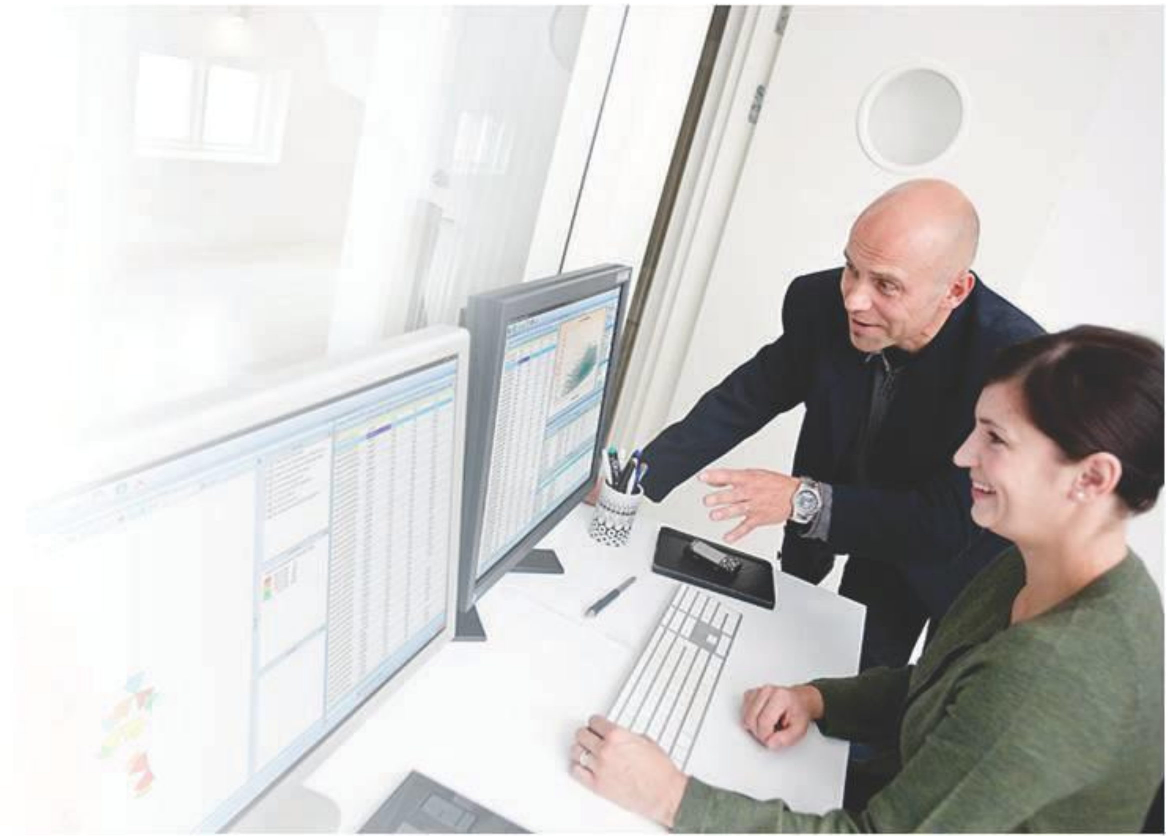
TEMS™ Discovery Network 11.0

Technical Product Description



Contents

1 Introduction

As today's wireless networks become more mature, dense, and heavily trafficked, operators require increasingly sophisticated methods to maintain their networks. TEMS Discovery Network post-processes the event-based performance data generated in network nodes – providing mobile operators with the information they need to ensure quality of service and satisfied subscribers.

Using TEMS Discovery Network, engineers responsible for radio network performance get easy access to comprehensive statistical information from which they can directly drill down into detailed analysis – even all the way to the individual call level. This information can be used for advanced network troubleshooting, optimization and feature verification.

This Technical Product Description covers the TEMS Discovery Network LTE, WCDMA & Subscriber Trace application plus the TEMS Discovery Network GSM application.

1.1 Bridging the Optimization Gap

TEMS Discovery Network bridges the gap between performance management tools and drive-test data, and provides RF engineers with an easier way to troubleshoot and optimize LTE, WCDMA, and GSM networks.

Performance management tools handling statistical counters show cells which are having problems, but the exact causes of the problems, or locations of the problems within the cell, are usually not provided. Drive-test tools, on the other hand, are specifically designed to reveal the causes and locations of problems, but can capture this critical data only if the problems are more or less constant and only when a drive test happens to be made.

TEMS Discovery Network bridges this gap by offering both the breadth of traditional performance management solutions and the depth of drive-test tools. TEMS Discovery Network processes event-based OSS data all the way down to the individual call level. This ability to look at real individual call data from the infrastructure side complements both the big picture provided by performance management systems and the thin slicing of traditional drive testing.

TEMS Discovery Network analyzes data sets large enough for statistical accuracy while at the same time offering detailed drilldown to facilitate precise problem localization. This leads to faster mean time to repair (MTTR) and other operational efficiencies, as well as improved customer satisfaction.

2 Data Source Overview

TEMS Discovery Network primarily works with the event-based data collection features found in network vendor nodes. In this section, a brief description is given of the event data formats supported.

2.1 Ericsson

2.1.1 WCDMA GPEH

For Ericsson WCDMA, the application for recording event data for large volumes of subscriber traffic in a specified area of cells is known as General Performance Event Handling (GPEH). This is an optional feature in the Ericsson system.

The GPEH application enables the collection, retrieval, and storage of event data. The files are generated in the network elements (i.e., RNC) in 15 minute Recording Periods (ROPs) and are collected together in the OSS-RC file storage.

GPEH can collect 3GPP-defined “external” messages from protocol groups such as RRC (Uu interface), RANAP (Iu interface), RNSAP (Iur interface), and NBAP (Iub interface).

However, GPEH can also collect internal messages between the modules in the RNC. These internal messages contain extremely valuable information, providing, for example, more details on the reasons for dropped calls. This information could never be collected from external probe/protocol analyzer solutions.

All of the traffic or only a fraction of traffic in the network area can be recorded.

WCDMA MRR-W

The MRR-W feature in Ericsson OSS-RC forces mobile phones in an area of the network to perform periodic measurements. These measurements are sent up to the network via the measurement report function – and these messages can be captured in a normal GPEH recording. This is an optional feature in the Ericsson system.

Usually, a picture of radio performance can be seen in the network at triggered measurements only, such as for soft handover. Therefore, MRR-W is an extremely powerful feature that can be used to evaluate radio performance, not just at the cell boundaries but throughout the entire cell area.

Periodic measurement reports are required for the RF diagnostics feature in TEMS Discovery Network.

2.1.2 LTE Cell Trace

For Ericsson LTE, the application for recording event data on an area of cells is called Cell Trace. This is an optional feature in the Ericsson LTE system.

The Cell Trace application enables the collection, retrieval, and storage of event data. The files are generated in the eNodeB and are collected together in the OSS-RC file storage area.

