TEMS™ Investigation 9.0
Data Collection

User's Manual

TEMS leads the world in helping wireless operators plan,
optimize and expand their networks.

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1. Introduction

Thank you for choosing TEMS Investigation 9.0 – the leading air-interface test tool for wireless networks. TEMS Investigation represents Ericsson's continuing commitment to *Making Wireless Better*.

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

We at Ericsson are confident that TEMS Investigation will satisfy all your measurement needs and that it will become an indispensable tool in your daily work.

1.1. Fundamentals of TEMS Investigation 9.0

TEMS Investigation 9.0 is an air interface test tool for UMTS and CDMA cellular networks, supporting all of

- GSM/GPRS/EGPRS (including interaction with GAN [UMA])
- WCDMA/HSDPA/HSUPA
- cdmaOne/cdma2000/1xEV-DO

The product is also capable of scanning WiMAX carriers.

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

1.1.1. Modules: Data Collection and Route Analysis

TEMS Investigation combines data collection, realtime analysis and post-processing – all in one product. It is divided into two modules, Data Collection and Route Analysis:

Data Collection

Route Analysis

Data Collection is the part of TEMS Investigation that interfaces with phones and other measurement devices, collects data, and records it in logfiles. It also allows presentation and analysis of a single logfile at a time. To customers familiar with TEMS, the Data Collection module can be described as essentially encompassing the functionality of the older technology-specific products TEMS Investigation GSM, TEMS Investigation WCDMA, and TEMS Investigation HSDPA. It also includes major functionality found in TEMS Investigation CDMA 4.0.

Route Analysis is a module that permits rapid analysis of multiple logfiles, originating from TEMS Investigation itself or from TEMS Automatic, TEMS DriveTester, or TEMS Pocket. Statistical binning of logfile data by area, time, or distance is supported.

The means of presentation – maps, line charts, and so on – are fundamentally the same in both modules.

Route Analysis also includes RAN Tuning, a reporting tool for UMTS data (packet-switched and circuit-switched). RAN Tuning evaluates the network in terms of accessibility, mobility, coverage, and retainability. The output ranges from management reports to detailed diagnostics.

1.1.2. Package Options – Licensing

The data collection functionality is optional. Customers who dispense with TEMS Investigation supported data collection are still able to use the non-realtime functions of the Data Collection application (single-logfile replay, logfile export, etc.). The Route Analysis component is always in the package.

Supported cellular technologies can be freely selected and combined, except that WCDMA always comes with GSM support included.

The Base Package provides the ability to collect data with Sony Ericsson phones in UMTS networks and with Qualcomm chipset based terminals in CDMA networks. Other phones are licensed separately for each supplier or, in the case of Qualcomm, for each chipset.

The Base Package permits data collection with one phone at a time. A separate license option is available for collecting data with multiple phones concurrently.

Audio quality measurement (AQM), including PESQ, is likewise sold as a separate option. This option includes all required hardware as well as the ability to connect that hardware to TEMS Investigation. Audio quality measurement is supported for both GSM/WCDMA and CDMA.

1.1.3. Connectable Equipment

TEMS Investigation 9.0 supports a wide variety of user terminals, including ones from Sony Ericsson, LG, Motorola, Nokia, Qualcomm, Novatel, Sierra

Wireless, Option, and Samsung. They allow extensive monitoring of both UMTS and CDMA networks and of GSM–UTRAN as well as cdmaOne–cdma2000–1xEV-DO interaction.

GAN- (UMA-)capable GSM equipment is supported.

A variety of devices are supported for GSM, WCDMA, CDMA, and WiMAX scanning.

GPS units can be connected for geographical positioning. Manual positioning (“pinpointing”) is supported, with indoor measurements in mind.

See the Getting Started Manual, section 4.1 for further details on the range of connectable equipment.

The number of external devices that can be connected simultaneously in the application is dependent on many factors, such as whether a data service is being run. See the Release Note for further information.

1.2. What’s New in TEMS Investigation 9.0

1.2.1. WiMAX Support

TEMS Investigation 9.0 introduces the ability to scan WiMAX carriers with a DRT4301A WiMAX scanner. The supported bands are 2.3 GHz, 2.5 GHz, and 3.5 GHz. (The 3.3 GHz band will be added in the future.)

WiMAX scanning capabilities are as follows:

- WiMAX preamble scan
- Continuous Wave scan
- WiMAX MAC decoding
  - FCH
  - DL-MAP
  - UL-MAP
  - Downlink Channel Descriptors (DCD)
  - Uplink Channel Descriptors (UCD)

1.2.2. Using the Sony Ericsson Z750i as Scanner

The Sony Ericsson Z750i phone can be used as a scanner in both GSM and WCDMA networks and has a rich set of scan modes implemented. With its wide frequency band coverage (WCDMA 850/1900/2100; GSM 850/900/1800/1900) and its added benefit of reducing and potentially eliminating the need for a far more expensive external scanner, the Sony Ericsson Z750i offers excellent value for money as a scanning device for both GSM and WCDMA.

1.2.3. New and Strengthened WCDMA Scanning Modes with Sony Ericsson Z750i

CPICH Scanning

The Sony Ericsson Z750i can perform CPICH scanning of up to 12 UARFCNs at a time. This is equivalent to the full number of carriers that can be accommodated on the WCDMA 2100 MHz band (each carrier requiring 5 MHz of bandwidth).

RSCP, Ec/No, and timing are all obtained separately for each Rake finger.

System Information Message decoding can be performed as an option for CPICH scanning. This captures a snapshot of the System Information Messages once for each cell camped on. However, an additional mode is also offered which focuses on continuous monitoring of System Information messages. See “BCH Scanning” below.

BCH Scanning

This form of scanning is focused on System Information Message decoding.

One good reason to keep constant watch on System Information Messages is to become thoroughly informed of cell configurations, not least neighbor relations. An example of refined output in TEMS Investigation that can be based on SIBs is the Missing Neighbor Detection event which warns about missing neighbors in WCDMA.

One piece of data found in the SIB 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 are extracted as information elements in TEMS Investigation.

Network Search

This function is highly useful for obtaining a bird’s-eye view of an unfamiliar WCDMA network. It will detect all WCDMA carriers (UARFCNs) that are in use on each WCDMA band (2100 MHz, 1900 MHz, 850 MHz). On each carrier found, one cell is detected and presented.

In network search 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. In contrast, a Sony Ericsson Z750i in scan mode is usually able to identify all carriers, overlapping or not, thus allowing faulty frequency allocations to be easily found and rectified.

1.2.4. GSM Scanning with Sony Ericsson Z750i

The Sony Ericsson Z750i is the first quad-band phone with GSM scanning capability to be connectable in TEMS Investigation.

Note further that the GSM scanning mode can alternatively be used as a spectrum analyzer for the purpose of detecting *WCDMA* carriers. This is possible for all WCDMA bands that coincide with GSM bands (currently including 850, 900, 1800, and 1900 MHz).

1.2.5. Refined C/I Measurement for GSM

A more sophisticated algorithm has been introduced for computing C/I in GSM networks. The new algorithm provides higher resolution at the top end of the radio quality range. This is of great interest for packet-switched data (EDGE in particular), because great performance improvements are obtained as the C/I rises to 20 dB and beyond. In EDGE the maximum throughput per timeslot is not approached until C/I goes up to around 35 dB: only then can data be put through at full throttle, using the MCS-9 modulation coding scheme which employs the smallest amount of channel error protection and accommodates the largest payload.

1.2.6. SQI-MOS for GSM and WCDMA

A new and thoroughly reworked SQI (Speech Quality Index) algorithm, used to judge the user-perceived quality of GSM and WCDMA voice calls, is introduced. The new SQI is presented on the MOS scale (1–5), and for this reason it is referred to as “SQI-MOS”. The SQI algorithm has also been recalibrated to align its output more closely with the PESQ speech quality measure. Both of these changes serve to enhance the interpretability of SQI scores.

The old SQI in dBQ (named simply “SQI” as before) is still available in the product.

Like the old SQI model, the model producing SQI-MOS is wholly parametric, which keeps the hardware requirements for its computation to a minimum.

1.2.7. AQM (PESQ) for CDMA

Audio quality measurement with PESQ is now offered for CDMA as well. The method of measurement and the interpretation of the results are the same as for UMTS.

1.2.8. WAP-based Streaming

WAP-based streaming setup is now available as an option in the command sequence tool.

1.2.9. WAP 2.0 Support

WAP 2.0 is now supported by the WAP and Video Streaming commands in the command sequence.

1.2.10. Support for New User Terminals

Please check the TEMS website for a completely up-to-date list of connectable user terminals: www.ericsson.com/solutions/tems/support/investigation/sup_ti.shtml. At the time of writing, the list of new connectable user terminals is as follows:

UMTS

- Sony Ericsson Z750i
- Nokia N95
- Nokia 6120
- Nokia 6121
- Motorola Razr2 V9 US

- Sierra Wireless Aircard 880/880E
- Sierra Wireless Aircard 881/881E

CDMA

- LG RD6230
- Samsung X799

1.2.11. Support for New Scanners

Please check the TEMS website for a completely up-to-date list of connectable scanners: www.ericsson.com/solutions/tems/support/investigation/sup_ti.shtml. At the time of writing, the list of new connectable scanners is as follows:

- PCTel LX 1x 800
- PCTel LX 1x 1900
- PCTel LX 1x 800 Basic
- PCTel LX 1x 1900 Basic
- PCTel LX 1x 800/1900 Basic

1.2.12. Support for New GPS Devices

- NMEA-HS Holux GPSlim 236 BT
- NMEA-HS Holux GPSlim 236 USB

1.2.13. Support for Windows Vista

TEMS Investigation can now execute on PCs running Windows Vista.

1.2.14. Enhanced TEMS Portfolio Compatibility

TEMS Investigation 9.0 can read logfiles from TEMS Automatic 7.0 and TEMS Pocket 6.0.

1.3. Other Recent New Features in TEMS Investigation

This section recaps some other functionality added to TEMS Investigation since the last major release (8.0).

1.3.1. CDMA Support

TEMS Investigation has integrated CDMA support into what was previously a UMTS-specific product. The cdmaOne, cdma2000, and EV-DO functionality is broadly similar to what was previously found in the separate product TEMS Investigation CDMA but also introduces important new features:

- Data collection with terminals based on Qualcomm chipsets MSM5100 (cdma2000), MSM6500 (EV-DO Rev 0), and MSM6800 (EV-DO Rev A).
- Wide range of radio and network measurements supported. A few examples of areas covered:
  - Access Probe information
  - Finger information (cdma2000 and EV-DO)
  - Active Set (cdma2000 and EV-DO)
  - Details on forward and reverse link FCH, SCH0, and DCCH channels
  - cdma2000 soft handoff
- Scanning with PCTel SeeGull LX:
  - Pilot scan mode: All pilots/selected pilots/Top N on one or several frequencies.
  - "Follow phone" scan mode: In this mode, the scanner uses as "master" a CDMA phone that is also connected in the application. The scanner will at all times scan the same RF channel and PN offset that the phone is using.
  - Information obtained in follow phone mode is extracted into new information elements: Polluter search (including recent history) and missing neighbor information.
  - RSSI (CW) scan mode.
- TEMS Investigation logfiles can be exported in MDM format.

1.3.2. HSUPA Support

Simply put, HSUPA (High Speed Uplink Packet Access) brings the same refinements to the UTRAN uplink as HSDPA brought to its downlink. That is, the purpose of HSUPA is to increase the maximum user throughput, to decrease the user delay, and to increase the system capacity. HSUPA is also known as Enhanced Uplink, EUL.

TEMS Investigation introduces a set of new information elements for diagnosing HSUPA performance (beyond basic throughput values, which are of course also obtained). These include: Average Serving Grant; Average E-TFCI; DTX Rate; UE Happy Rate; New Transmission Rate; Retransmission Rate; Number of times the transmission was limited by power; Number of times the transmission was limited by serving grant.

Besides the information elements, HSUPA mode reports are presented in the Mode Reports message window.

1.3.3. GAN (UMA) Monitoring

TEMS Investigation supports the GAN-capable Nokia 6086 GSM handset. Using this phone it is possible to

- obtain GAN-specific information elements, including WLAN Signal Level and RSSI, WLAN Access Point MAC Address and SSID;
- generate GAN events: rove-in/rove-out; handover between GERAN and GAN.

1.3.4. Audio Quality Measurement (AQM) with PESQ

PESQ, short for Perceptual Evaluation of Speech Quality, is the industry standard for speech quality measurement and a tried and tested tool in TEMS Automatic. It is now available in TEMS Investigation also.

The PESQ algorithm 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 standard P.862. For in-depth information about PESQ, see also www.pesq.org.

Other audio quality measurements performed by TEMS Investigation include echo delay, echo attenuation, and volume measurement.

1.3.5. Video Telephony Quality Index (VTQI)

This is an Ericsson proprietary algorithm for judging the quality of video calls. It is a no-reference method based primarily on BLER and on information about the codec and bit rate used to encode the video and audio signals.

1.3.6. Video Streaming and VSQI Enhancements

Video Streaming Testing

Video streaming testing has been extended to support live streaming, that is, reception of live broadcasts and repeating playlists sent out from streaming servers.

Video streaming can optionally be done through an RTSP proxy.

Streaming sessions are saved (to AVI files) exactly as they unfolded, i.e. with rebuffering events included in the file.

Video Streaming Quality Inde4x (VSQI)

The VSQI quality measure for video streaming has been refined in various ways, now conforming to ongoing standardization work within ITU-T where Ericsson takes part. Refinements (all applying to static VSQI, as opposed to the dynamic version) include:

- General performance improvement (closer match with subjectively rated quality)
- Improved handling of packet loss
- Improved handling of the combined effect of rebuffering and packet loss

1.3.7. New Missing Neighbor Events

Missing Neighbor Events Based on Phone Data (GSM/WCDMA)

Two new Missing Neighbor events have been introduced which are triggered by data from phones, thus providing a reliable indication of missing neighbors. The new events supplement the pre-existing one (for WCDMA) which is based on scan data only.

Missing Neighbor Events Based on Scanner-decoded Sys Info (GSM/ WCDMA)

TEMS Investigation already has several Missing Neighbor events, some based on phone data and others based on scanner data. What is new in this version is the ability to identify missing neighbors (in both GSM and WCDMA) using only a PCTel SeeGull scanner, without relying on a cell file to indicate existing neighbor relations. This is done by letting the scanner decode System Information broadcast by the cell. The System Information contains the cell's current neighbor list and so eliminates the need to have a cell file loaded in the application.

1.3.8. TPC per Cell (Sony Ericsson UEs)

This function enables inspection of power control commands from each cell in the active set separately, as opposed to the aggregate power control decision resulting from combining cells in soft handover. The cell-specific commands can be read out from the plain-text decoding of the TPC per Cell mode report delivered by Sony Ericsson UEs.

1.3.9. Logfile Post-processing with Python Scripts

A new API is provided for extracting arbitrary data from logfiles – information elements, events, plain-text decoding of messages – using Python scripts. This is a powerful feature enabling users to do their post-processing any way they like: compose customized reports, compute KPIs of their choice, etc. A number of sample Python scripts are provided with the application.

1.3.10. Route Analysis: New Tasks

The Route Analysis application has been augmented with two new tasks, both using the Map window:

- a benchmarking task, ideal for comparing PESQ and other quality measures between operators
- a filtering task for GSM, where the displaying of route markers is restricted to user-selected values of ARFCN and BSIC.

1.3.11. Event Counter Window in Data Collection

In the Data Collection application a new window has been created that keeps track of how many times various events have occurred, in real time as well as during replay. The set of events to display is fully user-configurable.

1.4. What's in This Manual (and What's Not)

This book covers TEMS Investigation 9.0 Data Collection. 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 Data Collection application.

A separate User's Manual is provided for TEMS Investigation 9.0 Route Analysis.

A further volume, Information Elements and Events, provides full details on all IEs and events found in the two applications. It also lists and describes all preconfigured presentation windows.

Besides these reference manuals, a Getting Started Manual is provided which covers all preliminaries; crucially the following:

- Configuring the PC for TEMS Investigation
- Installing the TEMS Investigation software
- Licensing issues
- Configuring the PC and phones for data services

The chapter on connecting external equipment is found in the present document.

External Equipment

The basics on external devices are covered in the Getting Started Manual, chapter 4.

In the remainder of this book, external devices are discussed further whenever certain capabilities are required in order for a function in TEMS Investigation Data Collection to be supported. The manual does not describe the full range of functions and capabilities of the connectable phones. For exhaustive information, please refer to the documentation accompanying the phones. The same applies to all other third-party products mentioned in the manuals.

Data Service Testing

Configuration of the PC and external devices is covered in the Getting Started Manual. The present document describes how to conduct data sessions from within TEMS Investigation Data Collection using the command sequence (see chapter 12).

Equipment Cases

The TEMS equipment cases, designed to accommodate phones and other equipment during drive tests, are not covered here but have their own manuals. These, however, sometimes refer to TEMS Investigation documentation.

Readme File, Release Note

Some technical issues not addressed in this manual are dealt with in the file Readme.rtf in the TEMS Investigation installation folder. The same information is reproduced in the Release Note issued with the current release.

FAQ

Many questions regarding TEMS Investigation are answered in the FAQ sections found on the Web at www.ericsson.com/tems under the link "Tech support".

Technical Support

If you have a question about TEMS Investigation which is not answered in any of the manuals nor in any of the other sources mentioned above, please contact technical support. Contact information is given on the Web at www.ericsson.com/tems under the link "Contact TEMS".

TEMS On-line Subscription Service

To sign up for the TEMS on-line subscription service, please go to www.ericsson.com/tems and click the link "TEMS Subscription Service". This free service includes e-mail notification of TEMS product launches, version upgrades and patches, as well as the on-line newsletter TEMS News.

1.5. Definitions

This section explains a number of central concepts in TEMS Investigation Data Collection 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 voice calls.

Event

An event is a signal 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 7.

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 Data Collection 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 18), may list either air interface messages, or mode or error reports produced by phones, or messages from various protocols, or events. Similarly, in the “Find in Logfile” dialog (section 7.2.2), a “message” may be an air interface message or a phone mode report.

Mode Report

A mode report is a status or measurement report generated by a phone.

Phone

The term “phone” covers both GSM phones, UMTS (WCDMA/GSM) user equipments (UEs), and CDMA phones. When a subset is meant, a suitable qualifier is prefixed, and/or a more precise term is used (“GSM phone”, “Sony Ericsson GSM phone”, “Nokia UE”, “Kyocera CDMA phone”, etc.).

Some user terminals supported by TEMS Investigation are in fact data cards 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.

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.

2. Basics of TEMS Investigation Data Collection

This chapter guides you through some fundamentals of TEMS Investigation Data Collection.

2.1. Recommended Skills

Since TEMS Investigation Data Collection 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 technologies concerned.

2.2. Installing TEMS Investigation

See chapters 3 and 5 in the Getting Started Manual.

2.3. Starting TEMS Investigation Data Collection

Once installed, the Data Collection application can be launched from the Start menu.

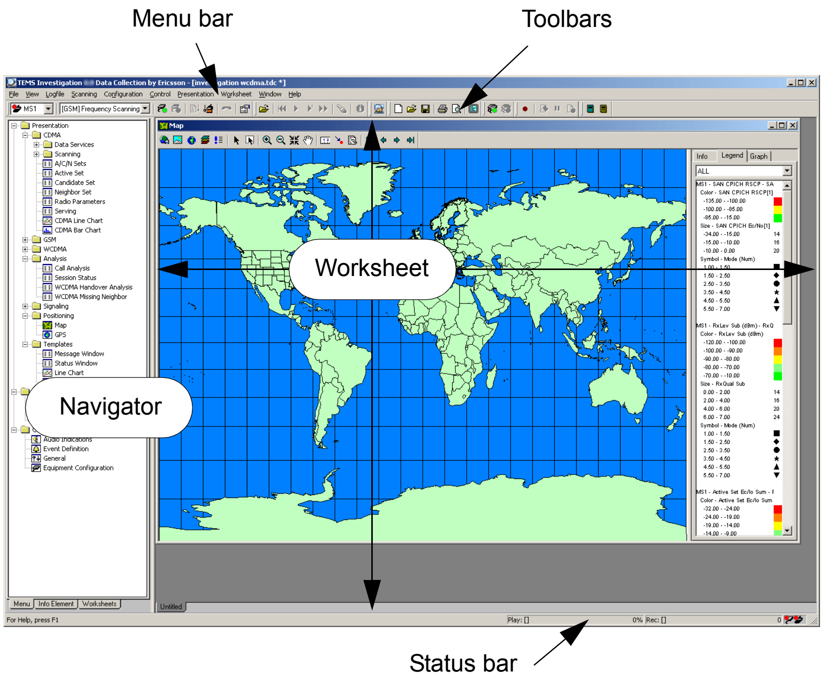
> **Note:** We recommend that you plug the external equipment you are going to use into the PC before starting TEMS Investigation.

- Choose Start → Programs → Ericsson → TEMS Products → TEMS Investigation 9.0 Data Collection.

In Windows Vista you must run the application as administrator. This option is selected by right-clicking the Start menu item above and choosing Properties → Shortcut tab → Advanced.

2.4. Quick Guide to the User Interface

This section gives a quick overview of the TEMS Investigation Data Collection user interface. 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.

Toolbars

Through the toolbars all the central functions are accessible. Most of the toolbar buttons are mirrored in the menus.

Navigator

From the Navigator, you can open presentation windows, change the color ranges of information elements, and manage your worksheets.

The Navigator is especially useful for configuring the workspace at the beginning of a session.

Menu Bar

The menus mirror most of the toolbars as well as the Navigator’s Menu and Worksheets tabs.

Status Bar

The Status bar displays symbols and short messages that indicate the current status of the application.

3. User Interface

This chapter goes through the user interface in more detail, and can be seen as an expanded version of section 2.4.

3.1. User Modes

TEMS Investigation Data Collection can be run in two different modes, one for testing and recording, and one for replay and analysis:

- *Drive testing mode:* The information presented on the screen is obtained from data-collecting devices connected to the PC. In drive testing mode you can record new logfiles.
- *Replay mode:* The presented information is read from a logfile. In this mode you replay logfiles for inspection and analysis. You can also use the recording function to copy material between logfiles.

The two modes are mutually exclusive. At the beginning of a session, the application is in replay mode. As soon as you connect external equipment, however, it switches to drive testing mode and remains in this mode as long as some external device is connected. Disconnecting all external devices returns the application to replay mode.

This means that:

- If you have a logfile open, you must close it before you can connect external devices.
- To be able to open a logfile, you must first disconnect all connected 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

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 Data Collection for the first time, a default workspace is opened. This also happens if you have never saved a workspace. After you have saved a workspace for the first time, the workspace last saved will be opened each time you start the application.

To start the application without loading any existing workspace, go to the directory <TEMS Investigation install dir>\Application and give the following command:

investigation.exe -newwksp

Besides the default workspace, which contains a bit of everything, some further predefined workspaces are supplied in the Application subdirectory. These are geared towards data collection, troubleshooting, and post-processing. By default, workspaces reside in the following directory:

- Windows Vista: C:\Users\<user>\Documents\TEMS Product Files\TEMS Investigation 9.0\Workspaces
- Windows XP: C:\Documents and Settings\<user>\My Documents\TEMS Product Files\TEMS Investigation 9.0\Workspaces

with workspaces for different cellular technologies kept apart in subdirectories.

Note: You cannot save changes to the predefined workspaces. To save your modifications, save workspace under a different name.

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.

Workspaces are handled from the File and View toolbar (see section 3.3.7 for further details), or alternatively from the File menu. Worksheets are handled from the Worksheet menu, which can also be accessed by right-clicking in a worksheet.

TEMS Investigation 9.0 Data Collection cannot load workspaces from older TEMS Investigation versions.

3.3. The Toolbars

The toolbars in the main window give speedy access to the most central functions of TEMS Investigation Data Collection. Most of these functions are mirrored in the menus (see section 3.5, page 26).

3.3.1. Equipment Control Toolbar

This toolbar is accessible in *drive testing mode*.

Selected Equipment: Combo box holding all enabled and connected external devices (strictly speaking, all *channels* of each device; see section 6.5, page 37).

Scanning Task: Shows the current scanning task (if any) assigned to the device selected in the Selected Equipment combo box. If the device is not capable of scanning, this box is grayed and contains the text “Not a Scanning Device”. See chapters 8–11 about scanning.

 **Connect:** Connect the external device displayed in the combo box to the left on the toolbar.

 **Disconnect:** Disconnect the external device displayed in the combo box.

See chapter 6, page 35 about connecting external equipment.

  **Start/Stop Scanning:** Start/stop a scan.

 **Scan Properties:** Set up a scan.

  **Redial:** *(In idle mode:)* Redial the last call. *(In dedicated mode:)* Terminate the ongoing call. In the latter case, the receiver symbol is crossed out.

 **Equipment Properties:** Set properties of the phone or GPS unit.

Properties of external devices are described in chapter 13, page 178.

3.3.2. Connections Toolbar

Connect All: Connect all enabled external devices.

Disconnect All: Disconnect all connected external devices.

3.3.3. 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.

Pause/Resume Recording: Pause the recording and end the current route in the logfile/Resume recording, starting a new route.

Swap Logfiles: Close the current logfile and continue the recording to a new file.

For a full description of the recording function, see section 7.1, page 50. Recording properties are set from the Logfile menu. See section 7.1.3, page 52.

3.3.4. Replay Toolbar

This toolbar is accessible in *replay mode*.

Open/Close Logfile: Open a logfile/Close the logfile that is currently open.

Rewind Logfile: Rewind the logfile to the beginning.

Play/Stop Logfile: Replay the logfile/Stop logfile replay. The speed of the replay is variable and is set from the Logfile menu; see section 7.2.1, page 56.

Step Logfile: Advance one step in the logfile.

Fast-forward Logfile: Play the logfile at high speed.

Find in Logfile: Search the logfile.

 **Information:** Show information about the logfile.

See section 7.2, page 55.

3.3.5. Report Toolbar

 **Generate Report:** Generate a report from one or several logfiles.

See section 7.6, page 69.

 **Generate Report KPI** *(UMTS only):* Generate a KPI report from KPI samples (which have in turn been exported from logfiles).

See section 7.7, page 74.

3.3.6. Route Analysis Toolbar

 **TEMS Investigation Route Analysis:** Launch the Route Analysis application.

3.3.7. 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.

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. It is divided into the following sections:

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:

Replay Section (Replay Mode)

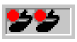
Shows the name of the logfile being replayed and indicates the percentage of the file that has been replayed.

Recording Section (Drive Testing Mode)

Shows the name of the file being recorded, its current size (number of reports from the phone), and the number of filemarks inserted (see section 7.1.1, page 51).

Connections Section

Shows the status of external equipment. Each channel of each device (see section 6.5, page 37) is represented by a symbol with or without a color indication.



The following symbols are used:

 Phone or scanner

 Phone data cable

 GPS unit

On the status bar, the symbols appear in that order from left to right: phones/scanners, data cables, GPS units. Devices of the same type are sorted by the number in their designations (“MS1”, etc.) with the lowest number first.

The status of the equipment is shown by adding various elements to the basic symbols:

Symbol	Meaning
	*(Red light)* The external device has been enabled but not connected in TEMS Investigation and is therefore not ready to be used. (It might not even be connected physically to the PC.)
	*(Green light and red triangle)* The GPS unit has been connected in TEMS Investigation but reports an invalid position.
	*(Green light)* The external device has been connected in TEMS Investigation. It is ready for use, or is being used.
	*(Green light and padlock)* The phone connected to the port is busy scanning.

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.

View Menu

From here you choose which toolbars and which other tools should be visible. The Full Screen mode hides the Navigator.

Logfile Menu

The Logfile menu mirrors the Record, Replay, and Route Analysis toolbars. From here you can also set recording and replay properties, and export logfiles (see sections 7.1.3, 7.2.4, and 7.5).

Scanning Menu

The Scanning menu mirrors the part of the Equipment Control toolbar that is to do with scanning.

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

Gives access to online help, containing the same information as this manual, and to the about page.

3.6. Keyboard Shortcuts

A number of central operations in TEMS Investigation Data Collection, 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, page 327.

4. The Navigator

The Navigator pane, located on the left in the TEMS Investigation Data Collection main window, allows you to set up and manage your workspace.

The Navigator has the following tabs:

- one that lists the types of windows provided (**Menu** tab: section 4.1)
- one that lists information elements (**Info Element** tab: section 4.2)
- one that gives an overview of your current workspace configuration (**Worksheets** tab: section 4.3).

You can hide the Navigator by switching to Full Screen mode (done from the View menu or from the File and View toolbar). Once you are done setting up and configuring your workspace, you may find it helpful to hide the Navigator in order to free the entire screen for your worksheets.

4.1. 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 8 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 15–23.

The control and configuration windows are also described in this volume. Please use the alphabetical index to locate them.

4.2. Info Element Tab

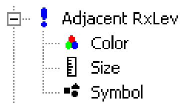
The Info Element tab lists all the information elements handled by TEMS Investigation Data Collection.

Regarding information element categories, see Information Elements and Events.

4.2.1. 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.

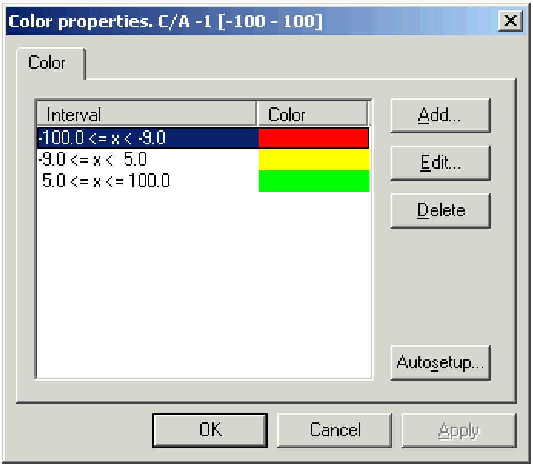


Some numeric elements have such presentation attributes defined by default; others do not. The attributes are edited from the Info Element tab; see section 4.2.2. When you add an information element to a presentation window, these settings are automatically used unless you have specified a different usage in that particular window (possible only with colors in certain window types; see section 15.4, page 212).

4.2.2. 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.

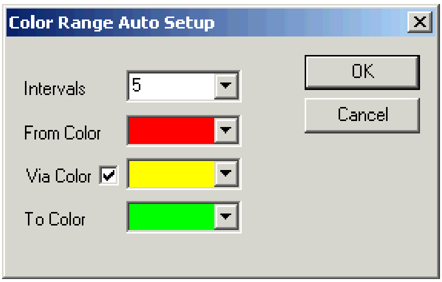
In either case, continue as follows:



4.2.2.1. Automatic Setup of Color Ranges

This is the easiest way to set up color ranges.

- Click Auto Setup.



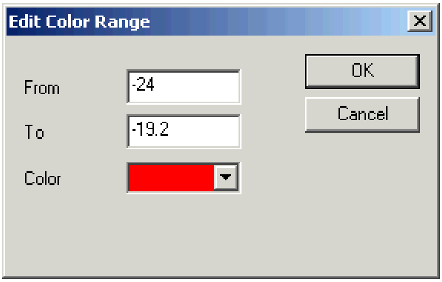
- Set the number of intervals.
- Choose colors for the extremes of the value range.
- Check the Via Color box if you want to use a specific color in the middle of the range. If you do not check the Via Color box, the intermediate color is chosen automatically based on the "From" and "To" colors.

When you click OK, a color range is created automatically with evenly sized intervals and suitable intermediate colors.

4.2.2.2. 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.

4.2.3. 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 4.2.2 above.

4.3. 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. 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 5.1.
- in a file with a plain-text, TEMS Investigation specific format (*.cel). This format is for UMTS only. GSM and WCDMA cells can be mixed in one file. See section 5.2.

CDMA cell files in TEMS Investigation CDMA CSV format can be converted to the XML format: see the Route Analysis User’s Manual, section 17.3. Regarding TEMS Investigation CDMA CSV cell files in general, see the Route Analysis User’s Manual, appendix D.3.

5.1. Creating a Cell File in XML Format

The XML-format cell file uses two XML schemas, which are found in the directory XMLSchema beneath the TEMS Investigation installation directory:

- 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.

The most convenient way of composing XML-format cell files is to load the above schemas into a suitable XML development tool, and fill in the data from there.

A full description of the XML format is found in the Route Analysis User’s Manual, appendix D.

5.2. 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 Route Analysis User's Manual, appendix C.

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.

5.3. 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, 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.

5.4. Loading Cell Data from TEMS CellPlanner

TEMS CellPlanner uses the XML format for cell data. XML cell files created with TEMS CellPlanner can be loaded into TEMS Investigation.

5.5. 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 23.5.5.1, 23.5.5.3, and 23.5.5.4.

- Serving cell and handover indication on the map. See section 23.5.5.2.
- Presentation of cell data on the Info tab of a Map window. See section 23.6.
- In logfile reports: Association of statistics with individual cells. Computation of cell ranking based on these statistics. See appendix F.3.
- Presentation of cell names in status windows, line charts, and bar charts. Configuration of status windows is covered in sections 16.2–16.3. Line charts: section 21.4.3. Bar charts: section 22.4.
- *(With WCDMA scan data:)* Best server indication on the map, based on scan data. See section 23.5.5.2.
- *(With WCDMA scan data:)* Generation of an event detecting (probable) missing neighbors. See Information Elements and Events, section 7.3.

6. Connecting External Equipment

This chapter describes how to establish contact with external devices in TEMS Investigation. Please note that the hardware key must be plugged in before you can connect external devices. See the Getting Started Manual, section 7.3.

Nearly all of the external devices supported by TEMS Investigation are automatically detected and enabled by the application after they have been plugged into the PC.

A few types of equipment must still be enabled manually. This option always exists as a fallback if the automatic detection fails.

> **Note:** We recommend that you plug your equipment into the PC before starting TEMS Investigation.

Concerning preparations for running data services, see the Getting Started Manual, chapter 8. Please note that the configuration of Dial-up Networking (setup of phonebook entries) in Windows must still be done manually.

Concerning PC and scanner configuration for using a WiMAX scanner, see the Getting Started Manual, chapter 9.

6.1. Connectable Equipment

See the Getting Started Manual, chapter 4.

6.2. Connection Procedure: Terminology

When you have plugged an external device into a PC port, two steps must be performed in TEMS Investigation before you can start using it: the device must first be *enabled*, then *connected* (in an abstract sense of the word). The opposites of “enable” and “connect” are “disable” and “disconnect”.

The word "connect" is sometimes also used to refer to the act of connecting a device physically to a PC port. The context always makes clear which is meant.

6.3. Plugging In External Equipment

Note that devices may be mounted in an equipment case, so that they will not be plugged directly into the PC.

6.3.1. Plugging In Phones

Nearly all supported phones connect to the PC via USB. A single USB cable connects the USB port on the phone to a USB port on the PC; both TEMS measurements and data service measurements are transferred through this cable. The two measurement categories are however kept apart in TEMS Investigation ("MS" vs. "DC") by means of the virtual COM port numbers generated by Windows. See section 6.6.

The CDMA phone Samsung SCH A900 uses a serial cable for TEMS measurements and a USB cable for data service measurements.

6.3.2. Plugging In Scanners

- PCTel SeeGull EX and SeeGull LX MM2 scanners connect via USB.
- Other PCTel SeeGull LX scanners connect to a COM port.
- Anritsu ML8720 scanners connect to a COM port.
- Anritsu ML8740/8741 scanners connect via USB.
- DRT4301A 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 100BaseT 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 100BaseT cables.

6.3.3. Plugging In GPS Units

- The GPS units sold as accessories to TEMS Investigation (Holux GPSlim 236) connect via Bluetooth or USB.
- Other supported GPS units connect via Bluetooth or through a USB or COM port.

6.3.4. Plugging In Equipment Cases

The TC-1520 and TC-1520B equipment cases connect via USB.

6.3.5. Plugging In Standalone AQM Modules

The standalone 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).

6.4. Starting TEMS Investigation Data Collection

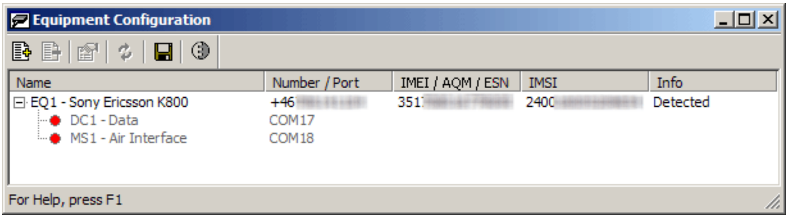
Launch the application from the Start menu:

- Choose Start → Programs → Ericsson → TEMS Products → TEMS Investigation 9.0 Data Collection.

In Windows Vista you must run the application as administrator. This option is selected by right-clicking the Start menu item above and choosing Properties → Shortcut tab → Advanced.

6.5. The Equipment Configuration Window: Basics

All devices that are known to TEMS Investigation, whether automatically detected or manually added, are listed in the Equipment Configuration window. In the example below, a Sony Ericsson K800i phone has been autodetected.



Each device is represented in the Equipment Configuration window by an “EQ” item, containing within it one further item (called “channel”) for each data source furnished by the device:

- for user terminals, an “MS” channel representing TEMS measurements and a “DC” channel representing data service measurements
- for scanners, an “MS” channel
- for GPS units, a “PS” channel (P for “positioning”).[1]

A common index is assigned to all of EQ, MS, and DC. You can change that number: see section 6.8.5.1.

The colored dot to the left of each channel shows the status of the channel in TEMS Investigation: red means “not connected”, green means “connected”. How to connect channels is explained in section 6.10.

The Number/Port column shows the phone number for each user terminal EQ. For channels, it shows to what port the channel is connected.

The IMEI/AQM/ESN column shows

- IMEI for UMTS phones (in the EQ row)
- ESN 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).

The IMSI column shows the IMSI of an UMTS phone’s subscription (in the EQ row).

At present the EQ designation is mainly used in the Equipment Configuration window. Outside this window, external devices are most often represented by their channels (MS/DC/PS). All channels are found in the combo box on the Equipment Control toolbar. Furthermore, for each channel of each device, a

1. GPS units built into scanners do not appear as separate devices in TEMS Investigation.

symbol appears on the main window status bar; see section 3.4, page 24 for details.

6.6. Automatic Detection (Enabling) of Equipment

6.6.1. Scope of Autodetect Function

Most of the devices supported by TEMS Investigation are detected and enabled automatically in the application.

For detailed information on what types of equipment are autodetected, please visit our website www.ericsson.com/tems and check the Tech Support section.

Generally, the following holds:

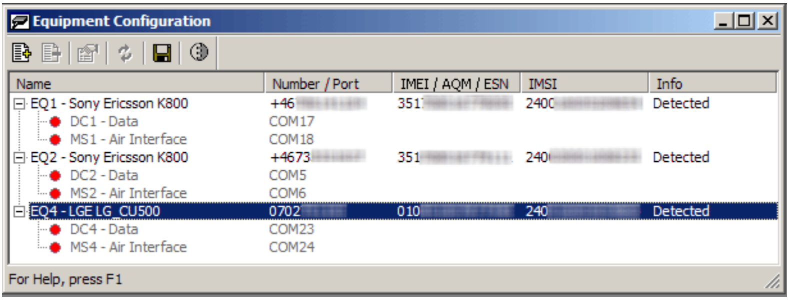
- Any device with USB connectivity that has VID and PID (vendor and product ID) properly encoded in it will be autodetected.
- All phones (not counting data cards) are normally autodetected.
- Certain data cards functioning as user terminals (such as Option GT) are autodetected, whereas others (such as Sierra Wireless) are not.
- PCTel and DRT scanners are autodetected. Other scanners are not autodetected.
- GPS units that use the NMEA protocol[1] as well as the Garmin GPS 18 are autodetected. Other GPS units are not autodetected.

Devices that are not autodetected must be enabled manually. See section 6.7.

6.6.2. Presentation in Equipment Configuration Window

Devices that have been autodetected by TEMS Investigation appear in the Equipment Configuration window with the value “Detected” written in the Info column.

1. This includes Bluetooth GPS units, provided that they have been paired correctly with the PC and the PC has been appropriately configured for Bluetooth.



6.6.3. Detection of Equipment Not Covered by License

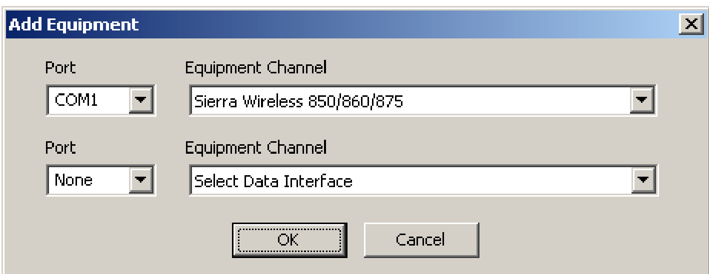
If you plug in a type of device for which you have no license, it will still appear in the Equipment Configuration window (provided that it can be autodetected). However, the text for this device will be red, and the Info column will read “No License”. The same thing will happen if your license only permits single-device data collection and you plug in a second device. A device tagged “No License” cannot of course be connected in TEMS Investigation.

6.7. Manual Enabling of Equipment

Devices which cannot be detected automatically must be enabled manually in the Equipment Configuration window. Manual enabling is always available as a fallback if the automatic detection fails.

To enable a device manually:

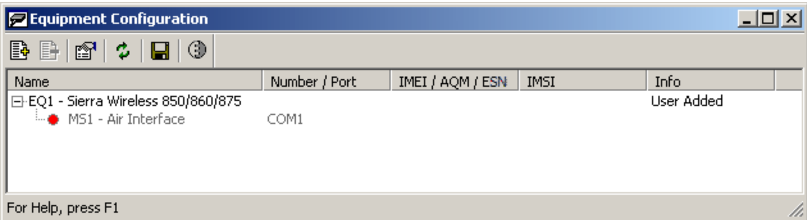
Click the Add button in the Equipment Configuration window.



Whenever a device is not autodetected, its COM ports appear in the Port combo boxes of this dialog. Two rows are provided in the dialog to allow enabling of two equipment channels (MS and DC).

See section 6.7.1 for instructions on specifying ports and equipment channels.

After you have finished the Add Equipment dialog, the enabled device appears in the Equipment Configuration window with the value “User Added” written in the Info column:



6.7.1. Details of Manual Enabling

Details of how to enable devices manually are given here for devices that cannot be autodetected by the application. Regarding other devices, see appendix C, page 332.

6.7.1.1. Scanners

For all scanners, only row 1 in the Add Equipment dialog is used. Row 2 is grayed out.

Anritsu ML8720

This scanner connects to a serial port.

- Under Port, choose the port to which the scanner is connected.
- Under Equipment Channel, there are two choices:
  - Choose “ML8720/ML8740 with GPS” if you wish to use a GPS that is connected directly to the scanner.
  - Choose “ML8720/ML8740” if you wish to use a separate GPS unit (not one connected to the scanner).

Anritsu ML8740/8741

These scanners connect via USB.

- Under Port, choose None.
- Under Equipment Channel there are two choices, as for the ML8720; see **Anritsu ML8720** above.

