during recording of the logfile, the corresponding MDM file will be closed at that point, and the export will continue to a new MDM file for that device.

10. Logfile Report

This chapter describes the layout and contents of the HTML file created by the logfile report generator.

The overall structure of the HTML file appears from the following figure. The contents of each part is described in a separate section below. Statistics on network parameters, and all scan data content, appear only insofar as the appropriate categories have been selected in the Report Generator wizard (see the User's Manual, section 10.8).

Header

Logfile information

Statistics
Worst cell indication
Thresholds
Events
Scan data

Charts
Distribution parameters
Scan data

Logfile report layout.

10.1. Header

The header shows the date and time when the report was generated, as well as the user name (**Prepared by**) and report number entered in the **Properties** dialog (User's Manual, section 10.8.5).

10.2. Logfile Information

Under this heading the following is indicated for each logfile:

- the logfile name
- what external devices (apart from a GPS) were used to record the logfile
- whether a GPS unit was used when recording.

In addition, this section contains:

- the total duration of all logfiles
- the MS designations of the external devices (“MS1”, etc.)
- *(if scanning has been performed)* a table listing all scanned channels/ scrambling codes, with links to the scan data graphs for individual channels/SCs, to the corresponding rows in the scan data statistics table (“s” links), and to the logfile or logfiles containing the data on each channel/SC. The purpose of the table is to give a compact overview of the scan and the channels/SCs covered.

10.3. Statistics

10.3.1. Worst Cell Indication

This section ranks cells on the basis of how often parameter thresholds have been crossed[1] and events triggered in each cell. Crossing one threshold adds one point to the #Thresholds score; crossing both thresholds adds two points. Each occurrence of an event adds one point. The threshold and event counts are weighted and combined, giving a single ranking of the cells. The worst cell is at the top of the list.

Note that the ranking can be based on arbitrary phone information elements and events.

10.3.2. Thresholds

The following is reported for each information element and threshold chosen:

1. That is: for a “greater than” condition, how many times the parameter has exceeded the threshold; for a “less than” condition, how many times it has dropped below it.

- How many times the element has crossed the threshold
- The average duration of the dips/peaks
- The cell or cells in which the threshold was crossed
- The logfile or logfiles in which the threshold was crossed.

10.3.3. Events

The following statistics are reported for each event:

- Number of occurrences
- The cell or cells in which the event occurred
- The logfile or logfiles in which the event occurred.

10.3.4. Scan Data

The following is reported for each channel scanned:

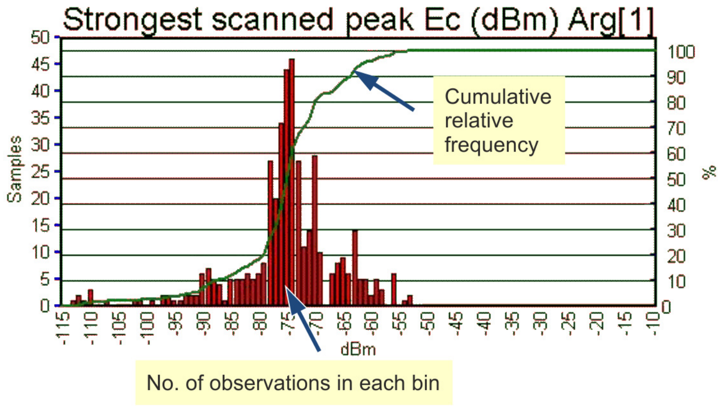
- Number of measurement samples
- Mean, median, minimum and maximum signal strength (averaging in mW domain)

10.4. Charts

10.4.1. Network Parameters

Distribution bar charts are drawn for all information elements that are compared with thresholds. The cumulative relative frequency[1] of the observations is plotted in each chart.

1. The cumulative relative frequency of a value *a* is the percentage of observations that are less than or equal to *a*.



The charts are saved in JPEG files; see section 10.5.1 below.

If you have defined custom ranges for an element, the distribution chart is drawn using one bar for each range, and a table is appended listing the values of the PDF (probability distribution function) and CDF (cumulative distribution function) for each range.

If no data is available for a particular chart, this is indicated in the HTML file by a text string ("No <IE name> data available"), and no chart appears.

10.4.2. Scan Data

- *GSM:* An RxLev chart is drawn for each ARFCN.
- *WCDMA:* An Ec/Io chart is drawn for each scrambling code.
- *LTE:* An RSRQ chart is drawn for each Cell Identity.
- *TD-SCDMA:* An Ec/Io chart is drawn for each CPI.
- *CDMA:* A PN Scan bar chart is drawn for each RF channel. A Strongest Scanned PN bar chart is also drawn.

The scan data charts always follow after the network parameter charts.

10.5. File and Directory Naming

10.5.1. Files

For each report, a new directory will be created under GeneratedReports and contain the following files:

- index.htm: HTML file with header, statistics, and links to JPEG images
- One JPEG file for each information element appearing in the threshold comparisons, files being named according to the format <IE name>_<argument>.jpg
- One JPEG file for each scanned channel/scrambling code/pilot, files being named according to the format Scan_<channel/SC/pilot no.>[<frequency band>].jpg
- Some auxiliary graphics files.

10.5.2. Directory

The directory name has the syntax

<prefix><month_nr><day_nr>_<index><suffix>

where <prefix> and <suffix> are the optional user-specified logfile prefix and suffix, <month_nr> and <day_nr> indicate the day on which the report was generated, and <index> is an incrementing counter used to distinguish between reports generated during the same day.

11. KPI Definitions

This chapter defines KPIs that can be computed in TEMS Discovery on the basis of events in TEMS Investigation logfiles.

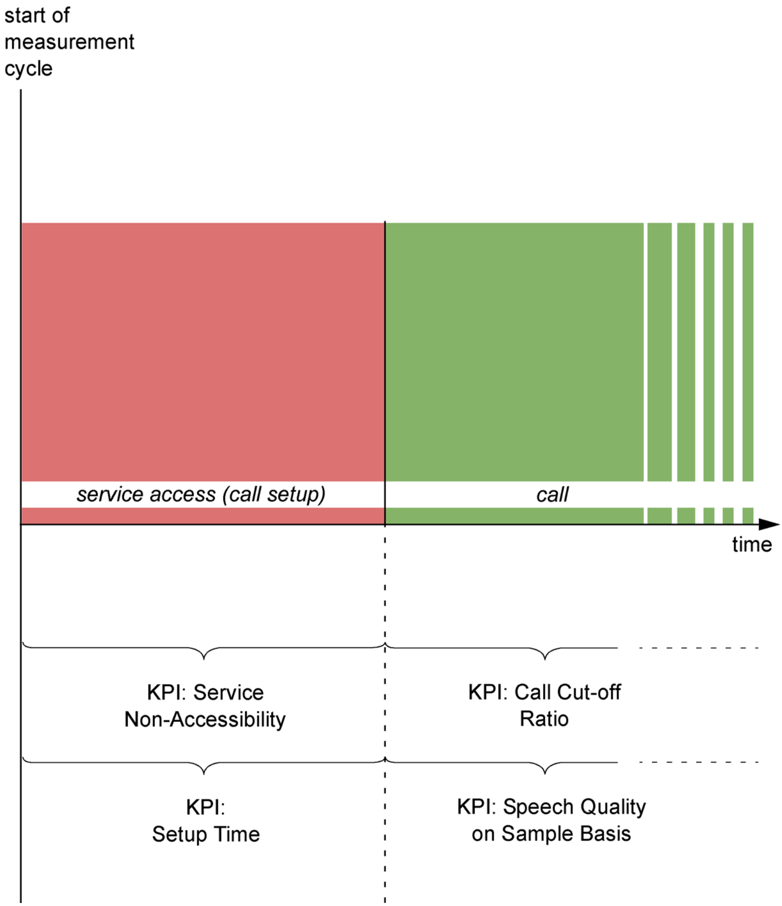
See Information Elements and Events, section 8.4 for a listing of KPI event types.