Cell Trace can collect 3GPP-defined “external” messages on all interfaces to and from the eNodeB. For example, all RRC protocol messages exchanged between the eNodeB and user equipment (UE) on the Uu interface can be recorded. Also, all communication with the evolved packet core (on the S1 interfaces) and other eNodeB (on the X2 interfaces) can be recorded.

However, Cell Trace can also collect “internal” messages between the modules in the eNodeB. These internal messages contain extremely valuable information, providing, for example, more details on the reasons for dropped calls. This information could never be collected from external probes.

2.1.3 Ericsson LTE MME Data (CTUM)

In the LTE system, for security reasons, the eNodeB usually has no visibility of the IMSI and IMEI.

However, within an Ericsson MME a Cell Trace UE ID Mapping (CTUM) file can be recorded. This allows the temporary identifiers used to identify calls in the eNodeB (and LTE Cell Trace recordings) to be associated to the IMSI and IMEI held in the MME.

When the LTE Cell Trace data is processed together with the CTUM data in TEMS Visualization then this allows Phone Model and Subscriber KPIs to be created.

The CTUM recordings must be enabled on the Ericsson MME. The resulting files can then be retrieved and processed into a separate CTUM project in TEMS Visualization.

Because MMEs typically operate in a pool, the CTUM files from all MME, which serve one network area, should be processed together. This single CTUM project can then be referenced by all the Ericsson LTE Cell Trace projects for that network area.

2.1.4 GSM R-PMO

For Ericsson GSM, the application for recording event data for large volumes of subscriber traffic in an area of cells is called Real-Time Performance Monitoring (R-PMO). This is an optional feature in the Ericsson GSM system.

R-PMO in OSS provides statistics on GSM networks, capturing comprehensive information based on measurement results and call events and displaying them in charts which are updated in near real-time. The data can be used for troubleshooting, monitoring, and verifying network functionality.

The event data streamed in real time to the OSS-RC can also be collected by R-PMO and exported to a file using the Raw Event Data Export (REDE) client. These exported REDE files can then be transferred, read, and post-processed by TEMS Discovery Network for detailed analysis.

2.1.5 GSM CTR

The Cell Traffic Recording (CTR) function is a standard feature in the Ericsson GSM systems. CTR provides the functionality to trace a specific cell in the network. Calls (up to 16 simultaneous) passing through this cell can be recorded and the performance of the cell can be analyzed in great detail.

2.1.6 Subscriber Trace (UETR, UE Trace, and MTR)

WCDMA UETR

For Ericsson WCDMA, the application for recording event data for specific subscribers is called UETR. This is a basic feature in the Ericsson WCDMA system.

The files are generated from the network elements (i.e., RNC) in 15-minute recording periods (ROPs) and are collected together in the OSS-RC file storage. A maximum of 16 UETR recordings can be active at any one time in one RNC.

UETR collects mainly external event data from protocol groups such as RRC (Uu interface), RANAP (Iu interface), RNSAP (Iur interface), and NBAP (Iub interface). In addition there is a limited set of internal events available – these are mainly generated for uplink measurements which are made in the NodeB and sent up to the RNC.

LTE UE Trace

For Ericsson LTE, the application for recording event data for specific subscribers is called UE Trace (User Equipment Trace). This is a basic feature in the Ericsson system.

The files are generated from the network elements (i.e., eNodeBs) in 15-minute Recording Periods (ROPs) and are collected together in the OSS-RC file storage. A maximum of 16 UE Trace recordings can be active at any one time in one eNodeB.

It is possible to collect trace. Normally 'Maximum' Trace depth is used to capture detailed information from each subscriber.

GSM MTR

For Ericsson GSM, the application for recording event data for specific subscribers is called MTR (Mobile Traffic Recording). This is a basic feature in the Ericsson system.

The files are generated in the network elements (i.e., BSCs) and collected together in the OSS-RC file storage. A maximum of 64 MTR recordings can be active at any one time in one MSC.

2.1.7 Ericsson Cell Configuration Files

Cell configuration files are used by TEMS Discovery Network to get information about the parameter settings and other network configuration information stored in the OSS-RC.

The Bulk CM format for WCDMA and LTE and the text CNAI format for GSM from Ericsson are supported. Only selected parameters are used by TEMS Discovery Network. A reference file can be used when information such as the site position, antenna beamwidth, and antenna direction is not available from the OSS-RC.

2.2 Huawei Networks

2.2.1 WCDMA Call Trace

For Huawei the WCDMA Call Trace formats (e.g., PCHR) are supported. An integration service is required to ensure correct support for the format type and version.

After activation of the call trace function in an RNC, all calls recorded until the call trace function is disabled. The call trace files can then be fetched directly from the RNC.

In the Huawei RNC a pre-processed call data record is generated for each call – which contains some key information elements extracted from the 3GPP protocol messages and also some RNC internal information elements. Not all 3GPP signaling is available as with Ericsson GPEH, for example.

The internal information elements, though, do give more details on events such as dropped calls and other failures – information that would not be available from a protocol analyzer.

2.2.2 WCDMA PM Counters

For Huawei WCDMA, the PM counter files from the RNC are supported. RNC level and Cell level counters are available from these files – RBS PM counter files are currently not supported.

The RNC PM counter files should be XML format – zipped or unzipped are supported.

Only the Measurement Units required to support the implemented KPI are decoded and stored.

2.2.3 Huawei Cell Configuration Files

The CFGMML format for Huawei WCMDA networks is supported. A reference file can be used when information such as the site position, antenna beamwidth, and antenna direction is not available from the OSS-RC.

2.3 Nokia Siemens Networks

2.3.1 WCDMA Megamon GEO Interface

A new Layer 3 data collector called Megamon has been introduced from NSN with the specific task of collecting, filtering, and forwarding event data from probes inside the network nodes.

For WCMDA, the Megamon server connects to the RNC and provides a number of different external interfaces to this event data for different purposes.

TEMS Discovery Network supports the Megamon GEO Interface which includes mainly 3GPP-defined “external” messages from protocol groups such as RRC (Uu interface), RANAP (Iu interface), RNSAP (Iur interface), and NBAP (Iub interface), but also some internal information on, for example, changes in radio bearers.

The TEMS Discovery Network Data Collector application is provided to convert the streaming data from the GEO Interface to sets of files in a format that can be processed directly by TEMS Discovery Network.

2.3.2 NSN Cell Configuration Files

Cell configuration files are used by TEMS Discovery Network to get information about the parameter settings and other network configuration information stored in the OSS-RC.

Currently, a simple text file is used to specify information such as the site position, antenna beamwidth, antenna direction, RNC-ID, and Cell-ID.

3 TEMS Discovery Network System Descriptions

This section provides a description of the two TEMS Discovery Network applications.