6.7.1.2. Data Cards

Sierra Wireless

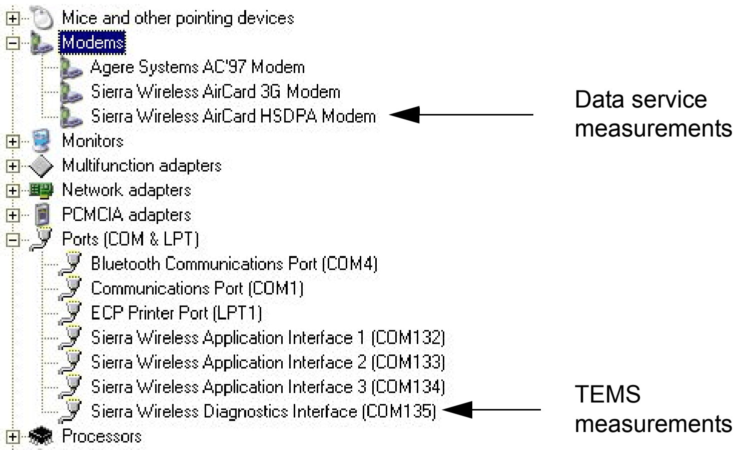
Use row 1 for TEMS measurements:

- Under Port, choose the virtual COM port number assigned to the *port* “Sierra Wireless Diagnostics Interface ...”.
- Under Equipment Channel, choose “Sierra Wireless ...”.

Use row 2 for data service measurements:

- Under Port, choose the virtual COM port number assigned to the *modem* “Sierra Wireless AirCard HSDPA Modem”. To find out the COM port number, right-click this item in the Device Manager and inspect the Properties dialog.
- Under Equipment Channel, choose “Qualcomm 3G Data Cable”.

See this screenshot of the Device Manager:



6.7.2. Manual Enabling of Equipment Not Covered by License

If you manually add a device for which you have no license, the device will appear in the Equipment Configuration window, but the text will be red and the Info column will read “No License” (just as for autodetected devices: compare section 6.6.3). The device cannot be connected in TEMS Investigation.

6.8. Further Features of the Equipment Configuration Window

6.8.1. The Refresh Function

If you are working with devices that can be autodetected, but the detection did not work as expected (for whatever reason), you can start the autodetect procedure over from scratch. To do this:

In the Equipment Configuration window, click the Refresh button.

6.8.2. Saving the Equipment Configuration

You can save the current setup in the Equipment Configuration window:

Click the Save button.

What this action does is to store the mapping between devices and EQ items in the Windows registry. This means that if a device is represented by (say) EQ3 and you save the configuration, 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 save function is applicable to all devices whose hardware permits a reliable identification. Such devices include phones with their IMEIs.

If you click Save once more, the previous configuration is overwritten. To remove all configuration information from the registry, click Save in an empty Equipment Configuration window.

> **Note:** TEMS Investigation no longer saves any information on equipment configuration in the workspace.

6.8.3. Re-pairing Phones with AQM Modules

When you match phones with AQM modules manually as described in section 6.8.5.2, 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:

Click the “Re-pair Phones with AQM Modules” button in the Equipment Configuration window.

This function operates the same way whether your AQM modules are standalone or mounted in an equipment case.

For each match made, the AQM identity will appear in the IMEI/AQM column for the phone’s MS channel. If a phone could not be matched with an AQM module, the text “No match” will be displayed briefly for that phone.

6.8.3.1. 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.

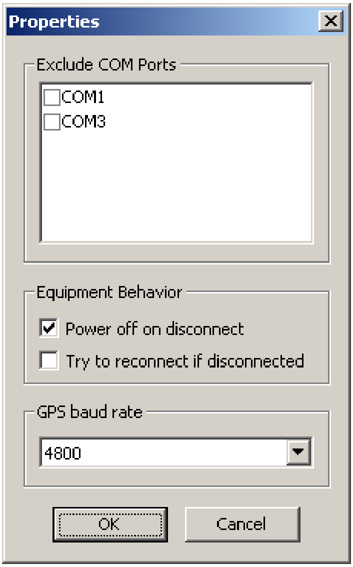
If you have been working with different equipment configurations connected at various times to the same PC, the following holds:

- 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.

6.8.4. Properties Dialog

A Properties dialog is provided where you can configure some properties of the set of EQs (as a whole) and of the autodetect procedure. To open this dialog:

In the Equipment Configuration window, click the Properties button.



Exclude COM ports

Here will be listed all COM ports (physical and virtual) that the autodetect function cannot associate with a recognized equipment type. This includes all COM ports used by devices that have nothing to do with TEMS Investigation (e.g. keyboard and mouse).

If you uncheck a COM port in this list, that port will be excluded from the autodetect procedure. If you have sensitive equipment attached to a port, equipment which may be disturbed by the port scanning performed by the autodetect function, it is advisable to exclude that port.

(Ports that are currently occupied by devices enabled in TEMS Investigation do not appear in the list.)

Power off on disconnect	See section 6.10.2, page 48.
Try to reconnect if disconnected	If you check this, TEMS Investigation will try to re-establish the connection to the external device following a spontaneous disconnect.
GPS baud rate	Here you can override the default baud rates for GPS units. To override the defaults, choose a baud rate from the combo box. This rate will then be used regardless of the type of GPS unit employed. (You cannot set differentiated baud rates of your own.)

6.8.5. EQ Item Context Menu

If you right-click an EQ item, a context menu pops up containing the following commands:

6.8.5.1. Change Equipment Number

Select a number to change the 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.

6.8.5.2. Select AQM Module

If you have purchased the audio quality measurement option, this is where you select the AQM module with which this EQ should interact. This selection is only applicable to phones supporting audio quality measurements (they are listed in the Getting Started Manual, section 4.2). For devices that are not used to perform audio quality measurements, "None" should be selected here.

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 6.8.3) to recreate the same pairing automatically, provided that the physical connections between phones and AQM modules are unchanged.

AQM modules do *not* themselves appear as EQs in the Equipment Configuration window.

6.8.5.3. Change Phone Number

If a phone is going to measure AQM, 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 in the Number/Port column in the Equipment Configuration window.

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 by using the Change Phone Number option.

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.

6.8.5.4. Delete

This command disables the selected device: see section 6.11.

6.9. Properties of Channels

Right-clicking an MS channel for a user terminal and choosing Equipment Properties opens the Properties dialog for the user terminal. See chapter 13, page 178.

6.10. Connecting and Disconnecting External Equipment in TEMS Investigation

Connecting external devices in the application is done as a separate step.

> **Note:** If you have a logfile open, you must close it to be able to connect equipment.

6.10.1. Connecting External Equipment

To connect a single channel of an external device:

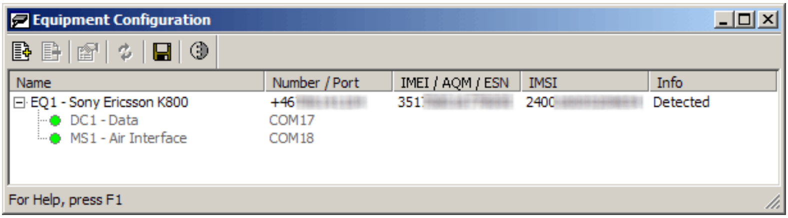
- Select the channel in the combo box of the Equipment Control toolbar.

 Click Connect on the Equipment Control toolbar.

To connect all channels of all external devices:

 Click Connect All on the Connections toolbar.

Connected channels are accompanied by a green-light symbol in the combo box. The symbols on the status bar and in the Equipment Configuration window likewise turn green.



Automatic Power-on following Connect

If the external device is power supplied by an external power source (e.g. a vehicle charger), it is powered on automatically when you click Connect or Connect All.

6.10.2. Disconnecting External Equipment

If you want to leave an external device plugged into the port, but disconnect a device channel (e.g. “MS1” or “DC1”) in the application for the time being, do as follows:

- Choose the device channel in the toolbar combo box.

 Click Disconnect on the Equipment Control toolbar.

To disconnect all channels of all external devices:

 Click Disconnect All on the Connections toolbar.

For a disconnected channel, all symbols representing it revert to red.

Automatic Power-off following Disconnect

If you check “Power off on disconnect” in the Properties dialog (section 6.8.4), the device will be powered off automatically when you disconnect it. Note that this function does not have anything to do with how the external device is power supplied.

6.11. Disabling External Equipment

If you want to remove an external device completely from the application, disable it:

- In the Equipment Configuration window, select the device (EQ item) you want to disable.

 Click the Delete button.

Alternatively, you can right-click the EQ item and choose Delete from the context menu.

7. Logfiles

This chapter explains:

- how to log information received from external devices to file (section 7.1)
- how to replay a logfile (section 7.2).

The chapter also describes:

- copying between logfiles (section 7.3)
- loading of logfiles from sources outside TEMS Investigation (section 7.4)
- logfile export (section 7.5)
- generation of logfile reports (sections 7.6, 7.7)
- merging of logfiles with uplink data files (section 7.8).

7.1. Recording Logfiles

> **Note:** Connection of external devices requires plugging in a hardware key with the appropriate license. See the Getting Started Manual, chapter 7.

Logfiles can be recorded in the following ways in TEMS Investigation:

- from the Record toolbar or Logfile menu
- from within command sequences.

All these procedures produce the same type of output file, with extension .log. The functions available for controlling the recording and modifying the logfile are however somewhat different in each case. For instructions on how to perform command sequence recording, consult chapter 12, page 137. The present section deals with direct recording, which is most simply handled from the Record toolbar.

To initiate recording of a logfile:

Click Start Recording on the Record toolbar.

You are asked to name the logfile. The default naming format is MMDD_nn.log, where MM is the current month, DD is the current day of the month, and nn is an incrementing counter starting at 01.

Now connect your equipment if you have not already done so. (By starting the recording first you ensure that you get all the measurement data on file.)

- Perform the desired tasks with your external equipment.

To pause the recording *without* closing the logfile, click Pause Recording.

Click the same button once more to resume the recording.

Special events indicating pausing and resumption are written to the logfile.

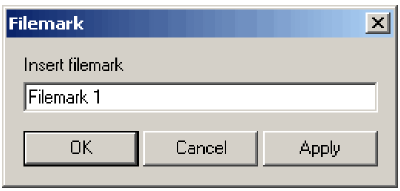
Click Stop Recording to end the recording and close the logfile. Once you have closed it, you cannot log any more data to the same file.

Alternatively, you can control the recording with the corresponding commands in the Logfile menu.

7.1.1. Inserting Filemarks

Filemarks are text strings which can be inserted manually in a logfile in order to tag interesting segments in the file. Filemarks can be searched for during logfile replay (see section 7.2 below). They are treated as events and appear as such in presentation windows. To add a filemark:

Click Insert Filemark and enter the filemark text.



You can also insert so-called *quick filemarks*; see section 7.1.3 below.

7.1.2. Swapping Logfiles

At any time while recording, you can close the current logfile immediately and continue recording to a new file.

Click Swap Logfiles.

If the original logfile was named according to the default format, the new logfile is named according to the format MMDD_02.log. For subsequent files the counter is incremented further. If the original logfile was named differently (say, mylogfile.log), the second file receives the name mylogfile_02.log, and so on.

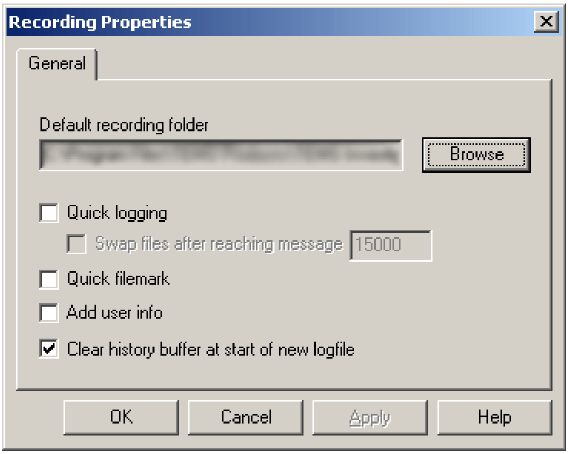
Note that if you have the "Quick logging" option turned on (see section 7.1.3), you can specify that logfiles should be swapped after a given number of messages have been logged. The manual swapping function is independent of this option and works also when it is active.

Note: The Swap Logfiles function must not be used when recording KPIs. All input to a KPI computation must be recorded in one file.

7.1.3. Further Recording Options

Some additional options are available when recording logfiles.

- Choose Recording Properties from the Logfile menu.



Default Recording Folder

Here you can change the default recording directory.

Quick Logging

If you check this box, TEMS Investigation will not ask for a logfile name before starting the recording, but create a default logfile name automatically (with the format MMDD_nn.log as described at the start of section 7.1).

To ensure that you will not end up with impractically large logfiles, you can check “Swap files after reaching message” and specify a limit on the number of air interface messages in a logfile. Then, once the given number of messages have been logged, the logfile is closed and the recording automatically continues to a new file.

Quick Filemark

If you check this box, the filemarks you insert will simply be integers. You will not be asked to enter a text string. Quick filemarks are useful for just marking one position or a few positions in the logfile without having to bother with writing comments.

Add User Info

If you check this box, you will get the opportunity to write a comment in the logfile after concluding the recording (a text box will pop up). If you use the swap logfiles function (see section 7.1.2), the text you enter in the box will be written to the last logfile only.

Clear History Buffer at Start of New Logfile

If you check this box, an internal history buffer (providing quick access to logfile data) 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.

7.1.4. Positioning Logfiles by Pinpointing

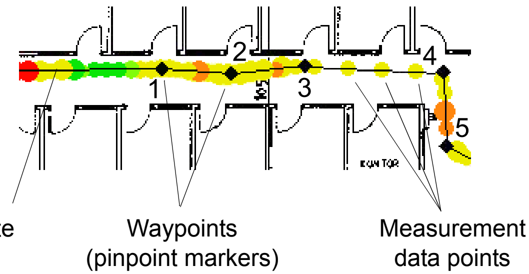
This section describes how to use the pinpointing technique for positioning logfile data. Pinpointing is useful in environments where GPS coverage is lacking.

7.1.4.1. Basic Pinpointing Procedures

First, to start the recording, click the Start Recording button as usual.

To record positions for measurements, you indicate your position by clicking on the map at regular intervals. As long as a phone is connected, clicks on the map will be interpreted as pinpointing actions. This is indicated by the Pinpoint button being down, and 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 filemarks with the information “Pinpoint”. Therefore the waypoints and connecting lines appear also when the logfile is replayed.

If you want to pause the recording temporarily, without closing the logfile:

- Pinpoint once just before pausing to ensure that all measurement data is plotted correctly.

Click Pause Recording.

To resume the recording, click the same button again, and pinpoint immediately so that all data can be accurately positioned.

When you are done with your entire measurement session, finish as follows:

Disconnect the phone.

- Pinpoint one last time to ensure that all data is accurately positioned.

Click Stop Recording to end the recording and close the logfile.

7.1.4.2. Advice on Pinpointing and Recording

From section 7.1.4.1 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 not the case in the figure in section 7.1.4.1, 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. It is wise not to replace the map during recording.

To optimize the performance of the Map window, you should remove all unused themes (see section 23.5) and avoid having other presentation windows open at the same time unless you really need them.

7.2. Replaying Logfiles

Replay of logfiles does not require the hardware key to be plugged in.

Note: To be able to replay a logfile, you must disconnect your external equipment.

Logfile replay is controlled from the Replay toolbar or from the Logfile menu. The quickest method is to use the toolbar buttons:

Open/Close Logfile: Open a logfile/Close the logfile that is currently open. Only one logfile can be open at a time.

Rewind Logfile: Rewind the logfile to the beginning.

Play/Stop Logfile: Replay the logfile/Stop logfile replay. The speed of the replay is variable and is set from the Logfile menu; see section 7.2.1 below. When the stop button is clicked to halt fast-forwarding, all presentation windows are updated.

Step Logfile: Advance one step in the logfile, i.e. read one more message from the phone. Note that a presentation window is not always updated when advancing a single step or just a few steps.

Fast-forward Logfile: Play the logfile at high speed. No updating of presentation windows takes place until the replay is stopped.

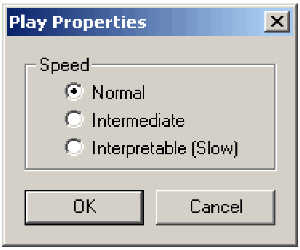
Find in Logfile: Search forward in the logfile for a time instant, a type of event, or a type of message. See section 7.2.2 below.

Information: See section 7.2.4.

7.2.1. Replay Properties

From the Logfile menu, you can adjust the speed of the logfile replay.

- Choose Logfile → Play Properties.



Normal	This is the default replay speed (and the fastest).
Intermediate	Somewhat slower than Normal.
Interpretable (Slow)	Very slow. At this speed, the screen is updated for each new message, which is not the case for the higher speeds.

7.2.2. Searching a Logfile

During replay you can search a logfile for one of the following:

- a time instant (e.g. “16:32:47”)
- a type of event (e.g. “Call Setup”)

- a type of Layer 3 message, Layer 2 message, or mode report
- filemarks with specified text.

To perform a search, click the Find in Logfile button on the Replay toolbar.

The dialog that appears has separate tabs for each of the above categories.

- Choose what you want to search for, then click either Find or Find Next.
  - If you click Find, the logfile is rewound to the beginning and then the first occurrence of the requested item is searched for. The dialog is closed immediately on clicking the Find button.
  - If you click Find Next, the search starts from the point to which the replay has progressed. The dialog remains open.

When an item of the specified type has been found, the replay halts at this point.

7.2.3. Replay Section of Status Bar

While a logfile is being replayed, the Replay section of the status bar shows the name of the file and indicates the percentage of the file that has been replayed.

7.2.4. Logfile Information

It is possible to view some information about logfiles.

Click Information on the Replay toolbar.

- The Header tab window shows data on the logfile currently in use.
- If the user who recorded the logfile made use of the “Add User Info” option (see section 7.1.3), the User Info tab shows the information input by this user.

7.3. Copying Logfiles

It is possible to copy material from one logfile to another by recording from a logfile that is being replayed. The replayed part of the file is then copied to a new logfile. This function is handy if you want to study a particular segment of a logfile more closely.

Note: The copy might not be fully equivalent to a complete logfile created in the usual manner. For instance, if only part of a call is copied, relevant data might be lost.

To perform the copying, follow the steps below:

- Make sure that you are in replay mode, that is, disconnect any external devices.

 Open the logfile you want to copy from (if it is not already open).

- Using the Replay toolbar, find the point in the logfile where you want to start copying.

 Halt the replay at this point by clicking Stop Logfile Replay.

 Click Start Recording and name the logfile.

- Using the Replay toolbar, replay the segment you want to copy. The segment is copied as the replay proceeds.

 Click Stop Recording (on the Record toolbar) when you want to stop the copying.

Note: If you close the logfile while recording is in progress, you must proceed by clicking Stop Recording.

It is not possible to record both phone data and logfile data in the same logfile. You cannot have external equipment connected and replay a logfile at the same time (see section 3.1, page 20).

7.4. Loading Logfiles from Other Sources

TEMS Investigation Data Collection can load and replay logfiles from the TEMS products listed below. Note that loading of files from certain sources (marked with * below) requires a Base Package license. See the Getting Started Manual, section 2.1.

- TEMS Investigation 9.0, 8.x, 7.x, 6.x
- TEMS Investigation GSM 5.x, 4.x, 3.x (except data recorded with SH888 or CF668 scanners)

- TEMS Investigation EDGE 1.x
- TEMS Investigation WCDMA 3.x, 2.x
- TEMS DriveTester GSM–TDMA 1.x (GSM logfiles)
- TEMS Pocket 6.0, 5.x *
- TEMS Automatic 7.0, 6.x (any MTU and HTU 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 Investigation Data Collection can also read

- EFEM logfiles from Motorola phones *
- MDM logfiles *
- logfiles from Anritsu ML8720 scanners (i.e. files logged by the scanner itself)
- MTR files (GSM; see section 31.1, page 312)

7.5. Exporting Logfiles

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 appendix D, page 338.
- MapInfo 3.0 (Interchange or Tab format)
- ArcView Shapefile: about version, see appendix E.2, page 340
- Marconi Planet DMS 3.1
- Ethereal
- MDM (CDMA)

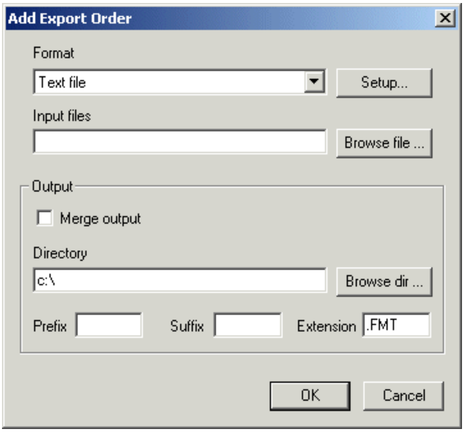
Some of these formats contain multiple files for each logfile. See appendix E, page 340 for details.

> **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.

7.5.1. Preparing an Export Order

- First, disconnect any external devices that are connected. This is necessary in order for the export to work properly.
- From the Logfile menu, choose Export Logfile.

Click Add. The Add Export Order dialog appears:



Format Select the output format for your logfiles.

The choice “KPI samples (XML)” exports KPI data from a logfile. See section 7.5.2.7.

Regarding the choice “Logfile with uplink data”, see section 7.8. (This is not a logfile export format in the usual sense.)

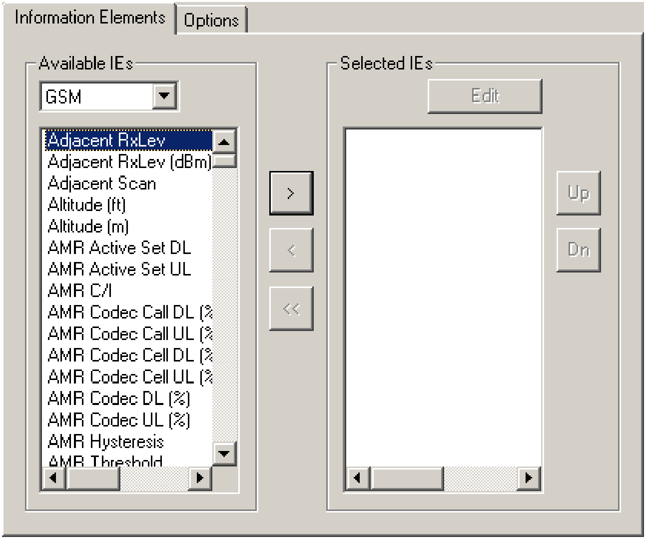
Input files Type or select the logfile or logfiles you want to export.

Output: 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.
Output: Directory	The directory where the export files are written.
Output: Prefix, Suffix	To the export file name you can add a descriptive prefix and suffix if desired – e.g. downtown as prefix and am or pm as suffix.
Output: Extension	File extension. Editable only for text files, where .fmt is the default. Export to other formats produces files with fixed extensions, as described in appendix E, page 340.

- Now click the Setup button to specify details of the export; see section 7.5.2 below.

7.5.2. Specifying the Contents of Export Files

On clicking the Setup button, a dialog appears whose contents partly depend on the format chosen. The Information Elements tab, however, is common to all 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 the 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. 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 phones. To export the item only from specified phones, you must edit the item; see **Editing the Selected Items** below.
- To export an information element from the GSM Uplink category, choose the 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 7.5.2.9.

Arranging Items in the Export Files

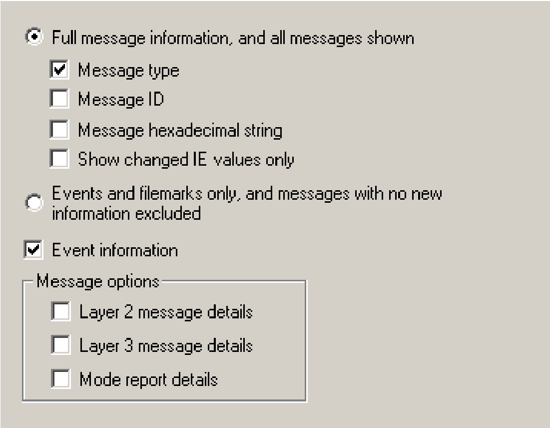
The order of the items in the Selected IEs list will also be the order in which they come in the export files. You can rearrange the items by selecting them and moving them using the Up and Dn buttons.

7.5.2.1. 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 appendix D, page 338. 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

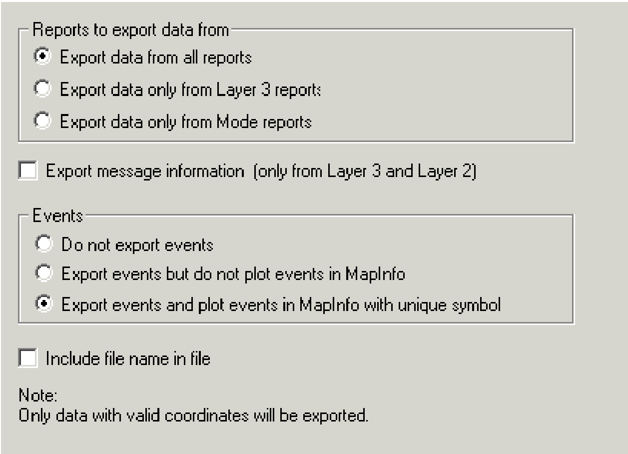
Governs whether the Event Info column is included in the export.

Message options

Check the relevant boxes in order to have Layer 2 messages, Layer 3 messages, and phones’ mode reports exported as unabridged plain text to a common separate file whose name ends in _textexp.txt.

7.5.2.2. 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 phone 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.

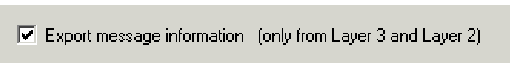
- *Do not export events:* No event information is exported.
- *Export events but do not plot...:* Events are exported, but no event-specific symbol is used in MapInfo when plotting on a map.
- *Export events and plot...:* Events are exported, and a unique symbol is used when plotting in MapInfo to distinguish 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 appendix E.1, page 340.

7.5.2.3. ArcView Specific Settings



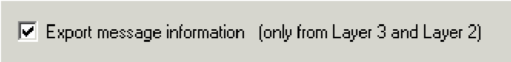
Export message information...

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 appendix E.2, page 340.

7.5.2.4. 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 Planet output, see appendix E.3, page 341.

7.5.2.5. Ethereal 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 appendix E.4, page 341.

7.5.2.6. MDM Specific Settings

MDM export is intended for logfiles recorded with Qualcomm chipset based devices.

The export encompasses all Qualcomm-specific CDMA/WCDMA 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 appendix E.5, page 341.

7.5.2.7. “KPI Samples”

Select “KPI samples (XML)” in order to export KPI data from a logfile. KPI samples are in XML format. One sample is produced for each execution of a KPI command.

KPIs can be calculated in two slightly different ways, as explained in section 25.2, page 291. In the setup dialog you choose between “Method A” and “Method B”.

To produce a KPI report, you feed the output from the export into the KPI report generator: see section 7.7, page 74.

7.5.2.8. “Logfile with Uplink Data”

This is not an ordinary logfile export format, but it has been grouped with these for convenience; see section 7.8, page 76.

7.5.2.9. 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 (section 7.5.2, page 63) 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.

7.5.3. Executing Export Orders

All the export orders you have defined are listed in the Export Logfile 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”).

7.6. Generating Logfile Reports

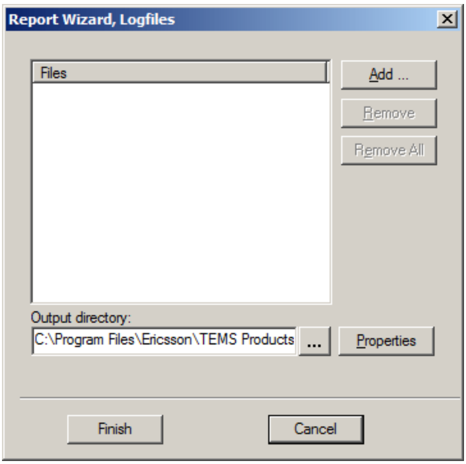
> **Note:** Route Analysis includes a reporting tool called RAN Tuning. See the Route Analysis User’s Manual, chapter 16, page 91.

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 appendix F, page 342.

- 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 connected, disconnect them. This is necessary in order for the report generation to work properly.

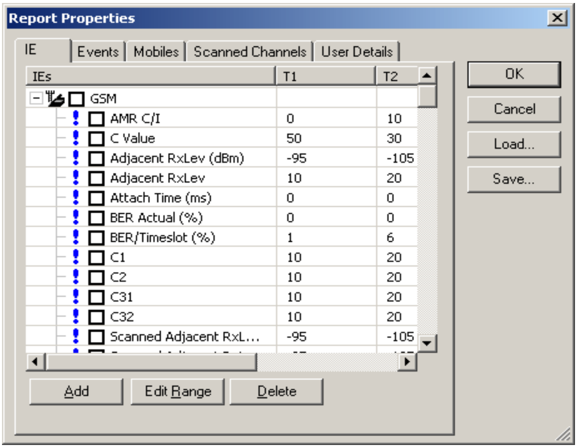
To prepare a logfile report, click Generate Report on the Report toolbar. This dialog appears:



- 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.

7.6.1. IE Tab



The report can compare information element values with thresholds. It will contain statistics of the type “Percentage of measurement points with RxLev Full below –100 dBm”.

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:

$$IE[Arg] \leq T_1, IE[Arg] \leq T_2$$

or

$$IE[Arg] \geq T_1, IE[Arg] \geq T_2$$

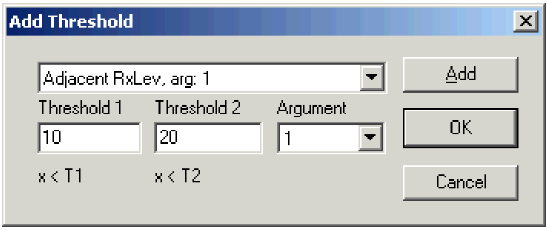
Whether peaks or dips are counted depends on the information element and cannot be changed.

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 appendix F.4, page 344). 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.

7.6.2. 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.

7.6.3. Mobiles Tab

- Check the external devices whose data you want to include in the report.

By default all devices used to record the logfile will be checked. GPS data, if available, is included implicitly.

7.6.4. 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. The same dialog is used for scan data from all cellular technologies. The number appearing within square brackets after each channel *(GSM)*/scrambling code *(WCDMA)*/pilot number *(CDMA)* is the frequency band/UARFCN/RF channel.

- Move the items that you wish to present from the Available box to the Selected box.

For each selected item, the report will contain RxLev/code power statistics (mean, median, min, max) and a bar chart. The averaging takes place in the mW domain.

7.6.5. User Details Tab

Here you can type a user name and a report number which will be printed in the report header.

7.6.6. 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.

7.6.7. Generating the Report

- In the Report wizard, click Finish.

The report will be stored under My Documents\TEMS Product Files\TEMS Investigation 9.0\GeneratedReports.

7.6.8. Report Contents

The logfile report has the following main sections (see appendix F, page 342 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.

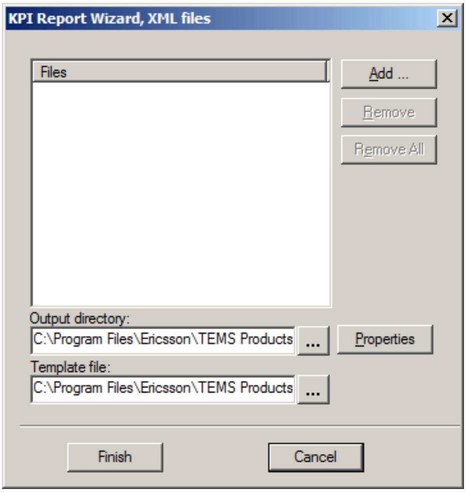
7.7. Generating KPI Reports (UMTS)

KPI data is exported from logfiles as “KPI samples” (section 7.5.1) in XML format. From one or several such XML files you can generate a *KPI report*, also in XML format, which presents KPIs based on the collected data. The report XML file comes with an XML stylesheet and is directly presentable in an XML-capable web browser.

For full details of logfile report contents and format, see appendix G, page 347.

- If you have a logfile open, it is recommendable to close it before generating the report.
- If any external devices are connected, you must disconnect them.

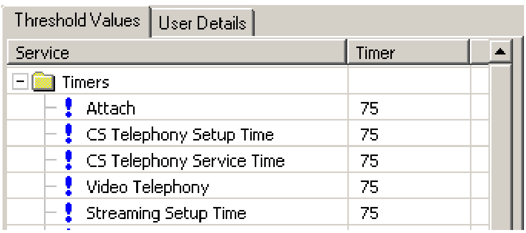
To prepare a KPI report, click the button Generate Report KPI on the Report toolbar. This dialog appears:



- First, choose the KPI sample or samples on which to base the report. Click Add and browse for the files. Those that you choose are listed in the Files box.
- Under Output directory, specify an output directory for the report. Enter a path, or click the button labeled "..." to browse your file system.
- Under Template file, choose the XML stylesheet (*.xslt) that should govern the layout of the KPI report. By default, a stylesheet stored under <TEMS Investigation install dir>\XMLStylesheet is chosen.

Now click Properties to customize the KPI report. A multi-tab dialog appears.

7.7.1. Threshold Values Tab



On this tab you indicate timeouts for various steps of data transfer procedures:

- Attach
- PDP context activation
- Service access; a separate timeout needs to be given for each service
- WAP activation
- MMS: MO transfer, notification, MT transfer

The timeouts affect the values of the corresponding KPIs measuring success/failure ratios and time.

If a timeout is exceeded for any step of the PS access procedure, the whole access procedure is considered as failed. When calculating the average access time, only attempts that were successful (in the same sense) are included. Similar handling applies to the “MMS send” and “MMS receive” KPIs.

A more precise description of KPIs and timeouts is found in appendix G.

7.7.2. User Details Tab

Here you can type a user name and a report number which will be printed in the KPI report header.

7.7.3. Generating the Report

- In the Report wizard, click Finish.

When the KPI report is ready it will be opened in the default web browser, provided that it supports XML.

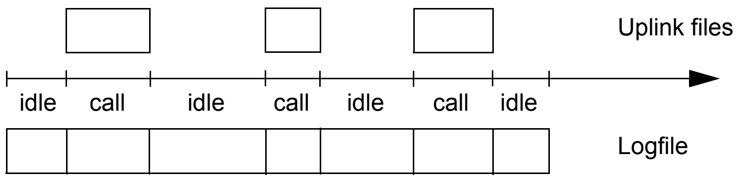
7.8. Merging Logfiles with Uplink (MTR) Data

It is possible to incorporate into logfiles data originating from Ericsson uplink data files (MTR files). See chapter 31. The term “MTR file” will be used in this section when referring to characteristics of this specific file type. Before going through the mechanics of merging the files, it is appropriate to outline how the merging algorithm works.

7.8.1. The Merging Algorithm

The task of the merging algorithm is to time-align – synchronize – the information in the uplink files with that in the logfiles. A time offset can be expected between the clock that governs uplink file time-stamping (for MTR files, the BSC clock) and the clock in the PC on which the logfiles were recorded.

While an uplink file contains (usually) one complete call involving a specific phone (actually a specific IMSI, i.e. subscriber identity), a logfile can comprise an arbitrary number of calls made by one or several phones. The typical situation, therefore, is that a logfile corresponds to multiple uplink files, each covering a logfile segment that concerns a single call: [1]



For each call in the logfile, the merging algorithm extracts a number of key characteristics: start time, stop time, and information about handovers (time of occurrence and serving cells involved). Then, each uplink file is compared to each call in the logfile with respect to these characteristics. The uplink files for which a reliable match has been found are finally incorporated into the logfile, aligned as indicated by the calculated time offset. The output is a new logfile (extension .log), augmented with the uplink information, which is represented as being reported by a fictitious phone “MS5”.

The merging algorithm may sometimes fail for certain uplink files; typical reasons for failure are discussed in section 7.8.2 below. When this happens, you can put the algorithm on the right track by providing additional information. There is also the possibility of aligning uplink files manually. Regarding this, see section 7.8.3 under **Handling Problematic Uplink Files**.

1. Note, however, that both types of file may contain call fragments. Multiple MTR files will be generated by a call if switching between BSCs occurs during the call (provided of course that all BSCs are recording). TEMS logfiles will contain fragments of calls whenever recording is not active throughout a call, and also when the “Swap logfiles” function is used so that the recording continues to a new file (section 7.1.3, page 52).

7.8.2. Limitations of the Merging Algorithm

If the merging algorithm has enough to go on, that is, if all calls in the files can be readily distinguished from each other by means of the characteristics considered, the procedure is straightforward. However, if this is not the case for some uplink file, so that there is difficulty in finding an obvious best match for it, the procedure will fail for this file.

Problems will thus arise with sets of similar calls, especially if they are short and lack distinctive features (namely, handover events). Multiple calls with uniform characteristics can indeed be expected when running a command sequence repeatedly (about command sequences, see chapter 12, page 137). Fragments of calls, whether in uplink files or logfiles, are also more likely to be problematic, because either the start time or stop time and thus the call duration is unknown.

Furthermore, the algorithm does not handle day transitions. Therefore, it cannot correctly process calls beginning before and ending after midnight, or deal with time offsets that are so large as to place part of the calls on a different day. In other respects the size of the time offset does not affect the performance of the algorithm.

7.8.3. Performing the Merge

The procedure is carried out from the Export Logfile window:

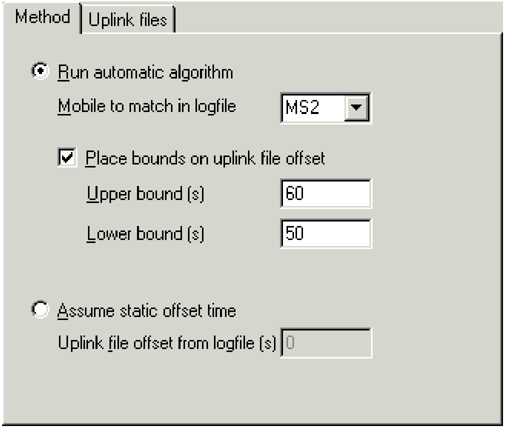
- From the Logfile menu, choose Export logfile.

 In the Export Logfile window, click Add.

- Under Input files, enter the logfile names, or click “Browse file” and select your files. (If you choose several logfiles, the merge will be done separately for each logfile.)
- Under Directory, specify a directory for the output.
- In the Format combo box, choose “Logfile with uplink data”.
- Click the Setup button.

In the dialog that follows, you decide how to perform the merge (Method tab) and what uplink files to include in it (Uplink files tab).

Method Tab



Unless you somehow know the exact time offset beforehand, you should begin by running the algorithm described in the previous sections. (If you do know the offset, you may want to carry out the alignment yourself. See section 7.8.3 under **Manual Alignment**.)

- “Mobile to match in logfile” determines what logfile data is considered when comparing it with the uplink files. If you have data from several phones in the logfile, but uplink files for a single phone, it is appropriate to disregard the data from the other phones: this eliminates a source of uncertainty in the matching process and also speeds it up.
- If you have some idea about the size of the offset, you can check “Place bounds on uplink file offset” and enter lower and upper bounds. This, too, increases the reliability and speed of the algorithm.

Uplink Files Tab

On this tab you choose your uplink files. You do not have to list them in any particular order.

Running the Merging Algorithm

When you have completed the Add Export Order dialog, the specified merge appears in the list in the Export Logfile window.

 Click Start to carry out the merge.

The procedure will take some time. When it has completed, you will receive a message ("Export Result") stating success or failure for each uplink file. See the example in section 7.8.5.

- If all uplink files have been successfully matched, you are done.
- If the algorithm has failed for some files, see **Handling Problematic Uplink Files** below. Do not close the Export Result window – you will need to inspect the information given there.

To terminate an ongoing merge, click Abort.

Handling Problematic Uplink Files

If no sufficiently reliable match is found for an uplink file, it is not included in the output logfile. There are two possibilities: Either there is no match – the data in the uplink file simply does not exist in the logfile –, or there is indeed a match to be found, but the algorithm has problems identifying it, typically for one of the reasons stated in section 7.8.2.

In the latter case, you can try to remedy the problem as follows. What the algorithm needs in order to align the troublesome file, or files, is more precise information about the offset. Often several calls in the logfile are good matches and there is a problem figuring out which is the correct one. Now, the offsets calculated for the successfully aligned uplink files (which should be nearly identical) should be similar to that of the remaining files as well. Therefore, you can assist the algorithm by feeding back the information on the offset: [1]

In the Export Logfile window, click the Edit Order button.

- Click Setup.
- On the Method tab, check "Place bounds on uplink file offset" and enter upper and lower bounds based on the values observed in the Export Result window. The bounds should be tight enough to ensure that a call in the logfile cannot be mistaken for an adjacent call.

Exit the dialogs, and click Start to run the algorithm again.

With this new constraint applied, it should be possible to align all the uplink files that have a genuine match.

---

1. The reasons for requiring that this be done manually are given in the section **Why the Manual Steps?** below (page 81).

Manual Alignment

If the procedure still fails for some files, they probably do not correspond to anything in the logfile. It might be the case, however, that some files are corrupt (for instance, they might be truncated). Even so, you might want of course want to use them. There may also be a day transition problem (see section 7.8.2). As a last resort, therefore, you can carry out the alignment by brute force, simply assuming an offset:

- On the Method tab, choose “Assume static offset time” and enter a value in the box. (The offsets obtained for the successfully aligned files should still be a good clue.)

 Click Start.

The remaining files will then be aligned unconditionally with the logfile according to the chosen offset.

You might also prefer to use this method if you have already determined the offset outside TEMS Investigation.

Why the Manual Steps?

You may ask why the offset that has been reliably determined for some uplink files is not automatically assumed for the other files (for which the algorithm has initially failed). After all, this would eliminate the need for intervention by the user.

The answer is that it has been thought safest to give a warning as soon as something goes wrong, and leave it to the user to decide what to do next with the concerned files. As already noted, they might not belong with the logfile at all, or they may be damaged and possibly uninterpretable.

7.8.4. Accuracy of the Alignment

> **Note:** This section is to a great extent MTR file specific.

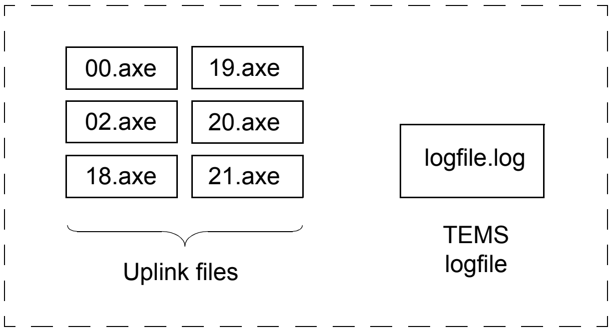
There are limits to the accuracy that can be achieved in time-aligning the uplink files. The accuracy is affected by the following factors:

- The time offset for an uplink file is computed as the average of the offsets for all characteristic events detected in the call (call start, call end, handovers, etc.). Therefore, the longer the call, the more reliable the offset, and vice versa.

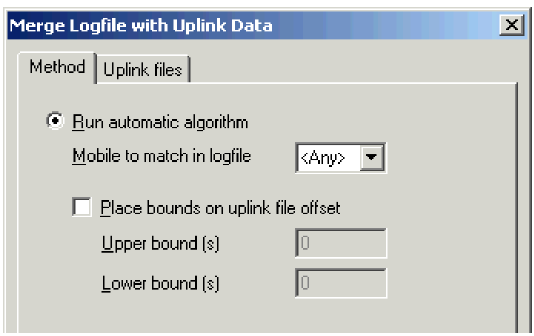
- Measurement reports in MTR files are not tagged with time-of-day information, but merely with a counter that is reset after each handover. This may have the effect that the MTR measurement reports are imperfectly synchronized with the measurement reports from the phone.