See the User's Manual, chapter 36 for a general introduction to KPIs.

Brief descriptions of the KPIs are given in the present chapter. Further technical detail on KPIs is provided in a separate document "KPI Definitions in TEMS Products", which is included in the TEMS Investigation documentation package.

11.1. Overview of KPIs for Circuit-switched Services

11.1.1. Diagram of Circuit-switched KPIs



KPIs for voice and video telephony.

11.1.2. Service Non-Accessibility (%)

Denotes the probability that the end-customer cannot access the service when requested although the phone indicates having network coverage.

11.1.3. Setup Time (s)

Denotes the time between sending of complete address information and receipt of call setup notification.

11.1.4. Speech Quality on Sample Basis (MOS)

Denotes the end-to-end speech quality computed sample by sample. The quality is judged using PESQ or POLQA (see the User's Manual, chapter 37).

11.1.5. Call Cut-off Ratio (%)

Denotes the probability that a successfully set up call is ended by a cause other than the intentional termination by either party.

11.2. Overview of KPIs for Packet-switched Services

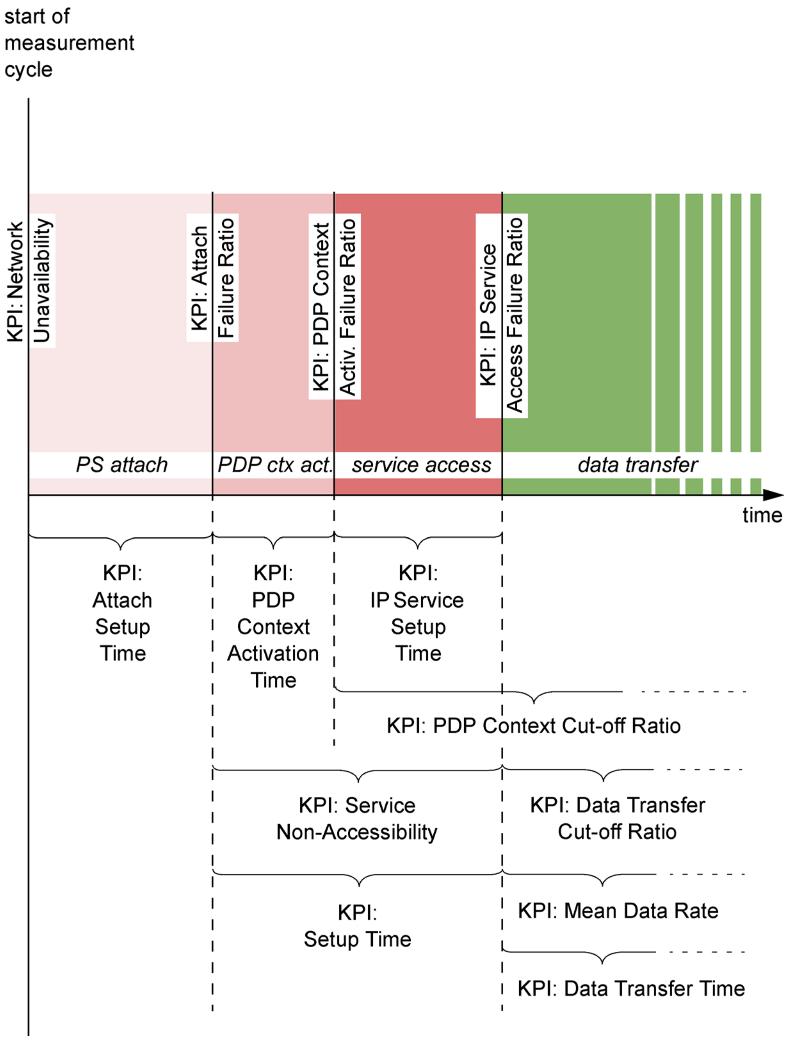
KPI data is logged for the following data services:

- FTP (but not SFTP)
- HTTP
- WAP
- MMS
- Streaming
- VoIP

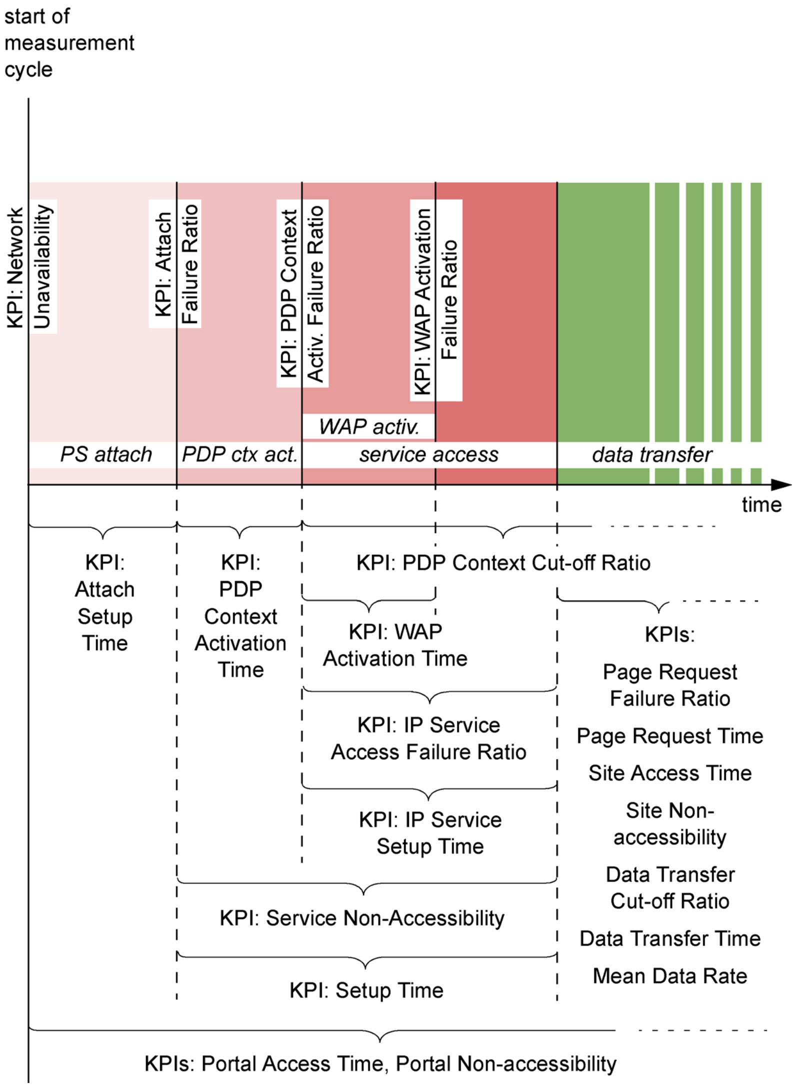
For FTP and HTTP, the set of KPIs is the same. For WAP, only one step is added. For MMS and streaming, on the other hand, the KPIs are more divergent.