- TEMS Discovery Network - WCDMA, LTE, and Trace
- TEMS Discovery Network - GSM

3.1 TEMS Discovery Network – WCDMA, LTE, and Trace

3.1.1 Supported Data Sources

The following data sources are supported in the TEMS Discovery Network WCDMA, LTE, and Trace application:

Data Source Support – TEMS Discovery Network Enterprise		
Vendor	**Type**	**Format name**
Ericsson	WCDMA Area Recording	GPEH
Ericsson	LTE Area/Cell Recording	Cell Trace
Ericsson	LTE MME data for IMSI and IMEI	Cell Trace User Mapping (CTUM)
Ericsson	Subscriber Trace	UETR (WCDMA), MTR (GSM), UE Trace (LTE)
Ericsson	Cell Configuration	Bulk CM (WCDMA & LTE), CNAI Export (GSM)
Huawei	WCDMA Area Recordings	WCDMA Call Trace e.g., PCHR – final format support determined with integration service
Huawei	WCDMA PM Counters	PM Counter files on RNC level in XML format
Huawei	Cell Configuration	CFGMML
NSN	WCDMA Area Recording	Megamon GEO Interface

3.1.2 System Overview

Figure 1 presents an overview of the TEMS Discovery Network application for WCDMA, LTE, and Trace.

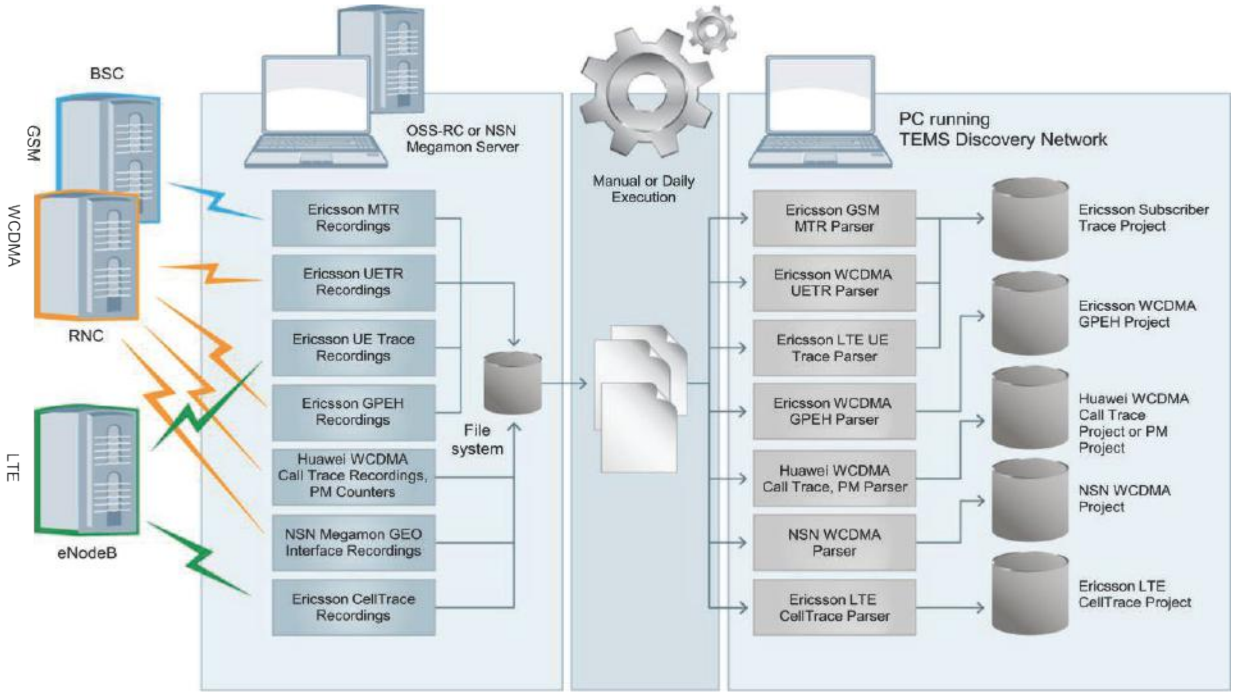


Figure 1 – TEMS Discovery Network WCDMA, LTE, and Trace

3.1.3 Parsing Engines

The parsing engines are at the heart of TEMS Discovery Network, taking the raw event data log-files and performing:

- **Sorting** of the data into individual calls
- **Analysis and interpretation** of the message sequences
- **Accumulation** of statistics

The state engines that perform the analysis and interpretation of message sequences add unique intelligence to the tool allowing for easier investigations into problems.

The accumulation of statistics is performed on many different dimensions for example – per project, per cell, per IMSI, per phone model etc.

3.1.4 Data Retrieval and Parsing

A set of event data logfiles already on the *local* machine can be selected and parsed within TEMS Discovery Network. Alternatively a connection can be specified to a *remote* (S)FTP machine (for example, on the Ericsson OSS-RC) and the logfiles can be retrieved and then processed directly.

Processing can be performed manually as needed or scheduled to occur once daily – for example, scheduled overnight so that new data is ready to analyze the following morning.

Each logfile type is processed into a separate project type; the exception is the UETR (WCDMA), UE Trace (LTE) and MTR (GSM) logfile types, which can be processed into the same Subscriber Trace project for multitechnology analysis on VIP subscribers.

3.2 TEMS Discovery Network – GSM

3.2.1 Supported Data Sources

The following data sources are supported in the TEMS Discovery Network GSM application:

Data Source Support – TEMS Discovery Network Enterprise		
Vendor	**Type**	**Format name**
Ericsson	GSM Area Recording	R-PMO
Ericsson	Subscriber Trace	MTR (GSM)
Ericsson	Cell Recording	CTR (GSM)
Ericsson	Cell Configuration	CNAI Export (GSM)

3.2.2 System Overview

The figure below presents an overview of the TEMS Discovery Network GSM application.

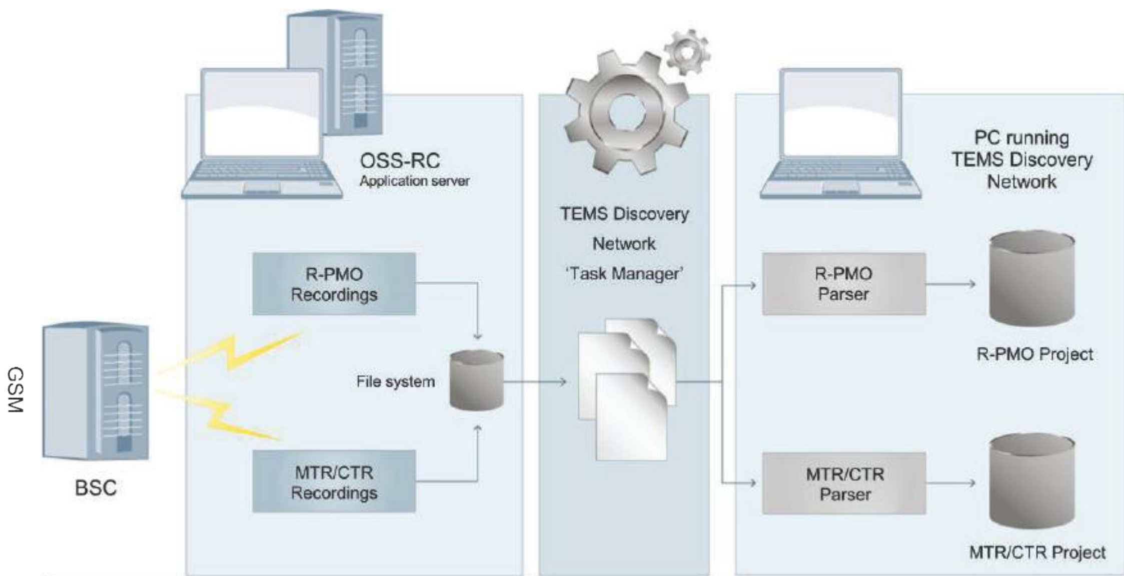


Figure 2 – TEMS Discovery Network GSM

3.2.3 Parsing Engines

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- **Sorting** of the data into individual calls
- **Analysis and interpretation** of the message sequences
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The state engines that perform the analysis and interpretation of message sequences add unique intelligence to the tool allowing for easier investigations into problems.