7.8.5. Example

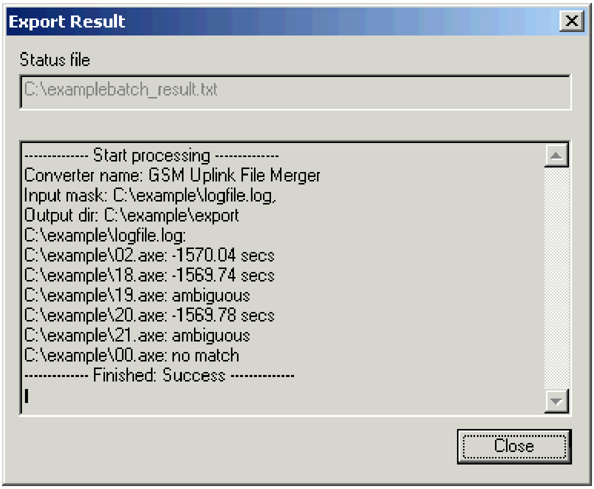
Suppose that we want to merge the following files:



We do not know anything about the offset, and therefore we first run the automatic algorithm without specifying any bounds:



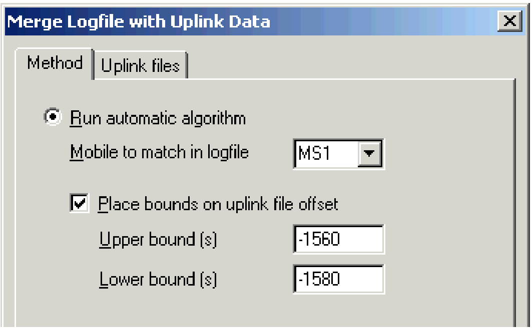
The following result is obtained:



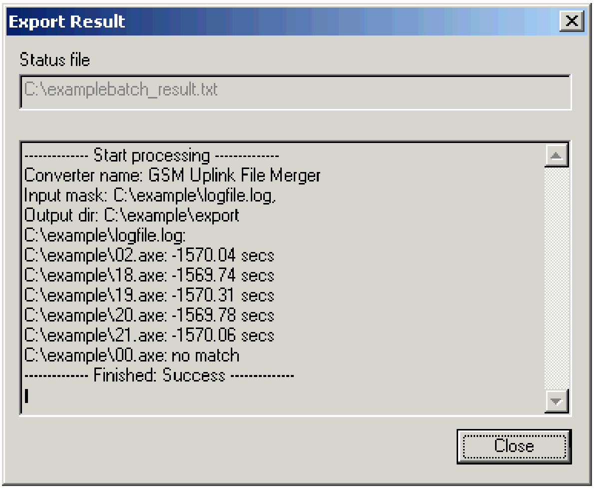
The outcome is indicated for each uplink file:

- A time indication after the file name means that the file was successfully matched and merged with the logfile. The time is the offset determined for this file. Here we see that files 02, 18, and 20 were successfully matched.
- “ambiguous” means that several good matches were found, and it was impossible to determine which of them is correct (here, 19 and 21).
- “no match” means that the uplink file matched nothing in the logfile (here, 00).

In the last two cases the merge has failed. File 00 most probably does not belong with the logfile at all, and in any case it cannot be aligned using the algorithm. For files 19 and 21, on the other hand, it should be possible to find a single match by specifying bounds on the offset. The offsets computed for 02, 18, 20 suggest a value close to –1570 seconds, so we fill in the dialog as follows:



Running the algorithm once more gives



Files 19 and 21 could now be aligned unambiguously, and the procedure is finished (file 00 must be discarded in the context).

8. GSM Scanning

TEMS Investigation Data Collection supports scanning of GSM radio frequency carriers with Sony Ericsson phones[1] and PCTel SeeGull LX/EX scanners. It is possible to scan with several devices simultaneously, and naturally the output from all of them can be displayed in parallel. How to connect phones and scanners is described in chapter 6.

> **Note:** A Sony Ericsson phone cannot act as an ordinary phone while it is scanning. In particular, it cannot engage in voice calls or data transfer.

Scanning tasks are set up from the Equipment Control toolbar, whereas the output of scans is primarily intended to be displayed in a suite of ready-made bar charts. However, since all scan data is available in information elements, you are free to present it in any presentation window.

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.

Some technical data on PCTel scanners is provided in appendix H, page 363.

8.1. Scanning Methods

You can scan an arbitrary user-selected set of channels. See section 8.2.

8.2. Frequency Scanning Mode

This mode scans an arbitrary unchanging set of channels.

- An ordinary GSM signal scan is supported by all scanning-capable devices.

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1. For specifics, see Information Elements and Events, section 5.2.

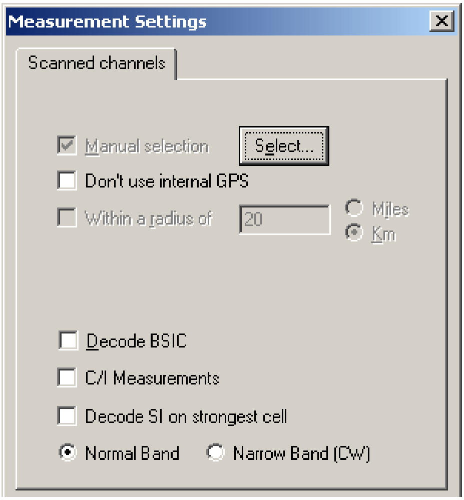
- With a PCTel scanner you can also do a CW (Continuous Wave) scan if no GSM signal but only the carrier is present. See section 8.2.5.

To set up the scan:

- Connect the device to scan with if it is not already connected. See chapter 6. (You must have the device connected to be able to access the Measurement Settings dialog.)
- On the Equipment Control toolbar, in the Scanning Task combo box, select “[GSM] Frequency Scanning”.

 Click the Scan Properties button.

The Measurement Settings dialog appears. It looks slightly different depending on what device is connected. Here is the dialog shown for a PCTel SeeGull scanner.

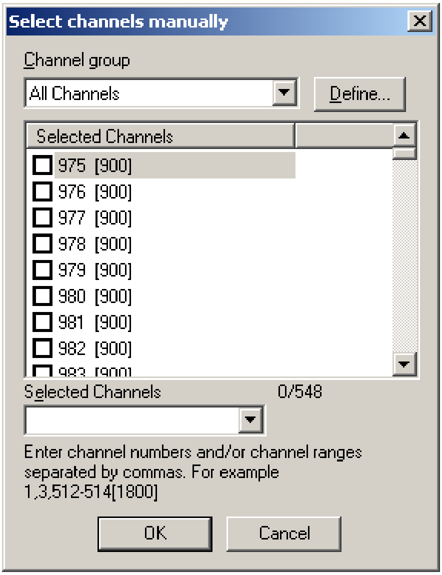


Manual selection/ Channel selection	Click the button to define the set of channels to scan. A new dialog appears; see section 8.2.1.
Don’t use internal GPS	Check this if you do not want to use the scanner’s internal GPS for positioning. Note that if you set up other (i.e. WCDMA) scanning methods for the same scanner, you must check this option for these methods as well, otherwise the internal GPS will be used anyway.

Within a radius of	Not used.
Decode BSIC	See section 8.2.2.
C/I measurements	See section 8.2.3.
Decode SI on strongest cell	See section 8.2.4.
Normal band; Narrow band (CW)	See section 8.2.5.

There is no limit to the selectable number of channels. However, it may happen that the task assigned exceeds the capabilities of the device. If so, the device will scan as many channels as it is capable of.

8.2.1. Channel Selection



You can select your channels either by checking them in the list box or by typing a text string in the field at the bottom:

Selecting Channels from a List

- Under Channel Group, choose a set to pick your channels from: all channels, a frequency band, or a group that you have defined yourself (see section 8.7, page 91).
- The chosen channel set appears in the Selected Channels list box. Check the channels you want to scan. To choose a set of channels, select the set (using Ctrl-click or Shift-click as usual), right-click in the selection, and choose Select/Deselect. Repeat to deselect. To scan all channels in the list, right-click in the list and choose Select/Deselect All. Repeat to deselect all channels.

Specifying Channels in a Text String

- In the Selected Channels combo box at the bottom of the dialog, enumerate the channels in a text string, using commas or spaces as separators and hyphens to indicate intervals.
- Channel numbers common to GSM 1800 and 1900 will be interpreted as GSM 1800 channels. To indicate a GSM 1900 channel, you must add “[1900]” after the channel number. GSM 1800 channels may optionally have “[1800]” appended to them.

Example: “1, 3, 5-8, 512, 512-514[1900]” selects the E-GSM channels 1, 3, 5, 6, 7 and 8, the GSM 1800 channel 512, and the GSM 1900 channels 512, 513 and 514.

The Selected Channels combo box maintains a history list of previous inputs; click the arrow to reuse these.

Note that input to the combo box overrides any selections in the list box (the list box is cleared).

8.2.2. BSIC Decoding

Checking the box “Decode BSIC” causes the Base Station Identity Code to be decoded whenever possible. It should be noted that BSIC decoding is computationally costly and considerably reduces the sample rate of the scanning device.

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.

8.2.3. C/I Scanning

(PCTel scanners only)

Checking the box “C/I Measurements” causes a subset of the “C/I” information elements to be updated, as described in Information Elements and Events, section 3.2. 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.

Sony Ericsson phones cannot measure C/I in scan mode.

8.2.4. System Information Decoding

(PCTel scanners only)

Checking the box “Decode SI on strongest cell” 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.

8.2.5. CW Scanning

(PCTel scanners only)

For PCTel scanners you select whether to perform a GSM signal scan (“Normal Band”) or a CW scan (“Narrow Band”). This setting applies to all channels you select for scanning as described in section 8.2.1. It is not possible to specify the type of scan for each channel separately.

Regardless of the type of scan selected, the measurements are delivered in the same information elements (Scanned RxLev, etc. in the “GSM” category).

8.3. Performing a Scan

- On the Equipment Control toolbar, choose the device to scan with in the combo box.

To start scanning, click the Start/Stop Scanning button.

While the scanning is going on, the combo box on the Equipment Control bar and the status bar both display the device with a padlock symbol, indicating that the device is busy scanning.

To stop scanning, click the Start/Stop Scanning button once more.

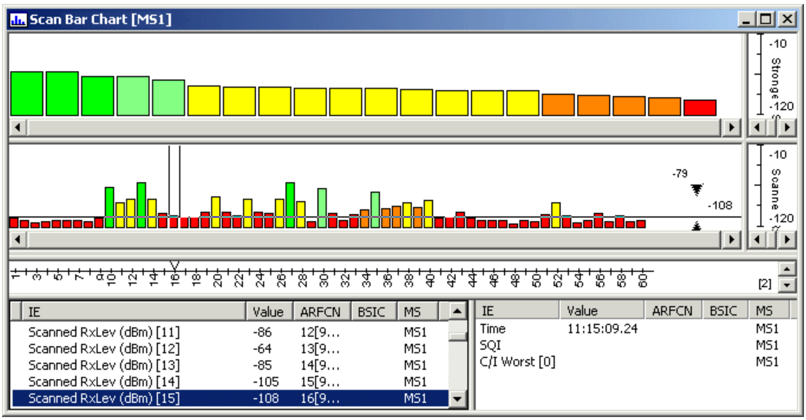
8.4. Recording Scan Data

To record scan data, create a new logfile as described in section 7.1.

8.5. Presentation of GSM Scan Data

The main vehicle for presenting GSM scan data is the Scan Bar Chart:

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 22.

Scan data can also be presented in status windows. There is no predefined status window for this purpose, but you can design one yourself: see chapter

16, page 214. The information elements of interest are those in Information Elements and Events, section 3.2 that are associated with scanning.

8.6. Replaying Scan Data

If you are replaying a logfile with scan data, you will probably want to replay the file slowly in order to see clearly what is happening. The replay speed is set from the Logfile menu (see section 7.2.1, page 56).

8.7. Defining Your Own Channel Groups

The set of channels displayed in the Selected Channels box is determined by the choice in the Channel Group combo box (see section 8.2.1; the default is All Channels). It is possible to define custom channel groups and show only the members of such a group in the list box. You may find this convenient if you often scan some restricted set of channels.

Note: A channel group does not define which channels are actually scanned. It only defines the set of channels that can be selected for scanning.

Channel groups are created and managed in the same way as scrambling code/UARFCN groups for WCDMA; see section 9.11, page 120 for full details.

9. WCDMA Scanning

TEMS Investigation Data Collection supports scanning of UMTS frequencies with one of the following devices:

- Sony Ericsson Z750i phone operating in scan mode
- PCTel SeeGull LX/EX scanner
- Anritsu ML8720/8740/8741 scanner.

It is possible to scan with several such devices concurrently. How to connect devices is described in chapter 6.

Scanning tasks are set up from the Equipment Control toolbar, whereas the output of scans is primarily intended to be displayed in a suite of ready-made bar charts and other windows. However, since all scan data is available in information elements, you are free to present it in any presentation window. The scanning presentation windows are fully synchronized with the rest of the application.

Note that the internal GPS in a PCTel scanner, as well as a GPS connected to an Anritsu scanner, will deliver data only while a scan is in progress.

Some technical data on PCTel scanners is provided in appendix H, page 363.

9.1. Scanning Methods and Scanning Capacity

TEMS Investigation offers these WCDMA scanning methods, supported using the various scanners as indicated:

	SE Z750i	Anritsu	PCTel SeeGull LX	PCTel SeeGull EX	Section Ref.
CPICH, static SC set	✓	✓	✓		9.4
CPICH, Top *N*	✓	✓	✓	✓	9.4
CPICH, SIB decoding	✓			✓	9.4
CPICH, High Speed/High Dynamic				✓	9.4.3
CPICH: P-SCH + S-SCH		✓	✓	✓	9.4
CPICH: No. of UARFCNs	12	1/2[a]	4	12	9.4
SCH timeslot			✓		9.5
Continuous Wave (CW)			✓	✓	9.6
Spectrum analysis			✓		9.7
Network search	✓				9.8

a. Depending on physical configuration.

The scanning methods are conceptually independent and 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 SCH timeslot scan at maximum resolution requires the full resources of the PCTel scanner, so that it cannot perform any other tasks at the same time.

A PCTel scanner has a capacity of 2,560 measurement points. As you set up the scanning tasks, you are continuously notified in the setup dialogs of how many measurement points you have used up.

The Sony Ericsson Z750i does not handle concurrent execution of multiple scanning methods (CPICH and Network search).

9.2. Performing a Scan

Regardless of scanning method, the procedure for performing a scan is as follows:

- Connect the device to scan with if it is not already connected. See chapter 6. (You must have the device connected to be able to access the Measurement Settings dialog.)
- Set up the scan according to one of the sections 9.4, 9.5.1, 9.6.1, or 9.7.1.

To start scanning, click the Start Scanning button.

While the scanning is going on, the status bar shows the padlock symbol , indicating that the scanner is busy.

To stop scanning, click the Stop Scanning button.

9.3. Recording Scan Data

To record scan data, create a new logfile as described in section 7.1.

9.4. CPICH Scanning (with SCH Scanning)

This method scans CPICH control channels, scrambled with cell-specific scrambling codes. Several UARFCNs can be scanned at a time.

Where supported, the same method also scans primary and secondary synchronization channels (P-SCH, S-SCH).

9.4.1. Scan Setup

- On the Equipment Control toolbar, choose the scanning device in the left combo box, and choose "[(W)CDMA] CPICH/PN Scanning" in the right combo box.

On the Equipment Control toolbar, click the Scan Properties button.

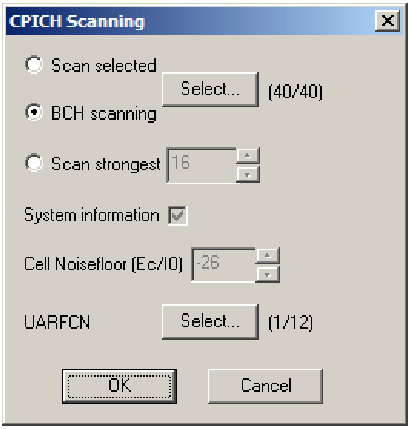
A dialog appears in which you choose what scrambling codes and UARFCNs to scan, and set some scan parameters. UARFCNs and scrambling codes are selected independently of one another. The details are different for each brand of scanner; see below.

9.4.2. CPICH Scanning with Sony Ericsson Z750i

CPICH scanning can be set up in the following ways:

- User-defined, static set of scrambling codes (common to all UARFCNs) scanned. Optional snapshot SIB decoding.
- User-defined, static set of scrambling codes (common to all UARFCNs) scanned. Unconditional and continuous SIB decoding.
- Strongest scrambling codes scanned (“Top *N*”). Optional snapshot SIB decoding.

These setups correspond to the radio buttons in the dialog below.



Scan selected Choose this to scan a static set of scrambling codes on all frequencies defined under “UARFCN” below.

Up to 40 scrambling codes can be selected. Click the Select button to pick your scrambling codes: see section 9.4.5.

The number of scrambling codes currently selected appears within brackets on the right.

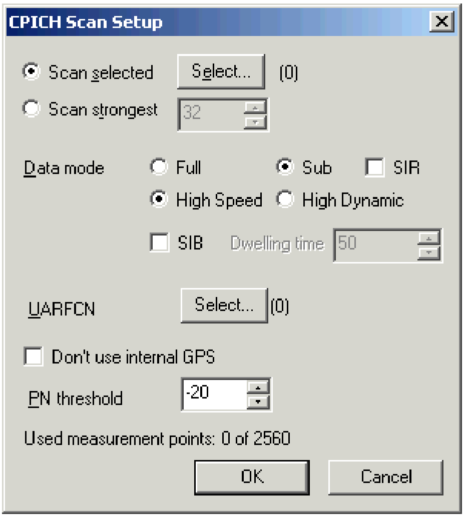
BCH scanning	If you choose this option, you select scrambling codes in the same way as for Scan selected, and the same scan data will be collected. However, the updating frequency will be considerably lower, and the sensitivity of the scrambling code detection may be lower as well. The processing time freed up in this way is instead used to 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 scan the *N* strongest scrambling codes ($N \leq 40$) on the chosen UARFCNs. The scanner automatically finds the strongest scrambling codes.
System information	This option can be selected for Scan selected and Scan strongest. If selected, 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 CPICH scanning. If the strongest cell does not change within two minutes, SIBs will be decoded again for that cell.
Cell noise floor (Ec/Io)	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.
UARFCN	Here you set the UARFCNs of the frequencies on which to scan the CPICH. The allowed range is dependent on the frequency band. Click the Select button to pick your UARFCNs. A dialog appears which is analogous to that described in section 9.4.5. The number of UARFCNs currently selected appears within brackets on the right.

9.4.3. CPICH Scanning with PCTel SeeGull LX/EX

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 (LX only)
- strongest scrambling codes ("Top *N*")

The image below shows all settings provided in TEMS Investigation for this scan mode. What settings are supported by the various PCTel SeeGull models appears from the table in section 9.1. Only supported settings are displayed in the dialog.



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 128 scrambling codes can be selected. Click the Select button to pick your scrambling codes: see section 9.4.5.

The number of scrambling codes currently selected appears within brackets on the right.

Scan strongest

Choose this to scan the *N* strongest scrambling codes ($N \leq 32$) on the chosen UARFCNs. The scanner automatically finds the strongest scrambling codes.

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 9.4.8 and 9.4.10).

Checking the SIR checkbox causes the scanner to deliver the information elements "Sc ... SIR" (requires PCTel scanner software release 5.0 or higher).

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 checkbox is disabled in this case.)
- For "Scan strongest", only P-SCH Ec/Io and S-SCH Ec/Io are excluded.

The default is always "Sub".

High Dynamic, High Speed

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.

SIB

Check this box to decode System Information blocks. With this option selected, a maximum of 16 scrambling codes can be scanned.

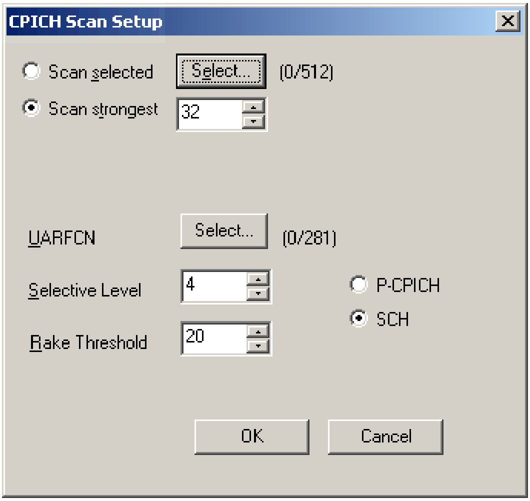
From the SIB decoding are extracted the information elements "Sc 1st (2nd, 3rd, 4th) Intra-freq Cells".

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.
UARFCN	Here you set the UARFCNs of the frequencies on which to scan the CPICH, P-SCH, and S-SCH. The allowed range is dependent on the frequency band. Click the Select button to pick your UARFCNs. A dialog appears which is analogous to that described in section 9.4.5. The number of UARFCNs currently selected appears within brackets on the right.
Don't use internal GPS	Check this if you do not want to use the scanner's internal GPS for positioning. Note that if you set up other scanning methods for the same scanner, you must check this box for the other methods as well, otherwise the internal GPS will be used anyway.
PN threshold	This is a signal code power threshold (in dB) used for the Aggregate Ec/Io and Delay Spread measurements (see section 9.4.7). 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.
Used measurement points	Number of scanner measurement points used so far by all scanning methods together. See section 9.1.

9.4.4. CPICH Scanning with Anritsu

The set of scrambling codes to scan on an 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*")



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. Click the Select button to pick your scrambling codes: see section 9.4.5. The number of scrambling codes currently selected appears within brackets on the right.
Scan strongest	Choose this to scan the *N* strongest scrambling codes (up to 32) for the chosen UARFCNs (“Top N”). The scanner automatically finds the strongest scrambling codes.
UARFCN	Here you set the UARFCNs of the frequencies on which to scan the CPICH, P-SCH, and S-SCH. The allowed range is dependent on the frequency band. Click the Select button to pick your UARFCNs (one or at most two, depending on the physical configuration of the scanner). A dialog appears which is analogous to that described in section 9.4.5. The number of UARFCNs currently selected appears within brackets on the right.

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.

P-CPICH, SCH This setting governs the choice of cell search method in Top N scan mode (“Scan strongest” option).

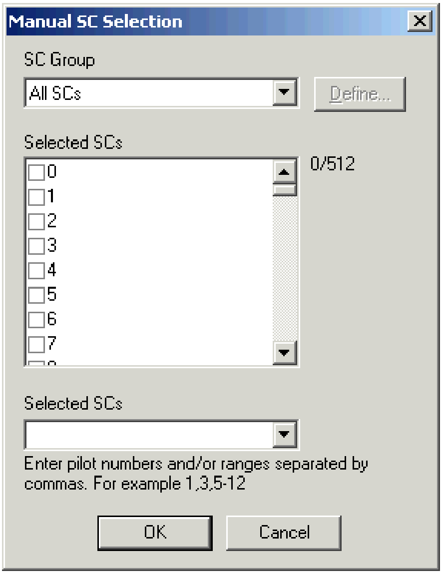
- If P-CPICH is selected, only CPICH channels will be scanned to find scrambling codes. (For all scrambling codes detected in this way, however, the scanner will measure and report on the P-SCH and S-SCH as well.) This mode is useful especially for troubleshooting of transmitters.

  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.

9.4.5. Manual Scrambling Code/UARFCN Selection

This section describes the dialog used to select scrambling codes manually. The dialog for selecting UARFCNs is completely analogous.



You can select your scrambling codes either by checking them in the list box or by typing a text string in the field at the bottom:

Selecting Scrambling Codes from the List

- In the Selected SCs list box, check the scrambling codes you want to scan. To choose a set of scrambling codes, right-click in the selection and choose Select. To scan all scrambling codes in the list, right-click in the list box and choose Select All. There are also corresponding context menu commands for deselecting scrambling codes. (The standard Windows Ctrl-click and Shift-click operations also work.)

Specifying Scrambling Codes in a Text String

- In the Selected SCs combo box at the bottom of the dialog, enumerate the scrambling codes in a text string, using commas or spaces as separators and hyphens to indicate intervals.

Example: “1, 3, 5-8, 511” selects scrambling codes 1, 3, 5, 6, 7, 8, and 511.

The Selected SCs combo box maintains a history list of previous inputs. Click the arrow to reuse history items. Note that input to the combo box overrides any selections in the list box (the list box is cleared).

Scrambling Code Groups

Under SC Group, you can define custom subsets of scrambling codes to govern what is displayed in the Selected SCs list. By default, all scrambling codes are displayed. To define a subset, click the Define button; see section 8.7.

9.4.6. Presentation: General

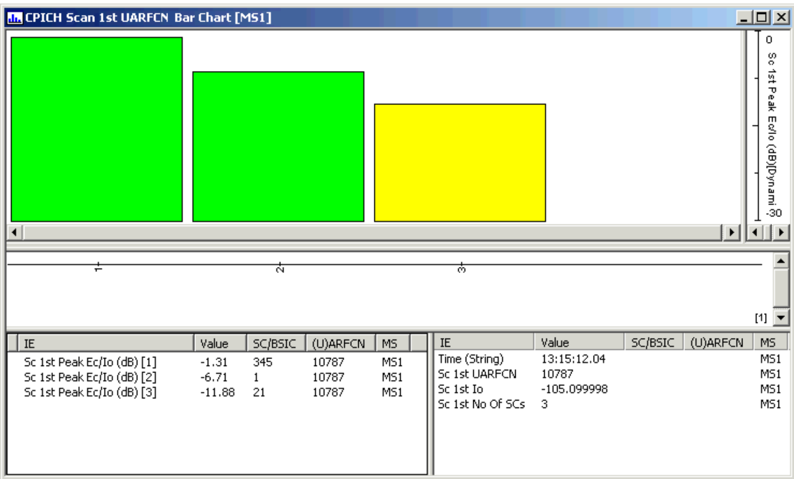
CPICH scan data is presented in

- the CPICH Scan bar charts (section 9.4.7)
- the CPICH Scan Data status window (section 9.4.8)
- the CPICH Scan line charts (section 9.4.9)

Synchronization channels are presented in the Synch Channels window (section 9.4.10).

9.4.7. 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 peak Ec/Io (see section 9.4.8) for each scrambling code found. About data sorting, see section 9.4.13.1.

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*).

9.4.8. 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 9.4.3).
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 3.3.

9.4.9. Presentation: “CPICH Scan” Line Charts

The default configuration of this window is as follows:

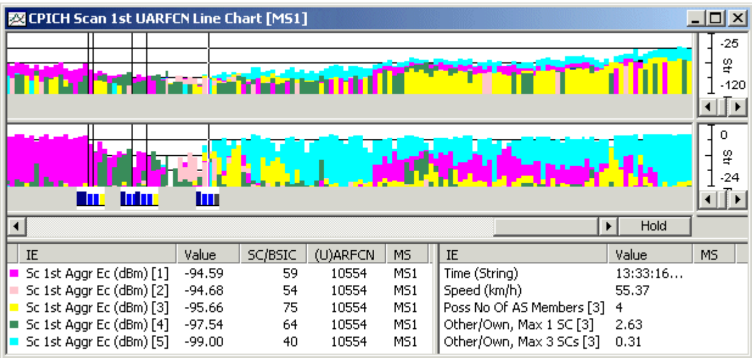


Chart Panes

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.

Additional Information Pane

The Additional Information pane (bottom right) shows the CPICH pilot pollution situation.

- *Poss No Of AS Members:*

  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.

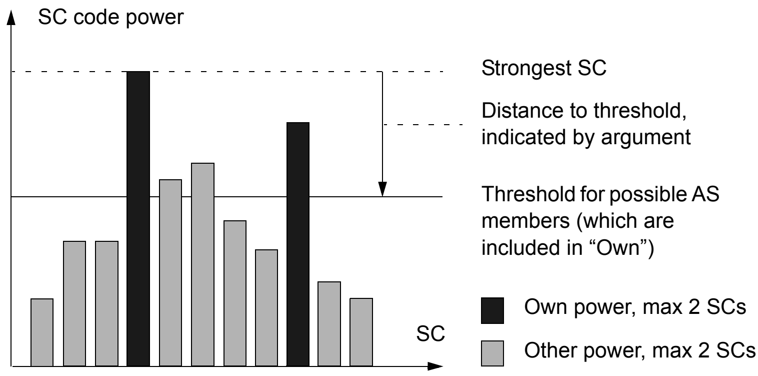
  Example: If the argument is 3 (default value), all SCs with a code power not more than 3 dB below that of the strongest SC will be counted. In the above figure, there are three such SCs, so the active set is judged to have a total of four possible members.

- *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.

9.4.10. Presentation: Synch Channel Data Window

This window presents scan data on the synchronization channels P-SCH and S-SCH, obtained with the CPICH scanning method.


Synch Channel Data [MS1]

UARFCN	SC	P-SCH Ec	P-SCH Ec/Io	S-SCH Ec	S-SCH Ec/Io
10713	0	-85,17	-9,75	-85,17	-9,75
10713	32	-96,67	-21,25	-99,42	-24,00
10713	30	-97,29	-21,88	-98,54	-23,13
10713	1	-85,17	-9,75	-97,29	-21,88
10713	13	-90,67	-15,25	-105,17	-29,75
10713	20	-96,67	-21,25	-99,67	-24,25
10713	11	-85,17	-9,75	-98,17	-22,75

SC Scrambling code number.

P-SCH Ec The peak power of the Primary Synchronization Channel, P-SCH (in dBm).

P-SCH Ec/Io	The peak power of the P-SCH (Ec) relative to the total signal power in the channel (Io), i.e. the difference between them in dB.
S-SCH Ec	The peak power of the Secondary Synchronization Channel, S-SCH (in dBm).
S-SCH Ec/Io	The peak power of the S-SCH (Ec) relative to the total signal power in the channel (Io), i.e. the difference between them in dB.

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 16.3, “Changing Status Window Properties”, on page 217.

9.4.11. Presentation: “Finger Info” Status Windows

These windows present Rake finger information obtained during CPICH scanning. For definitions of the information elements, see Information Elements and Events, section 3.3.

9.4.12. Presentation: BCH Scanning

With a Sony Ericsson Z750i, all scan data collected using the options Scan selected and Scan strongest are obtained for BCH scanning also (though less frequently); see sections 9.4.7–9.4.11 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 Neighbor Detection event which warns about missing neighbors in WCDMA. See Information Elements and Events, section 7.3.

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 information elements; see Information Elements and Events, section 4.4.13.

9.4.13. Customizing the Presentation

9.4.13.1. 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.

> **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.

- 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: This means that 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 at argument index 2, etc.

9.4.13.2. 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.

9.5. SCH Timeslot Scanning

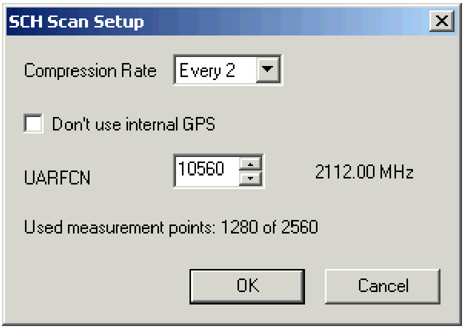
This method scans timeslot-length intervals, i.e. intervals 2560 chips long, on a Primary Synchronization Channel (P-SCH). It is useful for monitoring synchronization reference signals sent on this channel.

It should be pointed out that this scan is wholly separate from the P-SCH and S-SCH scans included in the CPICH scanning method (section 9.4).

9.5.1. Setup of SCH Timeslot Scan

- On the Equipment Control toolbar, choose the scanning device in the left combo box, and choose “[WCDMA] SCH Scan” in the right combo box.

 On the Equipment Control toolbar, click the Scan Properties button.



Compression Rate The time resolution of the scan:

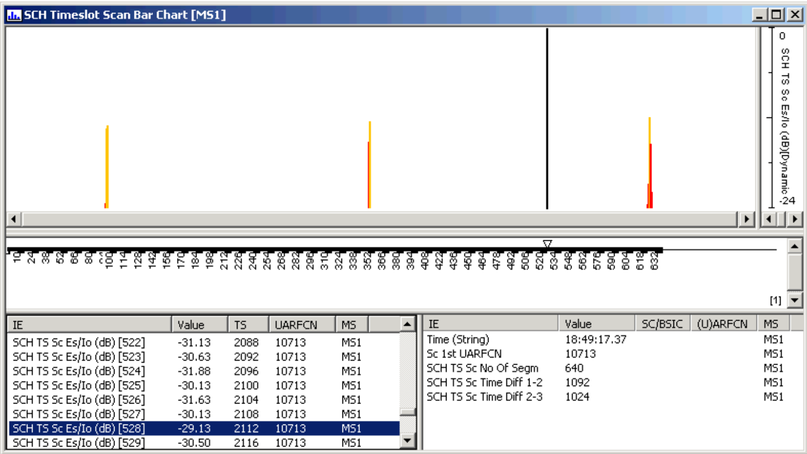
- “Every” means that a power value is reported for every chip in the timeslot.
- “Every 2”, etc. means that the *peak* (not average) power is reported for successive segments 2, 4, or 8 chips in length.

Don’t use internal GPS Check this if you do not want to use the scanner’s internal GPS for positioning. Note that if you set up other scanning methods for the same scanner, you must check this box for the other methods as well, otherwise the internal GPS will be used anyway.

UARFCN	Here you set the UARFCN of the frequency to scan. The frequency itself is indicated to the right of the combo box.
Used measurement points	Number of scanner measurement points used so far by all scanning methods together. See section 9.1.

9.5.2. Presentation: SCH Timeslot Scan Bar Chart

The bar chart displays an Es/Io trace for the latest timeslot scanned (2560 chips).



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 9.5.1. Since the SCH signals are repeated every timeslot, the spikes will normally remain in the same positions as the trace is updated.

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 3.3. Determining the time separation naturally does not require synchronization of the base station with GPS time.

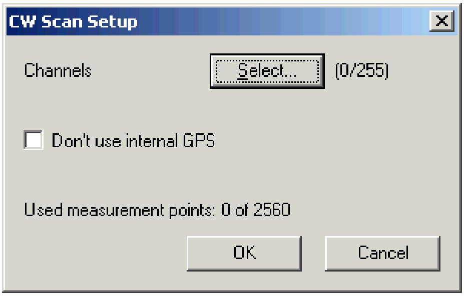
9.6. CW Scanning

This method scans specified UMTS frequencies (UARFCNs) for a continuous wave (CW) signal.

9.6.1. Setup of CW Scan

- On the Equipment Control toolbar, choose the scanning device in the left combo box, and choose “[(W)CDMA] CW Scan” in the right combo box.

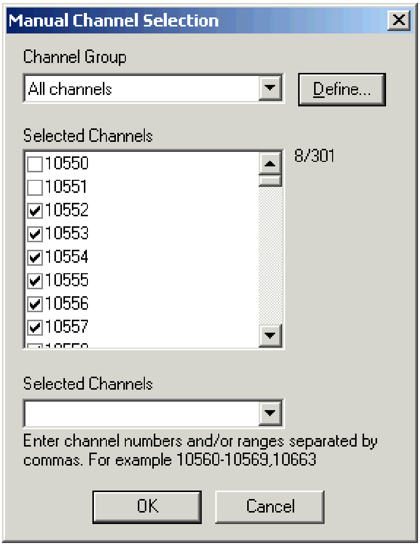
On the Equipment Control toolbar, click the Scan Properties button.This dialog appears:



Channels	Choose the UARFCNs to scan (up to 255). The allowed UARFCN range is dependent on the band supported by the scanner. Click the Select button to pick your channels: see section 9.6.1.1.
Don't use internal GPS	Check this if you do not want to use the scanner's internal GPS for positioning. Note that if you set up other scanning methods for the same scanner, you must check this box for the other methods as well, otherwise the internal GPS will be used anyway.
Used measurement points	Number of scanner measurement points used so far by all scanning methods together. See section 9.1.

9.6.1.1. Channel Selection

Clicking Select in the CW Scan Setup dialog brings up a new dialog which is similar to the one for selecting scrambling codes for the CPICH scan (section 9.4.5), except that UARFCNs are listed instead.

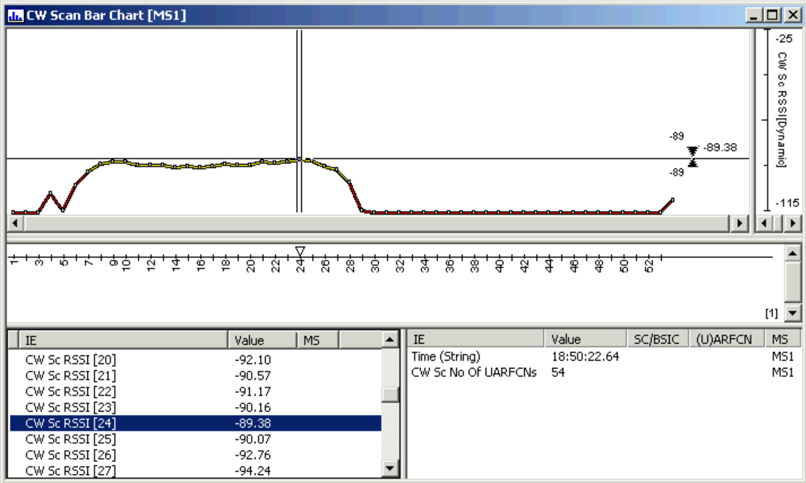


- Select UARFCNs either from the list box or by entering a text string in the combo box at the bottom.

Under Channel Group, you can define custom subsets of UARFCNs to govern what is displayed in the Selected Channels list. By default, all UARFCNs are displayed. To define a subset, click the Define button; see section 9.11.

9.6.2. Presentation: CW Scan Bar Chart

This bar chart displays RSSI for each UARFCN scanned.



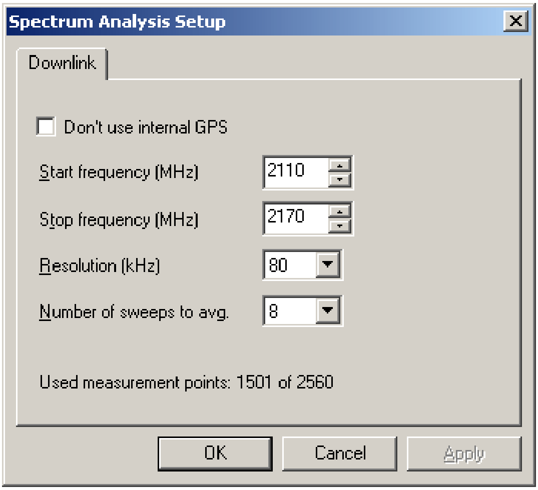
9.7. Spectrum Analysis

This scanning method shows downlink signal strength (RSSI) as a function of frequency.

9.7.1. Scan Setup

- On the Equipment Control toolbar, choose the scanning device in the left combo box, and choose “[WCDMA] Spectrum Analysis” in the right combo box.

 On the Equipment Control toolbar, click the Scan Properties button.



Don’t use internal GPS: Check this if you do not want to use the scanner’s internal GPS for positioning. Note that if you set up other scanning methods for the same scanner, you must check this box for the other methods as well, otherwise the internal GPS will be used anyway.

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.

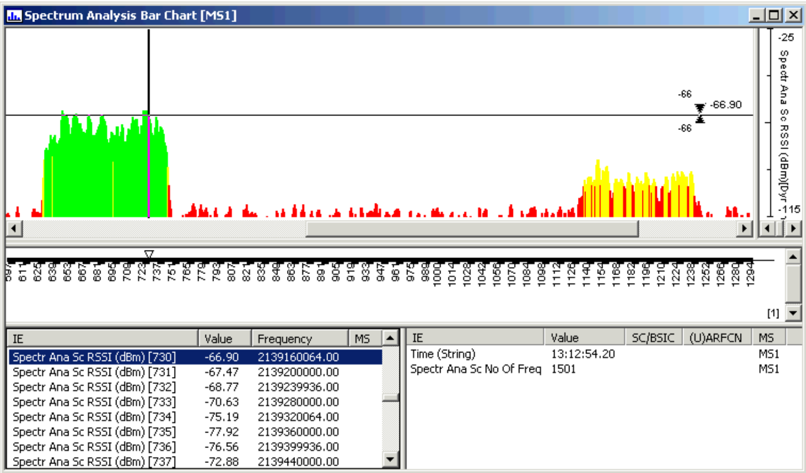
Resolution: Interval between successive scan samples in kHz, the highest selectable resolution being 5 kHz. The legend pane will list all samples; the chart, on the other hand, can of course only distinguish the samples as far as the screen resolution permits.

Number of sweeps to avg.: The number of sweeps on which to base the presented average RSSI. The minimum number is 1, and the maximum is 16.

Used measurement points	Number of scanner measurement points used so far by all scanning methods together. See section 9.1. 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.

9.7.2. 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.



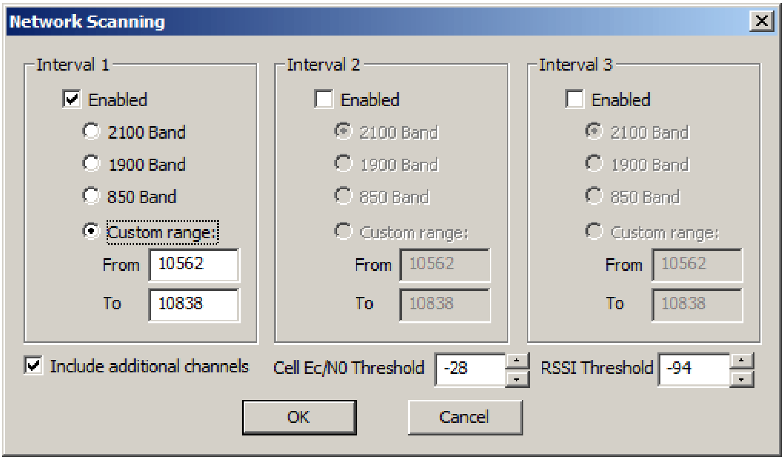
9.8. Network Search

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 WCDMA band (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 connectable devices, but the chart is retained to allow displaying of such data from old logfiles.

In network search 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. In contrast, a Sony Ericsson Z750i in scan mode is usually able to identify all carriers, overlapping or not, thus allowing faulty frequency allocations to be easily found and rectified.

9.8.1. Scan Setup



Interval 1, 2, 3	You can set up three separate UARFCN ranges to scan in the network search. Each range can be located on any of the listed frequency bands.
2100 Band, etc.; Custom range	Each UARFCN range to scan may be identical to an entire WCDMA frequency band, or it may consist of a portion of a band. In the latter case you specify the range endpoints under Custom range.

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 TS 25.101 section 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.

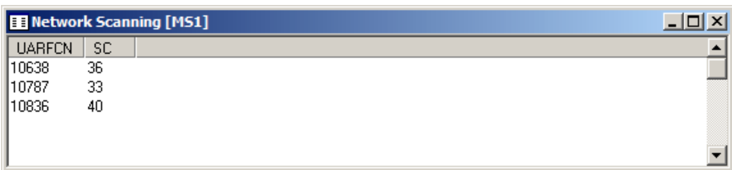
The default setting is –26 dB, which should be suitable in most situations.

RSSI threshold

RSSI threshold for detecting carriers.

The default setting is –94 dB, 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 very long search time (e.g. several minutes at –100 dB).

9.8.2. Presentation



The result of the network search is output in the Network Scanning 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.

9.9. Presenting WCDMA Scan Data in Status Windows

Scan data can also be presented for example in status windows of your own design. How to build a status window is covered in chapter 16, page 214. The information elements of interest are all found in Information Elements and Events, section 3.3.

9.10. Replaying Scan Data

If you are replaying a logfile with scan data, you will probably want to replay the file slowly in order to see clearly what is happening. The replay speed is set from the Logfile menu (see section 7.2.1, page 56).