It is helpful to consider all KPIs within the framework of packet-switched sessions. See the diagrams on the following pages depicting such sessions. Listings of KPIs follow in sections 11.2.2–11.2.8.

11.2.1. Diagrams of Packet-switched KPIs

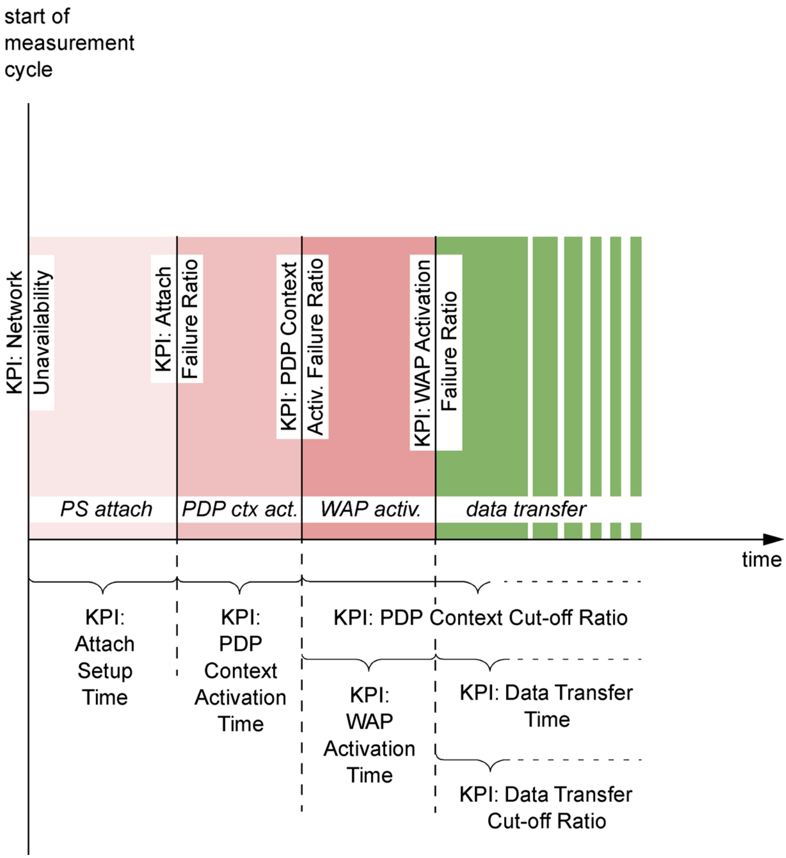


KPIs for FTP and HTTP.

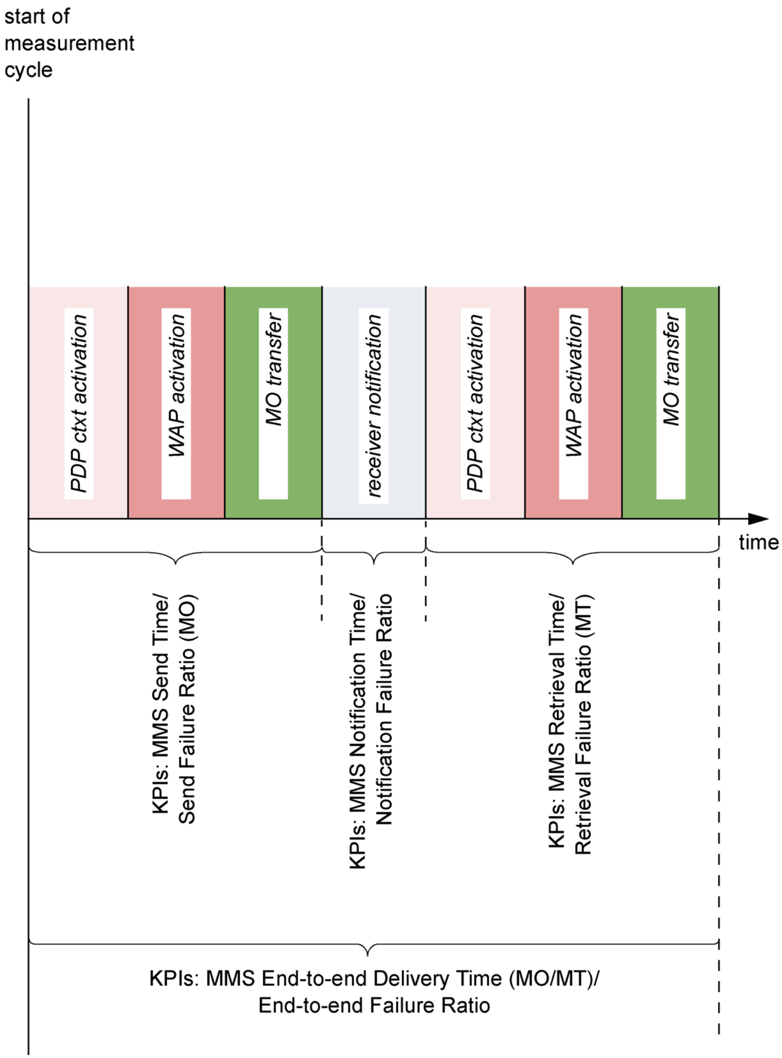


start of measurement cycle
KPI: Network Unavailability
KPI: Attach Failure Ratio
KPI: PDP Context Activ. Failure Ratio
KPI: WAP Activation Failure Ratio
WAP activ.
PS attach
PDP ctx act.
service access
data transfer
time
KPI: Attach Setup Time
KPI: PDP Context Activation Time
KPI: PDP Context Cut-off Ratio
KPI: WAP Activation Time
KPI: IP Service Access Failure Ratio
KPI: IP Service Setup Time
KPI: Service Non-Accessibility
KPI: Setup Time
KPIs:
Page Request Failure Ratio
Page Request Time
Site Access Time
Site Non-accessibility
Data Transfer Cut-off Ratio
Data Transfer Time
Mean Data Rate
KPIs: Portal Access Time, Portal Non-accessibility