The accumulation of statistics is performed on many different dimensions – for example, per project, per cell, per IMSI, per phone model, etc.

3.2.4 Task Manager

The task manager automates the process of retrieving and processing files from the OSS. Tasks can be scheduled overnight so that new data is ready to analyze the following morning.

4 Feature Availability

4.1 WCDMA, LTE, and Trace Application

The data source formats are licensed separately.

Additional optional features are:

- Geo Maps module (including Google Maps) for Ericsson WCDMA GPEH
- Geo Maps module (including Google Maps) for Huawei WCDMA Call Trace

4.2 GSM Application

TEMS Discovery Network GSM is a separate application with troubleshooting and optimization features specifically designed for GSM event data formats.

For a detailed description of the features available in TEMS Discovery Network GSM, refer to section 15.

5 Geo Maps

Available for:

- Ericsson WCDMA GPEH as a separately licensed geolocation module
- Huawei WCDMA Call Trace as a separately licensed geolocation module

The Geo Maps feature is a Google™ Maps based geographic analysis tool. It provides powerful visualizations of ***where*** network performance problems are occurring, allowing optimization resources to be more effectively deployed.

Since the Geo Maps feature is based on call trace recordings, all traffic types, phone models and locations (indoor/outdoor) are considered.

A Geo Map layer (called a Geo KPI) is created from a Metric + Filter. Currently the following Metrics and Filters are supported:

Metrics

- Call Start Best Cell Ec/No Average
- Call End Density
- Call Start Density

Filters

- Service (Speech, PS Interactive HS, PS Interactive R99, etc.)
- Band/UARFCN
- Type of call end (Drop, Block, etc.)

TEMS Discovery Network is supplied with a pre-defined set of Geo KPIs. However, the engineer can easily create his or her own Geo KPIs based on any selected Metric and Filter combination.

To display the Geo KPI layer on Google Maps, the engineer selects the entity to analyze (entire area, specific cell, cluster, Subscriber Group, Phone Model Group) and the Geo KPI.

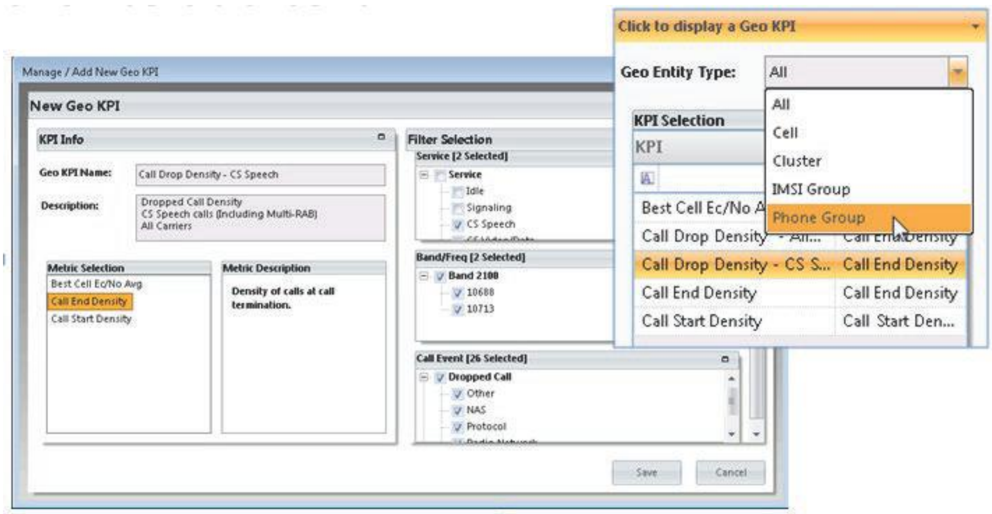


Figure 3 - User-defined Geo KPI creation and then display

Sample use cases for the Geo KPI layer are:

- To identify traffic and quality hotspots
- To identify locations of CS Speech Drops for a poorly performing cell
- For a specific Phone Model, to identify where calls are being made and any quality issues on a specific carrier
- For a group of subscribers, to identify locations of dropped calls, blocked calls and other issues (e.g., all TEMS Pocket and TEMS Automatic probes)

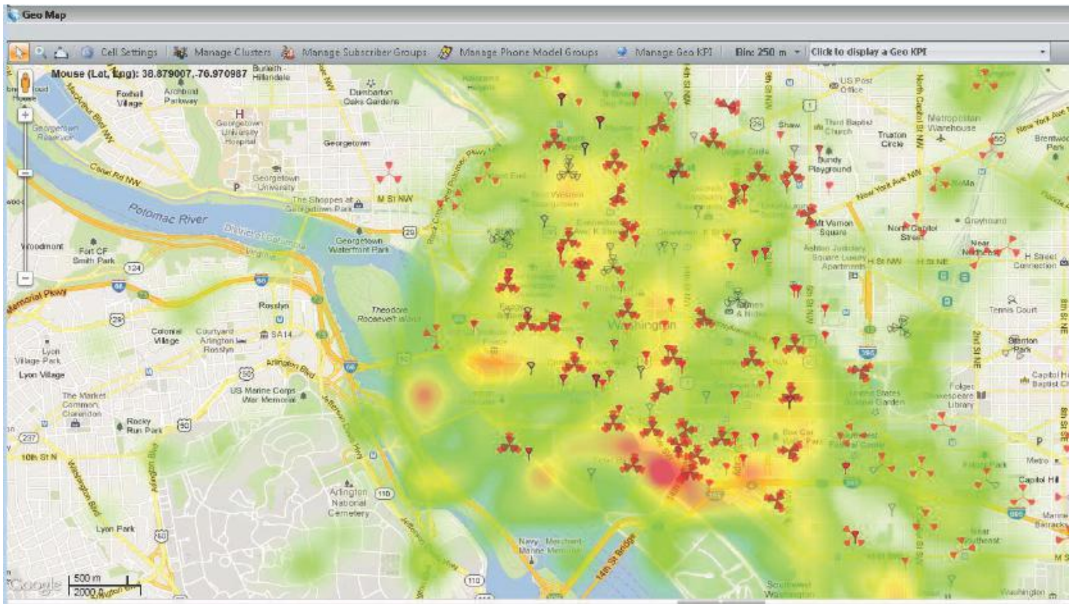


Figure 4 - Geo Map showing Call Density heat map - traffic hotspots are shown in red