9.11. Defining Scrambling Code or UARFCN Groups

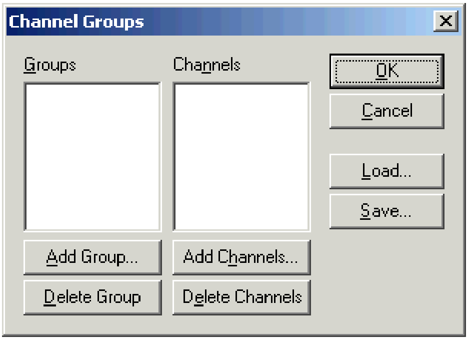
When selecting scrambling codes or UARFCNs manually, the set of items displayed in the list box is determined by the choice in the SC Group or Channel Group combo box. By default all items are displayed. It is possible to define custom groups of scrambling codes/UARFCNs and show only the members of such a group in the list box. You may find this convenient if you often scan some restricted set of scrambling codes/UARFCNs.

> **Note:** A group does not define which items are actually scanned. It only defines the set of items that can be selected for scanning.

To create a new group, proceed as follows:

 Click Scanner Properties.

- Click the appropriate Select button.
- In the new dialog, click the Define button next to the SC Group/Channel Group combo box.



Adding a Group

To create a new group:

- Click Add Group, and name the group. Then proceed to add items to the group; see below.

Once created, your group will appear in the SC Group/Channel Group combo box in the dialog “Manual ... Selection” (section 9.4.5).

Adding Items to a Group

- Select the group in the Groups list box.
- Click the “Add ...” button. A dialog appears which works exactly as the Selected SCs list box in section 9.4.5. In this dialog, select the items to add.

Deleting Items from a Group

- Select the items you want to delete and click the “Delete ...” button.

Deleting a Group

- Select the group you want to delete and click Delete Group.

Saving a Group

A group can be saved on file in binary format (file extension .chn). This is useful for instance if you want to transfer your groups to another computer. (The groups are of course also saved when you save your workspace, but in this case no CHN files are created, and you cannot access the groups separately.)

- Click Save... and name the group.

Loading a Group

- Click Load... and browse to select your file.

10. CDMA Scanning

TEMS Investigation Data Collection supports scanning of CDMA (IS-2000, IS-856, IS-95) RF channels with a PCTel SeeGull LX scanner. It is possible to scan with several such devices concurrently. How to connect scanners is described in chapter 6.

Scanning tasks are set up from the Equipment Control toolbar, whereas the output of scans is primarily intended to be displayed in a suite of ready-made bar charts and other windows. However, since all scan data is available in information elements, you are free to present it in any presentation window. The scanning presentation windows are fully synchronized with the rest of the application.

Note that the internal GPS in a PCTel scanner will deliver data only while a scan is in progress.

Some technical data on PCTel scanners is provided in appendix H, page 363.

10.1. Scanning Methods and Scanning Capacity

TEMS Investigation offers these CDMA scanning methods:

- Pilot scanning (section 10.4)
  - Static PN set
  - Top *N*
  - “Follow phone” mode
- CW (RSSI) scanning (section 10.5)
  - Static RF channel set
  - “Follow phone” mode

The scanning methods are conceptually independent and can be run concurrently by the PCTel scanner. Only the scanner measurement capacity places a limit on the possibilities of handling several scanning tasks in parallel.

A PCTel scanner has a capacity of 2,560 measurement points. As you set up the scanning tasks, you are continuously notified in the setup dialogs of how many measurement points you have used up.

10.2. Performing a Scan

The procedure for performing a scan is as follows:

- Connect the device to scan with if it is not already connected. See chapter 6. (You must have the device connected to be able to access the Measurement Settings dialog.)
- Set up the scan according to one of the sections 10.4 or 10.5.

 To start scanning, click the Start Scanning button.

While the scanning is going on, the status bar shows the padlock symbol , indicating that the scanner is busy.

 To stop scanning, click the Stop Scanning button.

10.3. Recording Scan Data

To record scan data, create a new logfile as described in section 7.1.

10.4. Pilot Scanning

This method scans pilots, scrambled with cell-specific PN sequence offsets. Up to four RF channels can be scanned at a time.

- On the Equipment Control toolbar, choose the scanning device in the left combo box, and choose “[(W)CDMA] CPICH/PN Scanning” in the right combo box.

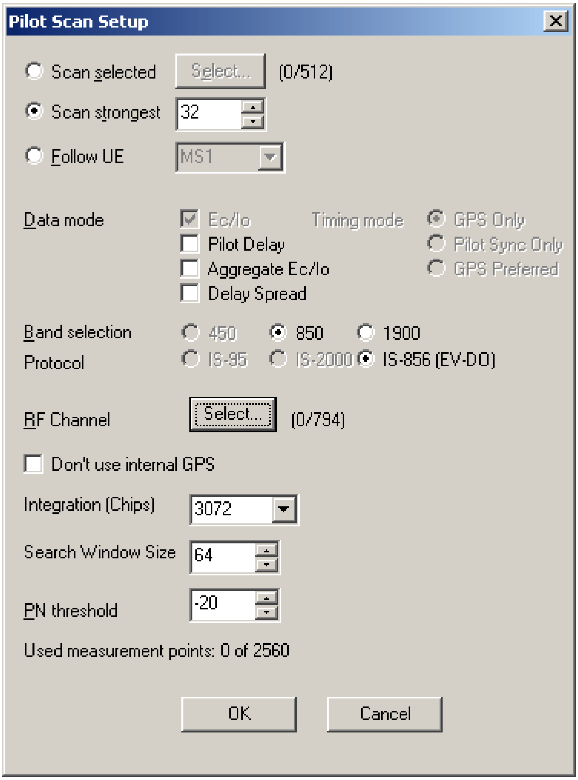
 On the Equipment Control toolbar, click the Scan Properties button.

A dialog appears in which you set up the scan.

10.4.1. Scan Setup

The set of pilots (PNs) to scan on each RF channel is composed in one of the following ways:

- user-defined, static set of pilots (up to 512, i.e. no restriction on number of pilots), common to all RF channels
- strongest pilots (“Top *N*”; up to *N* = 32) on each RF channel
- strongest pilots (“Top *N*”; *N* = 32) on the RF channel currently used by a CDMA phone that is also connected in the application.



Scan selected Choose this to scan a static set of pilots (up to 128) on all RF channels selected under “RF Channel” below.

Click the Select button to pick your pilots: see section 10.4.2.

The number of pilots currently selected appears within brackets on the right.

Scan strongest	Choose this to scan the *N* strongest pilots on the chosen RF channels. The scanner automatically finds the strongest pilots.
Follow UE	Choose this to scan the 32 strongest pilots on the RF channel that the CDMA phone in the combo box 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 are taken from the phone.
Data mode	Select the scan data you wish to collect. At least one of the boxes must be checked. • *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.[a] • *Delay Spread:* The number of chips between the first and last pilot Ec/Io peak above the PN threshold.

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.

Band selection

Choose the frequency band on which to scan.

Protocol

Choose the type of network on which to scan: IS-95 (cdmaOne), IS-2000 (cdma2000), or IS-856 (EV-DO).

RF Channel

Here you set the RF channels on which to scan the selected pilots. The allowed range is dependent on the frequency band. Click the Select button to pick your RF channels. A dialog appears which is analogous to that described in section 10.4.2.

The number of RF channels currently selected appears within brackets on the right.

Don’t use internal GPS

Check this if you do not want to use the scanner’s internal GPS for positioning. Note that if you set up other scanning methods for the same scanner, you must check this box for the other methods as well, otherwise the internal GPS will be used anyway.

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.
Search Window Size	This parameter indicates the length, in chips, of the time window in which the pilot is searched. The maximum window search size supported by the scanning receiver is 64. This is also the default and recommended setting.
PN threshold	This is a signal code power threshold (in dB) used for the Aggregate Ec/Io and Delay Spread measurements (see Data mode above). 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.
Used measurement points	Number of scanner measurement points used so far by all scanning methods together. See section 10.1.

a. This measurement does not appear as an information element; it is only found in scanner reports.

10.4.2. Manual Pilot/RF Channel Selection

This is completely analogous to manual selection of UARFCNs and scrambling codes in WCDMA; see section 9.4.5, page 101.

10.4.3. 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*).

10.4.4. Presentation: Strongest Scanned PN Bar Chart

This bar chart shows the strongest pilots scanned, regardless of RF channel.

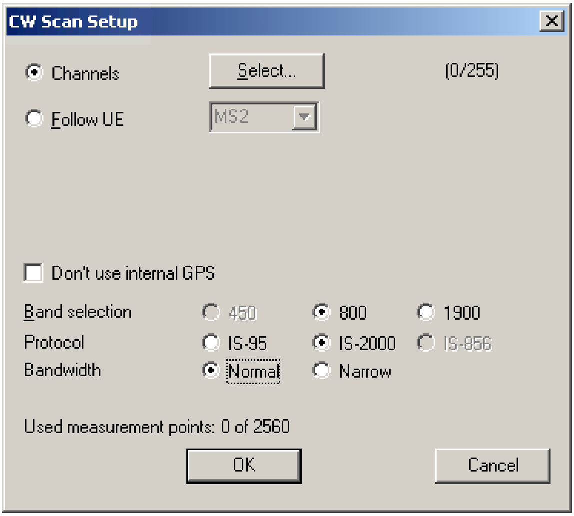
10.5. CW Scanning

This method scans specified RF channels for a continuous wave (CW) signal. This is alternatively referred to as "RSSI scanning". In TEMS Investigation, the term "CW" is used throughout, just as for WCDMA.

10.5.1. Setup of CW Scan

- On the Equipment Control toolbar, choose the scanning device in the left combo box, and choose "[(W)CDMA] CW Scan" in the right combo box.

On the Equipment Control toolbar, click the Scan Properties button.This dialog appears:



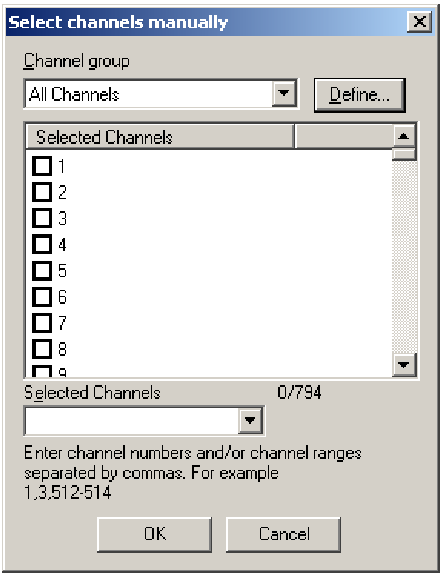
Channels	Choose the RF channels to scan (up to 255). The allowed RF channel range is dependent on the band supported by the scanner. Click the Select button to pick your channels: see section 10.5.1.1.
Follow UE	Choose this to scan the RF channel that the CDMA phone in the combo box is currently using (plus a number of adjacent RF channels).[a] 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.
Don’t use internal GPS	Check this if you do not want to use the scanner’s internal GPS for positioning. Note that if you set up other scanning methods for the same scanner, you must check this box for the other methods as well, otherwise the internal GPS will be used anyway.
Band selection	Choose the frequency band on which to scan.
Protocol	Choose the type of network on which to scan: IS-95 (cdmaOne), IS-2000 (cdma2000), or IS-856 (EV-DO).

Bandwidth	• "Normal" = CDMA band, bandwidth 1.2288 MHz. • "Narrow" = "Condensed" or CW band. For the cellular (800) band, the bandwidth is 30 kHz. For the PCS (1900) band, the bandwidth is 50 kHz.
Used measurement points	Number of scanner measurement points used so far by all scanning methods together. See section 10.1.

a. 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].

10.5.1.1. Channel Selection

Clicking Select in the CW Scan Setup dialog brings up a new dialog which is similar to the one for selecting scrambling codes for the pilot scan (section 10.4.2), except that RF channels are listed instead.



- Select RF channels either from the list box or by entering a text string in the combo box at the bottom.

Under Channel Group, you can define custom subsets of RF channels to govern what is displayed in the Selected Channels list. By default, all RF channels are displayed. To define a subset, click the Define button.

Channel groups are created and managed in the same way as scrambling code/UARFCN groups for WCDMA; see section 9.11, page 120 for full details.

10.5.2. Presentation: CW Scan Bar Chart

This bar chart displays RSSI for each RF channel scanned.

11. WiMAX Scanning

TEMS Investigation has the ability to scan WiMAX carriers with a DRT4301A scanner.

How to configure the PC and the DRT scanner for use with TEMS Investigation is covered in the Getting Started Manual, chapter 9. How to connect the scanner in TEMS Investigation is described in chapter 6 of this document.

The DRT scanner has a built-in GPS, which is however currently not used by TEMS Investigation.

11.1. Scanning Capabilities

WiMAX scanning capabilities are as follows:

- Supported bands are determined by the scanner and by the antennas. Currently 2.3 GHz, 2.5 GHz, and 3.5 GHz are supported.
- WiMAX preamble scan
- RSSI (CW, Continuous Wave) scan

11.2. General Scan Settings

Regardless of scan mode 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 11.1.
Channels	WiMAX channels to scan within the selected band. Each channel is specified as a number representing the center frequency of the channel. There is no limit on the number of channels that can be selected.
Technology	Always “WiMAX” at present.

11.3. 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).

- On the Equipment Control toolbar, choose the scanning device in the left combo box, and choose "[WiMAX] Preamble Scanning" in the right combo box.

11.3.1. Preamble Scan Specific Settings

Decode Threshold	Threshold (in dB) below which data is not decoded.
Detect Threshold	Threshold (in negative dB) below which no preamble detection is reported.
Enable AGC	Use of AGC (Automatic Gain Control) scanning parameter. It should normally be enabled.
Enable CFO	Measurement of Carrier Frequency Offset.
Enable DCD Decoding	Decoding of Downlink Channel Descriptor (a message containing information about downlink characteristics).
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 Frame Prefix Decoding	Decoding of 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 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 Preamble Power	Calculation of preamble power.
Enable Robust Scan	Currently not used.
Enable Statistical Information	This must be set on for measurement statistics (mean and standard deviation for RSSI, CINR) to be computed.
Enable UCD Decoding	Decoding of Uplink Channel Descriptor (a message containing information about uplink characteristics).
Enable Uplink Map Decoding	Decoding of uplink MAP messages. Compare Enable Downlink Map Decoding.
Logging Mode	Currently not used. When using the DRT scanner with TEMS Investigation, the scan data is always recorded in regular TEMS Investigation logfiles (*.log), regardless of how this parameter is set.
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 3.4).
Preamble Index List	User-selected list of preambles to search for and decode. For this field to be enabled, Top N must have been set to zero. Conversely, if you enter a nonzero Top N, this field is grayed.
Scan Mode	Currently not used. The setting is not applicable since TEMS Investigation assigns only a single Preamble scan task and a single RSSI scan task to the scanner.
Top N	If this field is set to *N*, the scan will return the *N* strongest preambles. Set this field to zero if you want to scan a fixed set of preambles (defined in Preamble Index List).

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.

11.4. RSSI (CW) Scanning

RSSI (or Continuous Wave, CW) scanning allows the operator to observe channel activity in preparation for more thorough scans.

- On the Equipment Control toolbar, choose the scanning device in the left combo box, and choose "[WiMAX] Rssi Scanning" in the right combo box.

Bandwidth	This setting is currently not applicable, since the scanner currently supports RSSI scanning only with 250 kHz bandwidth.

11.5. Presentation

WiMAX scans are presented in a suite of predefined charts and status windows. See Information Elements and Events, sections 8.1.5, 8.5.4, and 8.6.4.

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.

12. Command Sequences (with Data Service Testing)

Command sequences are used to automate testing of voice as well as data. They allow you to prerecord all the commands to be given to the phones during a drive test.

- For *voice calls*, if you are using several phones, you can make them call each other automatically.
- *Data service testing* encompasses the following applications: FTP, HTTP, Ping, e-mail, SMS, WAP, MMS, and video streaming. One or several phones can be used. With multiple phones, multiple sessions can be run concurrently. How to prepare the PC and phone for data services is covered in chapter 8 of the Getting Started Manual.
- The command sequence is also used to record data on which to base *KPIs*, indicating the performance of services.

Special commands are available

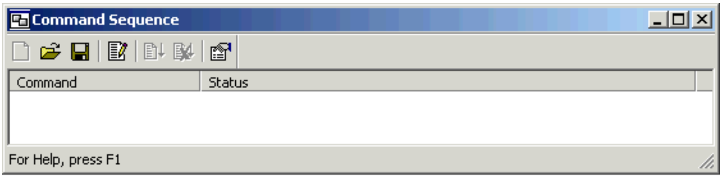
- for recording all data collected while executing the command sequence. The recordings will be ordinary logfiles (extension .log).
- for AT commands.

12.1. Capabilities of Phones

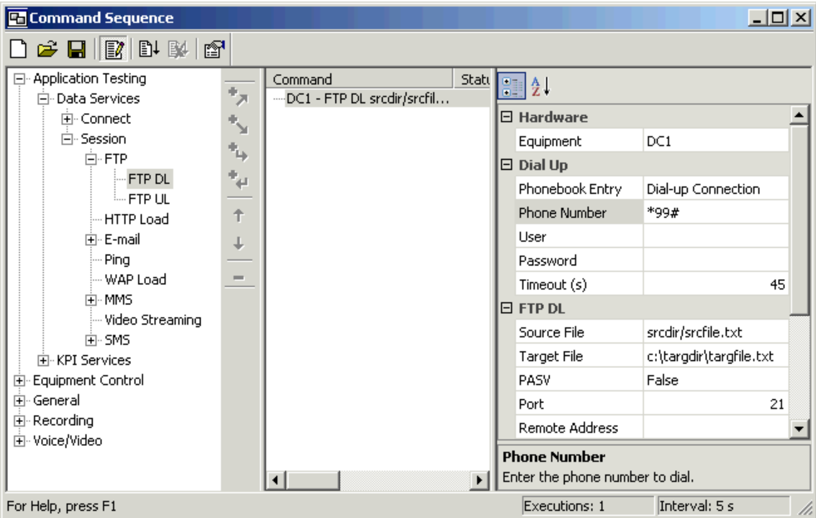
All phones sold with TEMS Investigation 9.0 support all commands in the command sequence.

12.2. Composing and Editing a Command Sequence

Command sequences are composed in, and executed from, the Command Sequence window found in the Control folder of the Navigator:



Click Edit in the Command Sequence window to start composing the sequence. The window splits into three panes:



- The available command types are organized in a tree structure in the left-hand pane.
- The command sequence is assembled in the center pane.
- The right-hand pane holds the arguments for the command currently selected in the center pane. Arguments can either be grouped into categories or be listed in alphabetical order; use the two buttons at the top to toggle between the two display modes. At the bottom of the right-hand pane is a box showing an explanation for the currently selected argument.

You can use the Tab key to jump between the panes.

The rest of this section deals with how to build up the command sequence. All arguments and other details of individual commands are gone through in subsequent sections.

12.2.1. Adding a Command to the Command Sequence

- To add a command at the end of the sequence, double-click the command name in the tree view.

To add a command B immediately above another command A, select A in the sequence, select the type of B in the tree view, and click the “Add above” button.

To add a command B immediately below another command A (at the same level of indentation), select A in the sequence, select the type of B in the tree view, and click the “Add below” button.

Alternatively, with the tree view in focus, press Shift + up arrow key to add command B above command A, or press Shift + down arrow key to add command B below command A.

12.2.2. Constructing Loops

- First insert a Loop command at the desired position in the sequence, as described in section 12.2.1.

To add the first command A to a loop, select the relevant Loop command in the sequence, select the type of A in the tree view, and click the Add Next Level button.

- To add further commands to the loop, select the appropriate existing command in the loop and add the new command above or below it, as described in section 12.2.1.

With the last command of a loop selected in the sequence, use the Add Previous Level button to indicate that the next command should not be part of the loop but follow the Loop command. (This can alternatively be accomplished by selecting the Loop command and adding the new command using the “Add below” button.)

Alternatively, with the tree view in focus, press Shift + right arrow key to add a command at the next level, or press Shift + left arrow key to add a command at the previous level.

Loops can be nested arbitrarily.

12.2.3. Editing the Command Sequence

- To edit the arguments of a command, select the command in the sequence. The arguments are displayed on the right. When the argument pane is in focus, you can press Enter to select the value of the currently selected argument.

To move a command one step upward in the sequence, select the command and click the Move Up button (or press Ctrl + up arrow key).

To move a command one step downward in the sequence, select the command and click the Move Down button (or press Ctrl + down arrow key).

If a loop is encountered during moving of a command, the command is inserted into the loop. To move the command out of and past the loop, perform another move action.

To delete a command from the sequence, select the command and click the Delete button, or press Delete on the keyboard. Deleting a Loop command removes the entire loop with all its contents.

When you are finished editing the sequence, click the Edit button once more so that it pops up. The tree view and argument panes are hidden, freeing the entire window for the command sequence.

12.3. Command Categories

The commands are divided into the following categories:

- General (Loop, Synchronize, Wait)
- Recording
- Voice/Video
- Equipment Control
- Application Testing (including KPIs)

12.4. Assigning Commands to Phones

For every command you must indicate to what phone or phones the command should be given. The assignment is indicated in the string representing the command in the sequence pane (e.g. “DC1 - HTTP Load”).

The “Equipment” argument of each command takes a subset of the following values: MSn, DCn, ALL, and ANY (n = 1, 2, ...). Regarding the device designations “MS” and “DC”, given to the phone at the time of connection, see chapter 6, page 35.

The rules that decide whether a command is assigned to the MS or the DC are given below. In sections 12.6–12.9, the precise assignment possibilities are indicated for the individual commands. Commands for data service testing are of course always assigned to the DC. It is never a problem in practice to choose the right type of device, since in the dialog you can only select devices that are compatible with the command you are composing.

MS

Used for:

- everything related to voice and video telephony
- general-purpose commands (e.g. Wait, Start Recording) that are given to control the execution of the above tasks

DC

Used for:

- everything related to data services
- AT commands; this includes SMS, since that service is implemented using AT commands
- general-purpose commands (e.g. Wait, Start Recording) that are given to control the execution of the above tasks

ALL

Many commands can alternatively be issued not to a single MS or DC but to *all* phones participating in the sequence, i.e. all phones to which at least one phone-specific command is given. (Note that this means there must be at least one command assigned to a specific phone in the sequence, since otherwise the set “ALL” will be empty.)

Whether ALL applies to MSs or DCs is generally obvious, but in a couple of case *both* are meant. See sections 12.6–12.13 for full details. For Stop Recording, ALL has a special meaning; see section 12.7.

ANY

A special assignment available for certain commands. For the meaning of this assignment, see section 12.7.

> **Note:** While the assignment in the user interface is always the logical one as given above, many phones in fact use the *modem* also for voice/video calls (notable exceptions are Motorola phones from E1000 onward and all Qualcomm chipset based devices). For such phones, the "Data Cable" device must always be enabled and connected (see chapter 6) to allow control by a command sequence – even if the command sequence contains only voice/video related commands.

12.5. Timeouts

Most commands have a Timeout parameter allowing the user to specify how long to wait for a command to succeed. If a timeout is exceeded, the task governed by the command is abandoned, and the execution proceeds to the next command in the sequence.

The above does *not* apply to timeouts for data session commands, where the function of the timeout is different: see session 12.11.2, "Timeout Parameters for Session Commands".

12.6. General Commands

Command	To	Explanation/Arguments
Loop	N/A	Repeat the commands indented beneath this command, either a fixed number of times or for a fixed length of time. If the fixed-time option is chosen, the command that is being executed when the time is up will always be allowed to finish. **Loop Type:** Select how to control the execution of the loop (see above). **Time/Count:** Loop execution time (in seconds) or number of loop executions.

How to compose loops is explained in section 12.2.2.

The entire sequence can also be set to repeat a specified number of times in the command sequence properties (section 12.15).

Command	To	Explanation/Arguments
Synchronize	ALL	When multiple phones are involved in a command sequence, every phone reaching a Synchronize command will halt at that point until all phones have reached the same command. Only then is the command sequence proceeded with. See section 12.14 for examples of situations where this command is needed.
Wait	ALL/ one MS/ one DC	Wait a specified number of seconds. **Wait Time (s):** Time to wait.

Command	To	Explanation/Arguments
Wait for Events	one MS/ one DC	Wait until *all* of a set of specified events have been reported by a specific phone. **Monitored Device:** The phone to monitor. Note that for data service related events, "DCx" must be chosen; for other events, "MSx" must be chosen. **Events:** Check the events to wait for. **Timeout (s):** Maximum time to wait.

12.7. Recording Commands

Note that logfiles always record data from *all connected* phones, not only the phones that participate in the command sequence (i.e. those to which some phone-specific command is given).

Command	To	Explanation/Arguments
Start Recording	one MS/ one DC/ ANY	Start recording a logfile. ("Quick logging" will be used; see section 7.1.3, page 52.) Assignment to ANY means that the recording is started when the *first* phone reaches this command. **Logfile Directory:** The directory where logfiles produced by the command sequence are stored. **Prefix, Suffix:** You can add a descriptive prefix and/or suffix to the default logfile name (MMDD_nn.log), for example seq1 as prefix and am/pm as suffix. **Timeout (s):** This timeout is not normally needed but is provided in case the application is not responding (for whatever reason).

Command	To	Explanation/Arguments
Stop Recording	one MS/ one DC/ ALL	Stop the recording of the logfile. The logfile is closed. Assignment to ALL means that the recording is stopped when the *last* phone reaches this command. **Timeout (s):** See Start Recording.

While recording governed by a command sequence is ongoing, the ordinary recording mechanism (for example, the Recording toolbar in the main window) is still enabled and will operate on that recording. You can thus stop the recording at any time by clicking the Stop Recording toolbar button. The execution of the command sequence is not affected by this action, except that the anticipated Stop Recording command becomes meaningless and will obviously fail.

12.8. Voice/Video Commands

These commands handle voice and video telephony calls. For AQM measurements a special type of voice call is provided. See arguments below.

Command	To	Explanation/Arguments
Dial	one MS	Dial a phone number and conduct a voice or video call. After dialing, the MS waits a user-specified time for the event Call Established. If this event does not occur, the MS may redial the call. The redial behavior is governed by the command arguments; see below.

Arguments of Dial Command

- **Phone Number:** The phone number to call. Valid characters are: +, #, *, 0, ..., 9. For AQM measurement, this should be the number to the Call Generator: see section 27.2.3, page 300.
- **Duration:** The default planned duration of the call. Note that the total call time may be extended if a redial occurs and the call timer is reset at that

point: see below. On the other hand, the call may be cut short by an event selected under Terminate On Event, or by the duration expiring in the Answer command (which see).

- **Call Type:** Voice, Voice + AQM, or Video. For Voice + AQM, all redial options are disabled.
- **Timeout (s):** The time to wait for each of the following events to be generated in turn: Call Initialization, Call Attempt, Call Setup, Call Established. The timer is reset for each step. If a timeout occurs in any of the steps, a redial is triggered if Timeout has been checked under Redial Trigger(s) and the number of redials already made is less than Max. Number of Redials.
- **Terminate On Event:** If you check one or several events here, the Dial command will terminate immediately if one of the selected events occurs.
- **Redial Trigger(s):** A redial can be triggered
  - by a block or drop (except blocks due to no service or limited service)
  - by a timeout (see Timeout argument)

  Check the circumstances in which a redial should be triggered.
- **Call Timer Reset on Redial:** If set to True, the call timer will be reset so that the call (if successfully established) will still be of a length equal to Duration. If set to False, the call timer will not be reset, and the call will be shorter than Duration.
- **Delay before Redials:** The time from the moment the redial is triggered until it is actually performed.
- **Max. Number of Redials:** The maximum total number of redials to make (whether triggered by Timeout or by blocks/drops) before giving up on the call and proceeding with the next command in the sequence.

Command	To	Explanation/Arguments
Answer	one MS	Wait for an incoming call to arrive and answer it when it arrives.

Arguments of Answer Command

- **Wait Time (s):** The time to wait for a Call Attempt event to occur. If no Call Attempt occurs within this time, the phone will abandon the Answer command.

- **Duration (s):** The default planned duration of the call. Note that the total call time may be extended if a drop occurs followed by a redial in the other party's Dial command (see Dial above). On the other hand, the call may be cut short by the duration expiring in the Dial command, or by the Dial command being prematurely terminated by an event.
- **Restart Command on Dropped Call:** If set to True, then if a drop occurs on the receiving side, the phone will reiterate the Answer command and start waiting for a new call. All timers are reset (for Wait Time, Timeout, and Duration). If set to False, the phone will abandon the Answer command following a drop.
- **Timeout (s):** This parameter comes into play after the Call Attempt has occurred. It specifies how long to wait for each of the subsequent events Call Setup and Call Established. The timer is reset for each step. If a timeout occurs in any of the steps, the phone will abandon the Answer command.

12.9. Equipment Control Commands

Command	To	Explanation/Arguments
AT Command	one DC	Any AT command that is supported by the phone can be given. **AT Command:** Enter the command here. **Timeout (s):** The time to wait for a Session End or Session Error report.

AT commands returning a printout of more than one line will be reported as failed in the Command Sequence window (Status = “Data Session Failed”). Nevertheless, such commands will in fact most likely have executed correctly.

The TEMS Investigation installation CD contains Sony Ericsson documents describing all AT commands supported by various Sony Ericsson phones. These documents can also be downloaded from developer.sonyericsson.com (search for “AT commands”).

12.10. Application Testing Commands: General

Application testing commands are used to test data services.

These are the main types of data sessions:

- sessions performed using Dial-up Networking
- sessions performed by sending AT commands to the phone
- sessions using WinWAP.

Regarding the use of “MS” and “DC” for command assignment, see section 12.4.

Separate commands are used when KPIs are to be calculated for data services. Read more about these in section 12.13.

12.11. Commands for Dial-up Networking Sessions

These commands are found under “Data Services” in the tree structure.

Dial-up Networking is used for FTP, HTTP, e-mail, video streaming, and Ping.

All commands in this category are assigned to a single “DC” device.

12.11.1. Connect Commands

12.11.1.1. Dial Up, Hang Up

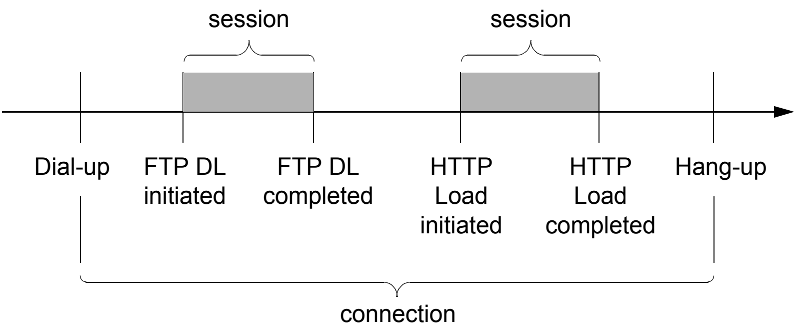
Dial Up and Hang Up are used to allow several data service sessions to be conducted after one another while maintaining the same data bearer connection.

If you do not use Dial Up and Hang Up, you must specify the dial-up parameters in the session commands themselves; see section 12.11.2. A new data bearer connection will then be established automatically for each new session in the command sequence, and terminated when the session is finished.

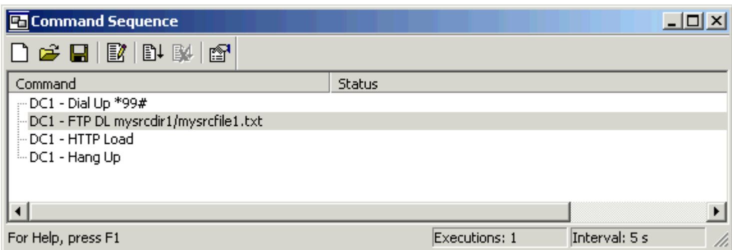
If you do use the separate Dial Up and Hang Up commands, be sure not to specify dial-up and hang-up parameters in the session commands as well. If you do the latter, a new connection will be set up for each session anyway, rendering the use of the Dial Up command pointless.

Note: If you use the explicit Dial Up command and execute the whole sequence multiple times (command sequence properties, section 12.15), then you *must* also include a Hang Up command, since otherwise the sequence will attempt to redial while a data session is already in progress. If you use implicit dialing (within session commands), the hang-up is also implicit.

This diagram clarifies the meaning of the terms *connection* and *session*:



In the following screenshot, line 2 and line 3 each constitutes a session:



Command Arguments

Command	Explanation/Arguments
Dial Up	Establish a data service connection. In the packet-switched case, a PDP context is activated (UMTS) or a PPP session established (CDMA); in the circuit-switched case, the phone works like an ordinary modem and performs a dial-up. **Phonebook Entry:** This refers to the phonebook entries created in Dial-up Networking (Getting Started Manual, chapter 8). Be sure to choose the phonebook entry associated with the correct COM port and hence the correct phone. **Phone Number:** Access phone number for the data service (e.g. *99#). If you enter a number here, it will override the one entered in the Dial-up Networking settings. **User, 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. **Password:** Server domain password. **Timeout (s):** The time to wait for each of the following events to be generated in turn: RAS Dial, IP Address Assigned. The timer is reset for each step. If a timeout occurs in any of the steps, the dial-up is abandoned.
Hang Up	Terminate a data service connection. In the packet-switched case a PDP context is deactivated (UMTS) or a PPP session ended (CDMA); in the circuit-switched case the phone performs a hang-up. **Timeout (s):** The time to wait for a RAS Hangup or PDP Context Deactivation event.

12.11.1.2. PS Attach, PS Detach

Command	Explanation/Arguments
PS Attach	Perform a packet service attach. Note that this command is *not* needed in conjunction with Dial Up and/or session commands, which implicitly include the attach. (The phone may in fact have attached automatically when powered on.) The command is provided for the sole purpose of testing the attach command in isolation. **Timeout (s):** Time to wait for a Session End event (attach successful) or Session Error event (attach failed).
PS Detach	Perform a packet service detach. Like PS Attach, this command is *not* needed in conjunction with Dial Up and/or session commands, which detach from the packet service as a final step. The command may however be useful to make sure that the phone is not attached to the packet service when starting measurements (if it has attached automatically at power-on, for example). **Timeout (s):** Time to wait for a Session End event (detach successful) or Session Error event (detach failed).

12.11.2. Session Commands

Each session command initiates a data service session. The session is completed before the command sequence execution proceeds to the next command assigned to the same device.

12.11.2.1. About Phonebook Entries

The Phonebook Entry argument, present for all session commands, refers to the phonebook entries created when configuring Dial-up Networking (Getting Started Manual, chapter 8).

If a Dial Up command is used, the phonebook entry is specified there, and the corresponding argument does not need to be used in the session command.

If there is no Dial Up command preceding a session command, the latter must specify the phonebook entry (as well as the other dial-up arguments).

If you save a command sequence (see section 12.18), the phonebook entries specified in the commands are saved along with the rest. Note that if you later use the sequence on a different PC that has different phonebook entries defined, and you save the sequence again, the new phonebook entries you have selected will replace the old ones in the command sequence file.

12.11.2.2. Timeout Parameters for Session Commands

Timeouts for session commands work differently from those for other commands (such as PS Attach/Detach). There is no timer ticking in TEMS Investigation while a data service session is running. Rather, the timeout setting is simply passed to the service as a specification of how long it should keep attempting to get the data transfer going and for how long it should try to restart the transfer in case of a later interruption. All details of checking this are left to the service, without TEMS Investigation interfering in any way. What is reported back to TEMS Investigation is a Session End event (indicating a successfully completed session) or a Session Error event (indicating that the session failed); but note again that TEMS Investigation is *not* waiting for either of these events to occur within a specified time.

12.11.2.3. FTP

General notes on FTP:

- For multi-phone FTP UL, use different target files for each phone.
- Paths and file names must have correct case.

Command	Explanation/Arguments
FTP DL	Download a file from an FTP server. *Dial Up and Hang Up sections:* See "About Phonebook Entries" above. **Source File:** The path and name of the file residing on the FTP server, e.g. srcdir/srcfile.txt. 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.txt. The drive letter must be included. **PASV:** Enables or disables passive FTP. Note that it is essential to set this correctly. **Port:** The FTP server port. The default port number is 21. **Remote Address:** The IP address of the FTP server. This can be either an alphanumeric string, not containing ftp:// at the beginning (for example, ftp.myftpserver.com), or a 12-digit number. The address may not contain a path to a subdirectory. **Account:** Account name on the FTP server (if applicable). **User:** User name on the FTP server. **Password:** User password on the FTP server. **Timeout (s):** See "Timeout Parameters for Session Commands" above. Should be at least 30 s.

Command	Explanation/Arguments
FTP UL	Upload a file to an FTP server. *Dial Up and Hang Up sections:* See “About Phonebook Entries” above. **Source File:** Drive letter, path, and file name identifying the file to be uploaded, e.g. C:\srcdir\srcfile.txt. The drive letter must be included. **Target File:** Path and file name describing where and how to store the file on the FTP server, e.g. targdir/targfile.txt. 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. **PASV:** Enables or disables passive FTP. Note that it is essential to set this correctly. **Port:** The FTP server port. The default port number is 21. **Remote Address:** The IP address of the FTP server. This can be either an alphanumeric string, not containing ftp:// at the beginning (for example, ftp.myftpserver.com), or a 12-digit number. The address may not contain a path to a subdirectory. **Account:** Account name on the FTP server (if applicable). **User:** User name on the FTP server. **Password:** User password on the FTP server. **Timeout (s):** See “Timeout Parameters for Session Commands” above. Should be at least 30 s.

12.11.2.4. HTTP

Multiple concurrent HTTP Load sessions are supported. This means that multiple sessions will result whenever multiple phones are used and/or some phones are instructed to download from multiple HTTP servers.

Command	Explanation/Arguments
HTTP Load	Download a file from an HTTP server, or one file each from several HTTP servers. *Dial Up and Hang Up sections:* See “About Phonebook Entries” above. **Remote Address(es):** The IP addresses of the HTTP servers. Click the “+” button to add one more IP address. Each IP address can be either an alphanumeric string, with or without http:// at the beginning (for example, www.myserver.com/mydir/myfile.txt), or a 12-digit number. **Port:** The HTTP server port. The default port number is 80. **Use Proxy Server:** Select whether to use a proxy server. **Proxy Port:** Proxy server port number. **Proxy Address:** Proxy server address. **Timeout (s):** See “Timeout Parameters for Session Commands” above.

12.11.2.5. Ping

Command	Explanation/Arguments
Ping Start	Initiate a sequence of pings. *Dial Up and Hang Up sections:* See “About Phonebook Entries” above. **Remote Address:** The IP address of the server to be pinged. This can be either an alphanumeric string or a 12-digit number. **Packet Size (byte):** Size in bytes of the packet sent with the Ping command. The maximum size is 2000 bytes. **Wait Time (ms):** Time between pings in milliseconds. **Number of Pings:** The number of pings to send. There is no upper limit. **Timeout (s):** See “Timeout Parameters for Session Commands” above. (In this case, what the service will wait for is simply a response from the pinged server.)

12.11.2.6. E-mail

Keep in mind that an e-mail must arrive at the server before it can be downloaded by the recipient; it is therefore recommendable to insert a Wait command of suitable duration before the Receive E-mail command.

Command	Explanation/Arguments
Receive E-mail	Receive an e-mail from a POP3 server. *Dial Up and Hang Up sections:* See “About Phonebook Entries” above. **Body/Attachment:** Name of the file to which the e-mail contents are to be written. All contents are written to a single file: header fields, body text, and attachments (if any). **Remote Address:** The IP address of the POP3 server. This can be either an alphanumeric string (for example, pop3.myserver.com) or a 12-digit number. **User:** User name of e-mail account. **Password:** Password for e-mail account. **Timeout (s):** See “Timeout Parameters for Session Commands” above.
Send E-mail	Send an e-mail to an SMTP server. *Dial Up and Hang Up sections:* See “About Phonebook Entries” above. **From:** E-mail address of sender. **To:** E-mail address of recipient. **Subject:** Content of e-mail Subject field. **Body Text File:** Name of file containing e-mail body text. **Attachment:** *(Optional)* Name of file to enclose with the e-mail as attachment. **Remote Address:** The IP address of the SMTP server. This can be either an alphanumeric string (for example, smtp.myserver.com) or a 12-digit number. **User:** User name of e-mail account. **Password:** Password for e-mail account. **Timeout (s):** See “Timeout Parameters for Session Commands” above.

12.11.2.7. Video Streaming

Command	Explanation
Video Streaming	Download streaming video from a streaming server and play it in TEMS Investigation.

The arguments follow below.

Dial Up and Hang Up Sections

See “About Phonebook Entries” above.

WAP Load Section

This section is used when doing streaming via a WAP page.

- **WAP Streaming:** Set this to true in order to enable the remaining parameters in this section.
- **Streaming Link:** The text string of the WAP page RTSP link to the stream that is to be downloaded.
- **Remote Address:** The IP address of the WAP page. The IP address can be either an alphanumeric string, with or without http:// at the beginning (for example, www.mywapserver.com), or a 12-digit number.
- **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 phone 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, given as a 12-digit number.
- **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, given as a 12-digit number.

- **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 phones accessing them.)

  Example of User Agent string (for Sony Ericsson K790i):

  User-Agent: SonyEricssonK790i/R1JG Browser/NetFront/3.3 Profile/MIDP-2.0 Configuration/CLDC-1.1
- **Timeout (s):** See “Timeout Parameters for Session Commands” above.

Video Streaming Section

- **Source File:** The file name of the video clip or streaming session description to be downloaded from the streaming server.
- **Target Directory:** If you wish to save the streamed content to a file, specify the directory where the file should be stored.
- **Target Formats:** If you wish to save the streamed content to a file, specify the file format here. At present, the only option is AVI. The file faithfully records the streaming session as it unfolded, preserving any disruptions due to buffering events.
- **Target Frame Rate:** The frame rate that will be used when saving the streamed content to file. The target frame rate should be at least as high as the native frame rate.
- **Port:** The RTSP port on the streaming server. The default port number is 554.
- **Local 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.
- **Remote Address:** The IP address of the streaming server. This can be either an alphanumeric string (for example, myserver.com) or a 12-digit number.
- **Use Proxy Server:** Specify whether to access the streaming server through an RTSP proxy server.
- **Proxy Address:** The IP address of the RTSP proxy: alphanumeric string or 12-digit number.
- **Prebuffering Length (s):** Length (in seconds) of segment to buffer during initial buffering. Min: 1 s. Max: 20 s.

- **Rebuffering Length (s):** Length (in seconds) of segment to buffer during rebuffering. Min: 1 s. Max: 20 s.
- **Measurement 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.
- **Duration (s):** For Measurement Mode = “Live”, specify the duration of the streaming session here. When this time has expired, the command terminates.
- **Timeout (s):** See “Timeout Parameters for Session Commands” above.

12.12. Commands for SMS, MMS, and WAP

SMS is implemented with AT commands. MMS and WAP sessions are conducted using WinWAP.

If a phone is going to send an SMS or MMS to itself, the Receive command must follow directly after the Send command in the sequence; if some other command intervenes, the message transfer may fail.

For SMS to work, the phone must support the following AT commands: AT+CMGF with format 0 or 1 and AT-CMGS.

Command	Explanation/Arguments
Receive MMS	Receive an MMS. The phone acting as recipient must *not* have automatic MMS download turned on (where the phone retrieves the MMS message from the MMS Center automatically as soon as it receives a notification). *Dial Up and Hang Up sections:* See “About Phonebook Entries” above. **Timeout (s):** See “Timeout Parameters for Session Commands” above.