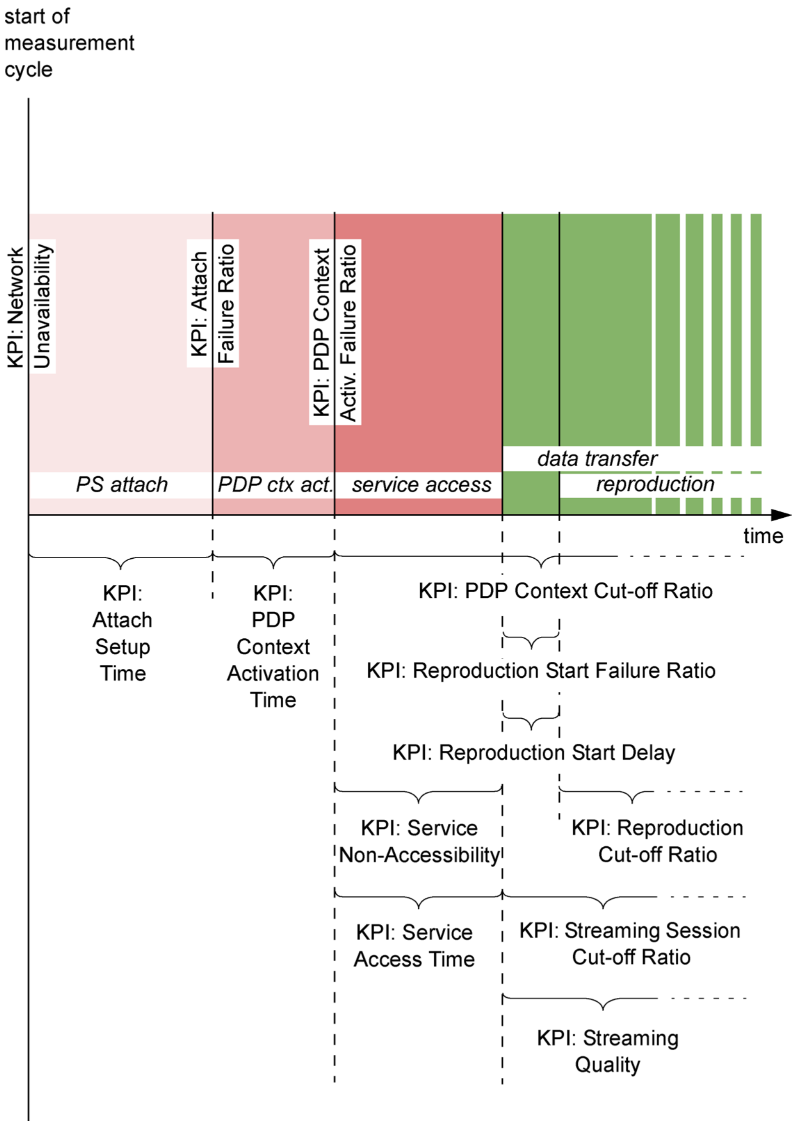
KPIs for WAP.



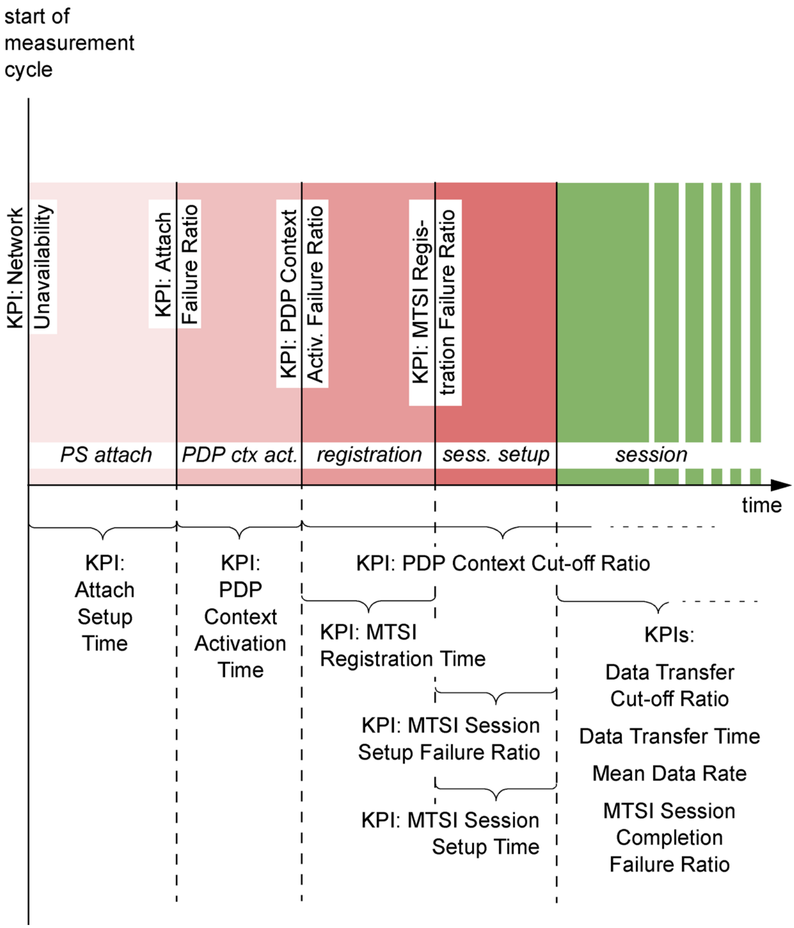
KPIs for MMS (diagram 1 of 2).
These KPIs apply equally to both sending and receiving.



KPIs for MMS (diagram 2 of 2).



KPIs for streaming.



KPIs for VoIP.

11.2.2. Service Independent KPIs

11.2.2.1. Network Unavailability (%)

Denotes the probability that no packet-switched network is available in the cell currently used by the customer.

In GSM, the phone has access to a PS network if it has received System Information 13. This message is read once per KPI measurement cycle, at the beginning of the cycle.

In WCDMA, matters are simpler: the phone is always known to have access to a PS network.

The information element “Mode - System” in TEMS Investigation indicates whether the phone is connected to a WCDMA or a GSM network.

11.2.2.2. Attach Failure Ratio (%)

Denotes the probability that a subscriber cannot attach to the PS network.

11.2.2.3. Attach Setup Time (s)

Denotes the length of the time period taken to attach to the PS network.

11.2.2.4. PDP Context Activation Failure Ratio (%)

Denotes the probability that the PDP context cannot be activated. It is the ratio of unsuccessful PDP context activation attempts to the total number of PDP context activation attempts.