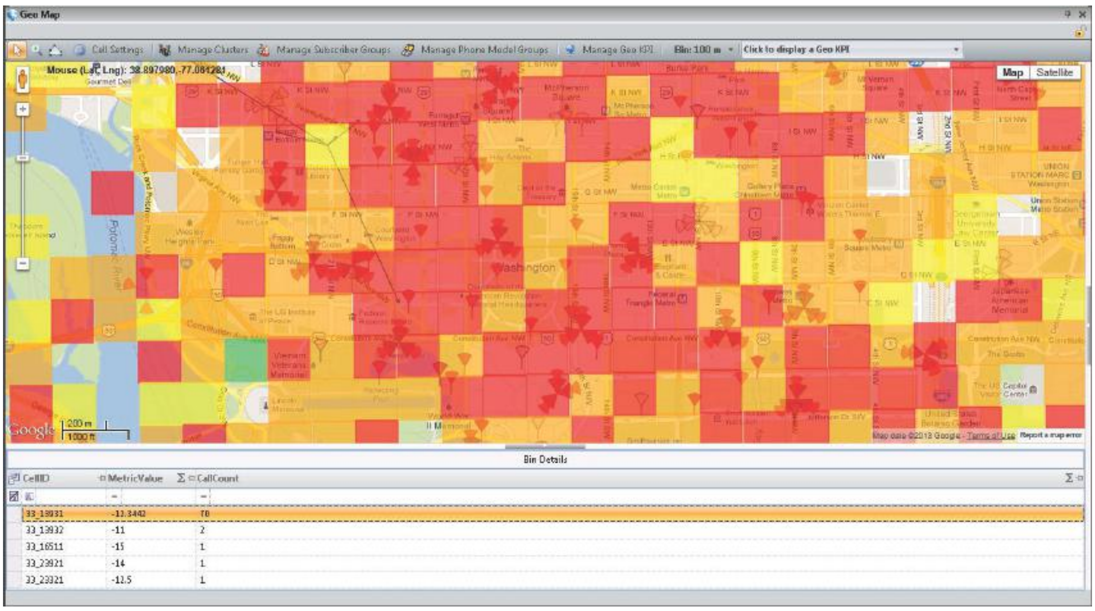


Figure 5 - Geo Map with colors representing average Ec/No at call start

6 Common Feature Highlights

This section describes features that are common between the different TEMS Discovery Network modules.

Note that these descriptions apply to the TEMS Discovery Network (WCDMA, LTE, and Trace) application. For a detailed description of the features available in TEMS Discovery Network GSM, refer to section 15.

6.1 Overview Statistics

Available for:

- Ericsson WCDMA GPEH Module
- Ericsson LTE Cell Trace Module
- Huawei WCDMA Call Trace
- NSN Megamon WCDMA GEO Interface Module
- Ericsson Subscriber Trace Module (WCDMA UTER, LTE UE Trace, and GSM MTR)

Area Recordings (GPEH, LTE Cell Trace, Huawei WCDMA Call Trace)

A summary of the available data is given in the overview grid. A set of basic KPIs is presented which gives an overview of the performance in each 15-minute Recording Period (ROP).

When clicking on selected values in this grid, the pie chart gives a more detailed breakdown. Clicking on one slice of the pie chart sends calls containing the event for detailed call-by-call analysis.

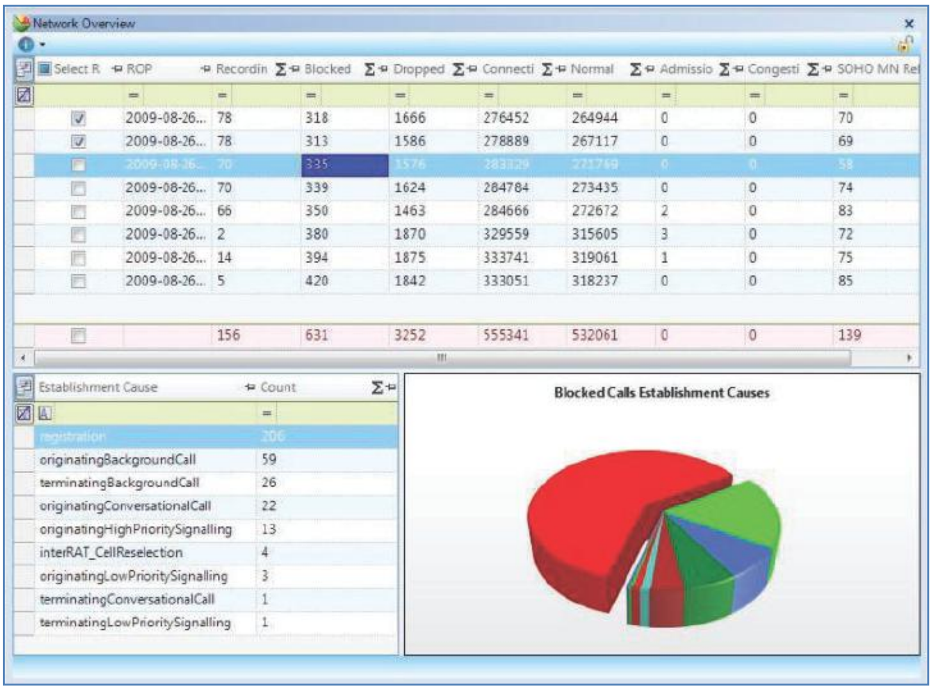


Figure 6 – Network Overview for Area Recordings

Subscriber Trace (Ericsson WCDMA UETR, LTE UE Trace, GSM MTR)

A summary of the available data is given in the overview grid. A set of basic KPIs is presented which gives an overview of the performance for each subscriber (IMSI) in the recordings.

See Section 10.1 for more details.

6.2 Cell KPI

Available for all area recording formats:

- Ericsson WCDMA GPEH Module
- Ericsson LTE Cell Trace Module
- Huawei WCDMA Call Trace
- NSN Megamon WCDMA GEO Interface Module

These views present a summary of some main key performance indicators (KPIs) calculated per cell during the selected scope. The KPIs are aggregated from the TEMS Discovery Network events generated during call analysis.

Charts quickly allow users to identify the 10 worst performing cells in terms of any selected KPI.

Figure 7 – Cell KPI: Worst Cells View

From these charts the user can then drill down into sections which give more detail on the KPI. Within each section, a chart showing the variation of the KPI over time (in 15-minute intervals) is available.

The following sections are available:

- Accessibility

- Retainability
- Mobility
- Data integrity (not available for Huawei Call Trace)

Calls that need to be analyzed in even greater detail can be sent for call-by-call analysis with a right-click. For WCMDA GPEH, dropped calls can also be geolocated on the map.

For WCDMA GPEH and Huawei Call Trace, the KPI can be presented for one or multiple service types (e.g., CS Speech, PS Interactive R99/HS, and PS Interactive EUL/HS). For the NSN WCDMA GEO Interface, the service type is based on the traffic class of the assigned RAB.