Command	Explanation/Arguments
Send MMS	Send an MMS. *Dial Up and Hang Up sections:* See “About Phonebook Entries” above. **Receiving Device:** The phone number or e-mail address to send the MMS to. The receiving device may be identical with the sender (but see the introduction to this subsection). **Source File:** 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 Gateway:** The IP address of the operator’s WAP (or MMS) gateway, given as a 12-digit number. **Gateway Port:** The WSP port on the server. The default port number is 9201. **MMSC URI:** The URI of the MMS Center (usually beginning with http://). **Timeout (s):** See “Timeout Parameters for Session Commands” above.
Receive SMS	Receive an SMS. **Timeout (s):** See “Timeout Parameters for Session Commands” above.

Command	Explanation/Arguments
Send SMS	Send an SMS. **Receiving Device:** The phone number or e-mail address to send the SMS to. The receiving device may be identical with the sender (but see the introduction to this subsection). **SMS Message:** Content of SMS message; this can be entered directly in the dialog or read from a text file. **Timeout (s):** See "Timeout Parameters for Session Commands" above.
WAP Load	Download a page from a WAP server, or one page each from several WAP servers. Note that WAP pages that redirect the user to a different page cannot be downloaded. *Dial Up and Hang Up sections:* See "About Phonebook Entries" above. **Remote Address(es):** The IP addresses of the WAP pages. Click the "+" button to add one more IP address. Each IP address can be either an alphanumeric string, with or without http:// at the beginning (for example, www.mywapserver.com), or a 12-digit number. **WAP Gateway:** The IP address of the operator's WAP gateway, given as a 12-digit number. **Gateway Port:** The WSP port on the server. The default port number is 9201. **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 phones accessing them.) Example of User Agent string (for Sony Ericsson K790i): User-Agent: SonyEricssonK790i/R1JG Browser/NetFront/3.3 Profile/MIDP-2.0 Configuration/CLDC-1.1 **Timeout (s):** See "Timeout Parameters for Session Commands" above.

12.13. Commands for KPI Calculation (UMTS)

These commands are used to obtain data for computing KPIs. Please note that in order to obtain KPIs, these commands and no others must be used; the corresponding regular commands for each service (covered previously in this chapter) do not produce the required output.

The KPI commands are similar to their non-KPI counterparts, but differ with respect to some parameters. The following differences are common to all commands:

- KPI commands do not have a Timeout parameter. Rather, timeouts are settable during post-processing so that performance requirements on which to base the KPIs can be freely adjusted. See section 7.7.1, page 75.
- KPI commands have an extra parameter, Location Category. This is simply an integer label (in the range 1 ... 9999) which will appear in the KPI report, making it easier to distinguish between test cases. See appendix G.5, page 361.
- KPI commands must always have their phonebook entry explicitly indicated, since they cannot rely on a preceding Dial Up command (compare section 12.11.2.1).

Other differences are covered in the table below. As regards parameters shared with non-KPI commands, see the descriptions of the latter in sections 12.11.2 and 12.12. The device assignment is always the same as for non-KPI commands.

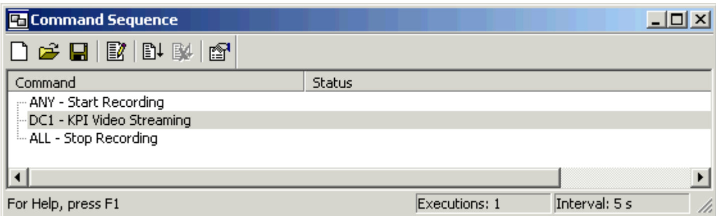
There are no KPIs for SMS.

Command	Explanation/Arguments
KPI Voice	Corresponds to Dial with Call Type = Voice or Voice + AQM (the same choice of call type is made in the KPI command).
KPI FTP DL, KPI FTP UL	Correspond to FTP DL and FTP UL respectively.
KPI HTTP	Corresponds to HTTP Load.
KPI Receive E-mail	Corresponds to Receive E-mail.

Command	Explanation/Arguments
KPI Send E-mail	Corresponds to Send E-mail.
KPI MMS	Corresponds to a Send MMS (the assigned phone is the sender) followed by a Receive MMS (the phone specified under **Receiving Device** is the recipient). Some of the MMS KPIs encompass both sending, notifying, and receiving. In order to verify that the same MMS has been sent and received, TEMS Investigation adds a timestamp of its own (content type "text/plain") to the MMS.
KPI WAP	Corresponds to WAP Load.

KPI commands must be used in conjunction with Start Recording/Stop Recording in order to have the KPI measurements recorded in a logfile.

Here is a simple example of a command sequence for KPI measurement:



For an overview of how to obtain KPIs, see chapter 25, page 290.

12.14. Tips and Tricks

The command sequence tool gives the user great freedom in assigning tasks to devices. It is possible to write sequences that do not work, or that produce unpredictable results. This section gives some advice on composing sequences.

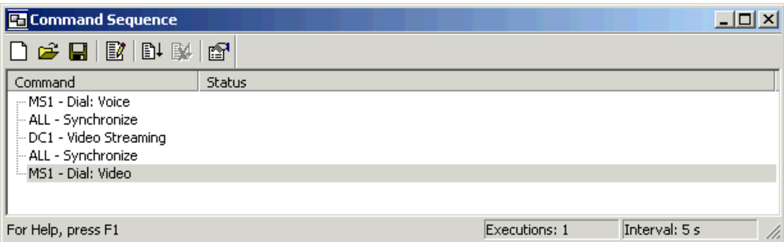
12.14.1. Synchronization

The Synchronize command (see section 12.6) needs to be used whenever the actions of several devices need to be aligned in time. By default, each device involved in a command sequence executes its commands independently of what the other devices are doing, so without synchronization there is no guarantee that different devices will reach a particular part of the sequence at the same time.

- When phones are to interact with each other at some point in the sequence, a Synchronize command needs to be inserted immediately before the interaction part.
- In benchmarking applications, it is often crucial to ensure that different phones begin their tasks at the exact same time. To accomplish this, insert a Synchronize command immediately before the benchmarking tasks in the sequence.

12.14.2. MS and DC Assignment

The MS and DC channels of the same phone must *not* be assigned commands in parallel, as if they were independent entities. Specifically, voice or video telephony (assigned to the MS) cannot be run in parallel with a data service (always assigned to the DC). In other words, you cannot assign a telephony command to MS1 and then have DC1 conduct a data session in the next command. Rather, a Synchronize command must be inserted between the two tasks, so that one task is finished before the next is begun. The example below shows how such a sequence might be written:



12.14.3. Collecting Data for RAN Tuning Reports

When composing command sequences that will collect data for RAN Tuning reports (Route Analysis User's Manual, chapter 16), please follow these guidelines:

- Insert a Wait command (at least 10 s) between calls.

- Use different command sequences for accessibility and retainability analyses. Generally speaking, short calls should be used for accessibility statistics and longer calls for retainability statistics.

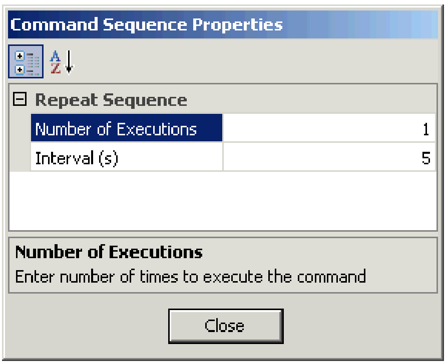
12.14.4. Windows Vista and IPv6

In Windows Vista, it is recommended that you disable IPv6 for all device modems, since otherwise dial-ups will require a lot more time. See the Getting Started Manual, section 3.16.2 for instructions.

12.15. Command Sequence Properties

The only editable generic property of a command sequence is the number of times it should be executed when started. The default is 1.

 Click the Properties button in the Command Sequence window.



Number of Executions	The total number of times to execute the command sequence.
Interval (s)	Interval between sequence executions in seconds.

12.16. Running a Command Sequence

Command sequences are run from the Command Sequence window.

> **Note:** When executing a command sequence, the keylock function must not be activated in any of the phones. If it is, the command sequence will not work properly.


To start executing a command sequence, click Start.

The phones involved in a command sequence will execute their commands independently of one another, except when phones engage in a service where they interact, or the Synchronize command is used. Compare section 12.14.

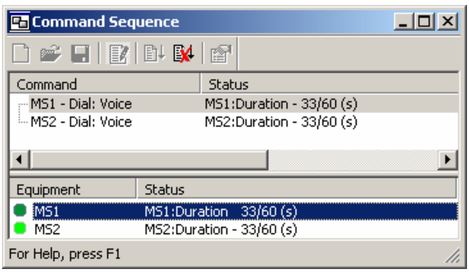

To terminate the execution of a command sequence, click Stop.

If you stop a command sequence while an SMS or MMS message is being transferred, you should wait until the receiving phone has received the message before restarting the sequence. Otherwise, unpredictable behavior may result.

Please note that command sequences from TEMS Investigation versions older than 7.0 cannot be run in TEMS Investigation 9.0.

12.16.1. Stopping and Restarting Devices

While a command sequence is running, an additional pane appears at the bottom of the window showing the status of all devices involved. The status information also appears in the command pane next to the command(s) being executed:



All devices that are executing the sequence are tagged with a green light on the left.

It is possible to stop and restart individual devices taking part in the command sequence without halting the execution of the whole sequence.

- To stop a device, right-click it in the bottom pane and choose Stop.

The device will now immediately stop participating in the sequence. While the device is winding up whatever it has been doing (for example, concluding an FTP session and hanging up), the dot on the left will be colored yellow. When the device has finished this task, the dot will turn red.

While a device is stopped, any other commands requiring interaction with the stopped device will of course fail. All commands not involving the stopped device, however, will continue to execute as normal. (If you stop *all* devices involved in the sequence, the entire sequence will terminate.)

- To restart a stopped device, right-click it in the bottom pane and choose Start. The device will resume participation in the sequence the next time the sequence execution starts over from the beginning.

12.16.2. Options for Individual Commands

- You can test a single command in a sequence by right-clicking it and choosing Run Command. This command will then be executed in isolation (as far as possible; any other devices that are supposed to interact with the assigned device must of course be operated manually).
- You can disable a command in a sequence by right-clicking it and choosing Disable. This command will then be skipped when the sequence is executed (and any tasks relying on the skipped command for their completion will naturally fail). To re-enable the command, right-click it again and choose Enable.

12.16.3. Running Multiple Command Sequences

It is possible to run several command sequences concurrently, each in a Command Sequence window of its own. However, no device can appear in more than one sequence; sequences cannot interact with each other in any way or be synchronized. The advantage of being able to run several sequences in parallel is that you can do testing with multiple devices at the same time without having to write a single long sequence controlling all devices.

12.17. Presentation of Data Service Testing

Running command sequences that test data services will produce the following output:

- Information elements in the “Data” category: see Information Elements and Events, section 3.5. Selections of these elements are by default presented in the data service oriented line charts and in the Data Session status window. See Information Elements and Events, sections 8.1 and 8.5.
- A number of events pertaining to RAS, to various services, and more: see Information Elements and Events, sections 7.3 and 7.4. These are by default presented in the data service oriented line charts.
- Messages in the Data Reports message window: see Information Elements and Events, section 8.3.3.
- *(For UMTS, if KPI commands have been used:)* KPI data, serving as the basis for KPI reports.

12.18. Saving and Loading Command Sequences

Command sequences can be saved as XML files.

To save the command sequence currently in the Command Sequence window, click Save and specify a name for the XML file.

Regarding the saving of phonebook entries, see section 12.11.2.

To open an existing command sequence, click Open and select your XML file.

12.19. Data Session Error Messages

Below are listed error messages that may occur when doing data service testing with a command sequence.

12.19.1. 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)* URI or IP address put into FTP Account field instead of Remote Address field.
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.
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 disconnected from TEMS Investigation. Try reconnecting the phone. • *(FTP)* Use of leading slash for root-located file.

Message	Explanation
The address is not valid	Possible causes: • Use of non-existent URI or IP address as remote address. • The DNS lookup of the host name failed. • *(FTP)* Path appended to the URI or IP address under Remote Address (not allowed: see section 12.11.2.3).
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.

12.19.2. RAS Error Messages

Message	Explanation
Cannot find the phonebook entry	The Dial-up Networking entry referenced by the Dial Up command does not exist. Create a new phonebook entry in Network and Dialup Connections based upon the modem entry for the phone (see the Getting Started Manual, section 8.4). This error usually occurs when the command sequence has been transferred from another computer: see section 12.11.2, “About Phonebook Entries“.
Internal error	An invalid APN was used.
No answer	The remote computer did not respond.

Message	Explanation
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 from the Windows HyperTerminal by sending the following command to the phone: AT+CGDCONT=1, "IP","myserver.com" (replace the final string by the correct URI). See also the Getting Started Manual, section 8.5.
The request has timed out	A subsequent error occurred after an initial PDP Context Activation error. Stop, reload, and restart the command sequence.
Unknown error	Possible cause: Use of *99****n*# as access phone number in Dial Up (where *n* indicates the *n*th APN entry in the phone). Some phones do not accept this syntax.

12.19.3. 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.

Message	Explanation
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.
User not accepted	The user name was invalid.

12.19.4. E-mail Error Messages

Message	Explanation
Failed to add attachment to the message	Adding an attachment failed.

Message	Explanation
HELLO command was rejected or not responded to by the server	The client attempted to initiate a connection with the e-mail server, but the server did not respond.
Invalid values of parameters	Typically reported when the e-mail 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 e-mail 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 e-mail 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.

12.19.5. 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.

Message	Explanation
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 command sequence 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 audio/video 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 audio or video codec.

12.19.6. MMS Error Messages

Message	Explanation
Message not found on MMSC	The message could not be located on the MMSC.
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 below.

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.

Message	Explanation
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.

12.19.7. 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.

13. Device Properties

From TEMS Investigation you can view and modify certain properties of connected devices. To access the property dialog of a device, do as follows:

- Choose the device on the Equipment Control toolbar.

Click the Equipment Properties button. (Alternatively, right-click the device in the Equipment Configuration window and choose Properties.)

13.1. Overview of Control Function Support in Devices

This overview covers Sony Ericsson, Motorola, and Nokia phones. Other supported devices share little or none of the control functionality listed here.

Connectable Nokia phones that belong to the "Nokia UMTS NTM v3" generation are Nokia 6120, 6121, and N95.

Control Function	Sony Ericsson					Mot.		Nokia			
	Z750i	K800i	K790i/a	K600i	W600i	Razr V3xx, Razr2 V9	E1000, E1070, Razr V3x	UMTS NTM v3	UMTS NTM v2	GSM NTM v2	GAN NTM v2
Access class control	✓	✓	✓	✓	✓						
Auto answer	✓	✓	✓	✓	✓						
Barred cells, access control	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
BLER target control (WCDMA)	✓	✓									
C/A measurements (GSM)	✓	✓	✓	✓	✓						
Channel verification (GSM)[a]	✓	✓	✓	✓	✓						
EDGE capability control	✓		✓								
HSPA capability control	✓										
L3 messages, discard/ignore	✓	✓	✓			✓					
Lock on ARFCN	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Lock on GSM band	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lock on PLMN	✓	✓	✓	✓	✓						
Lock on RAT	✓	✓		✓		✓	✓	✓	✓		✓
Lock on SC	✓	✓		✓		✓	✓	✓	✓		
Lock on UARFCN	✓	✓		✓		✓					
Lock on WCDMA band	✓					✓	✓	✓	✓		
Redial on block	✓	✓	✓	✓	✓						
Reserved cells, access control	✓										
Speech codec control (GSM)	✓	✓	✓	✓	✓						
TxPower control (GSM)	✓	✓	✓	✓							

a. See chapter 32, page 315.

13.2. Properties of Sony Ericsson Phones

This section deals with viewable and editable properties of Sony Ericsson phones.

Properties not dependent on the network configuration can be edited as soon as the phone has been enabled; it does not even have to be attached to a PC port. When you connect the phone in the application, the phone retrieves all settings you have specified for it. Network-dependent settings, however (such as locking on a channel: see sections 13.2.3.5 and 13.2.3.3), cannot be modified unless the phone is connected.

Any changes to the properties will apply until the phone is disabled.

This section describes all tabs appearing for Sony Ericsson phones that are currently offered with TEMS Investigation. Some tabs appear only for a subset of these phones, and the precise contents of some tabs differ between phones. The screenshots below show representative examples of dialog contents.

Functions of Dialog Buttons

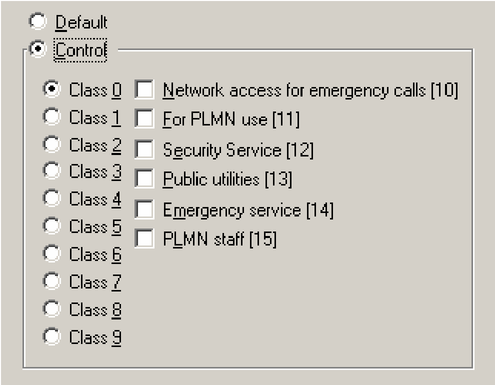
Besides OK and Cancel, the Properties dialog contains the buttons Reset and Apply. These buttons have the following functions:

- Apply saves all the changes made (on all tabs), like OK, but without exiting the dialog.
- Reset restores all the default settings (on all tabs) and exits.

13.2.1. General Properties

13.2.1.1. Access Class Control Tab

On this tab, access class settings (see 3GPP 22.011, chapter 4) can be manipulated.

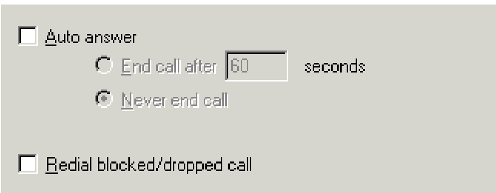


Classes 0 ... 9	Every phone is by default allocated randomly to one of these classes. You can change the default allocation here.
Network access for emergency calls, etc. (Classes 10 ... 15)	Membership of these classes entitles a phone to make access attempts in various special situations. Check the classes that you want the phone to be a member of.

13.2.1.2. Call Tab

TEMS Investigation can answer incoming calls automatically, that is, simulate off hook (*auto answer*). This feature ensures that network originated calls can be properly established without any need for manual actions.

It is also possible to have the last dialed number automatically redialed.



Auto answer	Check the box to enable auto answer. Enter the call length in seconds, or choose “Never end call”.
Redial dropped/ blocked call	Check the box to have the last dialed number redialed after a call has been dropped or blocked.

13.2.1.3. Discard Messages Tab

Alternative name: Messages Control

For certain Sony Ericsson UEs you can discard Layer 3 messages of specified types.

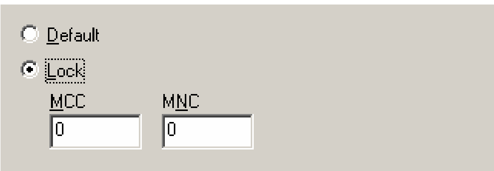
- In the tree view, check the types of message that you want to discard. (The UE can store up to 10 message types in its memory.)

When you click OK or Apply, the settings are sent to the phone, whereupon the tab is blanked (all boxes are unchecked).

Discarded messages are colored red in the Layer 3 Messages window and tagged with a special note in the plain-text decoding; see section 18.3, page 224.

13.2.1.4. Lock on PLMN Tab

You can lock the phone 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 phone will go into limited service mode.



13.2.2. WCDMA Properties

13.2.2.1. BLER Target Tab

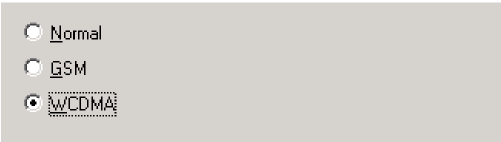
For certain Sony Ericsson UEs you can override the BLER target set for the UE by the network.

Normal	No modification of BLER target.
Modify	The BLER target (in percent) for the UE will change to the value you set in the combo box.

13.2.2.2. RAT Control Tab

Alternative name: CAS System Capability Control

Certain Sony Ericsson UEs can be locked to either WCDMA or GSM. The RAT lock function works only in idle mode.



Normal	No forcing of UE network selection.
GSM	The UE is forced to camp on a GSM network whenever one is available.
WCDMA	The UE is forced to camp on a WCDMA network whenever one is available.

RAT Control vs. GSM Settings

For phones equipped with both WCDMA and GSM control functionality, the RAT Control setting takes priority over all GSM-specific settings, including the GSM band and channel lock settings described in sections 13.2.3.5, 13.2.3.3, and 13.2.3.1.

On the assumption that both types of network are available, this has the following implications:

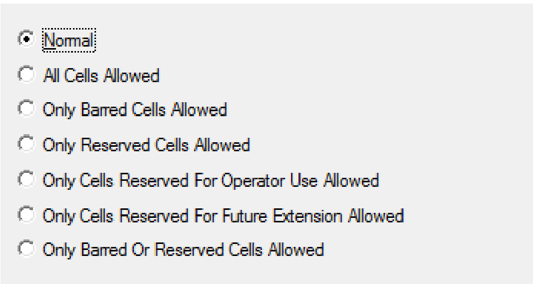
- If RAT Control is set to “WCDMA”, the phone will be locked to WCDMA indefinitely[1]; specifying GSM bands or channels to lock on will *not* by itself force the phone into GSM mode.

- If RAT Control is set to “Normal”, the phone will camp on whatever network the fixed side prescribes (as it normally does). If and when the phone switches to GSM, any GSM settings you have made will take effect, and if this includes locking to a GSM band and/or channel subset, the phone will remain in GSM mode indefinitely (no longer obeying contrary orders from the fixed side).
- In order to force immediate use of GSM, you must set RAT Control to “GSM”; the phone will then be locked to a GSM network indefinitely, and any GSM-specific settings you have made will take effect.

Note again that the RAT lock function has an effect in idle mode only.

13.2.2.3. WCDMA Cell Bar Control Tab

On this tab you can modify the phone’s behavior with respect to accessing of barred, reserved, and other cells:

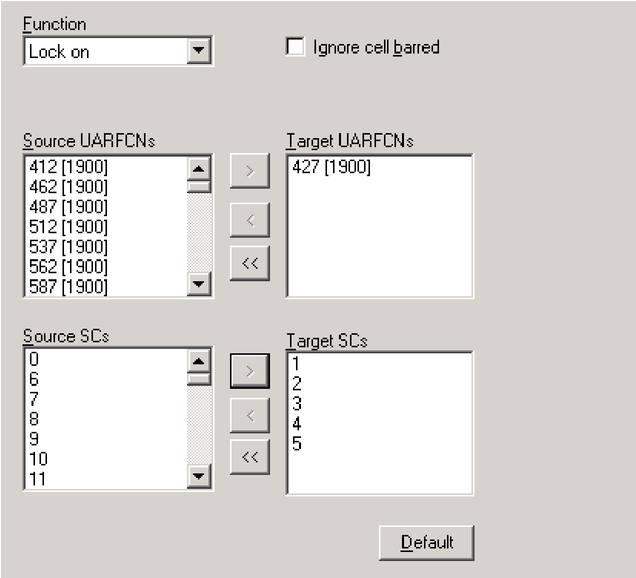


Normal	No change from normal cell barring behavior.
All Cells Allowed	The phone will access any cell, also barred and reserved ones.
Only Barred Cells Allowed, etc.	Which types of cell the phone will access is restricted in the manner indicated.

13.2.2.4. WCDMA Cell Selection Control Tab

On this tab you can lock the UE to, or bar the UE from, UARFCNs or scrambling codes in WCDMA, in idle mode as well as connected mode.

1. Except if you put the phone in scanning mode (chapter 8), in which case it ceases to behave like a phone at all.

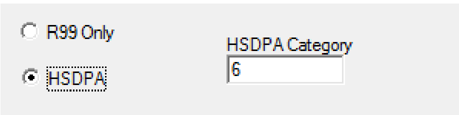


Function	Choose “Lock on” to lock on UARFCNs/scrambling codes. Choose “Prevent” to bar UARFCNs/scrambling codes. “Normal” means no effect on default behavior.
Ignore cell barred	Check this if you want the phone to ignore the “Barred” flag in the base station (this flag normally prevents the phone from accessing the cell).
Source UARFCNs	Lists the UARFCNs you can choose as targets.
Target UARFCNs	Lists the set of UARFCNs to lock on or exclude. Use the left and right arrow buttons to move channels between the boxes. Click the double right arrow to clear the Target channels box. 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.

Source SCs	Lists the scrambling codes you can choose as targets.
Target SCs	Lists the scrambling codes to lock on or exclude. Use the left and right arrow buttons to move channels between the boxes. Click the double right arrow to clear the Target channels box. 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 Target SCs box is grayed).
Default	Restore default settings. You must click Apply for this to take effect.

13.2.2.5. WCDMA RRC Radio Capability Control Tab

For phones supporting HSDPA you can enable or disable the HSDPA capability.



R99 Only	Only WCDMA R99 capability is enabled.
HSDPA	HSDPA capability is enabled. You can also set what HSDPA category the phone should report. These categories are defined in 3GPP TS 25.306 Table 5.1a.

13.2.2.6. Tabs Listing Messages and Mode Reports

For certain Sony Ericsson UEs, a tab named “SEMC Log Mask” or “Extended reports”, or a number of other tabs, are provided listing messages and mode reports delivered by the UE. There is normally no reason to change the default settings.

- Path Searcher must be checked for the Finger Info information elements (WCDMA) to be valid.

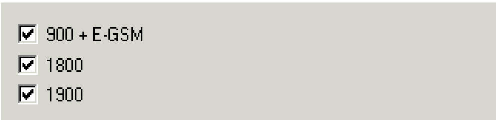
- Regarding TPC per cell, see Information Elements and Events, section 6.1.

13.2.3. GSM Properties

Regarding conflicts with the WCDMA RAT control settings, see section 13.2.2.

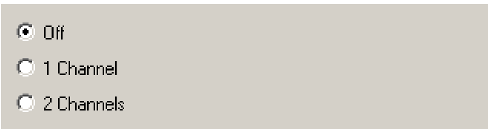
13.2.3.1. GSM Band Control Tab

You can restrict the phone’s use of frequency bands. This will of course result in failed calls if you have forbidden all bands that are currently available in the area. By default no restrictions are imposed.



13.2.3.2. GSM C/A Tab

Phones 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.

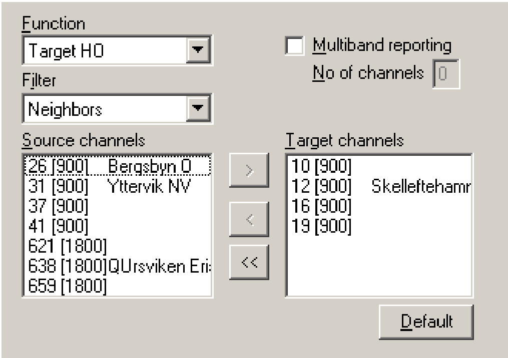


13.2.3.3. GSM Dedicated Mode Tab (and Related Toolbar Buttons)

When the phone is in dedicated mode, you can manipulate handovers. Specifically, you can do one of the following:

- prevent handover to specified channels. The phone will then report no RxLev for these channels.
- force handover to a specified channel, or restrict handovers to a chosen channel set. The phone 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.

Definition of channel sets is carried out exactly as for idle mode. See section 13.2.3.5.



Function — To manipulate handovers, choose “Prevent HO” or “Target HO” (that is, force handover).

Filter, Source channels, Target channels — In the Target channels box, list the channels to which you want to force or prevent handover.

Multiband reporting — If you check this box, only the specified number of channels from the other band will be reported.

Default — Restore default settings for dedicated mode. You must click Apply or OK for this to take effect.

13.2.3.4. GSM EDGE Capability Control Tab

For EDGE-capable phones you can choose to disable the EDGE capability (“Off”). This function can be used to force data transfer over GPRS rather than EDGE.

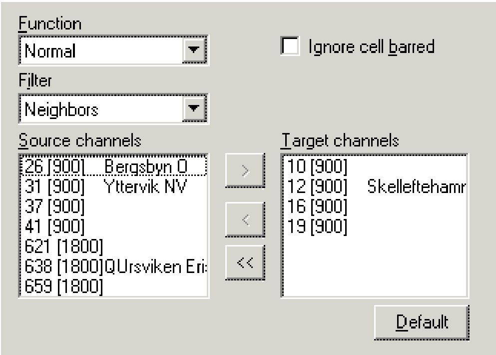
The Reset button resets this setting to the factory default (that is, “On”).

13.2.3.5. GSM Idle Mode Tab

When the phone 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.

You define the set of channels to lock on, or exclude, by selecting them in the Source channels box and moving them to the Target channels box.

The phone will remain locked to the specified channel set until the Target channels list is cleared or the phone is power cycled. At most 32 channels can be in the target set.



Function — Choose “Lock on” to lock on a set of channels. Choose “Prevent” to exclude a set of channels.

“Normal” means no effect on default behavior.

Filter — Choose which channels should be listed in the Source channels box. “Neighbors” lists all neighbors currently reported by the phone. “Cell file” lists all cells given as neighbors of the current serving cell in the cell file.

Ignore cell barred — Check this if you want the phone to ignore the “Barred” flag in the base station (this flag normally prevents the phone from accessing the cell).

Source channels — Lists the channels (ARFCNs) that you can choose as targets.

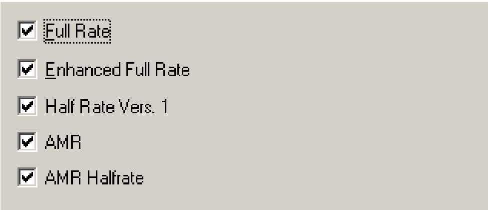
Target channels — Lists the channel set to lock on or exclude. Use the left and right arrow buttons to move channels between the boxes. Click the double right arrow to clear the Target channels box.

Default — Restore default settings for idle mode. You must click Apply or OK for this to take effect.

13.2.3.6. GSM Speech Codec Tab

Alternative name: CAS Speech Codec

You can choose which of the available speech codecs should be enabled in the phone. By default all codecs are enabled.



13.2.3.7. GSM TxPower Control Tab

For each GSM frequency band you can specify a TxPower value which will override the network allocated TxPower. Regarding the latter, see 3GPP TS 45.005, section 4.1.

13.3. Properties of Motorola UEs

For all settings on these tabs, you need to click the Send button to transfer the settings to the UE. Click Close to exit the dialog without transferring any changes made.

13.3.1. Logs

It is possible to govern what categories of data will be recorded by a Motorola UE. This is done from the UE property page. Any changes to the properties apply until the UE is disabled.

The items listed on the two tabs constitute everything that the UE can record. When you connect the UE, all items on the Basic Logs tab are by default checked and will be recorded. The items on the Extended Logs tab are by default unchecked.

- To turn off recording of a log, uncheck it.
- To turn off recording of all logs on a tab, click Clear all.

All logs appear as messages in the Layer 2 Messages, Layer 3 Messages, or Mode Reports window, and can be inspected there in plain-text decoded format. See chapter 18.

13.3.1.1. Basic Logs Tab

Below is indicated which information elements (if any) are updated by each of the logs on the Basic Logs tab. The information elements are from the “WCDMA” category unless otherwise noted.

Log	Updated IEs
L3 RRC Message Report	RB Setup UL DPCH SC, UL Interference Serving
L3 Broadcast Message Report	SIB Id
L3 Paging Message	–
DL Inner Loop Power Ctrl	SIR, SIR Target
Random Access	–
RLC Statistics	“RLC” elements
UL Signal Strength Power Ctrl	UE Tx Power
RAT	–
RRC State	“RRC State” elements
UE Identity	Phone Software Version
DL Transport Channel	“Trsp Ch” elements
UE Intra-Freq	“AS”, “Det Neigh”, “Mon Neigh”, “SAN”, “Serving”, and “Str Neigh” elements (active set and neighbors on the same frequency); UTRA Carrier RSSI
UE Inter-Freq	“Det Neigh”, “Mon Neigh”, “SAN”, and “Str Neigh” elements (neighbors on other frequencies)
Cell Reselection Measurement	–

Log	Updated IEs
GSM Carrier RSSI	“GSM Neigh” elements
GSM Dedicated Mode	“GSM” category: Mode, Mode (Num), Neighbor ARFCN, Neighbor BSIC, Neighbor RxLev
GSM Idle Mode	“GSM” category: Mode, Mode (Num), ARFCN BCCH, BSIC, RxLev Full, RxLev Sub, RxQual Full, RxQual Sub, Neighbor ARFCN, Neighbor BSIC, Neighbor RxLev
GSM L3 Message and Channel Request	“GSM” category: RxQual Full, RxQual Sub, ARFCN BCCH, BSIC
GSM System Information	–
GSM L3 GMM/SM/ SMS Report	–

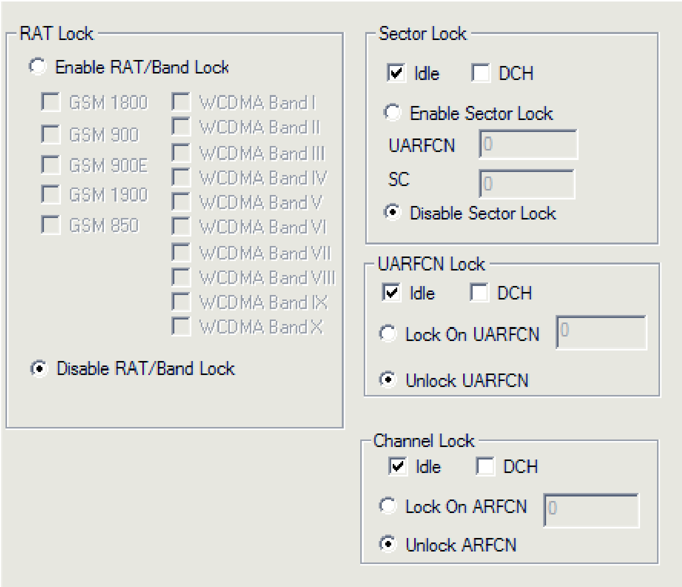
13.3.1.2. Extended Logs Tab

The logs on the Extended Logs tab do not update information elements.

13.3.2. Control Functionality

For additional details on control functions, please refer to Motorola’s own documentation, included on the TEMS Investigation installation CD under TI 9.0 UE SW → Motorola.

13.3.2.1. RAT/Band/Frequency/Cell Lock Tab



RAT Lock	You can lock on various bands and sets of bands. The list is self-explanatory.
Sector Lock	You can lock on a UARFCN/SC combination in WCDMA idle as well as connected mode. Check “Idle” and “DCH” as desired to set the scope of the sector lock.
UARFCN Lock	You can lock on a UARFCN in WCDMA idle as well as connected mode. Check “Idle” and “DCH” as desired to set the scope of the UARFCN lock.
Channel Lock	You can lock on a band and ARFCN in GSM idle as well as dedicated mode. Check “Idle” and “DCH” as desired to set the scope of the channel lock.

13.3.2.2. UE Handling Tab

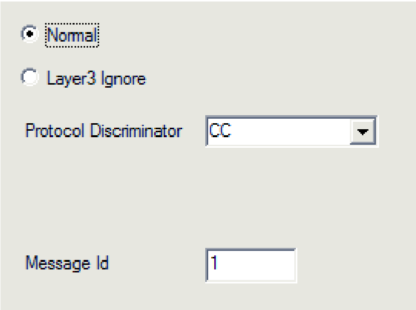
From this tab you can perform some basic UE operations: turn off, restart, enter PIN.

13.3.2.3. Cell Barring Tab

On this tab you can set cell barring behavior in GSM and WCDMA mode. The phone can be configured to ignore cell barring for cells of specified types.

13.3.2.4. Layer 3 Ignore Tab

On this tab you can instruct the phone to ignore specific Layer 3 messages.

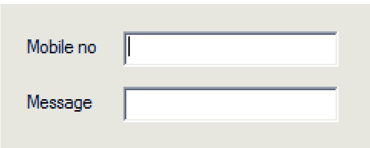


To enable this function, select the Layer 3 Ignore option.

To ignore a message, select its category under Protocol Discriminator, then enter its message ID (as defined in the 3GPP specifications) and click Send.

13.3.2.5. SMS Tab

From this tab you can send an SMS message to a mobile phone.



Mobile no.	The number of the phone that should receive the SMS.
Message	The SMS message string.

13.4. Properties of Nokia UEs

13.4.1. Band/Channel Control Tab

The settings on this tab apply in GSM mode only. They are the same as for Nokia GSM phones; see section 13.5.1.

13.4.2. Cell Barring Tab

The settings on this tab apply in GSM mode only. They are the same as for Nokia GSM phones; see section 13.5.2.

13.4.3. RAT Lock Tab

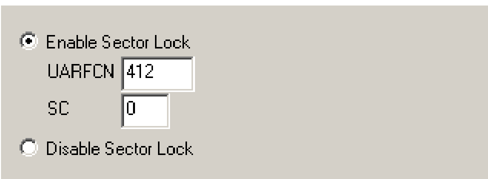
Release System Lock (dual)	The UE will not be locked to a radio access technology.
GSM	The UE will be locked in GSM mode.
WCDMA	The UE will be locked in WCDMA mode.

RAT Control vs. Technology-specific Settings

If you lock a Nokia UE on a RAT, then try to apply a locking function for a different RAT, the UE will go into No service mode. For example, this will be the result if you lock the UE 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 UE will immediately switch to WCDMA and lock on the WCDMA cell you selected.

13.4.4. Sector Lock Tab

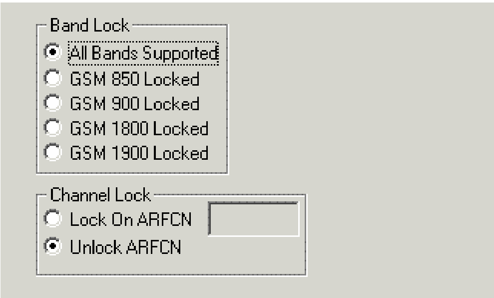


The settings on this tab apply in WCDMA mode only.

Enable Sector Lock	The UE will be locked to the chosen UARFCN and SC.
Disable Sector Lock	The UE will not be locked to a UARFCN or SC in idle mode.

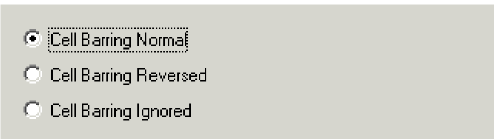
13.5. Properties of Nokia GSM Phones

13.5.1. Band/Channel Control Tab



You can lock the phone to a single band and/or a single ARFCN. The channel lock function works in idle mode only.

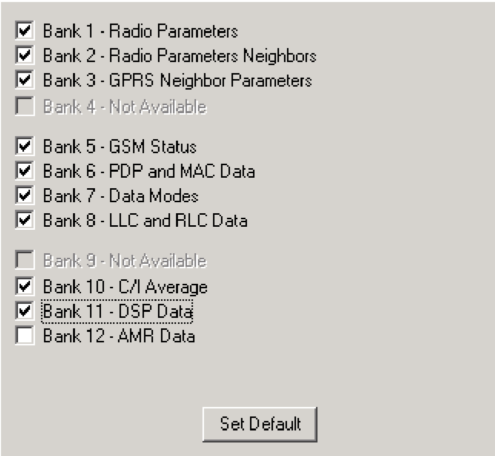
13.5.2. Cell Barring Tab



Cell Barring Normal	The phone will not camp on barred cells.
Cell Barring Reversed	The phone will camp *only* on barred cells.

Cell Barring Ignored The phone will ignore cell barring.

13.5.3. FTD (Field Test Display) Log Mask Tab



This tab governs which categories of data the phone will log. By default all log banks are checked except nos. 4 and 9, which are not used, and no. 12 (AMR Data). Of logbanks 10–12, only two can be selected at a time, so to be able to select no. 12 you must deselect one of the others.

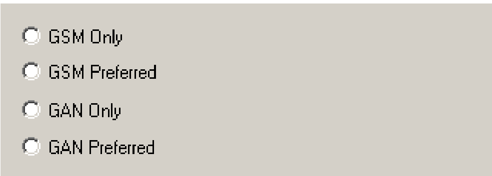
Description of Log Banks

No.	Name	Contents
1	Radio Parameters	GSM and GPRS serving cell information
2	Radio Parameters Neighbors	GSM neighbor information
3	GPRS Neighbor Parameters	GPRS neighbor information
4	Not used	

No.	Name	Contents
5	GSM Status	Channel lock status
6	PDP and MAC Data	General TBF and PDP context information
7	Data Modes	GMM SNDCP information
8	LLC RLC Data	LLC and RLC information
9	Not used	
10	C/I Average	C/I average
11	DSP Data	FER information
12	AMR Data	AMR information

13.5.4. GAN Mode Selection Tab

This tab appears for GAN-capable phones. Here you can set the phone’s GAN mode. At the outset no option is selected (TEMS Investigation does not query the phone for its GAN mode setting, because there is no way to do so).

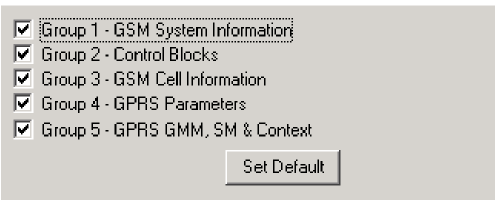


GSM Only The phone always stays in GERAN mode and never switches to GAN mode.

GSM Preferred	The phone stays in GERAN mode as long as a PLMN is available and allowable via GERAN (per 3GPP TS 23.122). If the phone can no longer access a GERAN, it may search for GAN coverage and if possible rove in to a GAN, thus entering GAN mode. While in GAN mode, if a PLMN becomes available and allowable again via GERAN, or the phone leaves GAN coverage, the phone will rove out or hand over from GAN and switch back to GERAN mode.
GAN Only	The phone always stays in GAN mode and never switches to GERAN mode.
GAN Preferred	Whenever the phone is in GERAN mode, if GAN coverage becomes available, then (unless a PLMN search is in progress) the phone will rove in or hand over to GAN, which may result in switching to GAN mode. If the phone leaves GAN coverage, it will rove out from GAN or hand over to GERAN (whichever is applicable), which may result in switching to GERAN mode.

Reference: UMA Architecture (Stage 2) R1.0.4 (2005-5-2), section 9.1.1.

13.5.5. Trace Log Mask Tab



This tab shows further log banks (compare section 13.5.3), all of which are by default selected.

Description of Log Banks

No.	Name	Contents
1	GSM System Information	GSM system information
2	Control Blocks	GSM/GPRS Layer 1 sent/received control blocks
3	GSM Cell Information	Channel Request Packet Channel Request EGPRS Packet Channel Request GSM serving cell information GSM neighbor information GSM DSF value GSM RLT counter value GSM/GPRS transmit power level GSM timing advance value GSM measurement traces – serving and neighbor GSM channel configuration information
4	GPRS Parameters	GPRS & EGPRS timeslot configuration GPRS & EGPRS coding scheme GPRS & EGPRS data counters
5	GPRS GMM, SM & Context	GPRS context information GPRS GMM/SM messages

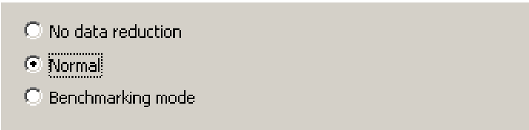
13.6. Properties of Qualcomm Chipset Based Devices

Control functionality for Qualcomm chipset based devices is chiefly limited to enabling and disabling of logs. Other tabs that appear are described below.

13.6.1. Data Reduction Tab (CDMA)

For CDMA phones, a dialog tab named Data Reduction appears. The purpose of these settings is to keep the logfile size down by sifting phone reports that are sent very frequently and saving only a small fraction of these reports. Only certain report types are subject to such filtering, but the selection differs between the filtering modes (see below). One example of a highly frequent report that will be filtered is the Searcher And Finger report, which is sent several hundred times each second.