11.2.2.5. PDP Context Activation Time (s)

Denotes the length of the time period taken to activate a PDP context.

11.2.2.6. PDP Context Cut-off Ratio (%)

Denotes the probability that a PDP context is deactivated without this being initiated intentionally by the user.

PDP context deactivation not initiated intentionally by the user can be caused by either SGSN failure or GGSN failure, so the PDP context may be deactivated either by the SGSN or by the GGSN.

> **Note:** The precondition for measuring this parameter is that a PDP context has been successfully established.

11.2.3. General Data Service KPIs

The following KPIs are computed for all or many of the data services supported (as indicated in the above diagrams):

11.2.3.1. Service Non-Accessibility (%)

Denotes the probability that a subscriber cannot access the service successfully due to a failure that has occurred either during PDP context activation or during service access. This means that the data transfer cannot be started.

> **Note:** This KPI is defined differently for streaming. See section 11.2.7.

11.2.3.2. Setup Time (s)

Denotes the period of time it takes to access a service successfully, from the moment the dial-up connection is established until the first data packet is received.

11.2.3.3. IP Service Access Failure Ratio (%)

Denotes the probability that, after successfully activating a PDP context, a subscriber cannot access the service, so that the data transfer cannot be started.

11.2.3.4. IP Service Setup Time (s)

Denotes the time period needed to establish a TCP/IP connection to the FTP server, from sending the initial query to a server until the first data packet is received.

11.2.3.5. Mean Data Rate (kbit/s)

Denotes the average data rate measured throughout the entire connect time (application throughput).

11.2.3.6. Data Transfer Cut-off Ratio (%)

Denotes the probability that a data transfer cannot be completed when it has been started successfully.

11.2.3.7. Data Transfer Time (s)

Denotes the time needed to successfully complete a data transfer.

11.2.4. Ping KPIs

(No diagram is drawn for Ping KPIs.)

11.2.4.1. Ping Roundtrip Time (ms)

Denotes the time required for a packet to travel from a source to a destination and back.

11.2.5. WAP KPIs

("WAP Portal" and "WAP Site" KPIs not in ETSI)

For WAP, one more step is added to the procedure of setting up the data connection: activating the WAP session.

11.2.5.1. WAP Activation Failure Ratio (%)

Denotes the probability that the subscriber cannot activate the WAP session.

11.2.5.2. WAP Activation Time (ms)

Denotes the length (in ms) of the time period taken to activate the WAP session.

11.2.5.3. WAP Page Request Failure Ratio (%)

Denotes the probability that a WAP page request is unsuccessful after a timeout period.

11.2.5.4. WAP Page Request Time (s)

Denotes the time (in seconds) elapsed from selection of the WAP page link until reception of the first data packet containing WAP page content. Only successful measurements are taken into account when calculating the average time.

11.2.5.5. WAP Portal Access Time (s)

Denotes the time (in seconds) taken to load the requested portal homepage including all images and navigational elements, i.e. the average time between initiation of WAP service access and the display of the homepage via GPRS/UMTS. Only successful measurements are taken into account when calculating the average time.

11.2.5.6. WAP Portal Non-accessibility (%)

Denotes the probability that the requested portal homepage, including all images and navigational elements, is not successfully downloaded.

11.2.5.7. WAP Site Access Time (s)

Denotes the time (in seconds) needed to download the requested portal homepage, including all images and navigational elements. Only successful measurements are taken into account when calculating the average time.

11.2.5.8. WAP Site Non-accessibility (%)

Denotes the probability that a WAP page, including all images and navigational elements, is not successfully downloaded. This parameter uses the GPRS/UMTS service. When starting the test, a WAP connection between the mobile and the WAP server already exists.

11.2.6. MMS KPIs

For MMS, the KPI structure is more complex and multi-tiered than for the other services; the top-level KPI (MMS End-to-End Delivery Time) spans both sending, notifying, and receiving.

The MMS session setup involves WAP activation, so the WAP KPIs (see section 11.2.5 above) are computed for MMS also.

The following KPIs are MMS-specific:

11.2.6.1. MMS Send Failure Ratio (MO) (%)

Denotes the probability that the subscriber cannot send an MMS message despite having requested to do so by pushing the “send” button.

(The chain of operations is: PDP Context Activation → Service Access → WAP Activation → MMS Send.)

11.2.6.2. MMS Send Time (MO) (s)

Denotes the length of time (in seconds) elapsing from the moment the sender pushes the “send” button until the MMS data transfer to the MMSC is completed.

11.2.6.3. MMS Notification Failure Ratio (%)

Denotes the probability that the Multimedia Messaging Service is not able to deliver a notification of a successfully sent MMS message to the receiving party's phone.

11.2.6.4. MMS Notification Time (s)

Denotes the length of time (in seconds) elapsing from the moment the MMS data transfer to the MMSC is completed until the receiving party receives the MMS notification.

11.2.6.5. MMS Retrieval Failure Ratio (MT) (%)

Denotes the probability that the MMS message cannot be downloaded by the receiving party’s phone, although the latter has received an MMS notification.

11.2.6.6. MMS Retrieval Time (MT) (s)

Denotes the length of time (in seconds) elapsing from the WAP Get Request until the completion of the MMS download from the MMSC.

11.2.6.7. MMS End-to-End Failure Ratio (%)

Denotes the probability that an MMS cannot be conveyed successfully from sender to receiver, that is, a failure occurs somewhere along the line after the sender has pressed the “send” button and before the receiver is able to download it.

11.2.6.8. MMS End-to-End Delivery Time (MO/MT) (s)

Denotes the length of time (in seconds) elapsing from the moment the sender pushes the “send” button until the receiver has completed the MMS download from the MMSC.

11.2.7. Streaming KPIs

Streaming-specific KPIs are as follows:

11.2.7.1. Service Non-Accessibility (%)

Denotes the probability that the first RTP data packet of the stream cannot be received by the phone when requested by the user. The reception of a packet is completed by the appearance of a “buffering” message in the user's streaming client.

11.2.7.2. Service Access Time (s)

Denotes the duration of a service access from requesting the stream at the portal until the reception of the first stream data packet by the phone.

11.2.7.3. Reproduction Start Failure Ratio (%)

Denotes the probability of unsuccessful stream reproduction.

11.2.7.4. Reproduction Start Delay (s)

Denotes the time elapsing from reception of the first stream data packet by the phone until the phone starts reproducing the stream.

11.2.7.5. Reproduction Cut-off Ratio (%)

Denotes the probability that a successfully started stream reproduction is ended by a cause other than the intentional termination by the user.

Possible causes for stream reproduction cut-off include:

- Radio bearer loss
- Synchronization errors
- Streaming server/system failure/errors
- Protocol errors
- Streaming player failure/errors

11.2.7.6. Streaming Session Cut-off Ratio (%)

(not in ETSI)

Denotes the probability that a streaming session is ended by a cause other than the intentional termination by the user, either before or after start of reproduction.