For LTE Cell Trace, there are two types of KPI: KPIs related to whole connections (these are broken down by service type) and KPIs related to individual eRABs within the connection (these KPIs are broken down by the QCI for the eRAB). This allows performance for VoLTE connections, for example, to be investigated separately.

6.3 Cluster KPI

Available for:

- Ericsson WCDMA GPEH Module
- Ericsson LTE Cell Trace Module
- Huawei WCDMA Call Trace

Aggregated performance for a group of cells can be calculated and presented in the cluster KPI view.

For cluster KPIs, the polygons that define the geographic area of the cluster can either be imported in MapInfo or defined directly in the tool. Once stored in the database, the cluster KPIs are automatically updated to show data on the new clusters.

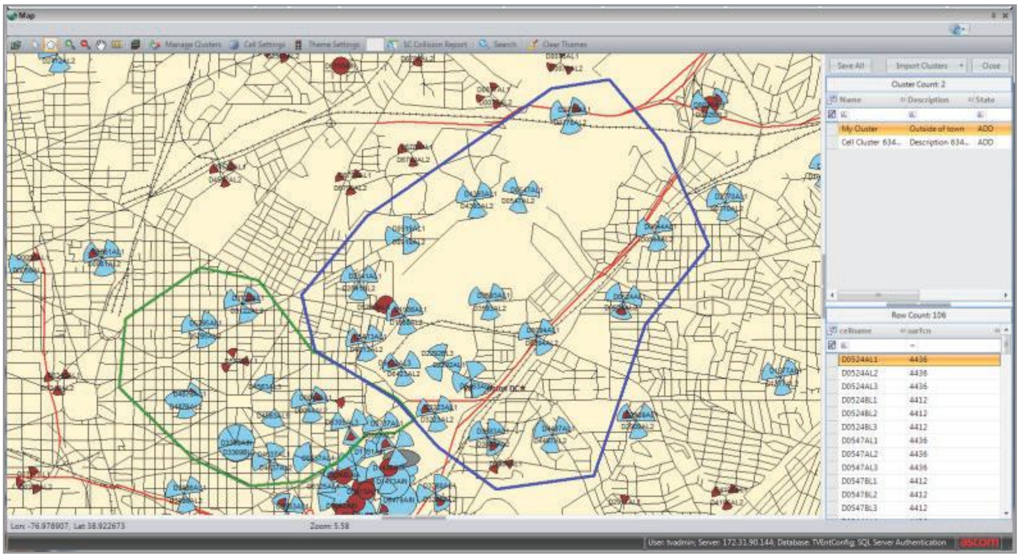


Figure 8 – Cluster Creation

6.4 Phone Model KPI

Available for:

- Ericsson WCDMA GPEH Module
- Ericsson LTE Cell Trace Module
- Huawei WCDMA Call Trace
- NSN Megamon WCDMA GEO Interface Module

The phone model KPI view presents a summary of some main key performance indicators calculated per phone model or per individual IMEI-TAC for the selected scope.

The “worst phone model” section allows phone models or IMEI-TAC that are generating high numbers of drops, blocks, and other exceptional events to be quickly identified. The reason for the poor performance can then be investigated directly by sending the affected calls for detailed call-by-call analysis.

It is also possible to send dropped calls to the dropped call analyzer function to determine if all of the dropped calls have the same common factor.

For WCMDA projects the Phone Model KPI are based on the IMEI-TAC taken from the NAS messages. The IMEI are only available for a fraction of calls - as determined by core network settings – normally much less frequently than the IMSI. This affects the reliability of Phone Model KPI.

However, during processing for a WCDMA project TEMS Discovery Network does look for any instance of an existing IMSI and IMEI pairing - filling in the missing IMEI wherever possible. This becomes more effective the longer the project duration (as the chance of a subscriber making at least one call with an IMEI and IMSI pairing increases).

For LTE projects the Phone Model KPIs are based on the IMEI-TAC taken from the Cell Trace User Mapping (CTUM) files from Ericsson MME. These must be taken from all MME in a pool and processed as a pre-requisite.

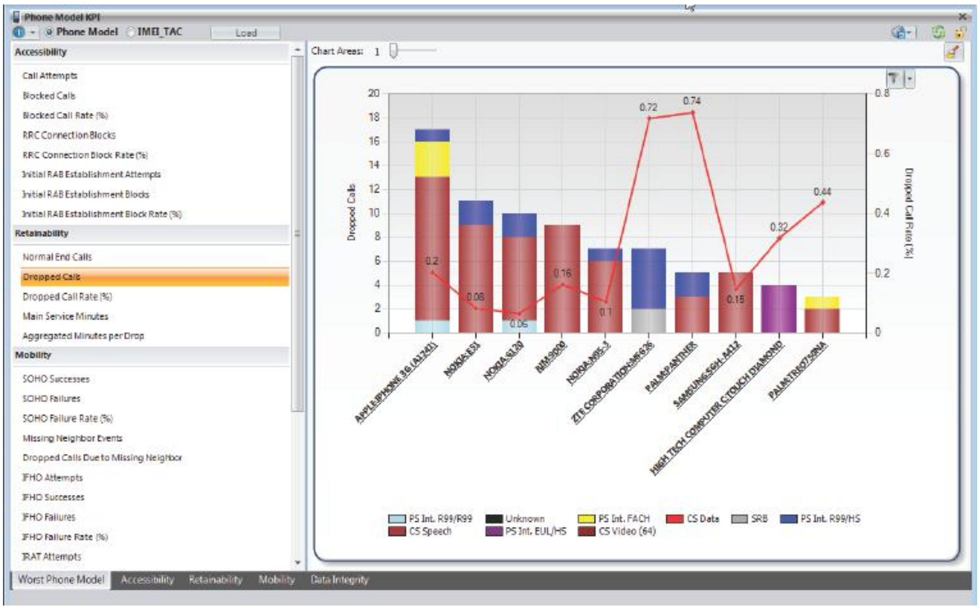


Figure 9 – Phone Model KPI

6.5 Subscriber KPI

Available for:

- Ericsson WCDMA GPEH Module
- Ericsson LTE Cell Trace Module
- Huawei WCDMA Call Trace

The subscriber KPI view presents a summary of some main key performance indicators calculated per IMSI for the selected scope.

The “worst IMSI” section allows subscribers who are generating high numbers of drops, blocks, and other exceptional events to be quickly identified. Often, a small number of users can be the reason behind major performance problems in one area of the network.

6.6 Dropped Calls Analyzer

Available for:

- Ericsson WCDMA GPEH Module
- Huawei WCDMA Call Trace

The dropped call analyzer feature allows common factors behind dropped calls to be quickly identified. For example, if all the calls were dropped on/at the same:

- Subscriber
- Cell
- IMEI-TAC
- Phone model
- RAB type
- Drop reason/cause
- Location (available with geolocation option for Ericsson)
- Time

The analysis can be performed for dropped calls on a specific cell or on a specific phone model.