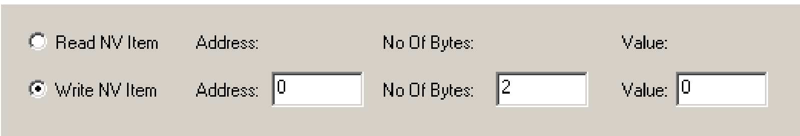
The data reduction settings are saved in the PC registry, not in the TEMS Investigation workspace. When you click Send, the settings take effect for all CDMA (cdma2000/EV-DO/cdmaOne) devices that are currently enabled in TEMS Investigation.



Unfiltered	No data reduction; all phone reports are saved in the logfile.
Normal	Data is reduced to an extent that should be suitable for most purposes.
Benchmarking mode	Data is reduced more harshly than in Normal mode to enable logging with a larger number of phones simultaneously.

13.6.2. NV Item Read/Write Tab (UMTS)

This tab allows you to inspect and modify settings for Qualcomm chipset based UMTS devices by reading and writing items over the Qualcomm NV interface.



The Value input field under Write NV Item is limited to 4 bytes; this is however sufficient to cover most of the 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 phone’s calibration parameters or otherwise damage the phone 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 value by studying these reports.

After an NV write the phone is always automatically reset, and consequently it is disconnected in TEMS Investigation.

13.7. 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.

14. 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.

14.1. Presentation of Events

Events that occur are listed in the Events window. Regarding this window, see Information Elements and Events, section 8.3.

Events can also be presented

- as symbols on the map (see section 23.5.4, page 268)
- as symbols and vertical lines in line charts (see section 21.4, page 235)
- as audio signals (see section 14.7, page 208).

14.2. Predefined and User-defined Events

Definitions of all predefined events are found in Information Elements and Events, chapter 7.

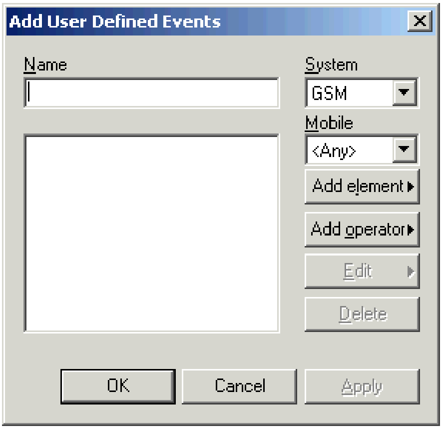
User-defined events are specified by logical expressions, which trigger the event when they evaluate to true. These expressions can contain

- Layer 3 messages
- other events
- conditions involving information elements.

14.3. 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 MS. If you choose “Any”, the event can be triggered by any external device.

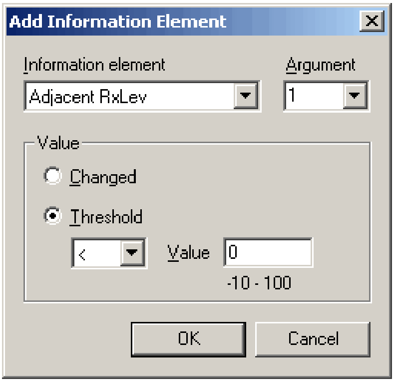
You build up the event expression by using the add buttons on the right. The structure of the expression is displayed in the box beneath the Name field.

14.3.1. 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.

14.3.2. 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.

14.3.3. 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.

14.3.4. 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 then added to the list in the Event Definition window.

See section 14.6 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.

14.4. Editing User-defined Events

- Select the event you want to edit in the Event Definition window.
- Click Edit and make the desired changes.

14.5. Deleting User-defined Events

- Select the event you want to delete in the Event Definition window.
- Click Delete.

14.6. Example of Event Definition

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 and in the other presentation windows.

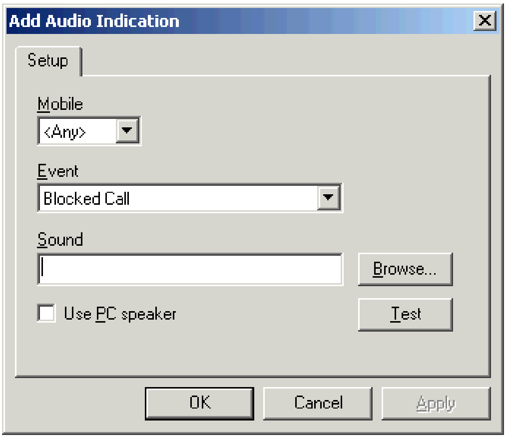
14.7. Audio Indications for Events

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.

14.7.1. Adding Audio Indications

Click Add in the Audio Indications window.



Mobile Choose an external device.

Event Choose an event.

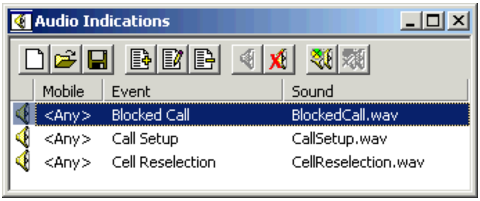
Sound Enter the path to the WAV file you want to use, or click Browse and select the file.

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.



14.7.2. Editing Audio Indications

- Select the audio indication to be edited.

 Click Edit and make the desired changes.

14.7.3. Activating Audio Indications

Audio indications are by default active. They may however be deactivated (see section 14.7.4 below). To activate a deactivated audio indication:

- Select the audio indication.

 Click Activate Sound.

14.7.4. Deactivating Audio Indications

To deactivate an audio indication:

- Select the audio indication.

 Click Deactivate Sound.

14.7.5. Muting All Audio Indications

To disable all audio indications, independently of their status (active or deactivated):

 Click Mute All.

From now on, no audio indications will be played until you decide to enable them again. 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.

14.7.6. 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.

14.7.7. Deleting Audio Indications

- Select the audio indication to be deleted.

 Click Delete.

15. Presentation: Basics

This chapter covers the fundamentals of data presentation.

15.1. The Data: Information Elements and Events

The presentation windows are used to present *information elements*, *events*, and *messages*, either in real time or during logfile replay. Real-time and logfile data are presented in fundamentally the same way; 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, 4, and 5 of that volume.

Regarding predefined events, see Information Elements and Events, chapter 7.

15.2. Types of Presentation Window

The following presentation windows are available in TEMS Investigation Data Collection:

- status windows: chapter 16, page 214
- Event Counter windows: chapter 17, page 220
- message windows: chapter 18, page 222
- the Video Monitor window: chapter 19, page 227
- the GPS window: chapter 20, page 230
- line charts: chapter 21, page 232
- bar charts: chapter 22, page 240
- Map windows: chapter 23, page 259.

15.3. 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 replay 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 phone, 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 18.5.

15.4. 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 4.2, page 28, 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.

15.5. 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.

15.6. 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.

15.6.1. 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 is .stm, .lch, .map, or .mw, depending on the window type.

15.6.2. 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.

16. Status Windows

This chapter explains the workings of status windows.

16.1. 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, section 8.1. In addition, a blank template is available which you can use to compose your own status windows.

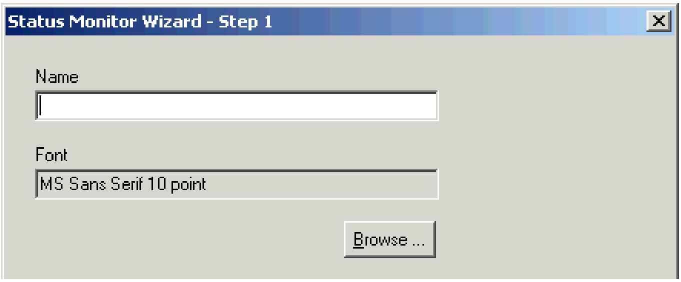
To set up a status window, use the Setup Wizard (section 16.2). The Setup Wizard is intended to be run only once. Later on, you can modify the window using the Properties dialog, which is described in section 16.3.

16.2. Setting Up Status Window Contents

The contents of a status window are conveniently set up using the Setup Wizard.

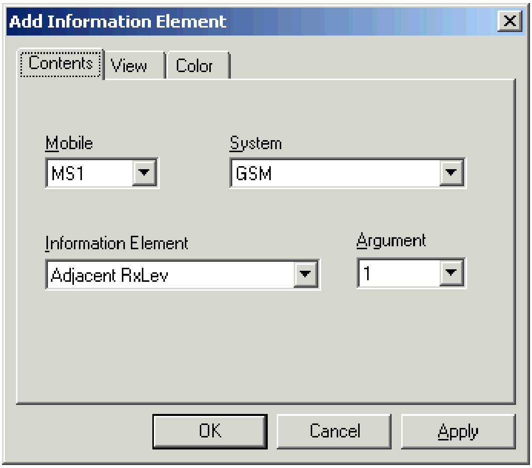
> **Note:** Setting the number of columns and rows in the status window cannot be done with the Setup Wizard. Also, you cannot enter text in the status window using this tool. For these purposes you must use the Properties dialog. See section 16.3, page 217.

- 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.

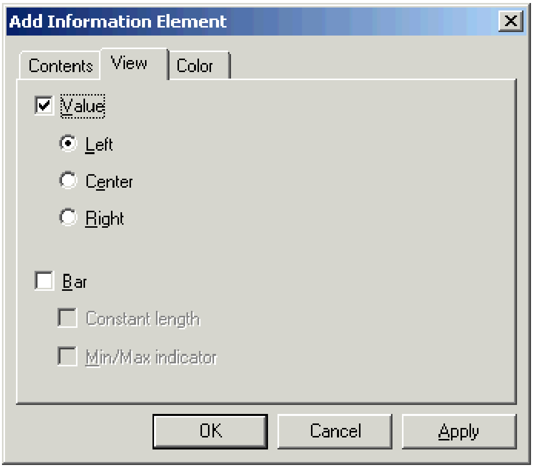
- Click Next to proceed to Step 2.
- To add an information element, click Add.



Mobile	Choose which device to pick the information element from.
System	Choose an information element category. See Information Elements and Events, chapter 2.

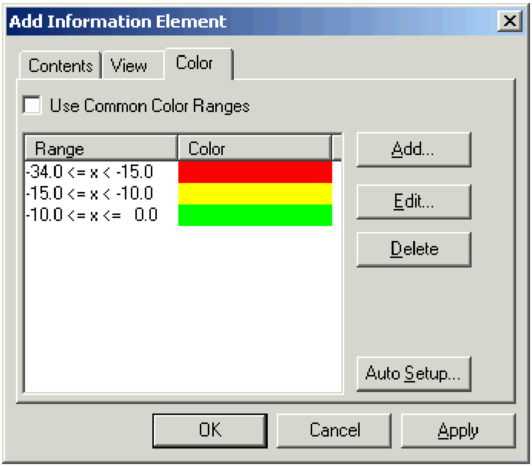
Information element	Choose an information element.
Argument	Enter an argument for the information element (if it needs one).

- Select the View tab.



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.

- Select the Color tab to customize colors and color ranges.



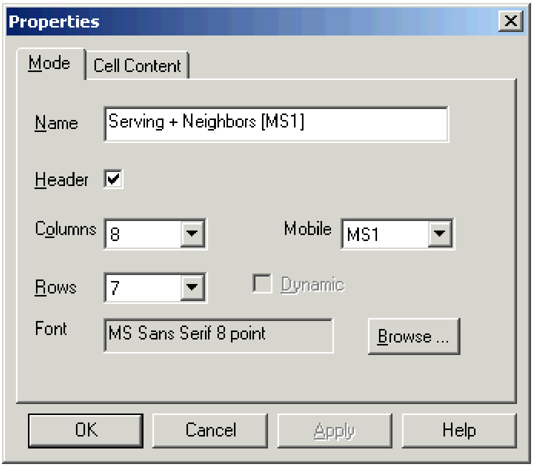
Use common color ranges	Check the box if you want to use the default color range of the information element. If you want to define a special color range here, uncheck the box and specify the range (see section 4.2, page 28 for details on how to do this).

Click Apply to add more information elements. Click OK when you are done adding information elements. Then exit the Setup Wizard by clicking Finish.

16.3. Changing Status Window Properties

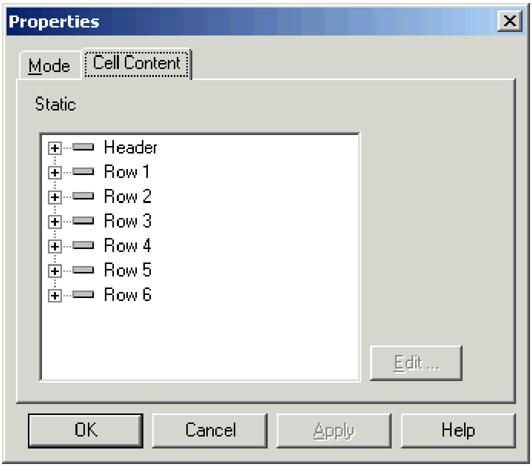
- Right-click in the status window and choose Properties from the context menu.

The Mode tab governs the layout and appearance of the window:



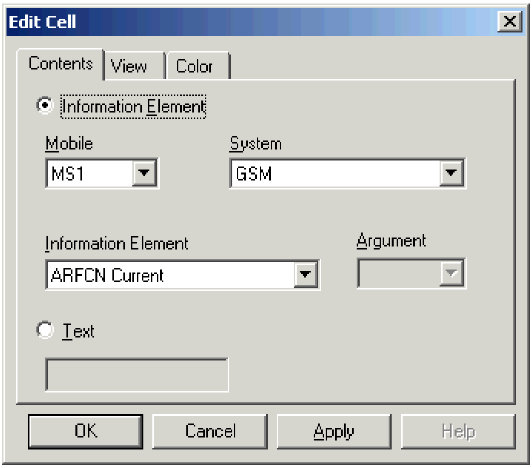
Name	Enter a new name if desired.
Header	Check if you want a header in the window. (The contents of the header are defined on the Cell Content tab.)
Columns	Set the number of columns.
Rows	Set the number of rows.
Font	Click Browse and select a font.
Mobile	If you choose a device in this box, all the 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 Contents tab. See below.)

- To edit the contents of the status window, select the Cell Contents 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 16.2 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 Contents tab.

17. Event Counter Windows

An Event Counter window in Data Collection keeps track of the number of times a set of events have occurred. What events to show is user-configurable.

The Event Counter window has its counterpart in Route Analysis in the Data Selector window, which is likewise used to display event statistics, though in a somewhat different format. See the Route Analysis User’s Manual, sections 5.3.1 and 8.2–8.4.

17.1. 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 17.4 and 17.4.1.
- To remove an existing tab, right-click in the window and choose Remove Tab from the context menu.

17.2. 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.

17.3. 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 and replay mode,

- when a new logfile is opened
- when a logfile is closed.

In replay mode, a reset is also performed when the logfile is rewound.

17.4. Changing Event Counter Window Contents and Properties

- Right-click in the Event Counter window and choose Properties from the context menu.

17.4.1. 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.

17.4.2. 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.

18. 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 Data Collection.

Preconfigured message windows are listed in Information Elements and Events, section 8.3.

18.1. Changing Message Window Contents and Properties

- To access the message window Properties dialog, right-click in the window and choose Properties.

18.1.1. General Tab

On this tab you choose which devices to show messages from. MS and DC devices are distinguished.

The tab also holds the window title, which is user-editable.

18.1.2. 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.

18.1.3. 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 14.3), you must select it on this tab in order for it to display in the message window.

18.1.4. Columns Tab

Here you decide which columns to include in the message window:

- **Equipment:** The device that delivered the message.
- **Mobile 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 of message or event.
- **Message 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.
- **Time:** Timestamp of message.
- **Protocol:** The protocol to which the message belongs.

18.2. 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.

18.3. 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 13.2.1.3, page 182) are highlighted in red in the Layer 3 Messages window. Further, an explanatory string is added to the plain-text decoding of such messages.

18.4. Message Window Catch-up

If you open a new message window when in replay mode, the new window will catch up and load all data from the beginning of the logfile.

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 disconnected 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.

18.5. 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 rules:

- 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 in time are selected and colored gray. (If no such rows exist, nothing is selected in the window.)

18.6. Freezing a Message Window

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.

This works in both drive testing mode and replay mode.

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.

In replay mode, if you have frozen a message window, stopped the replay, and then resume replaying of the logfile, the message window “wakes up” automatically.

18.7. Window-specific Features

18.7.1. IP Analysis Window

The protocol analysis function in the IP Analysis window is turned off by default. To turn it on, do as follows:

- From the Navigator, open the General window.
- In the General window, double-click the item “Data”. A Properties dialog appears with a tab named “IP Analysis”.
- In the Packet Capture section, change the setting to On.
- The Packet size parameter 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.
- Click OK to exit the dialog.

18.7.2. 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.

19. Video Streaming and the Video Monitor (UMTS)

TEMS Investigation supports streaming of video recordings through UMTS phones. 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 phones.

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.

19.1. How to Test Video Streaming

To test the video streaming service, you need a phone capable of handling this service. All UMTS phones sold with TEMS Investigation 9.0 possess this capability.

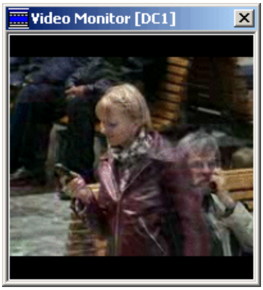
The mechanics of setting up and conducting a streaming session are handled by the Video Streaming command in the Command Sequence tool: see section 12.11.2.7, page 158.

Video clips suitable for testing are supplied on the installation CD in the subdirectory Video Clips. 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 29, page 305) will use a bit rate value received from the server, but the VSQI score will then be less accurate.

19.2. The Video Monitor

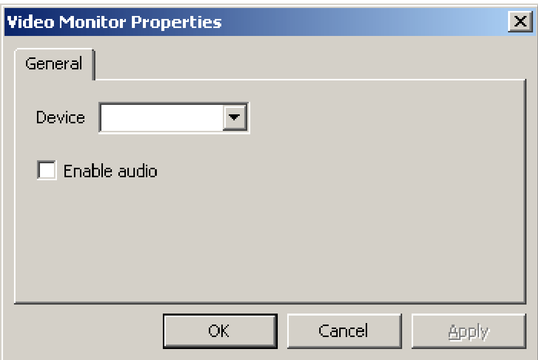
To display the streamed video clip, you use the Video Monitor:



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 phones simultaneously and monitor information elements and events for all these sessions in other presentation windows.)

19.2.1. 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.

19.3. Evaluating Video Streaming Performance

Throughput and other generic performance measures are recorded for video streaming (as for other data services) in the information elements belonging to the “Data” category: see Information Elements and Events, section 3.5.

This category also contains some elements which are specific to video streaming:

- Session Current Packet Loss (%). This is of interest primarily for streaming, since this is the only supported service for which the received signal is presented in real time in TEMS Investigation.
- VSQI Realtime Score and VSQI Intermediate Score. VSQI (Video Streaming Quality Index) is a quality measure developed by Ericsson specifically for estimating the viewer-perceived video and audio quality of a video streaming session. It is described in more detail in chapter 29, page 305. VSQI is also the subject of a technical paper which includes general discussions of video streaming as well as video quality measurement. It is found on the installation CD in the subdirectory Documents.

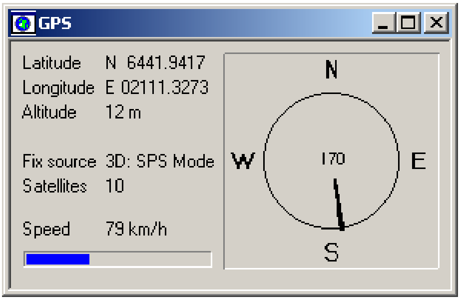
One streaming-related event, Streaming State Changed, is provided for monitoring the doings of the streaming video client. See Information Elements and Events, section 7.4.

19.4. Troubleshooting Video Streaming

- UDP ports for video streaming must be free. See the Getting Started Manual, section 3.9.
- Testing of video streaming with TEMS Investigation requires that RTP/ UDP traffic can be run with the phone 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 Analysis window. See Information Elements and Events, section 8.3.3.

20. The GPS Window

This window shows information from the GPS unit. Exactly what information is shown 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)

20.1. Changing GPS Window Properties

The GPS window can be configured to show only the parameters that interest you:

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. [a]

a. This option exists to allow presentation of positions incorrectly regarded by the GPS as invalid.

Time Tab

Offset to GMT	When a GPS unit is connected, the offset to GMT is automatically entered to synchronize to the current time zone. It is possible to change this offset if necessary. Click the Set PC Clock button to set the PC clock according to GPS time, plus/minus offset (if any).

Datum Tab

On this tab you can convert GPS data to a different geodetic datum in the presentation in case your map and your GPS use different datums.

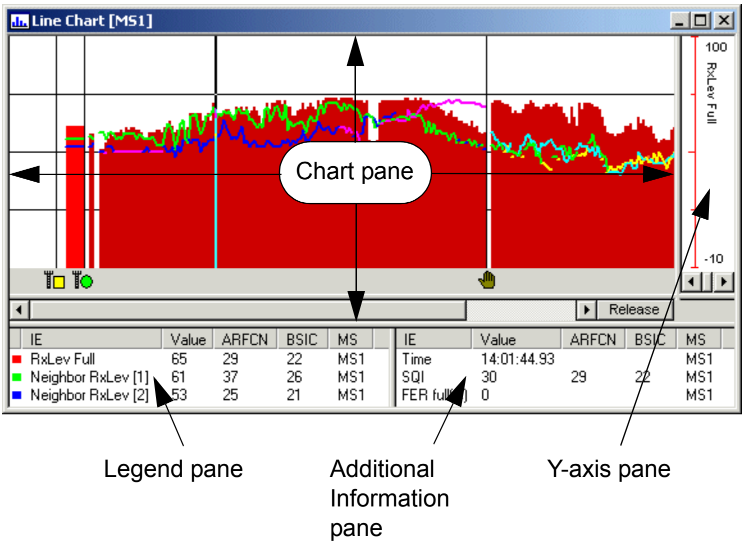
Datum Before Conversion	The datum used by the GPS. Most GPS units use WGS 84 (including all those recommended for use with TEMS Investigation; see the Getting Started Manual, section 4.1.4). Normally, therefore, this setting does not have to be changed.
Datum After Conversion	The datum to convert to (the one used by the map). First select the correct region, then the datum.

21. 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, section 8.5.

21.1. 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.

21.2. 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. Up to seven elements can be accommodated in each chart. 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 7. 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 15.3, page 212). Clicking somewhere in a replayed logfile segment in the chart (after stopping the replay) displays details about the chosen instant in the two text panes. You can also move backwards and forwards in a replayed 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.

You can freeze the line chart during recording or replay by clicking the Hold button. Clicking the button again (now labeled Release) makes the chart catch up with the presentation in the other windows.

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.

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 21.4.3, page 237 ("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 21.4 under **Additional Information Tab**, page 239. 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.

21.3. Time Scale

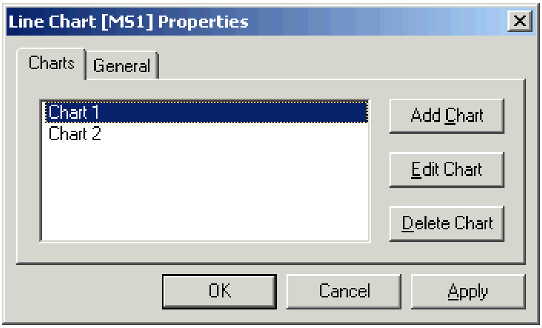
The horizontal axis of the line chart does not have an exact time scale, and so is not labeled with a unit of time. However, as a rule of thumb, two points are plotted each second both in idle and dedicated mode.

(GSM:) If the phone 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.

21.4. 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.

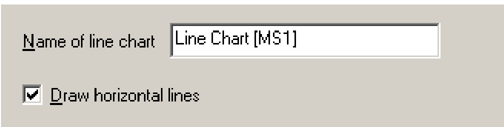
21.4.1. Adding Charts



- To add a new chart in the Line Chart window, click Add Chart.

21.4.2. Editing General Properties of a Chart

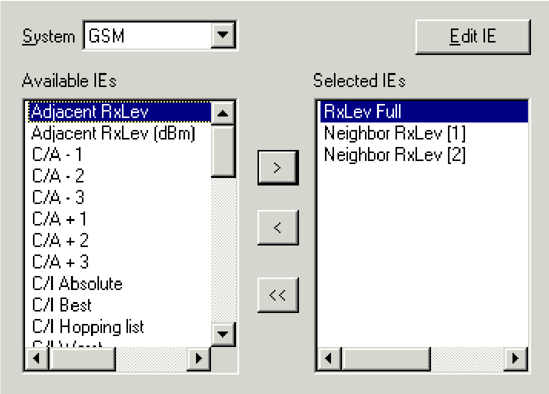
On the General tab of the Line Chart Properties dialog, you can edit the line chart window name and deselect the horizontal grid lines which by default are drawn in the background.



21.4.3. 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

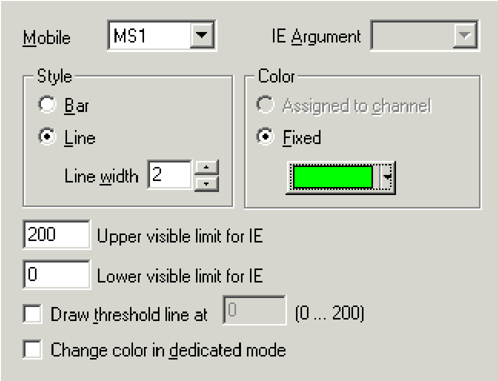
Here you edit the set of information elements to plot and how to present them. The information elements that can be plotted are chiefly those that represent or are derived from measured physical quantities (e.g. signal strength). Flags, frequency and channel numbers, scrambling code indices, timeslot 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 Ctrl and Shift 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 21.4.4, page 239.
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...”, above.
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 phone 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 event 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

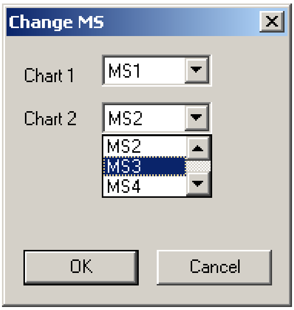
Here you choose the information elements to view in the Additional Information pane. This tab works exactly like the Information Elements tab, except that here any information element can be selected.

Clicking the Edit IE button in this case naturally only enables you to change the device and argument, since the additional information is presented only as text and not graphically.

21.4.4. 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 21.4.3. 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.)

21.4.5. Deleting a Chart

- In the Line Chart Properties dialog, select the chart you want to delete and click the Delete Chart button.

21.5. Exporting the Line Chart Window

The line chart window can be exported separately to a file with extension .lch. See section 15.6, page 213.

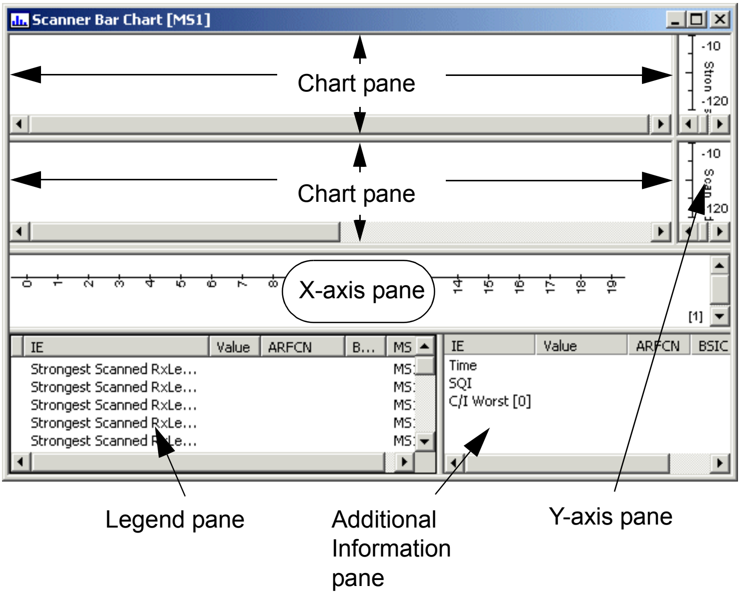
22. Bar Charts

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 chart 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, section 8.6.

22.1. 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 indices 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.

22.2. 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 15.3, page 212.

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 22.4.2.

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 22.4.1.1 ("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.

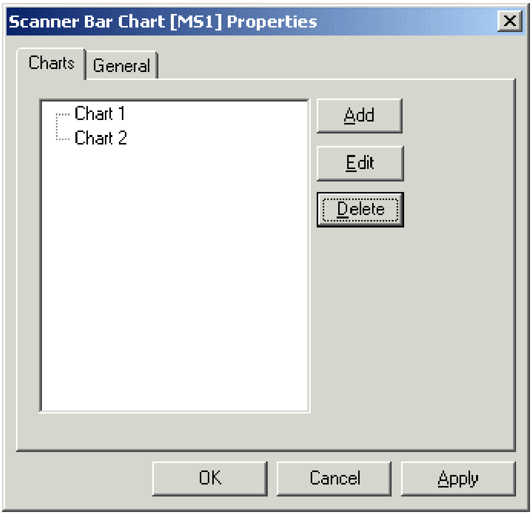
The Additional Information Pane

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 22.4.3.

22.3. 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.

22.3.1. Adding Charts



To add a new chart in the bar chart window:

- Click Add.

22.3.2. Deleting a Chart

To delete a chart:

- In the Bar Chart Properties dialog, select the chart you want to delete and click the Delete button.

22.3.3. 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.

22.4. 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.

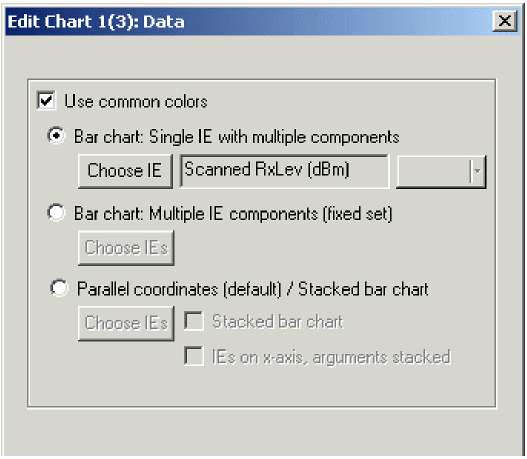
You will now work through a sequence of three dialogs. In doing so you specify

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 22.4.1–22.4.3. Examples of bar chart presentations are found in section 22.5.

The first dialog that appears is this:

22.4.1. Presentation Mode, Data, Colors



In this step you select the following (full details on subsequent pages):

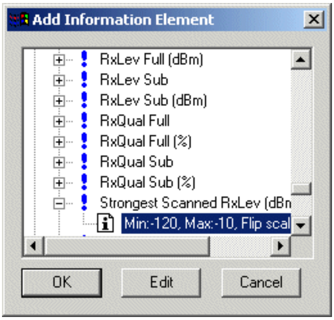
- *Presentation mode.* The bar chart is very flexible in that it can be configured in a variety of ways. These fundamental presentation modes are offered:
  - Bar chart: Single IE with multiple components
  - Bar chart: Components from multiple IEs (fixed set)
  - Parallel coordinates presentation/Stacked 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, C/A, SQI, TA). Flags, (U)ARFCN 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 4.2, page 28).

22.4.1.1. 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.

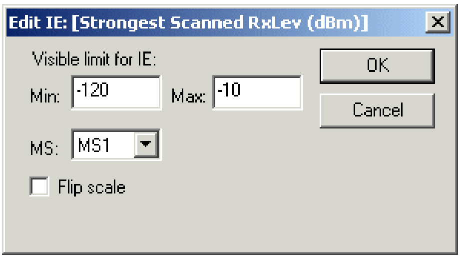
It is possible to dynamically adjust the number of components to show, by making it dependent on another (suitably chosen) information element: see section 22.4.2.

- 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 Add 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.

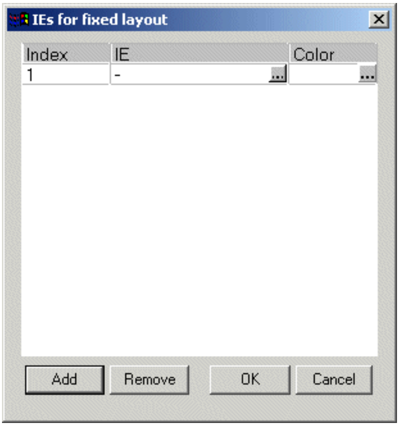
For an example of a Single IE presentation, see section 22.5.

22.4.1.2. 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:



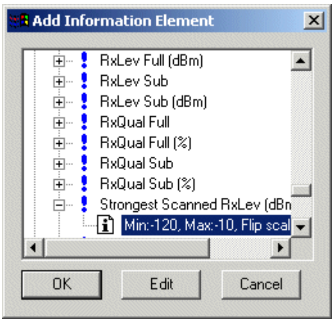
Here, a varying number of information elements may already be listed, depending on the type of bar chart concerned (template or predefined, etc.).

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.

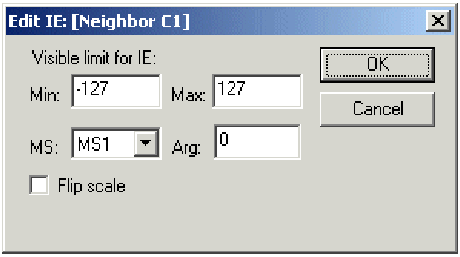
- To specify the data that should be represented by a bar (i.e. an index on the x-axis), click the ... button in the IE column, in the relevant table row. To add a new bar, click the Add button. A new row will then be inserted at the bottom of the table once the contents of the bar have been specified.

In either case, the Add Information Element dialog appears:



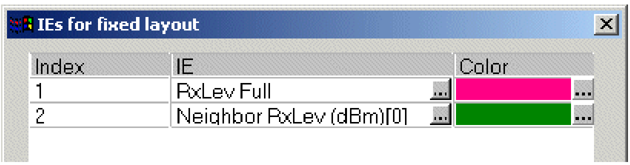
- Select an information element.

- Double-click the item (or click the Edit button):



- Specify range and scale properties, as described for the Single IE presentation mode (see page 246).
- If the information element is one with arguments, pick an argument.
- Click OK to exit the Edit IE dialog.
- Click OK in the Add 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.

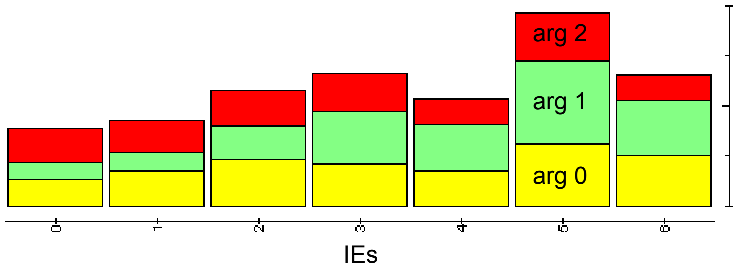
For an example of a Multiple IE Components presentation, see section 22.5.

22.4.1.3. Parallel Coordinates/Stacked Bar Chart Presentation Mode

This presentation mode is the most complex one. It has the following fundamental properties:

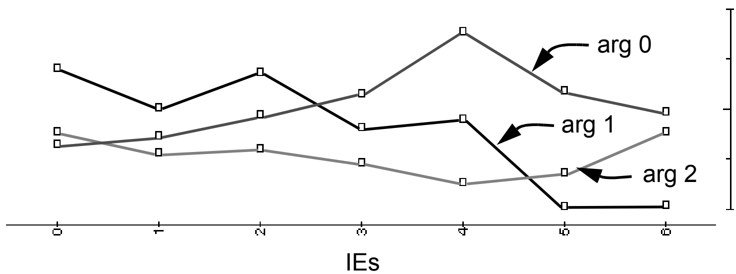
- A set of information elements is shown.
- Each information element may have arguments, and an arbitrary number of components of each element may be shown at the same time. The information elements are distributed on the x-axis, and arguments are displayed in the y-direction.
- There are two graphical 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:



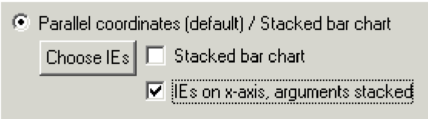
The parallel coordinates presentation is selected by default in this mode.

Setting Up Basic Properties of the Presentation

To set up this presentation, proceed as follows:

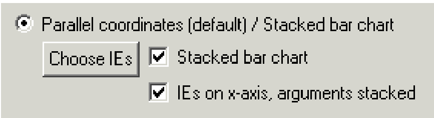
- Select “Parallel coordinates (default) / Stacked bar chart”.

If you want a *parallel coordinates presentation*, make 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:

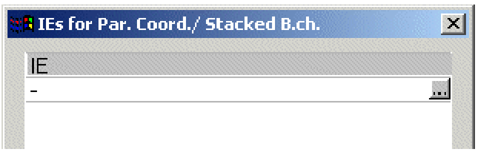


- Uncheck “IEs on x-axis, arguments stacked” if you want to reverse the roles of the axes so that arguments, rather than information elements, are distributed on the x-axis.

Selecting Data

After deciding the basic properties of the presentation:

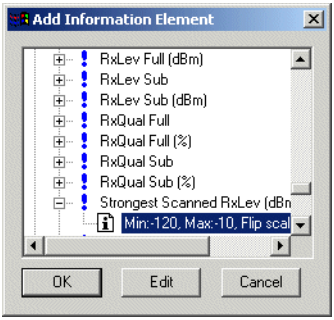
- Click “Choose IEs” to select your data. This dialog appears:



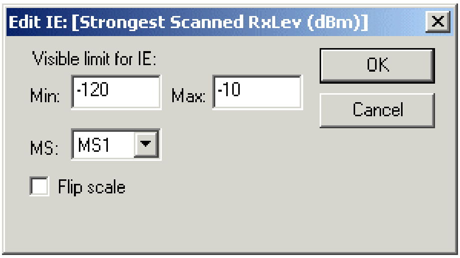
Here, a varying number of information elements may already be listed, depending on the type of bar chart concerned (template or predefined, etc.).

- 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 Add Information Element dialog appears.



- Select an information element.
- Double-click the item (or click the Edit button):

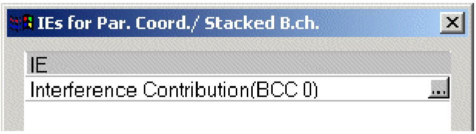


- Specify range and scale properties, as described for the Single IE presentation mode (see page 246).

> **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 Add 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:

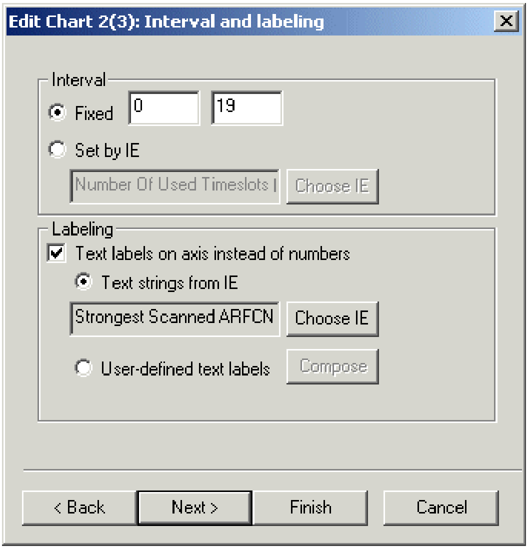
- Keep the default color ranges for the information elements. To this end check the Use common colors box.
- Use fixed colors, one for each argument. The colors are chosen by the application and cannot be edited. Choose this option by unchecking Use common colors.

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 22.5.

22.4.2. 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.

22.4.3. Additional Information

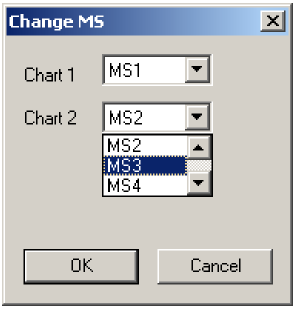
Here you choose the information elements to view in the Additional Information pane. This dialog works like the Information Elements tab in the line chart properties (see page 236), but since the additional information is presented only as text and not graphically,

- any information element can be selected
- clicking the Edit IE button only enables you to change the device and argument.

22.4.4. 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 22.4.1.1, page 246. Therefore, there is a shortcut for this operation.

- Right-click in the bar chart window. From the context menu, choose Change MS:

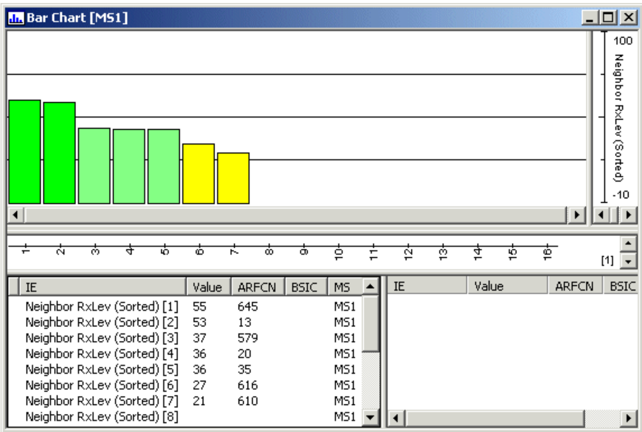


- For each chart, select the device to pick data from. (The information elements selected in the charts will be unchanged.)

22.5. Examples of Bar Chart Presentations

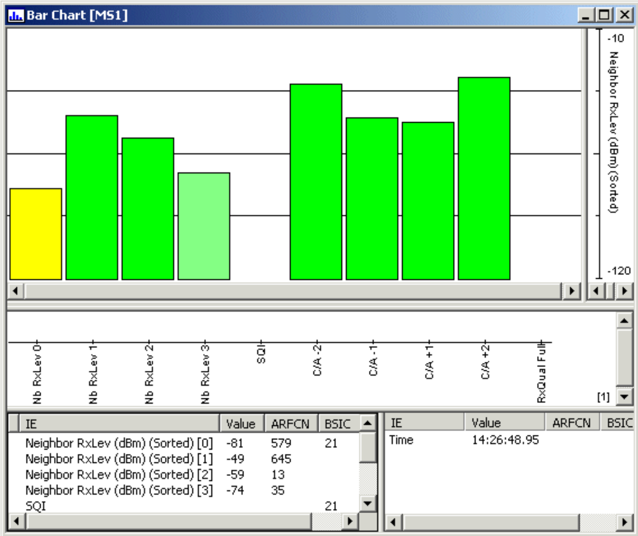
Here are a couple of examples of how the presentation modes can be used.

Single IE



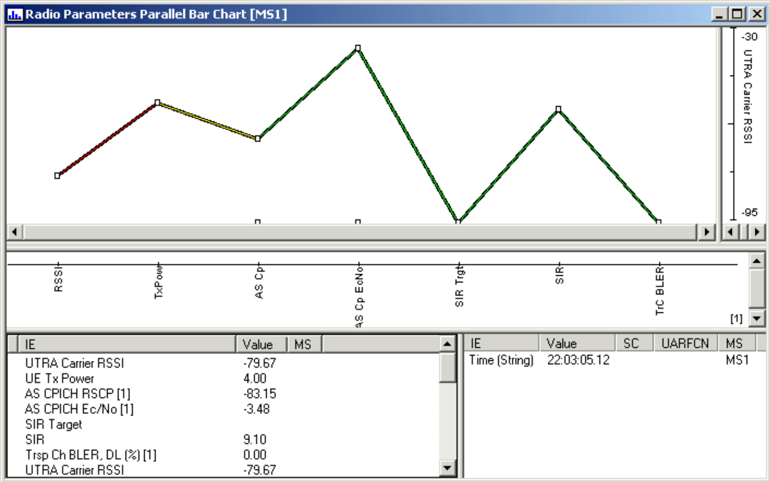
Single IE presentation: Neighbor RxLev (Sorted).

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. Note that only half of the legend is visible in the picture.

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 line, 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).

22.6. Exporting the Bar Chart Window

The bar chart window can be exported separately to a file with extension .bch. See section 15.6, page 213.