11.2.7.7. Streaming Quality (MOS-VSQI)

Denotes the quality of the stream reproduction as assessed by the VSQI algorithm. VSQI takes both audio and video into account.

11.2.8. VoIP KPIs

VoIP-specific KPIs are as follows:

11.2.8.1. MTSI Registration Failure Ratio (%)

Denotes the probability that the terminal cannot register towards IMS when requested.

11.2.8.2. MTSI Registration Time (s)

Denotes the time elapsing from the IMS registration request until the terminal is registered to IMS.

11.2.8.3. MTSI Session Setup Failure Ratio (%)

Denotes the probability that the terminal cannot set up an MTSI session. An MTSI session setup is initiated when the user presses the “call” button and concludes when the user receives, within a predetermined time, a notification that the callee has answered.

11.2.8.4. MTSI Session Setup Time (s)

Denotes the time elapsing from initiation of an MTSI session until a notification is received that the session has been set up.

11.2.8.5. MTSI Session Completion Failure Ratio (%)

Denotes the probability that a successfully set up MTSI call is ended by a cause other than intentional termination by either party.

11.3. Interdependence of KPIs

It should be noted that there is a correlation between KPIs measuring failure ratios and KPIs measuring times. This is because in the computation of the latter, only successes are taken into account while failures are disregarded.

For example, the KPIs Service Non-Accessibility and Setup Time are correlated.

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RouteFinder User's Manual

1. Introduction

RouteFinder™ is a utility for searching logfiles in TRP format recorded with TEMS products. Logfiles can be searched according to a wide variety of criteria, including:

- originating TEMS products and data-collecting devices
- date
- location
- events and messages occurring in the file
- information elements having valid values in the file.

All options for search rules in RouteFinder (names of device models, information elements, events, etc.) are intended to be self-explanatory. If in doubt about the meaning of a search option, please consult the documentation for the TEMS products used to record your logfiles. For example, to find out about the precise contents and meanings of events in TEMS Automatic, look them up in the documentation accompanying that product.

The selectable search options span all relevant TEMS products. This means that the options displayed may not all be applicable to the product or products you are using.

This document contains some references to logfile properties exhibited in TEMS Investigation. It should however be underlined that RouteFinder is a stand-alone tool that can be used to search TRP files originating from any TEMS product, independently of TEMS Investigation.

2. Fundamentals

Please note that RouteFinder requires a set of license options that covers all TEMS products whose logfiles you want to search. See the Installation Guide, section 3.3.4.

2.1. Starting RouteFinder

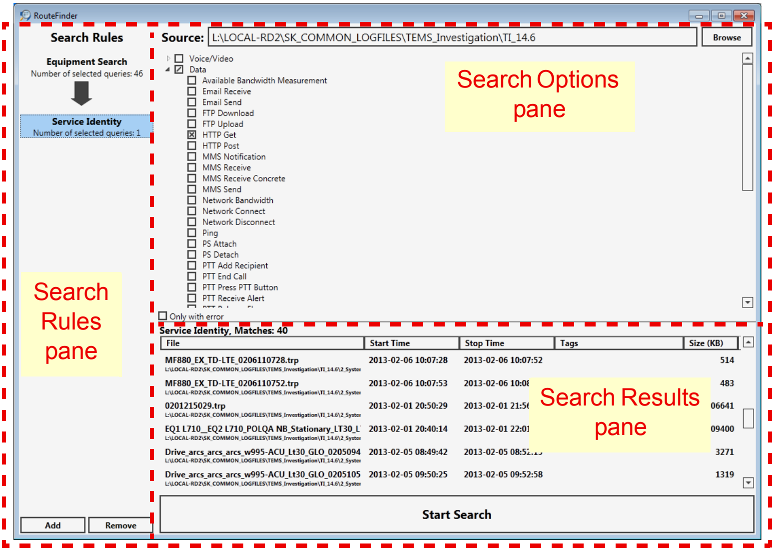
- Choose **Start** → **All Programs** → **Ascom** → **TEMS Products** → **Utilities** → **RouteFinder**.

RouteFinder can also be launched from within TEMS Investigation, either by clicking a toolbar button or from the Logfile menu.

2.2. Overview of the User Interface

The RouteFinder application window is divided into three main areas, as depicted below.

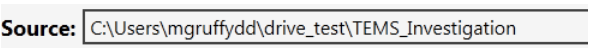
- The **Search Options** pane is where you set up your search rules.
- The **Search Rules** pane shows the search rule sequence you have built.
- The **Search Results** pane is where you run the search and have the results displayed.



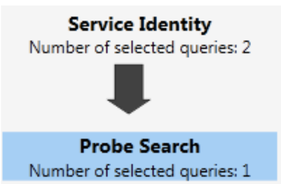
2.3. Quick Guide to Using RouteFinder

Here is a very brief summary of how to use RouteFinder. All of these steps are covered in more detail in chapters 3 and 4.

1 Point out **where** to search TRP files: Enter a path in the **Source** field.

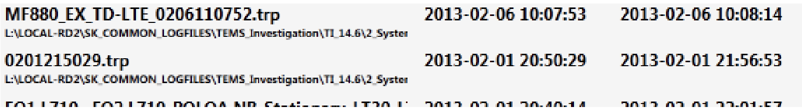


2 Specify **what** to search for in TRP files. Click **Add** in the Search Rules pane, then define the rule in the Search Options pane. The rule is added in the Search Rules pane. You can set up several rules.



3 **Run** the search by clicking the **Start Search** button. The rules in the Search Rules pane are applied one by one to the logfiles in the **Source** directory. The progress is indicated inside the Start Search button.

4 The **matching logfiles** are listed in the Search Results pane. You can click files in the list and have the tracks contained in these files plotted on a map which appears in the Search Options pane.



3. Setting Up Search Rules

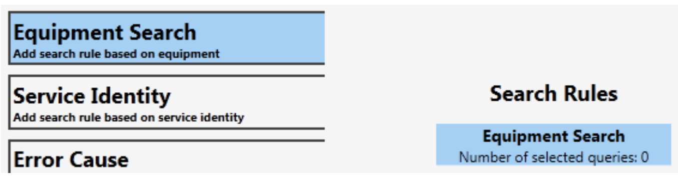
3.1. Specifying Where to Search

- In the **Source** field at the top of the window, select a directory to search for TRP files. All the subdirectories of that directory will be searched as well.