Troubleshooting efforts can be focused more efficiently. For example, it can be determined quickly if most of the drops in one cell are caused by one “rogue” subscriber, or if most of the drops for one phone model are for a specific RAB type.

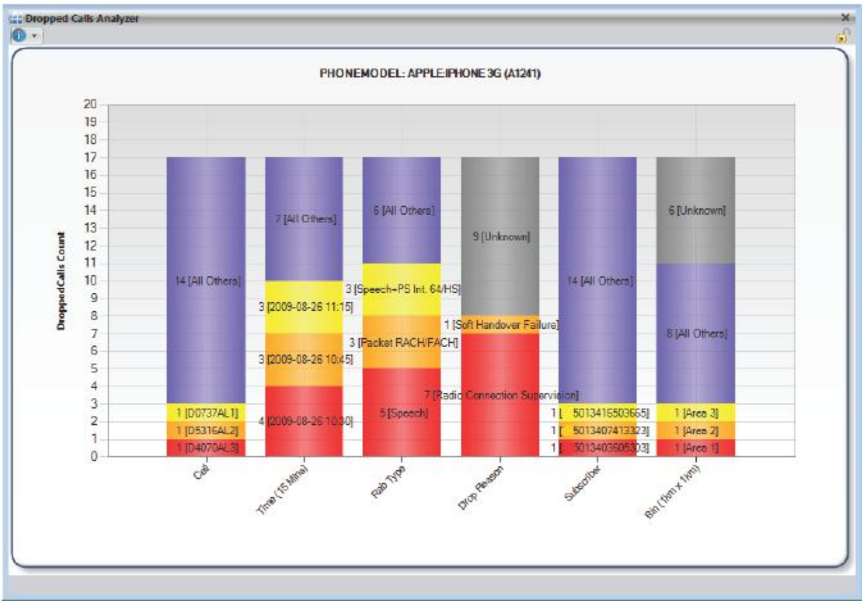


Figure 10 - Dropped Calls Analyzer

6.7 Cell Capacity Analysis

Available for:

- Ericsson WCDMA GPEH Module
- Huawei WCDMA Call Trace

With the cell capacity analysis feature, cells with resource issues can quickly be identified.

Samples of the resources usage in each cell are recorded periodically, every 2 seconds for Ericsson WCDMA and every 10 seconds for Huawei WCDMA Call Trace. These samples are then aggregated up to statistical views for quick identification of problem cells, it is then possible to drill down and examine the resource usage in the cell in great detail with charts at individual sample level.

For Ericsson WCDMA peak usage values critical resource types for each during each 15-minute ROP are calculated. These resource types are:

Downlink resource types

- DL power
- DL channel elements (hardware)
- The number of HSDPA users

Uplink resource types

- UL interference
- UL channel elements (hardware)
- The number of EUL users

The peak value is defined as the 95th percentile for the DL power, UL interference, and channel element resource types, and simply the maximum number of HSDPA and EUL users.

The values in the grid represent the highest of these values for the cell during the entire selected scope.

It is then possible to drill down into a detailed capacity chart to see the values for all ROPs for the selected cell.

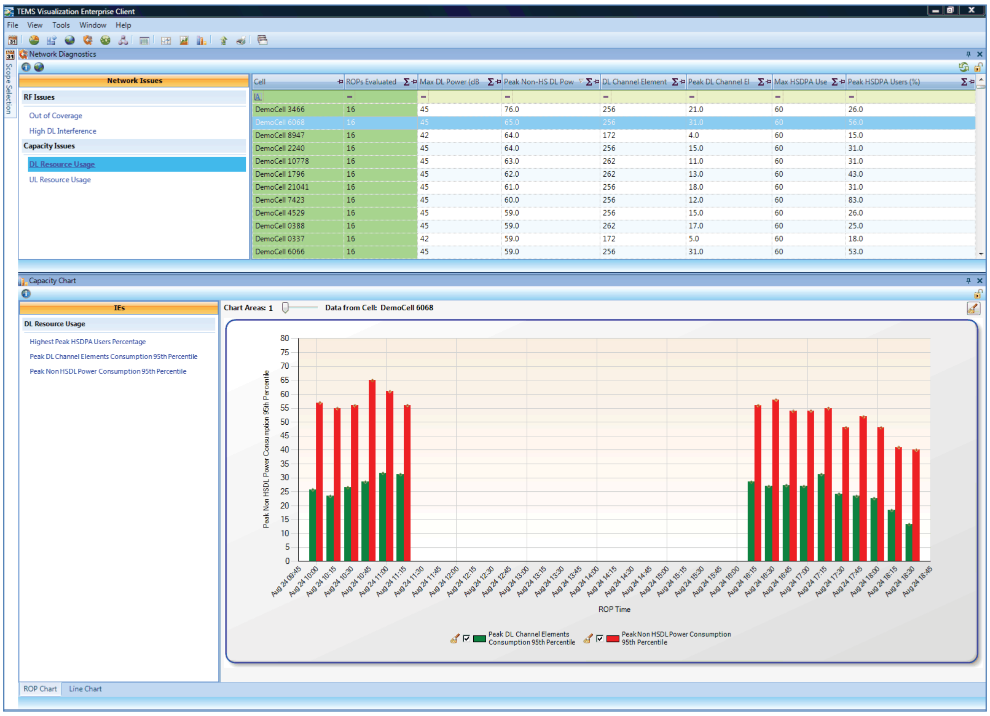


Figure 11 - Capacity Diagnostics Grid for All Cells, plus Chart for a Selected Cell Showing Peak Values per ROP

A single ROP can then be selected and an extremely high-resolution plot of the resource usage over time presented. However, the charts are completely configurable, so all resource types, including ASEs, spreading factors, numbers of CPM users, non-HS power, can be viewed on the same chart with a simple drag-and-drop.