23. 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.

Map files used in TEMS Investigation Data Collection must be in MapInfo, bitmap, or uncompressed TIF format. Note also 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.

23.1. Highlights of This Chapter

This chapter contains a great deal of information, and you might not need all of it. The following sections, however, are central:

- First, to be able to use a map file in TEMS Investigation, you must work through some preliminaries which are described in sections 23.3–23.4.
- Then you can proceed to set up what data you want to present on the map. How to do this is explained in section 23.5, page 263. If you have loaded a cell file and want to view cell information, turn to section 23.5.5, page 269.

23.2. Map Concepts

In this section, some central concepts relating to Map windows are defined. You might want to skim this section the first time around to make yourself familiar with the concepts. The concepts are explained again as they are brought up later in the chapter; use this section 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, bitmap, and 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; a further layer is provided for pinpoint markers. 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.

23.3. Constructing a GeoSet from Map Files

A Map window in TEMS Investigation works with a GeoSet instead of an ordinary workspace. If you have a new map that you want to use in TEMS Investigation, you should 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.

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.

If your map is in bitmap format (extension .bmp), you must generate TAB files for it. This is done by positioning the map as described in section 23.4. If possible, avoid using 24-bit bitmap images as maps.

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.

- 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.

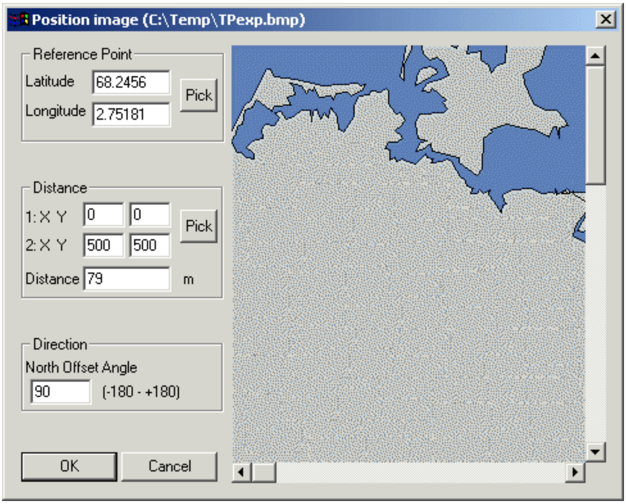
The map should now be displayed in the Map window. You are ready to start presenting data: see section 23.5.

> **Note:** 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 23.7.2, page 284.

23.4. Positioning Bitmap and TIF Maps

If you open a map in bitmap or uncompressed TIF format that has not yet been assigned geographical coordinates and scale information, you must supply this data yourself.

Click Position Map.



23.4.1. Specifying the Map Position

In this step you input the coordinates of a point on the map.

- In the Reference Point section, in the Latitude and Longitude fields, enter the coordinates (in decimal degrees) of the point you wish to use.
- Click the Pick button in the Reference Point section.
- On the map, click the point that has the given coordinates.

23.4.2. Specifying the Map Scale

In this step you indicate the distance between some two points on the map, so that the map scale can be calculated.

- In the Distance section, click the Pick button.
- On the map, click the first point and keep the mouse button down. When you move the mouse, a dashed blue line appears. Release the mouse button at the second point. The coordinates of the chosen points appear in the "X Y" fields.
- In the Distance field, enter the actual distance between the two points.

23.4.3. Setting the Map's North Direction

What remains is to indicate the north direction of the map.

- In the Direction section, in the North Offset Angle field, enter the offset between the map's x-axis and its direction of north. For example, if the map is oriented with north pointing up, enter 90°. The offset lies between –180° and +180°, a positive number indicating a clockwise offset.
- Click OK.

Your map is now positioned. A file with the same name as the image but with the extension .tab is created. The *.tab file is the map file you will use from now on.

23.5. Presenting Data: Themes

This section describes how to present cellular network data on the map.

In short, 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 23.7, page 283.

23.5.1. Themes and Theme Types

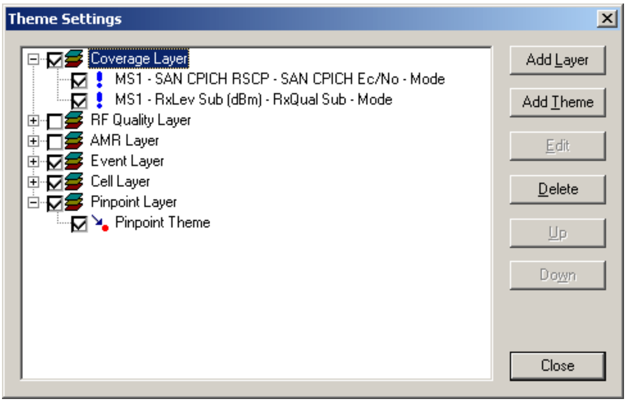
A theme is basically a bundle of settings describing how to present a set of data. These are the main types of theme, each presenting a different kind of data:

- *information element (IE) themes,* presenting a set of information elements (at most three); see section 23.5.3, page 265
- *event themes,* presenting an event; see section 23.5.4, page 268
- *cell themes,* presenting cell information; see section 23.5.5, page 269. There are several subtypes of cell theme.
- the *Pinpoint theme,* presenting pinpointing information; see section 23.5.6, page 279.

23.5.2. 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:

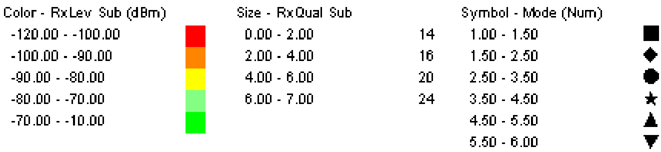
- IE themes in the Coverage, RF Quality, and AMR layers
- event themes in “Event Layer”

- cell themes in “Cell Layer”
- the pinpoint theme in “Pinpoint Layer”.

You can add new presentation layers if desired. How to manipulate layers is the subject of section 23.7.

23.5.3. 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 phone is in idle mode, dedicated mode, and so on:

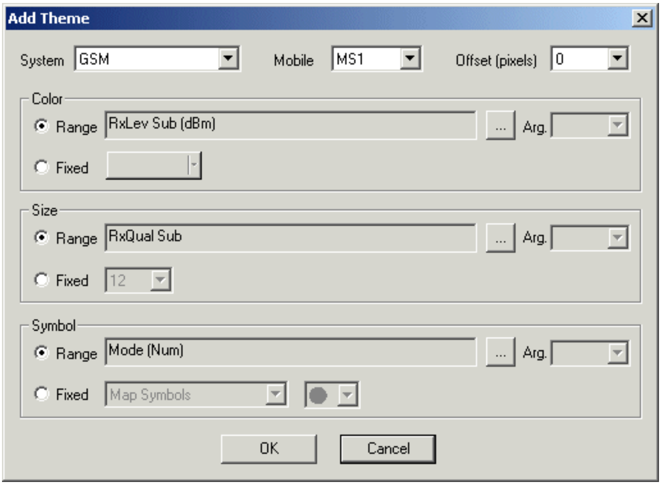


More generally, it is appropriate to use the color and size attributes for information elements with a continuous value range, and to use a suite of symbols for such things as status parameters having a small set of possible values.

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 4.2, page 28. 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 23.7).
- 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 23.5.3.1 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.

23.5.3.1. 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 phone switches to a different RAB).
- *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.

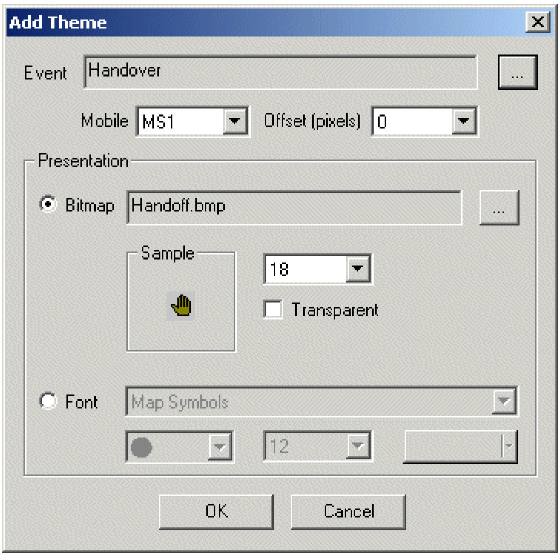
- *Map zoom.* The plotting density on the map is dependent on the current zoom of the Map window. When you zoom in, more markers are filled in to show the route in more detail; when you zoom out, markers are drawn more sparsely. Specifically, a new theme object (whether a symbol or a line) is drawn next to the latest one if the centers of the two objects will be more than 5 pixels apart on the screen.

23.5.4. 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 23.5.3. 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 as event symbol. Select a bitmap and set its size.
Transparent	Check if you want to use a transparent symbol: • If Transparent 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 Transparent 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.

23.5.5. Presenting Cell Information[1]

To present cell information, 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 23.5.2.)

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

1. This presentation also applies to Wi-Fi access points defined in an XML cell file (see the Route Analysis User’s Manual, appendix D.7.7). Where the presentation differs between cellular technologies, Wi-Fi follows GSM, with the obvious exception of GSM-specific information such as the Cell ARFCN theme.

the creation of cell themes displaying arbitrary groups of cells. See section 23.5.5.1 below.

How to load cell files is described in section 5.3, page 33. It is possible to have more than one cell file loaded.

The following kinds of cell theme exist:

- Basic plotting of cell sites (Cell theme): section 23.5.5.1
- Indication of serving cell and handover (Cell Line theme): section 23.5.5.2
- Visualization of neighbor relations (Cell Color theme): section 23.5.5.3
- *(GSM:)* Indication of cells using the same ARFCN as a given cell (Cell ARFCN theme): section 23.5.5.4

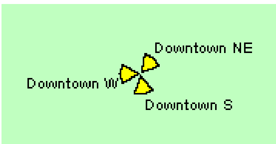
To create a new cell theme, proceed as follows:

- In the Theme Settings dialog, select "Cell Layer".
- Click Add Theme. The Select Theme Type dialog appears.
- Choose a cell theme type.

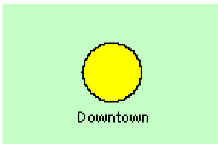
23.5.5.1. The Cell Theme

This theme is concerned with basic plotting of cell sites.

Presentation on Map



Three-sector site
(three cells)



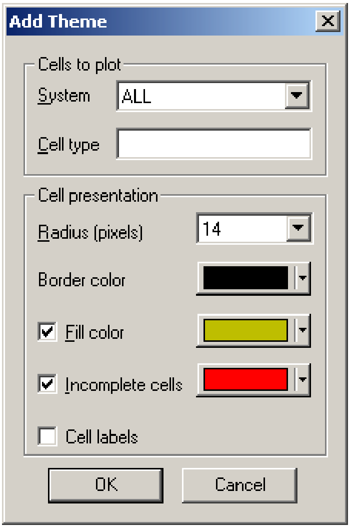
Omni cell

The zoom of the Map window does not affect this theme. All cell sites are always plotted, regardless of the zoom.

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 all of the remaining illustrations in section 23.5.5.

Note that certain cells are filled with other colors by other cell themes, which by default hide the Cell theme; see sections 23.5.5.3 and 23.5.5.4.

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 Route Analysis User’s Manual, appendices C and D.)

Cell type Type of cell indicated in cell file. In XML cell files this is identical with the CELL_TYPE element: see the Route Analysis User’s Manual, appendix D.7.10. 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 23.6. (However, this highlighting ceases to be visible if a Cell Color or Cell ARFCN theme is also displayed: see sections 23.5.5.3 and 23.5.5.4).
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 360º 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: • GSM cells: Cell name. • WCDMA cells: Cell name and SC. • CDMA cells: Cell name.

23.5.5.2. 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: phone or scanner.

Use with Phone Data

For a phone, this theme is used to indicate

- the serving cell (WCDMA/CDMA idle mode; GSM)
- 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 23.5.5.1).

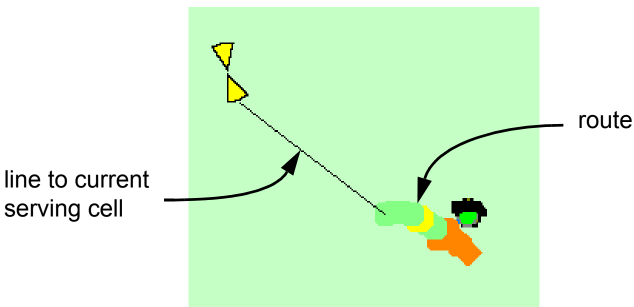
Use with WCDMA Scan Data

With WCDMA scan data, the Cell Line theme gives a *best server indication*. This points out the cell using the currently strongest scrambling code, as measured by the scanner. No interaction with the base station is involved (since the scanner lacks such capabilities); rather, GPS data and the contents of the information element Sc Best Aggr Ec (dBm) are correlated with the coordinates in the cell file, and the cell is identified which an UE at the same position would be most likely to use.

Use with CDMA Scan Data

The Cell Line theme works the same way for CDMA scan data as for WCDMA scan data (points out strongest pilot in terms of Aggregate Ec). See above.

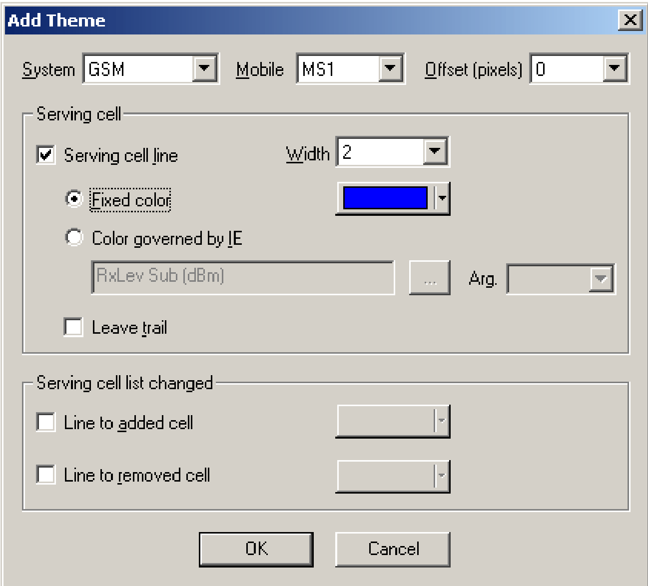
Presentation on Map



Like IE theme markers (section 23.5.3.1), 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 phone 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 23.5.3), 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 UE has moved on. 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. Available also for best server indications, although no actual handover is involved.

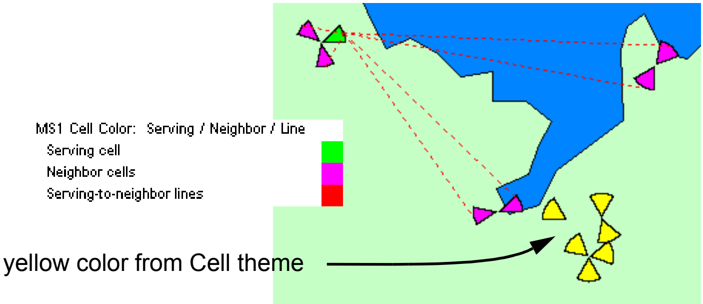
23.5.5.3. The Cell Color Theme

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 phone’s neighbor reporting. The only phone data fed into this theme is the serving cell data.

By default, therefore, in the realtime presentation as well as during logfile replay, the cell drawn in green will be the phone’s current serving cell. However, if you stop the replay and click an arbitrary cell, the theme will be displayed with that cell as serving cell instead, *independently* of the phone's interaction with the network.

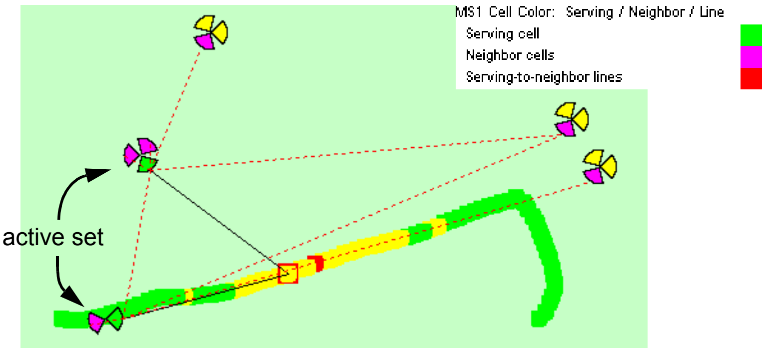
Presentation on Map

- GSM example:



Cell Color theme (no route).

- WCDMA example:

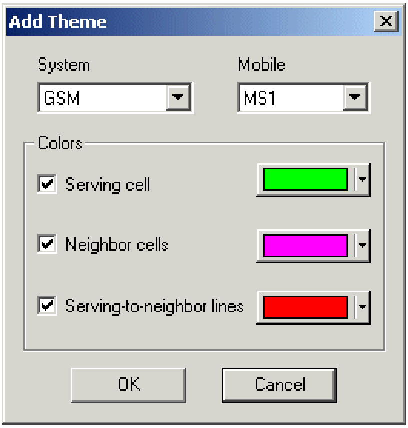


Cell Color and Cell Line themes. Active set members are pointed out by solid lines (black). Neighbors are indicated for all active set members (dashed red lines).

- 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 23.5.5.1). 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



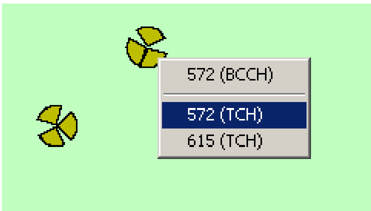
System	Not used; the choice does not matter.
Mobile	Choose the phone whose serving cell is to be displayed.
Colors: Serving cell	The fill color to use for the serving cell. If you uncheck this box, the cell is not drawn (and, by default, the version of it displayed in the underlying Cell theme will be 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	GSM: Check this to display dashed lines connecting the serving cell with each of its neighbors. WCDMA/CDMA: Check this to display, for each active set member, dashed lines connecting the active set member with each of its neighbors.

23.5.5.4. 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 replay of old logfiles containing interferer identification data is still supported.

To display the theme, do as follows:

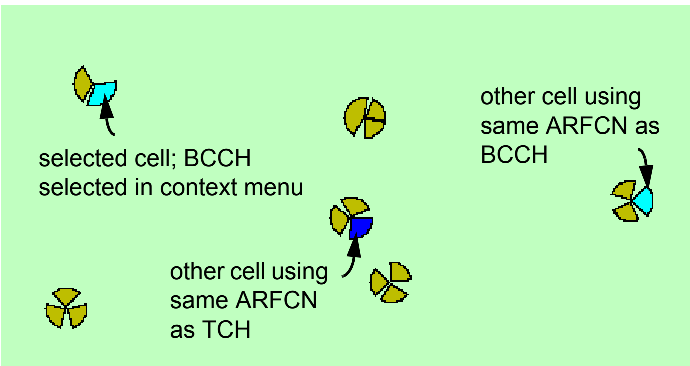
- Right-click the cell of interest. A context menu appears, listing the BCCH and the TCHs that it uses. Choose the ARFCN that you want to search for among other cells:



By default, matching cells are colored as follows:

- Cells that use the selected ARFCN as BCCH are colored cyan (light blue).
- Cells that use the selected ARFCN as TCH are colored blue.

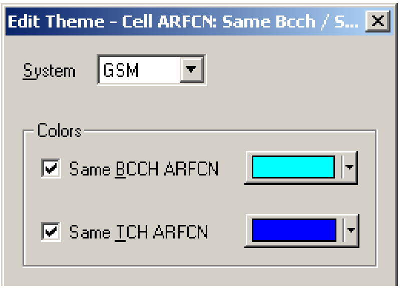
Presentation on Map



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



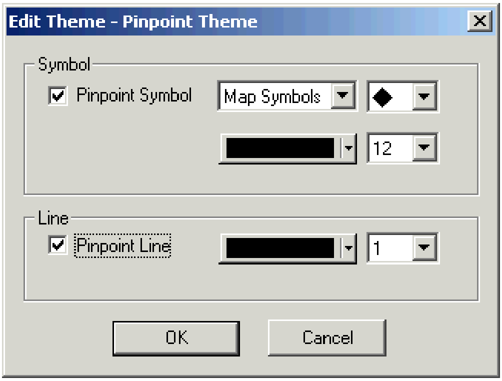
System	Not used; the choice does not matter.
Same BCCH ARFCN	The fill color to use for cells that use the selected ARFCN as BCCH.
Same TCH ARFCN	The fill color to use for cells that use the selected ARFCN as TCH.

23.5.6. Presenting Pinpointing

The Pinpoint theme presents the markers that you create when using pinpointing rather than a GPS to position data (section 7.1.4, page 53).

> **Note:** The Pinpoint theme is needed in order for the pinpointing mechanism itself to work. Therefore, this theme should never be removed.

The following properties can be edited for the Pinpoint theme:



Symbol	Type, size, and color of waypoint symbols.
Line	Color and width of lines connecting waypoints.

23.5.7. Editing Themes

To edit a theme:

- In the Theme Settings dialog, select the theme you want to edit.
- Click Edit.

23.5.8. 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 23.7).

23.5.9. 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 themes (section 23.5.5).

23.5.10. Deleting Themes

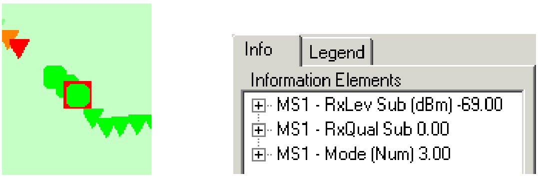
To delete a theme:

- In the Theme Settings dialog, select the theme you want to delete.
- Click Delete.

23.6. The Right-hand Pane

23.6.1. 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.

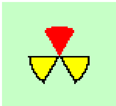


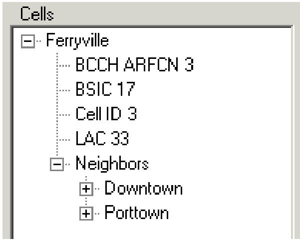
IE marker

Event marker

For cells, a selection of cell and channel parameters are shown, along with the cell's defined neighbors (the red cell is highlighted):

1. Exception: If a Cell Color theme is active, the selected cell is presented as a serving cell and is colored green.





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 23.6.2.

23.6.2. 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 using Ctrl + click or Shift + click.)

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 both during recording and during replay. During replay, the statistics cover only the part of the logfile that has been replayed and plotted so far, not the entire logfile. On the other hand, it should be noted that the plotting may be more or less thinned out (see section 23.5.3.1), so that more data goes into the statistics than actually appears on the map.

23.6.3. 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.

23.7. Layers

Section 23.5 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.

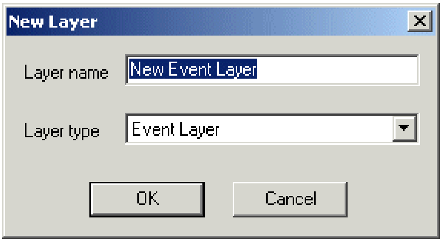
23.7.1. Adding Presentation Layers

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 23.5.1.

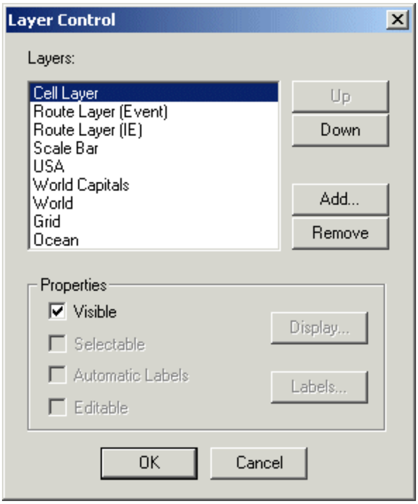
23.7.2. Layer Control

The Layer Control 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 23.10, page 288).

- 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 23.5.8).
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.

23.8. Map Context Menu

When you right-click in the map, a context menu appears with choices as described below.

23.8.1. 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).

23.8.2. Previous View

This command returns you to the previous map view. (No further history of views is maintained, however.)

23.8.3. 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.

23.8.4. Setting the Map Projection

This command allows you to set the map projection. It should be the same as in the cell file.

23.9. 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 previously been 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 23.3 and 23.10.

 **Open Map:** Open a map.

 **Position Map:** Position a map which is in bitmap or uncompressed TIF format. See section 23.4.

 **Layer Control:** Manage layers or change displaying or labeling properties. Changes are only temporary and cannot be saved. See section 23.7.2. To make changes to the GeoSet, use the GeoSet Manager's layer control; see section 23.10.1.

 **Add/Edit Themes:** Add or remove presentation layers, or add, edit or remove themes. See section 23.5.

 **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 23.6.2).

 **Area Statistics Tool:** Click and drag to view statistics for presentation layer objects within a rectangle (see section 23.6.2).

 **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.

Clear Map: Remove all the information in presentation layers from the map, except cell site information.

The following buttons can only be used 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.

23.10. 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.

23.10.1. Layer Control

The Layer Control works the same way as in Map windows. See section 23.7.2.

23.10.2. 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.

24. The General Window

In the General window, found in the Navigator’s 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.

25. Key Performance Indicators – KPIs (UMTS)

TEMS Investigation Data Collection offers a set of KPIs (Key Performance Indicators) for measuring the user-perceived performance of a number of circuit-switched and packet-switched services.

The present chapter gives an general discussion of KPIs as well as an overview of how to obtain them with the application. Listings and brief definitions of the KPIs are found in appendix G, page 347. Full detail on technical matters is given in separate documents which are found on the installation CD in the subdirectory Documents.

In the present version of TEMS Investigation, KPIs can be computed for GSM and WCDMA.

25.1. Purpose of KPIs

All KPIs have been designed according to ETSI TS 102 250-2 V1.4.1 for performance measurements, that is, to measure *accessibility*, *retainability*, and *integrity*.

25.1.1. 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.

25.1.2. 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.

25.1.3. 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.

25.2. Obtaining KPIs in TEMS Investigation

25.2.1. General Procedure

To obtain KPIs, perform the following steps:

1. Write a *command sequence* containing one or several KPI commands, enclosed by Start Recording and Stop Recording. See chapter 12, page 137, and particularly section 12.13, page 163.
2. *Run* the command sequence in order to measure KPIs and record the measurements in a logfile.
3. *Export* the logfile as "KPI samples". The output from the export is one or several XML files. See section 7.5, page 59. Here you can choose between two slightly different methods of KPI measurement.[1]
4. Generate a *KPI report*, using the output from the logfile export. This produces an XML-format summary of the KPI measurements, consisting of statistics and charts. An XML stylesheet is supplied so that the report can be viewed directly in a web browser. The general layout of the report is similar to that of the ordinary logfile report in Data Collection. See section 7.7, page 74.

25.2.2. Points to Bear in Mind

A couple of things must be observed when recording KPI data:

- For services other than voice and video telephony, both the MS and the DC device need to be connected. Furthermore, for a given phone, it is essential that both associated devices have the same number (MS1 and DC1, etc.). When phones are autodetected, the required assignment is produced automatically. If devices are assigned differently, the KPI measurements will not be correct.
- The Swap Logfiles function (section 7.1.2, page 52) must not be used when recording KPIs. This is because all input to a KPI computation must be obtainable in a single logfile.
- 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 on the installation CD in the subdirectory Documents.

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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)."

26. Speech Quality Index – SQI (UMTS)

TEMS products offer the quality measure SQI (Speech Quality Index) for estimating the downlink speech quality in a GSM or WCDMA cellular network as perceived by a human listener. SQI has been developed by Ericsson, and computing SQI requires data collected with Sony Ericsson phones.

This chapter examines the workings of the SQI algorithm. See also the document “Speech Quality Measurement with SQI” which is included on the TEMS Investigation installation CD in the subdirectory Documents.

26.1. Background

SQI is a long-standing feature of TEMS products. However, in this version of TEMS Investigation, the SQI algorithm has been completely reworked, although its fundamental function remains similar to that of the old one. The focus of this paper is to describe the new algorithm (called “SQI-MOS” in the application; see section 26.3). 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 will soon be available in mobile phones and networks, the SQI-MOS algorithm includes a model for rating wideband speech.

26.2. Input to the SQI-MOS Algorithm

SQI-MOS takes the following parameters as input:

- The *frame error rate (FER)*, i.e. the percentage of frames that are lost on their way to the receiving party, usually because of bad radio conditions.

  Frame errors also occur in connection with *handover*, and these are treated like any other frame errors by the SQI-MOS algorithm. It should be noted that in WCDMA, handover frame 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 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 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
- 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.

26.3. SQI-MOS Output

The SQI-MOS algorithm produces a new quality estimate at intervals of approximately 0.5 s. Such a high update rate is possible thanks to the low computational complexity of the algorithm.

1. In contrast, the old SQI algorithm includes a special “handover penalty” mechanism lowering the SQI score whenever a handover has occurred.

The output from the SQI-MOS calculation is a score on the ACR[1] MOS scale widely used in listening tests and familiar to cellular operators. The score is thus a value ranging from 1 to 5.

One thing that needs pointing out is 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 26.4.1.

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.

26.4. 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).[2] In fact, the SQI-MOS models have mostly been trimmed using PESQ scores, rather than actual listening tests, as benchmarks.[3] 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 26.4.1.

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. ACR stands for Absolute Category Rating: this is the “regular” MOS test where speech samples are rated without being compared to a reference.
2. See www.pesq.org.
3. 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 26.2).

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).

26.4.1. Notes on PESQ for 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; a mapping could then be applied to align the wideband scores to narrowband.

Unfortunately, things are not that simple. Wideband PESQ is much more sensitive to speaker bias than is narrowband PESQ (compare the introduction of section 26.4): at a fixed FER, wideband PESQ scores for

1. This is a phenomenon independent of the circumstances described in section 26.3.

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. The largest correction was applied to the clean-speech SQI-MOS score (i.e. at zero FER), while the rock-bottom SQI-MOS (the worst possible score, attained at very high FERs[2]) was left unchanged.

26.5. Comparison with Other Radio Parameters

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 (see 3GPP TS 45.008, section 8.2.4), it cannot of course provide more than a rough indication of speech quality.

1. See 3GPP TR 26.975, “Quality in Clean Speech and Error Conditions”, v7.0.0.
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.

27. Audio Quality Measurement (AQM) including PESQ

Audio quality measurement, including PESQ, can be purchased as an option with TEMS Investigation. It can be performed in GSM, WCDMA, and CDMA networks.

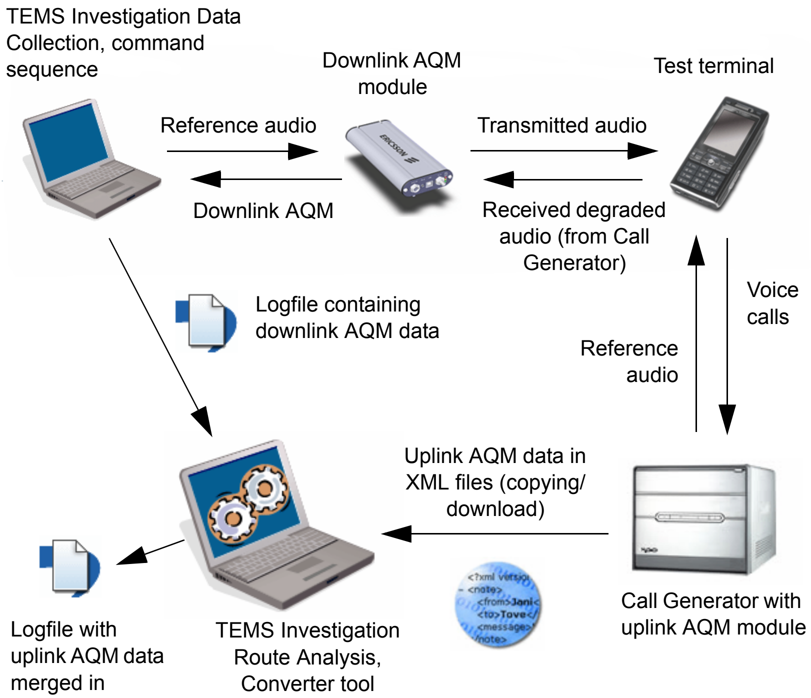
PESQ, short for Perceptual Evaluation of Speech Quality, is the industry standard for voice quality measurement. The PESQ algorithm measures end-to-end speech quality by comparing one party’s undistorted input signal (serving as reference) with the degraded version of the same signal received by the 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 standard P.862. For in-depth information about PESQ, see also www.pesq.org.

27.1. Audio Quality Measurement in TEMS Investigation

In TEMS Investigation, audio quality measurements are made during mobile-originated voice calls made from a phone to a component known as the Call Generator[1]. The actual computation is done in dedicated hardware units called AQM modules: one connected to the phone and to the PC, handling the downlink; and one housed in the Call Generator, 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. This name has been taken over from a similar system component used in TEMS Automatic. In TEMS Investigation, the component currently does not generate calls but merely receives them.



- The speech segments to be used as references are loaded into the AQM modules and into the test phone.
- The phone calls the Call Generator and plays the reference sentences. The Call Generator 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: echo delay, echo attenuation, and volume. See Information Elements and Events, section 4.3.8.
- 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 Converter tool is used. See the Route Analysis User’s Manual, chapter 17.

27.2. Obtaining and Presenting AQM Data

Here is an overview of how to record and present audio quality measurements in practice.

27.2.1. Prerequisites

You need to possess the following:

- License for collecting AQM data: see the Getting Started Manual, section 2.3.2.
- Phone supporting audio quality measurement: one of those listed as AQM-capable in the Getting Started Manual, section 4.2.
- One or several downlink AQM modules (either standalone units or DSP cards mounted in an equipment case). One AQM module is required for each phone that you want to measure AQM with.
- Call Generator for calculation of uplink AQM data.

27.2.2. Practical Considerations

- An external antenna must be used with the phone during collection of AQM data. Using the phone’s built-in antenna would interfere with the DSP in the AQM module. (The above applies regardless of whether your AQM module is standalone or mounted in an equipment case or backpack. For drive testing, mounting the antenna on the car roof will provide sufficient distance and shielding. The TEMS Indoor Backpack has a metal plate at the top which is intended for mounting of external antennas.)
- 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.

27.2.3. 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 command sequence containing a Dial command with Call Type = “Voice + AQM”, instructing the phone to make a voice call to the Call Generator (identified by its phone number). See section 12.8, page 145.
  - If you wish to synchronize AQM calls from multiple phones, use the Synchronize command in the sequence; see sections 12.6, page 143 and 12.14, page 164. Note that all of the calls must be handled in the same sequence to enable synchronization. To also make all calls terminate at the same time, simply use the same call duration for all phones.
  - Use the Start Recording and Stop Recording commands as usual to have the calls recorded in a logfile.
- Connect your AQM equipment case (or alternatively your phone and standalone AQM module) to the PC and point to the requisite driver files as described in the Getting Started Manual, section 5.5.7.
- Associate the phone with the AQM module in the Equipment Configuration dialog: see section 6.8.5.2, page 46. 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 6.8.5.3, page 47.
- 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 command sequence and record your logfile or logfiles.

27.3. Merging Uplink AQM Data into Logfiles

After completing your measurements, use the Converter tool to merge the uplink AQM data (recorded by the Call Generator) into the logfile, which already contains the downlink AQM scores. See the Route Analysis User’s Manual, section 17.2. Note that this task does not require an AQM license.

27.4. Presenting AQM Data

27.4.1. Information Elements

All AQM data is available as information elements, so that they can be included in any presentation.

Status windows named Speech Quality are provided where all AQM information elements (as well as some other data) are presented.

When viewing (downlink) AQM data in real time, or when replaying a logfile where the uplink AQM data has not yet been merged in, you must keep in mind that this data will lag behind other information elements because of the processing delay in the DSP. The offset is 5.5 s, or one speech sentence. Downlink Frequent AQM is not displayed at all prior to merging.

When you merge the uplink AQM data into the logfile, the 5.5 s offset is removed so that all data is correctly aligned.

See also the Route Analysis User’s Manual, section 17.2.3.

27.4.2. PESQ Key Performance Indicator (KPI)

A PESQ-based KPI is provided. See appendix G.2.5, page 349.

28. 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. The VTQI algorithm has been developed by Ericsson. How it works is the subject of this chapter.

See also the document “Video Telephony Quality Measurement with VTQI” which is included on the installation CD in the subdirectory Documents.

28.1. General Properties of VTQI

Like SQI (chapter 26), 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 29.4.1).

28.2. 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 current implementations 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.

28.3. 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.

28.4. 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.

29. 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, which has been developed by Ericsson.

See also the document “Video Streaming Quality Measurement with VSQI” which is included on the installation CD in the subdirectory Documents.

29.1. General Properties of VSQI

Like SQI (chapter 26), 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”.

29.2. 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 29.4.1.

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).

29.3. 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 29.2 above), however, even slight problems with blockiness, jitter, and so on will still be noticed by the algorithm and affect the VSQI score.

29.4. Static and Dynamic VSQI

Two versions of the VSQI algorithm have been devised: one static and one dynamic version.

Static VSQI is presented in Session End reports concluding streaming sessions (Data Reports message window). It does not appear as an information element. Dynamic VSQI, on the other hand, is contained in the information element VSQI Realtime Score.

29.4.1. 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 is naturally not affected by this limitation.)

29.4.2. Dynamic (Realtime) VSQI

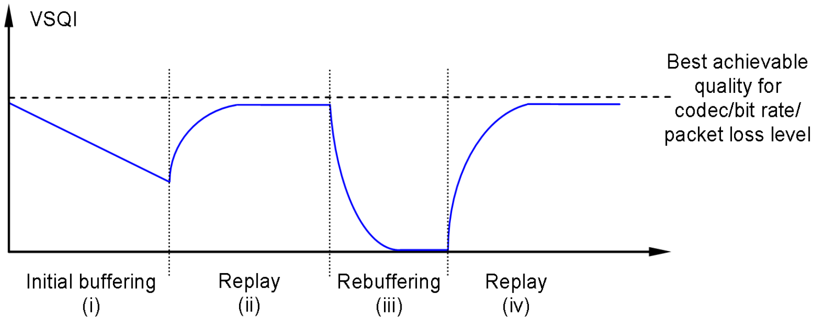
The dynamic or realtime version of VSQI estimates the quality of a streaming video clip as perceived by viewers at a moment in time. It is updated regularly – at intervals of the order of 1 s – while the video clip is playing. Each VSQI output value is dependent on the recent history of the streaming 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.

30. 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.

30.1. Why 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.

30.2. 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 26, page 293). In this way, areas with inadequate quality can be identified. However, if frequency hopping is used in the network, it is difficult to pinpoint 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.

30.3. 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.

30.4. 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.

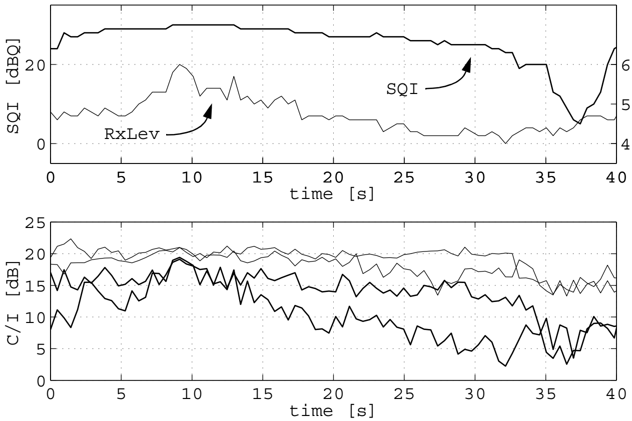
If true C/I is within the range 0 to 15 dB, and four frequencies are used for transmission, and there are no DTX interruptions, the measurement error is typically smaller than 1 dB.

30.5. 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.

31. Uplink (MTR) Data (GSM)

This chapter explains the concept of uplink data and points out the benefits of utilizing such data in the network analysis.

31.1. Uplink Data: MTR Files

In cellular networks using infrastructure from Ericsson, it is possible to record so-called MTR files. The MTR (Mobile Traffic Recording) function traces the behavior of an individual phone by recording event data produced in the Base Station Controller (BSC), as well as measurement data from the BTS and from the phone itself. The phone-originated data is also a subset of what is found in the TEMS logfile, although in the MTR file it is not tagged with any positioning information. The remainder of the MTR file data is referred to as "uplink data" within the TEMS Investigation framework, and MTR files are called "uplink files" in this manual outside the present section, unless characteristics specific to MTR files are dealt with. It should be noted that MTR files contain no idle mode data, but only data from calls. In general, one MTR file is generated for each call.

MTR files can be recorded for voice calls only, not when running a data service.

This manual does not go into the details of obtaining and transferring MTR files. In the instructions given here it is assumed that you already have the requisite MTR files stored on your computer.

At present, TEMS Investigation is not capable of reading uplink data from other manufacturers' equipment.

31.1.1. Supported MTR File Versions

All R6.x, R7, R7.1, R8, and R10 versions as well as MTR 2005 in binary format.

31.2. Utilizing Data from Uplink Files

Uplink files can be replayed as-is in TEMS Investigation. They can however also be merged with the corresponding TEMS logfiles, producing output in the form of an augmented logfile which can be replayed in the usual manner. (See section 31.3 below.) The contents of the uplink file can thus be viewed concurrently with the downlink data recorded in the TEMS logfile. A further advantage of merging the files is that geographic positioning can be obtained for the uplink data.

The uplink data is presented as a separate class of information elements; see section 31.4.

The benefit of studying uplink data is that it yields a clearer picture of what is going on in the network and thus permits the network analyst to draw more informed conclusions. Handovers are a case in point, as is discussed in the following section.

31.2.1. Uplink Data on Handovers

Decisions about handovers are made for the phone by the network (normally in the BSC), and not by the phone itself. The phone contributes in the decision-making process by reporting the signal strength of neighboring cells, but the network bases the final handover decision on other information as well (independent measurements of signal strength, and also estimates of radio quality and timing advance). Now, the TEMS logfile only contains the phone's own "advisory" measurements, whereas the uplink file includes the final decision arrived at by the BSC (expressed as ranking of neighbors). Therefore, the uplink data shows more clearly how the phone interacts with the network.

31.3. Merging Uplink Files with TEMS Logfiles

Merging and synchronization of the two file types are carried out from the Export Logfile window. Refer to section 7.8, page 76 for a complete description of this procedure.

31.4. Presentation of Uplink Data

The uplink data is available as a separate class of information elements – the "GSM Uplink" category on the Navigator's Info Element tab. There are status windows, a message window, and a line chart dedicated to presenting this data. See Information Elements and Events, sections 8.1.3, 8.3.1, and 8.5.2.

A full listing of information elements culled from the MTR file is found in Information Elements and Events, section 3.6.

Note: For MTR files, the “GSM Uplink” category in fact also includes the downlink data found in the file, data which duplicates some of the information in the TEMS logfile (although the values may not be exactly identical).

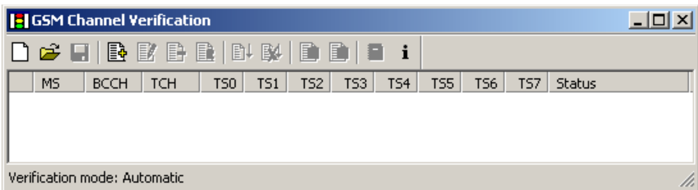
32. GSM Channel Verification

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.

32.1. The GSM Channel Verification Window

- To perform GSM channel verification, open the GSM Channel Verification window from the Control menu or the Control folder in the Navigator.



In this window, each row corresponds to a particular combination of BCCH and TCH.