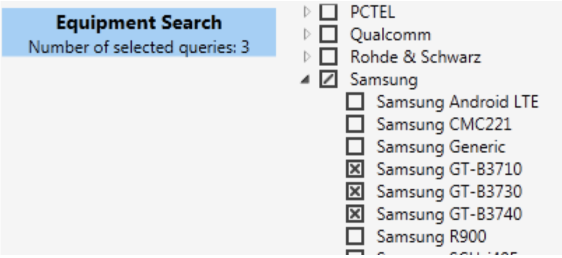
3.2. Adding Search Rules

- To add a new search rule, click the **Add** button at the bottom of the Search Rules pane. Alternatively, right-click in that pane and choose **Add** from the context menu that appears. The new rule is provisionally labeled “None” to indicate that its type has not yet been selected.

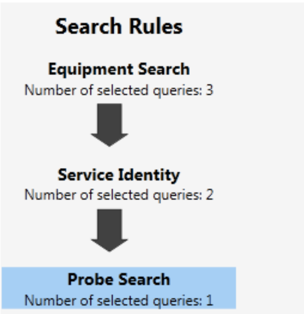
- Now select a type of search rule from the Search Options pane. The type designation is transferred to the item in the Search Rules pane.



- Proceed to make the desired selections in order to define the search rule. Section 3.5 gives more detailed guidance on each of these. The Search Rules pane is updated with the number of queries you have selected.



One search rule of each type can be defined. The rules are ordered from top to bottom in the Search Rules pane in the same order as you define them:



At present, no mechanism is provided for reordering search rules; you therefore need to plan your search strategy ahead. See the advice in section 3.4.

3.3. Removing Search Rules

- To remove a search rule from the Search Rules pane, select it and click the **Remove** button. Alternatively, right-click the rule and choose **Remove** from the context menu.

3.4. Groups of Search Rules – How to Search Efficiently

The search rules can be divided into two groups:

1. Rules that can be evaluated from logfile metadata alone, without examining the full contents of the logfile.[1] This evaluation is very fast.
2. Rules that require combing through the full logfile contents, starting from the beginning of the file and stopping where the first match is found (if that occurs). This process, for obvious reasons, is much more time-consuming.

The rules belonging to group 2 are **IE**, **Event** and **Message**, whereas all others belong to group 1.

It is **strongly recommended** to order your search rules so that metadata is searched first, preferably in such a way that you are left with a relatively small set of logfiles. Then apply rules that require traversal of the entire logfiles to that set.

3.5. Description of Search Rules

3.5.1. Equipment Search

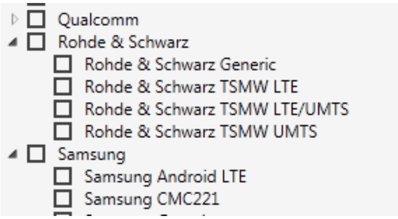
This search rule matches logfiles that include data from devices of specified makes and/or models.

All devices that are connectable in at least one TEMS product appear among the search options.

UEs are grouped by chipset at the top level. Note that this causes a vendor such as Samsung to appear in multiple places in the tree, since Samsung uses chipsets from several manufacturers. If an individual device contains more than one chipset, that model itself appears in multiple places, once for each chipset it houses. Each checkbox then matches only logfile data originating from that particular chipset, and not data from other chipsets in the device.

---

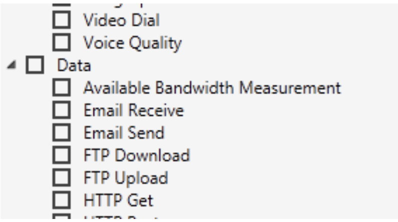
1. This is equivalent to *opening* the logfile in TEMS Investigation and inspecting the data on the Logfile tab of the Navigator pane, but without *loading* the file (clicking the Fast-forward button).



3.5.2. Service Identity Search

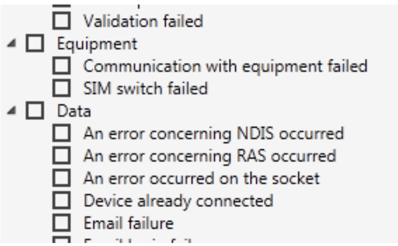
This search rule matches logfiles where specified services or testing activities have been executed, for example: CS voice, HTTP Get, or SIP Register.

If you check the **Only with error** checkbox, only activities that failed will be matched.[1]



3.5.3. Error Cause Search

This search rule matches logfiles where specified types of error occurred.



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1. This is equivalent to Result = "Failed" in TEMS Investigation logfile metadata (Navigator → Logfile tab → Activities subtab).

3.5.4. Geographical Area Search

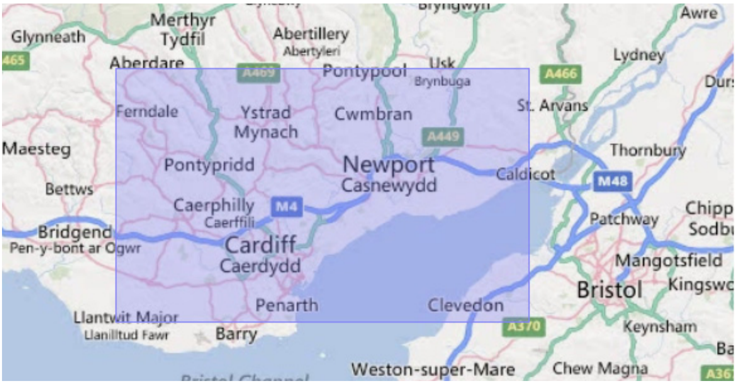
This search rule matches logfiles that originate from a particular geographical area, specified as a latitude–longitude bounding box.

You define the target area in the map view that appears. First navigate to the appropriate region by panning and zooming the map. Pan by dragging, and zoom using the mouse scroll wheel (or whatever mechanism you ordinarily use for scrolling).

When you have your target area in view, draw a bounding box on the map as follows:

- Press and hold the Ctrl key.
- Position the mouse pointer where you want the upper left corner of the bounding box.
- Press and hold the left mouse button, then drag the mouse pointer to the spot where the bounding box should end.
- Release the mouse pointer and the Ctrl key.

The bounding box is drawn as a blue semi-transparent rectangle on top of the map. A logfile will count as a match if some part of it was recorded within the bounding box.



Please note that you cannot pan the map from within a bounding box. Grab the map outside the bounding box in order to pan it.

Practical tip: The bounding box dimensions stay fixed on the screen when you zoom the map. This means you can shrink and expand the search target area simply by zooming the map in and out.

To remove the bounding box, hold Ctrl and click anywhere in the map.

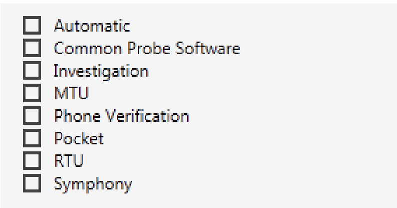
The map view is also used to present tracks in logfiles turned up by a search. See section 4.2.2.

3.5.5. Date Search

This search rule matches logfiles that were recorded between two specified dates. The **Start Date** and **Stop Date** are compared to the logfile metadata indicating when the recording started and ended.[1]

3.5.6. Probe Search

This search rule matches logfiles originating from specified TEMS products.



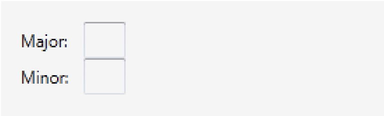
3.5.7. Probe Version Search

This search rule matches logfiles originating from a TEMS product with a particular version number.

For example, to search for version 9.0 of TEMS Automatic, set **Major** to 9 and **Minor** to 0.

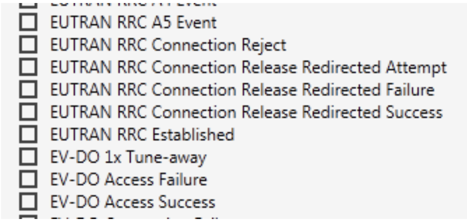
---

1. In TEMS Investigation, the latter data is displayed as “Start Time” and “Stop Time” on the Logfile tab of the Navigator pane.



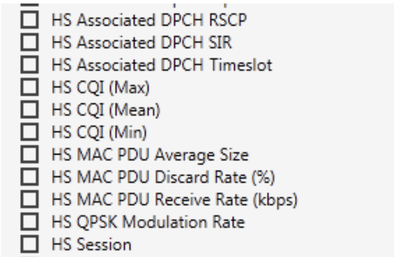
3.5.8. Event Search

This search rule matches logfiles where specified events occur. The selectable events are listed in alphabetical order.



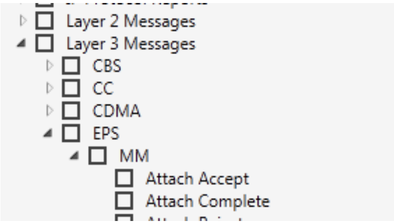
3.5.9. Information Element Search

This search rule matches logfiles where specified information elements take on valid values. The selectable information elements are grouped alphabetically.



3.5.10. Message Search

This search rule matches logfiles where specified messages occur. You can search for Layer 3 and Layer 2 messages, device mode reports, and much more.


Layer 2 Messages
Layer 3 Messages
CBS
CC
CDMA
EPS
MM
Attach Accept
Attach Complete

4. Running a Search

4.1. Search Procedure

When you are done defining your search rules, you can run the search.

- Click the **Start Search** button.

What happens first is that the logfile directory is scanned, and the number of TRP files in it is counted:

After this scan has completed, the search begins, with the rules defined in the Search Rules pane being applied from top to bottom.

While the search is in progress, the following is displayed inside the search button (relabeled **Cancel Search** during this time):

- *Top left:* Sequence number of file currently being searched / Total number of TRP files to search.
- *Bottom left:* Name of file currently being searched.

- To abort the search, click the search button once more. If you run the same search again, it will start over from the beginning.

4.2. Presentation of Search Results

4.2.1. Textual Presentation

Logfiles matching search rules are listed in the Search Results pane at the bottom.

Service Identity, Matches: 40

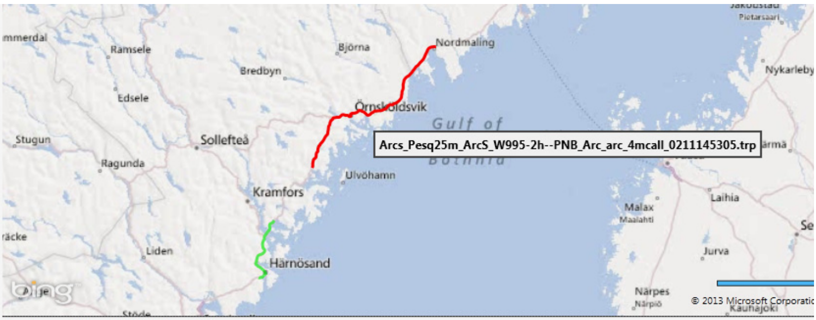
File	Start Time	Stop Time	Tags	Size (KB)
MF880_EX_TD-LTE_0206110728.trp L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster	2013-02-06 10:07:28	2013-02-06 10:07:52		514
MF880_EX_TD-LTE_0206110752.trp L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster	2013-02-06 10:07:53	2013-02-06 10:08:14		483
0201215029.trp L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster	2013-02-01 20:50:29	2013-02-01 21:56:53		106641
EQ1 L710__EQ2 L710_POLQA NB_Stationary_LT30_L L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster	2013-02-01 20:40:14	2013-02-01 22:01:57		109400
Drive_arcs_arcs_arcs_w995-ACU_Lt30_GLO_0205094 L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster	2013-02-05 08:49:42	2013-02-05 08:52:15		3271
Drive_arcs_arcs_arcs_w995-ACU_Lt30_GLO_0205105 L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster	2013-02-05 09:50:25	2013-02-05 09:52:58		1319

The top line shows the search rule last applied ("Service Identity" in the above example) and the total number of matching TRP files after that step of the search was completed. This information is also updated continuously during the search.

For each file are listed the time the recording started and stopped, any tags entered into the file, and the file size.

4.2.2. Map Plotting of Logfile Tracks

You can select one or several logfiles in the Search Results pane (the latter by holding Ctrl and clicking). All positioned tracks contained in these files are then drawn in the Map view, which is displayed automatically in the top right pane. When you mouse over a track, it turns red, and the corresponding logfile name appears in a tooltip.



Equipment Search, Matches: 267

File	Start Time	Stop Time	Tags	Size (KB)
L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster				
Arcs_ArcS_ArcS_W995-2hourVOiceQuality_Arc_arc_ L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster	2013-02-11 13:01:35	2013-02-11 13:29:34		14193
Arcs_Pesq25m_ArcS_W995-2h--PNB_Arc_arc_4mcall L:\LOCAL-RD2\SK_COMMON_LOGFILES\TEMS_Investigation\TI_14.6\2_Syster	2013-02-11 13:53:05	2013-02-11 14:54:23		29559
Arcs_Pesq25m_ArcS_W995-2h--PNB_Arc_arc_4mcall	2013-02-11 14:54:46	2013-02-11 16:24:04		38788

4.3. Context Menu Commands in the Search Results Pane

Right-clicking a logfile or a selection of several logfiles in the Search Results pane brings up a context menu with the following choices:

- **Copy Selected Files:** Copy the selected files to the Windows Clipboard.
- **Copy Full Path:** Copy the full paths of the selected files (including the file names) to the Windows Clipboard.
- **Open Containing Folder:** This command is available only for a single selected file. It opens a Windows Explorer window displaying the directory where the selected file is stored.

4.4. Opening a Logfile in TEMS Investigation

If you have TEMS Investigation installed, you can open a logfile in that application by dragging it from the Search Results pane in RouteFinder to the **Logfile** tab of the TEMS Investigation Navigator pane.

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