Throughout chapter 32, the following terminology will be used:

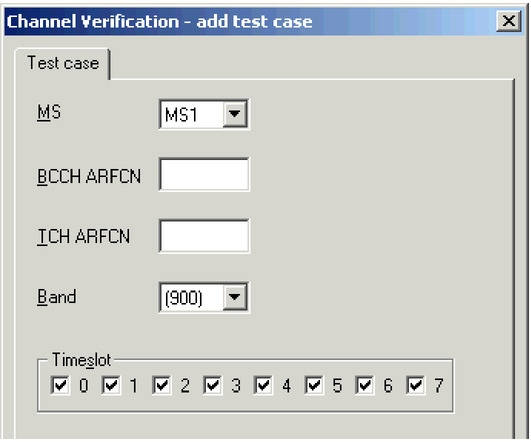
- *Test case:* One row in the GSM Channel Verification window, i.e. one BCCH/TCH combination.

1. Sony Ericsson UEs with both GSM and WCDMA capability must be locked on GSM (see section 13.2.2.2, page 183) 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 32.11, page 324).

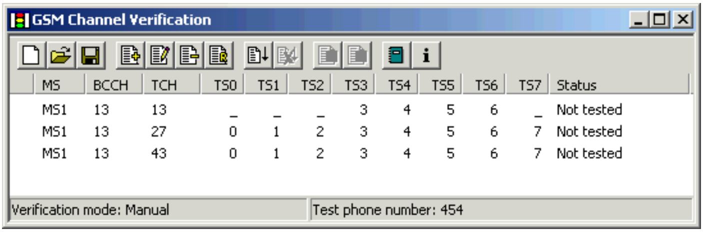
32.2. Adding a Test Case

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 TS 0 and TCHs in TS 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 represented by digits, while timeslots not concerned by the test are marked “_”.

32.3. 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 32.8). 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 32.10) or save the test case in a special file format (section 32.11).

To remove a test case, select it and click the Delete button.

32.4. Manual and Automatic Verification

There are two fundamentally different ways of performing channel verification.

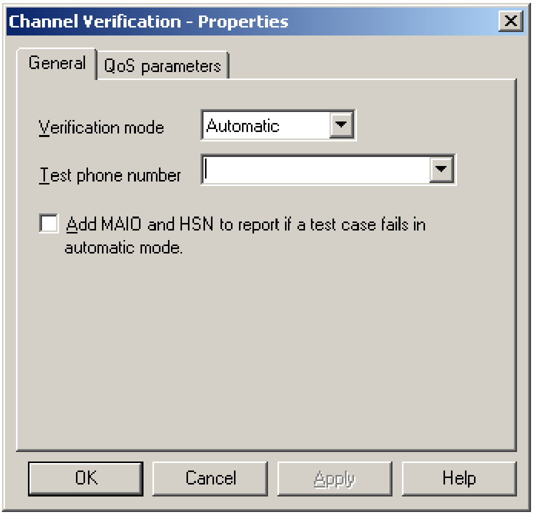
- *Automatic* verification: For each timeslot, TEMS Investigation decides whether the timeslot can be accepted or not. In order for a timeslot to pass, the call must be set up correctly and maintained for a user-specified period of time, and in addition a set of user-specified quality requirements must 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 made quicker, 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.

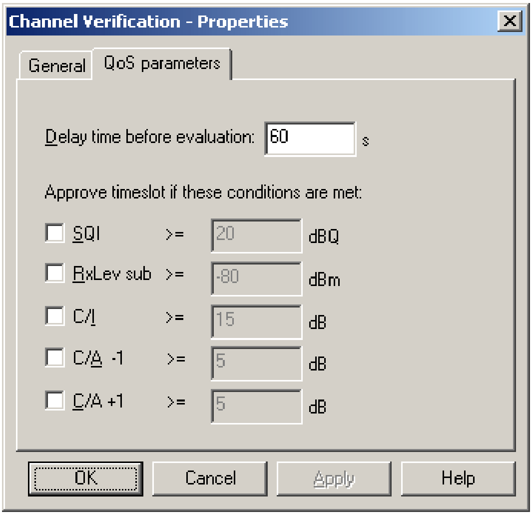
You choose how to perform the test in the Properties dialog.

In the GSM Channel Verification window, click the Properties button.



Verification mode	Choose manual or automatic.
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 32.10) for any test case that fails in automatic verification mode.

- Choose the QoS parameters tab to stipulate 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.

32.5. Connecting Phones

Before running the test you must naturally connect the phones assigned to do the testing.

Note: In manual verification mode only one phone can be used.

32.6. Running the Test

32.6.1. Getting Started

To be able to execute a test you must have done the following:

- Prepared your test cases according to sections 32.1–32.3.
- Chosen manual or automatic verification mode, and indicated a phone number to call: see section 32.4.
- Connected 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 32.1), 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.

32.6.2. 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.

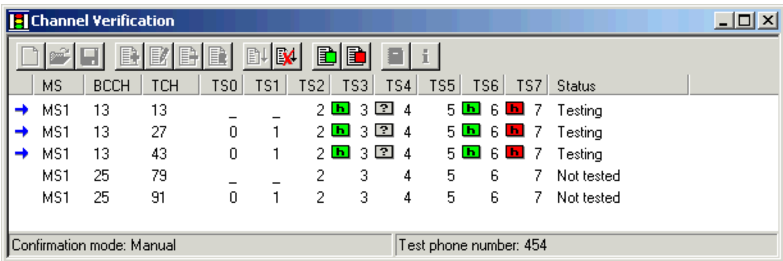
32.6.3. Automatic Verification

If you have chosen automatic verification, the application will itself accept the timeslot (if possible), marking it green ; 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 32.13, “Error Conditions”.

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.

32.6.4. 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.

32.7. Stopping the Test

In order to stop the test currently running:

In the GSM Channel Verification window, click Stop. All test cases which had status Testing will change to Stopped.

To resume, 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.

32.8. 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.

32.9. 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 32.13, “Error Conditions”. The error condition is also indicated in the leftmost column by the symbol .

32.10. 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 32.9. 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.

32.11. 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 the file.

32.12. 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.

32.13. 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 not used where assumed).
Timeout	Ten consecutive calls made where the call setup procedure could not be concluded successfully.
MS not connected	Phone not connected at start of measurement.

33. Support Contact Information

For support in using TEMS Investigation, please contact Ericsson according to the directions found at

www.ericsson.com/tems

under the link “Contact TEMS”.

To sign up for the TEMS on-line subscription service, please go to the same web site and click the link “TEMS Subscription Service”. This free service includes e-mail notification of TEMS product launches, version upgrades and patches, as well as on-line TEMS News.

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
Generate KPI report	Alt + K
New workspace	Ctrl + N
Open workspace	Ctrl + O
Generate logfile report	Ctrl + R
Save workspace	Ctrl + S

A.2. Drive Testing Shortcuts

Function	Shortcut
Connect all	F2
Disconnect all	Ctrl + F2
Connect (single device)	F3
Disconnect (single device)	Ctrl + F3

Function	Shortcut
Swap logfiles	F4
Insert filemark	F5
Start recording	F6
Pause recording	Shift + F6
Resume recording	Alt + F6
Stop recording	Ctrl + F6
Redial last call	F7
End call	Ctrl + F7
Show equipment properties (for device selected on Equipment Control toolbar)	F8
Start scanning	Ctrl + J
Stop scanning	Ctrl + K
Show scanning properties	Ctrl + L

A.3. Replay Shortcuts

Function	Shortcut
Open logfile	Shift + F10
Play logfile	F10
Step logfile	Alt + F10
Stop logfile	Ctrl + F10
Find in logfile	Ctrl + F

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

Equipment Configuration Window

Function	Shortcut
Add equipment	Shift + A
Delete equipment	Shift + D
Open Properties dialog	Shift + P
Save equipment labels	Shift + S

Command Sequence Window

Function	Shortcut
Edit sequence	Ctrl + E
Start sequence	Ctrl + G
Stop sequence	Ctrl + H
New sequence	Ctrl + N
Open sequence	Ctrl + O

Function	Shortcut
Save sequence	Ctrl + S
Show sequence properties	Alt + Enter

Appendix B. File Types in TEMS Investigation Data Collection

Extension	File Type
.aex	Setup file for ArcView format logfile export
.bch	Bar chart export file
.cel	Cell file
.chn	Scanning channel group
.eth	Setup file for Ethereal format logfile export
.evt	User-defined event
.fmt	Logfile exported in text format
.lch	Line chart export file
.log	Logfile
.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 Data Collection workspace
.tex	Setup file for text format logfile export

Appendix C. Manual Enabling of External Equipment

In this appendix are given instructions for manual enabling of a variety of equipment that is normally autodetected by TEMS Investigation. The instructions are provided in case the equipment (for whatever reason) is not recognized by the application.

The procedure of locating ports and modems in the Window Device Manager generally extends straightforwardly to equipment not covered here.

C.1. Phones

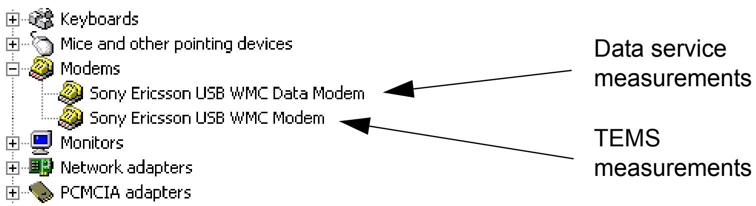
Regarding Sierra Wireless, see section 6.7.1.2, page 42.

Sony Ericsson UEs

- For TEMS measurements, choose the virtual COM port number assigned to the *modem* “Sony Ericsson [<*model name*>] USB WMC Modem”.
- For data service measurements, choose the virtual COM port number assigned to the *modem* “Sony Ericsson [<*model name*>] USB WMC Data Modem”.

To find out the COM port numbers, right-click these items in the Windows Device Manager and inspect the Properties dialog.

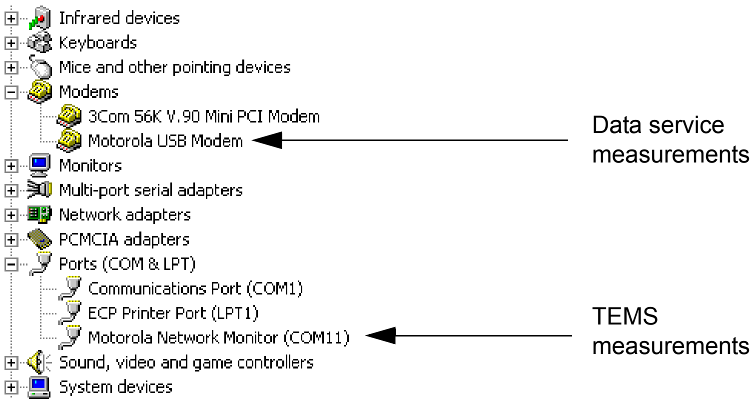
See this screenshot of the Device Manager:



Motorola UEs

- For TEMS measurements, choose the virtual COM port number assigned to the *port* “Motorola Network Monitor”.
- For data service measurements, choose the virtual COM port number assigned to the *modem* “Motorola USB Modem”. To find out the COM port number, right-click this item in the Device Manager and inspect the Properties dialog.

See this screenshot of the Device Manager:

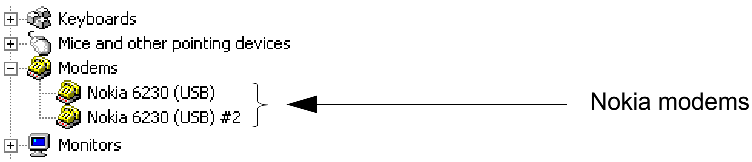


Nokia GSM Phones

- For data service measurements, choose the virtual COM port number assigned to the modem you selected when configuring Dial-up Networking, i.e. preferably “Nokia <*model no.*> (USB) ...”.
- For TEMS measurements, choose the virtual COM port number assigned to the other modem, i.e. “Nokia <*model no.*> (USB) #2”.

To find out the COM port numbers, right-click the modems in the Device Manager and inspect the Properties dialog.

See this screenshot of the Device Manager:

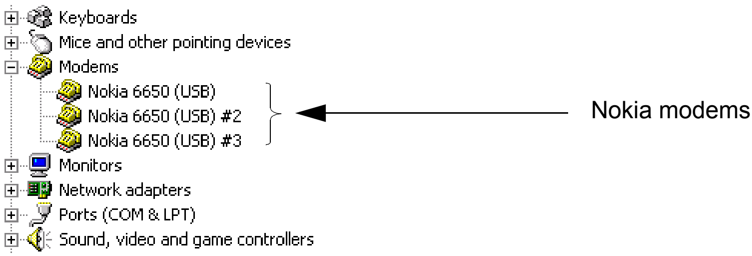


Nokia UEs

- For data service measurements, choose the virtual COM port number assigned to the modem you selected when configuring Dial-up Networking, i.e. preferably the port with the *middle* number.
- For TEMS measurements, choose the virtual COM port number assigned to one of the other “Nokia <*model name*> (USB)” modems. Tests have indicated that it is best to choose the port with the *highest* number.

To find out the COM port numbers, right-click the modems in the Device Manager and inspect the Properties dialog.

See this screenshot of the Device Manager:



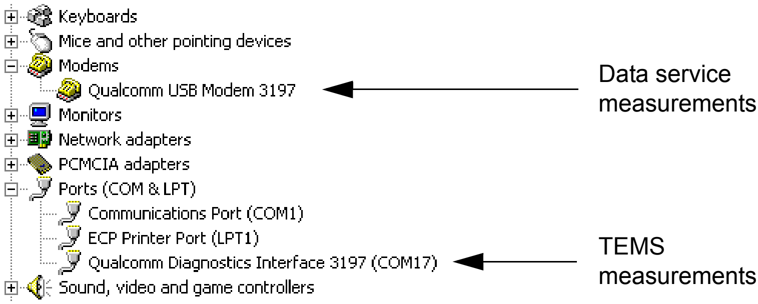
Qualcomm MSM6275 and MSM6280 Chipset Based UEs

A number of representative examples are given of how to connect these terminals.

For the Qualcomm TM6275/TM6280 and Samsung ZX-10/ZX-20, do as follows:

- For TEMS measurements, choose the virtual COM port number assigned to the *port* “Qualcomm Diagnostics Interface ...”.
- For data service measurements, choose the virtual COM port number assigned to the *modem* “Qualcomm USB Modem ...”. To find out the COM port number, right-click this item in the Device Manager and inspect the Properties dialog.

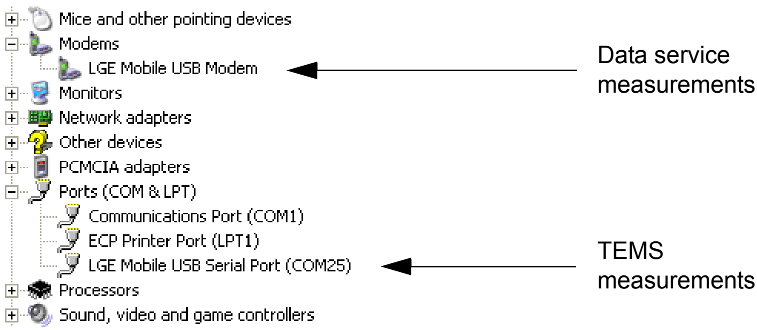
See this screenshot of the Device Manager:



For the LG CU320/CU500, do as follows:

- For TEMS measurements, choose the virtual COM port number assigned to the *port* “LGE Mobile USB Serial Port”.
- For data service measurements, choose the virtual COM port number assigned to the *modem* “LGE Mobile USB Modem”. To find out the COM port number, right-click this item in the Device Manager and inspect the Properties dialog.

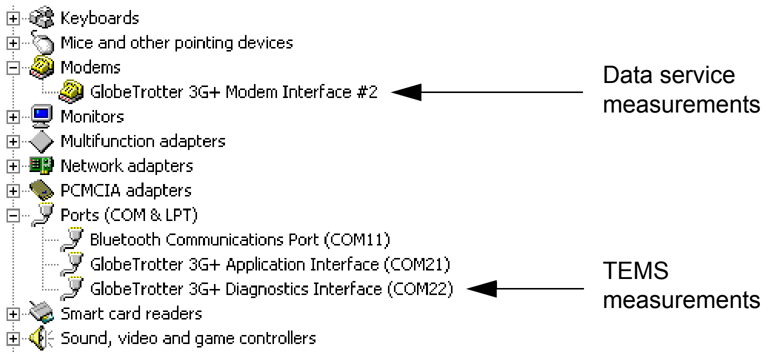
See this screenshot of the Device Manager:



For the Option GT Max data card and other GlobeTrotter data cards, do as follows:

- For TEMS measurements, choose the virtual COM port number assigned to the *port* “GlobeTrotter 3G+ Diagnostics Interface ...”.
- For data service measurements, choose the virtual COM port number assigned to the *modem* “GlobeTrotter 3G+ Modem Interface ...”. To find out the COM port number, right-click this item in the Device Manager and inspect the Properties dialog.

See this screenshot of the Device Manager:



C.2. Scanners

See also section 6.7.1.1, page 41.

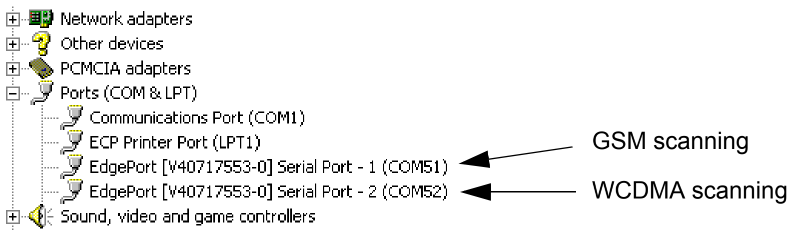
PCTel SeeGull LX MM2 Scanners for GSM/WCDMA

These scanners connect via USB.

The scanner splits into two devices in TEMS Investigation: one for GSM and one for WCDMA scanning. You therefore need to add the scanner twice in the application.

- Under Port:
  - For GSM scanning, choose the *lower* virtual COM port number.
  - For WCDMA scanning, choose the *higher* virtual COM port number.

See this screenshot of the Device Manager:



- Under Equipment Channel, these choices exist for SeeGull:
  - "SeeGull LX GSM with GPS": GSM scanning, scanner GPS in use
  - "SeeGull LX GSM": GSM scanning, scanner GPS not in use
  - "SeeGull LX WCDMA with GPS": WCDMA scanning, scanner GPS in use
  - "SeeGull LX WCDMA": WCDMA scanning, scanner GPS not in use

If you are scanning on both GSM and WCDMA, and you want to use the scanner GPS, choose the GPS only for one device – otherwise the GPS data will be written twice to the logfile.

PCTel SeeGull LX MM2 Scanners (CDMA)

These are handled the same way as the GSM/WCDMA models; see above. Two choices are provided under Equipment Channel:

- "SeeGull LX CDMA with GPS": Scanner GPS in use
- "SeeGull LX CDMA": Scanner GPS not in use

PCTel SeeGull LX (Non-MM2 Models)

These scanners connect to a serial port.

- Under Port, choose the port to which the scanner is connected.
- Under Equipment Channel, make the appropriate choice: see the listing for the MM2 models above. For example, for a single-band WCDMA scanner, choose "SeeGull LX WCDMA and GPS" if you wish to use the internal GPS of the scanner, and choose "SeeGull LX WCDMA" if you wish to use a separate GPS unit, ignoring the scanner GPS.

C.3. GPS Units

For all GPS units, only row 1 in the Add Equipment dialog is used. Row 2 is grayed out.

- Under Port, choose the correct port.
- Under Equipment Channel, choose the correct GPS model/GPS protocol.

Appendix D. Text Export Format for Logfiles

D.1. General

The text export format for logfiles uses an ASCII representation with tab delimited data. The default file extension is .fmt.

D.2. File Header

The first line in the file contains column headers. Headers marked * are or can be excluded in the reduced version of the text export file (see section 7.5.2.1, page 63):

- 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.

D.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:tt, where tt = 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 triggered by the message, if any.
Event Info	Event parameters, if any. Example (WCDMA, Radio Link Addition): SC added: 1, SHO type: unknown, Event type: e1a.
Information element columns	Value of information element component.

Appendix E. Notes on Third-party Logfile Export Formats

Compare section 7.5, page 59 on logfile export.

E.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

E.2. Export to ArcView

ArcView 3.2 for Windows has been 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.)

E.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)

E.4. Export to Ethereal

Exported file for each logfile:

- *.eth – Ethereal format file

E.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 disconnected 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.

Appendix F. Logfile Report

This appendix 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 section 7.6, page 69).

Header

Logfile information

Statistics
Worst cell indication
Thresholds
Events
Scan data

Charts
Distribution parameters
Scan data

Logfile report layout.

F.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 (section 7.6.5, page 73).

F.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.

F.3. Statistics

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.

1. i.e. 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.

Note that the ranking can be based on arbitrary phone information elements and events.

Thresholds

The following is reported for each information element and threshold chosen:

- 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.

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.

Scan Data

The following is reported for each channel scanned:

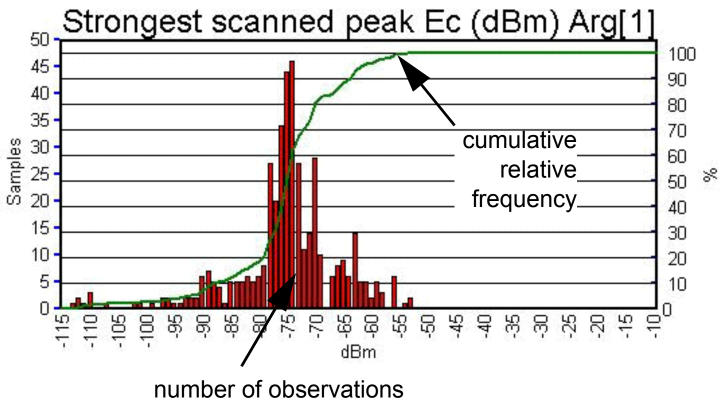
- Number of measurement samples
- Mean, median, minimum and maximum code power (averaging in mW domain)

F.4. Charts

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 F.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.

Scan Data

- *GSM:* An RxLev chart is drawn for each channel.
- *WCDMA:* An Ec/Io chart is drawn for each scrambling code.
- *CDMA:* A PN Scan bar chart is drawn for each RF channel. A Strongest Scanned PN bar chart is also drawn.

In either case, the scan data charts follow after the network parameter charts.

F.5. File and Directory Naming

F.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.

F.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.

Appendix G. KPI Report (UMTS)

This appendix describes the contents of the KPI report.

KPIs are computed separately for each Location Category label.

See chapter 25, page 290 for a general introduction to KPIs.

Detailed technical definitions of all KPIs are provided in separate documents which are found on the installation CD in the subdirectory Documents.

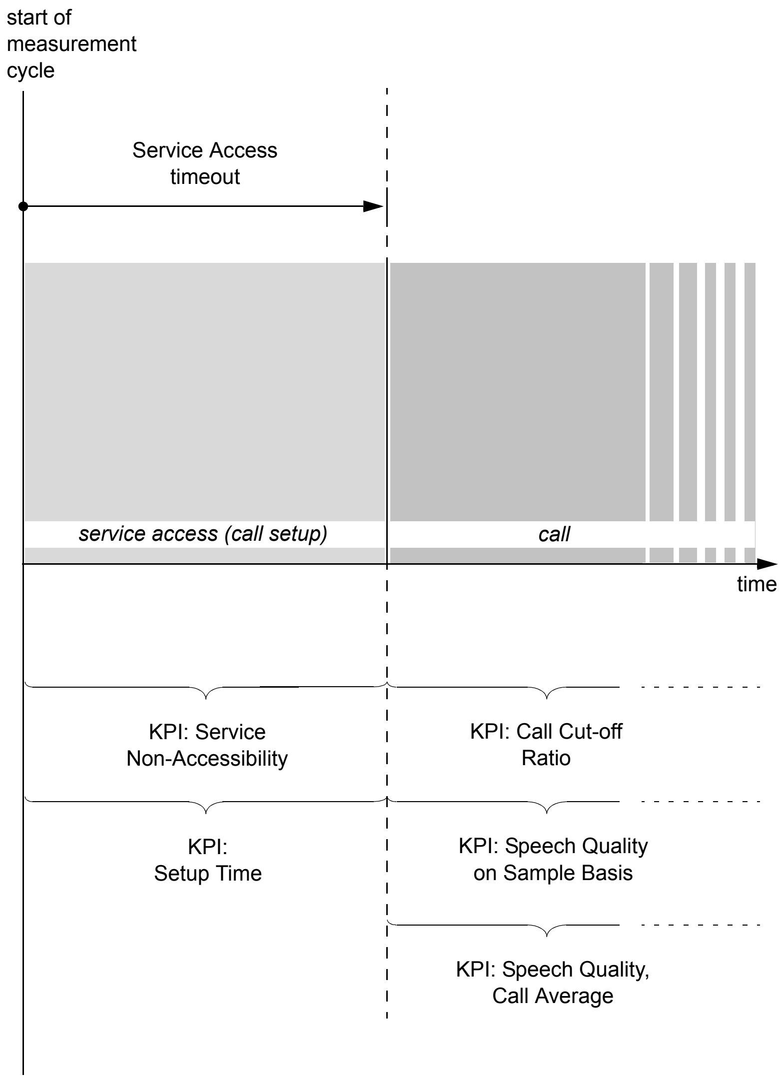
G.1. Report Header

The header shows

- the report number ("Report number" field in KPI report properties: section 7.7.2, page 76)
- the date and time when the report was generated
- who prepared the report ("User name" field in KPI report properties).

G.2. Overview of KPIs for Circuit-switched Services

G.2.1. Diagram of Circuit-switched KPIs and Timeouts



KPIs and timeouts for voice and video telephony.

G.2.2. Service Non-Accessibility [%]

Denotes the probability that the end-customer cannot access the service when requested although the phone indicates having network coverage.

G.2.3. Setup Time [s]

Denotes the time between sending of complete address information and receipt of call setup notification.

G.2.4. Speech Quality on Sample Basis [dBQ]

Denotes the end-to-end speech quality computed sample by sample.

The quality is that judged by the old SQI algorithm; at present no KPI reflecting the new SQI-MOS score is provided. See chapter 26.

G.2.5. Speech Quality, Call Average [MOS-PESQ]

Denotes the average speech quality during a call.

The quality is judged using the PESQ algorithm (see chapter 27). The averaging is done in two steps: first the average PESQ is computed for each call, and then a new average is taken over all single-call PESQ scores. In other words, all calls are given equal weight.

G.2.6. 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.

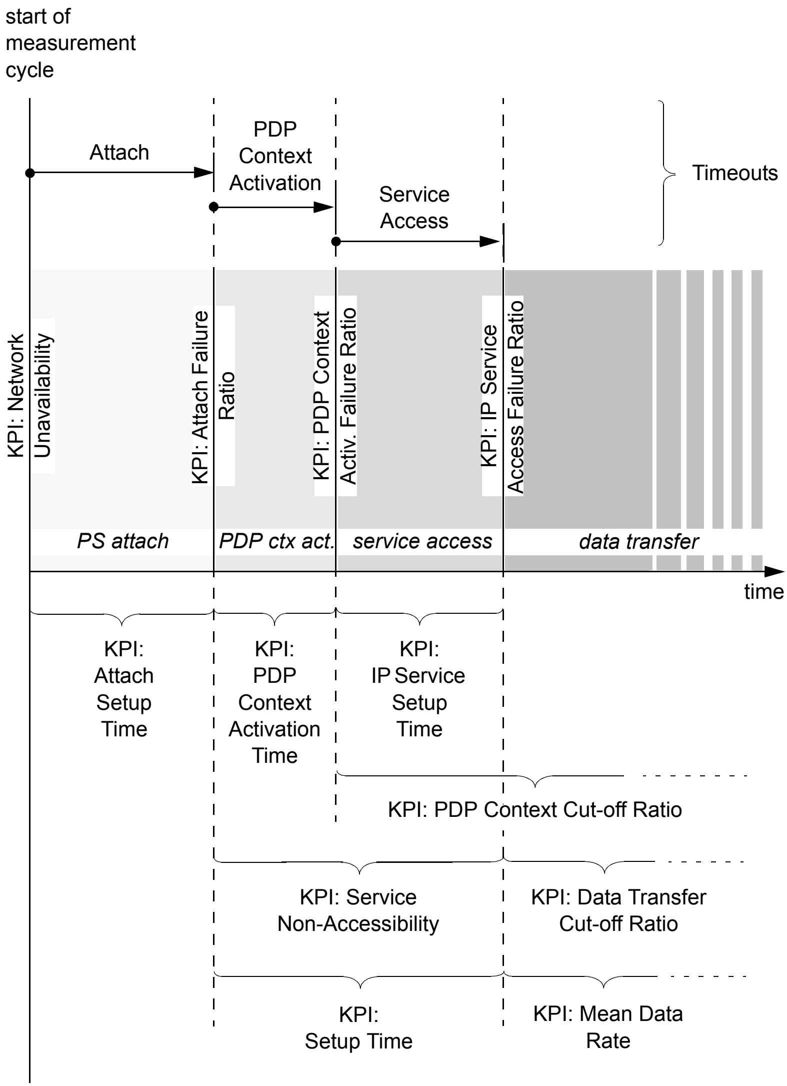
G.3. Overview of KPIs for Packet-switched Services

KPIs are calculated for all supported data services except SMS.

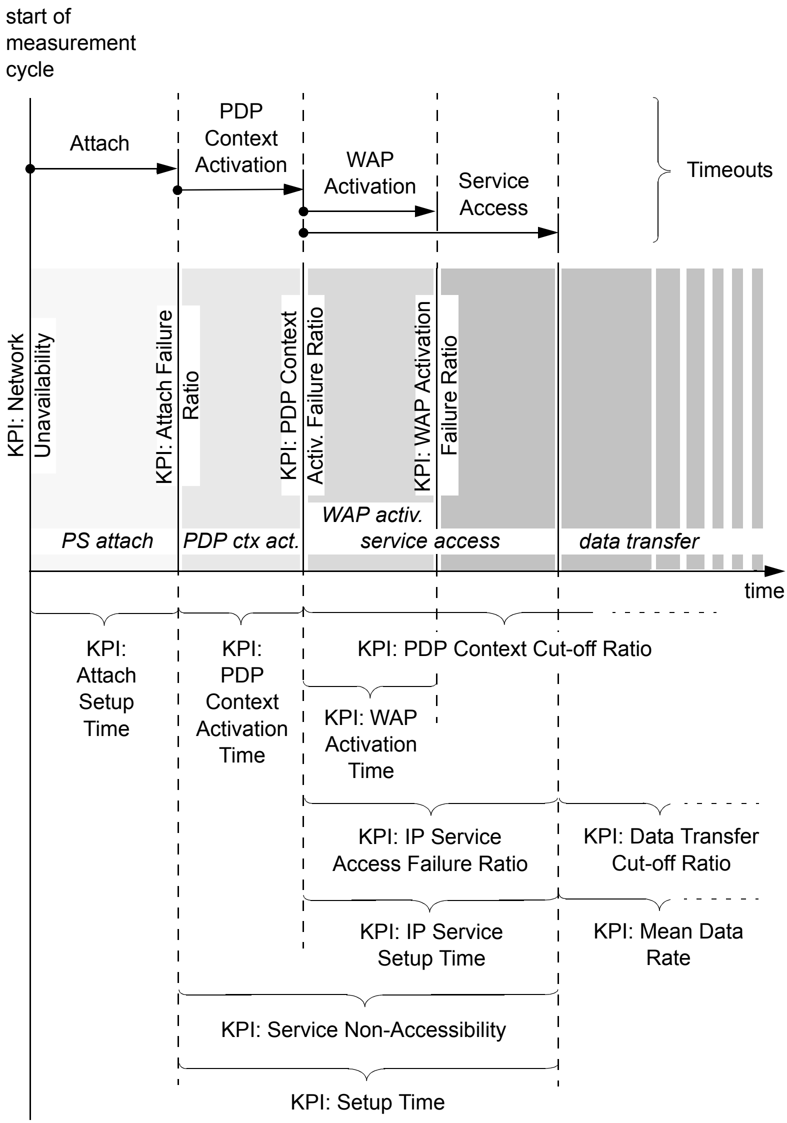
For FTP, HTTP and e-mail, the set of KPIs is the same. For WAP, only one step is added. For MMS and streaming, on the other hand, the KPIs are more divergent.

It is helpful to consider all KPIs, as well as their associated user-configurable timeouts (section 7.7.1, page 75), within the framework of packet-switched sessions. See the diagrams on the following pages depicting such sessions. Listings of KPIs follow in sections G.3.2–G.3.6.

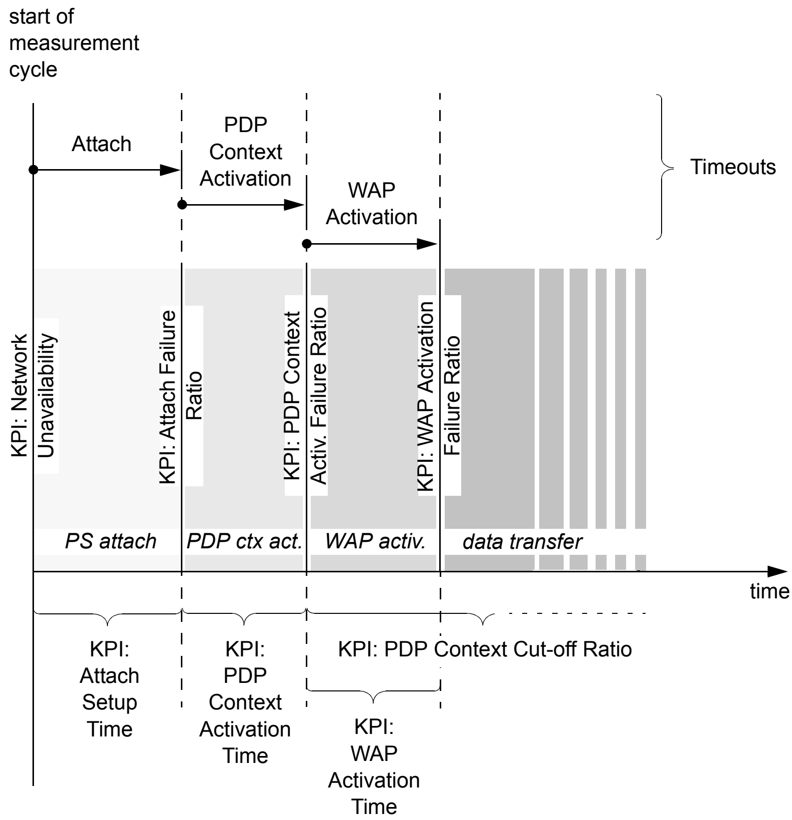
G.3.1. Diagrams of Packet-switched KPIs and Timeouts



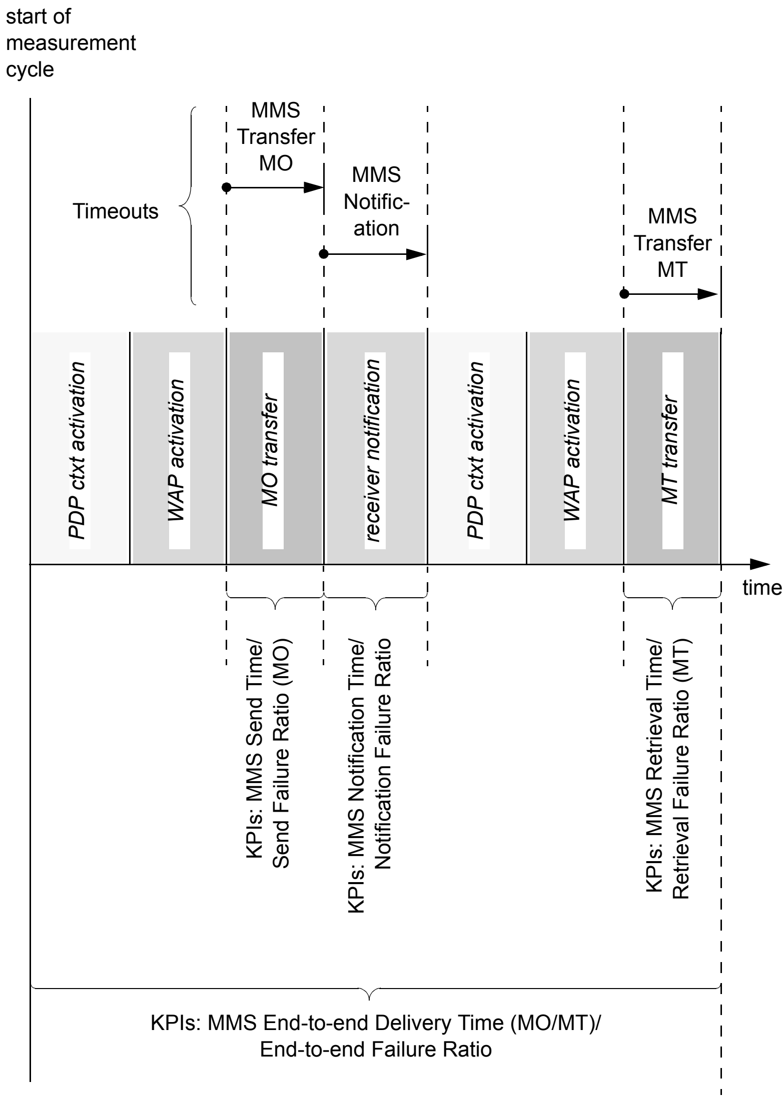
KPIs and timeouts for FTP, HTTP, and e-mail.



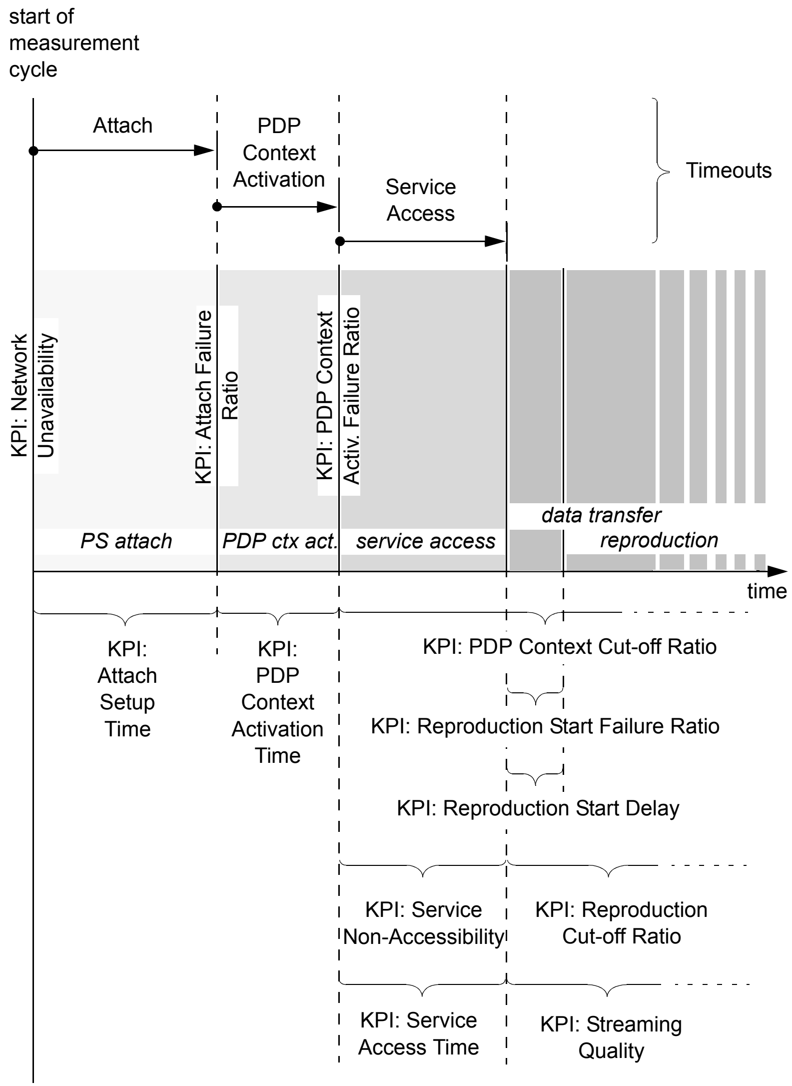
KPIs and timeouts for WAP.



KPIs and timeouts for MMS (diagram 1 of 2).
These KPIs apply equally to both sending and receiving.



KPIs and timeouts for MMS (diagram 2 of 2).



KPIs and timeouts for streaming.

G.3.2. Service Independent KPIs

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.

Attach Failure Ratio [%]

Denotes the probability that a subscriber cannot attach to the GPRS/UMTS PS network.

Attach Setup Time [s]

Denotes the length of the time period taken to attach to the GPRS/UMTS PS network.

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.

PDP Context Activation Time [s]

Denotes the length of the time period taken to activate a PDP context.

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.

G.3.3. General Data Service KPIs

The following KPIs are computed for all or many of the data services supported (as indicated in the above diagrams):

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 G.3.6.

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.

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.

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.

Mean Data Rate [kbit/s]

Denotes the average data rate measured throughout the entire connect time (application throughput).

Data Transfer Cut-off Ratio [%]

Denotes the probability that a data transfer cannot be completed when it has been started successfully.

G.3.4. WAP KPIs

For WAP, one more step is added to the procedure of setting up the data connection: activating the WAP session.

WAP Activation Failure Ratio [%]

Denotes the probability that the subscriber cannot activate the WAP session.

WAP Activation Time [ms]

Denotes the length (in ms) of the time period taken to activate the WAP session.

G.3.5. 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 G.3.4 above) are computed for MMS also.

The following KPIs are MMS-specific:

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.)

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.

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.

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.

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.

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.

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.

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.

G.3.6. Streaming KPIs

Streaming-specific KPIs are as follows:

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.

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.

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

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.

Reproduction Start Failure Ratio [%]

Denotes the probability of unsuccessful stream reproduction.

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.

G.4. Timeouts

The timeout values set in the KPI report properties (section 7.7.1, page 75) are reproduced in the report:

- Attach timeout
- PDP context activation timeout
- Service access timeouts (service-specific)

- WAP activation timeout
- MMS timeouts: MMS transfer MO, MMS notification, MMS transfer MT

G.4.1. Interdependence of KPIs; Dependence of KPIs on Timeouts

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. The frequency of success is in turn dependent on the timeout settings.

For example, the KPIs Service Non-Accessibility and Setup Time are correlated. Moreover, the lower the corresponding timeouts are set, the lower the average setup time (i.e. in the cases where the setup was deemed successful) and the higher the non-accessibility percentage, and vice versa.

G.5. Logfile Information

This section contains:

- the logfile or logfiles in which the KPI data was recorded
- the data services used in each logfile
- the categories with which the KPI measurements were labeled (Category parameter in command sequence: section 12.13, page 163).

G.6. File and Directory Naming

G.6.1. Files

For each report, a new directory will be created under GeneratedReports and contain the following files:

- index.xml: XML file with all textual information and links to JPEG images
- JPEG files with bar charts for KPIs and PIs denoting times, data rates, and message sizes.
- Some auxiliary graphics files.

G.6.2. 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.

Appendix H. Technical Notes on PCTel Scanners

These notes apply to all supported PCTel SeeGull LX and EX scanners.

H.1. Reference Point for Signal Level Measurement

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.

H.2. Antenna Cable Attenuation

The magnetic mount antenna provided with the scanner is a 0 dBd gain antenna.

The Smarteq cable loss at 2 GHz is specified at 1.86 dB per meter cable maximum. If the length of the cable is 2.6 m, the maximum loss from the antenna to the scanner at 2 GHz is 4.84 dB.

The following table shows the attenuation at various frequencies:

Frequency (MHz)	Attenuation (dB/m cable)	Total Attenuation of 2.6 m Cable (dB)
900	0.90	2.34
1800	1.33	3.46
1900	1.39	3.61
2000	1.86	4.84
2100	1.47	3.82

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