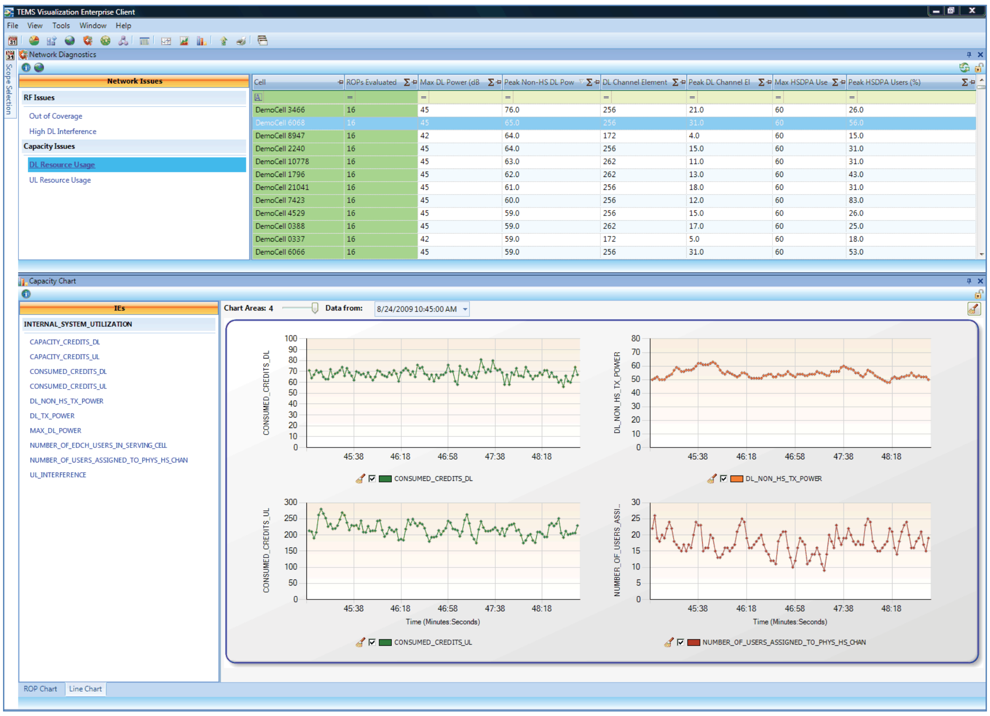


Figure 12 - Capacity Diagnostics Showing a Line Chart for a Single Selected ROP

For Huawei WCDMA, peak usage values during the entire recording period are calculated and presented. These resource types are:

- Total DL Power
- Non-HS Power
- Equivalent Users Downlink
- Equivalent Users Uplink
- HSDPA Users
- HSUPA Users

For a selected cell, an extremely high-resolution plot of the resource usage over time can then be presented.

6.8 Exception Analysis

Available for:

- Ericsson WCDMA GPEH Module
- Ericsson LTE Cell Trace Module
- Huawei WCDMA Call Trace
- NSN Megamon WCDMA GEO Interface Module
- Ericsson Subscriber Trace Module (WCDMA UTER, LTE UE Trace, and GSM MTR)

The exception analysis view is a good place to start analyzing the contents of a database for exceptional events.

It gives a summary of **all** of the call related messages recorded for the selected scope and **all** of the TEMS Discovery Network events generated.

For selected exceptional messages, a further breakdown of the number of calls per detailed cause value is presented. This is an extremely powerful method of determining root causes of problems and also determining if only certain types of RABs are affected.

For WCDMA modules, a summary of the decoded NAS messages is also presented.

Calls that contain exceptional messages (e.g., dropped call events, system release messages, system block messages) or events that need to be analyzed in greater detail can be sent directly to detailed call-by-call analysis with a right-click.

The count of individual ERAB releases and the Ue connection release are calculated separately. As an example, for a VoLTE call with 3 QCIs, we will count 3 different ERAB releases and one Ue release event.

Redirection to other radio access technologies using RRC connection release is calculated separately from INTERNAL PROC UE CONTEXT RELEASE. This separation will better present normal call releases caused by redirection.

A release, in which there still is data in the buffer, will be counted as a Dropped Call event.

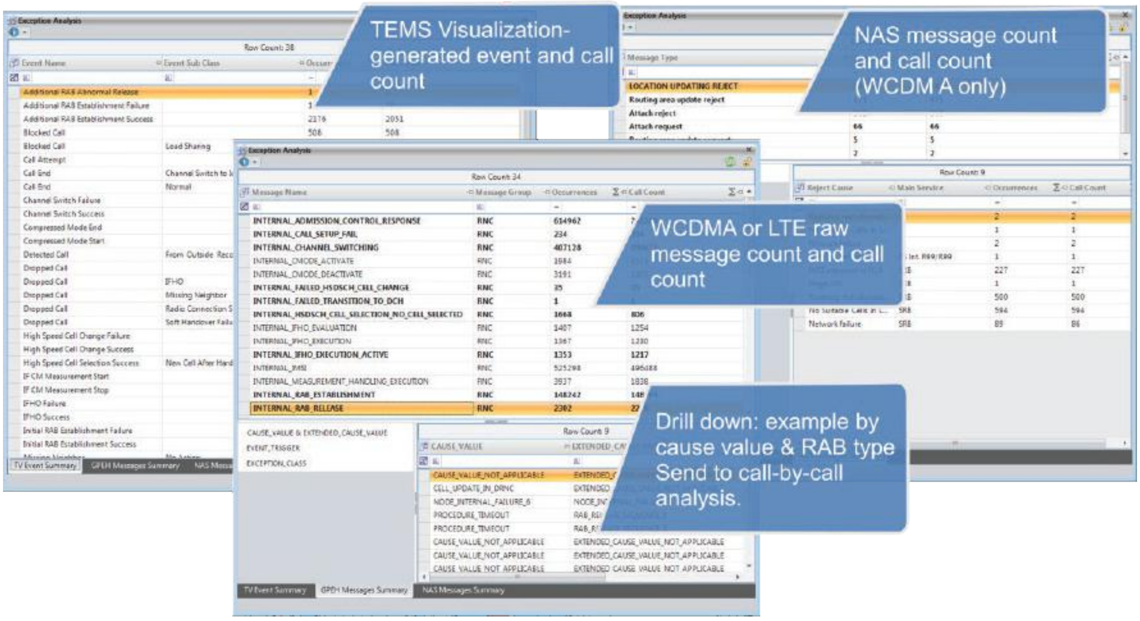


Figure 13 – Exception Analysis and Drilldown

6.9 Call Analysis and Measurement Views

Available for:

- Ericsson WCDMA GPEH Module
- Ericsson LTE Cell Trace Module
- Huawei WCDMA Call Trace
- NSN Megamon WCDMA GEO Interface Module
- Ericsson Subscriber Trace Module (WCDMA UETR, LTE UE Trace, and GSM MTR)

The call analysis views give the user summary information for each call in the Call List – and then allow the user to drill down to analyze individual calls in the Call Messages and Measurement views.

Calls can be sent for analysis from many of the different features: for example, all dropped calls for a specific subscriber or all calls affected by missing neighbor events.

A single call is then selected from the Call List. All of the messages for the selected call are then available in the Call Messages view along with the TEMS Discovery Network events generated from these message sequences. Any reported radio link measurements are also available in the synchronized Measurement view, and changes in serving cell can be seen as lines on the map.

Note that for Huawei networks only a sample of the last messages at call end is available. For WCDMA networks R13 and later these signaling messages are only available for abnormal end calls.

For Ericsson and NSN Networks the NAS messages exchanged between the UE and the core network are also available and it is also possible to drill down even further to view the entire content of an individual message in the Details view.

From the summary information per call in the Call List large groups of calls can be analyzed for patterns. This is an extremely powerful feature which can, for example, quickly identify if all dropped calls in a cell are generated by the same user (by the IMSI), on the same RAB type, the same establishment distance from the site and the same RF conditions at call end.

For Ericsson WCDMA GPEH, in the Call List, additional diagnostic information is available for each dropped call. An analysis of the message sequences just prior to the dropped call is performed to give possible causes. These include Channel Switching Failures, Missing Neighbors, Pilot Pollution and RF Conditions, and can help identify the reasons behind each drop and possible corrective actions.

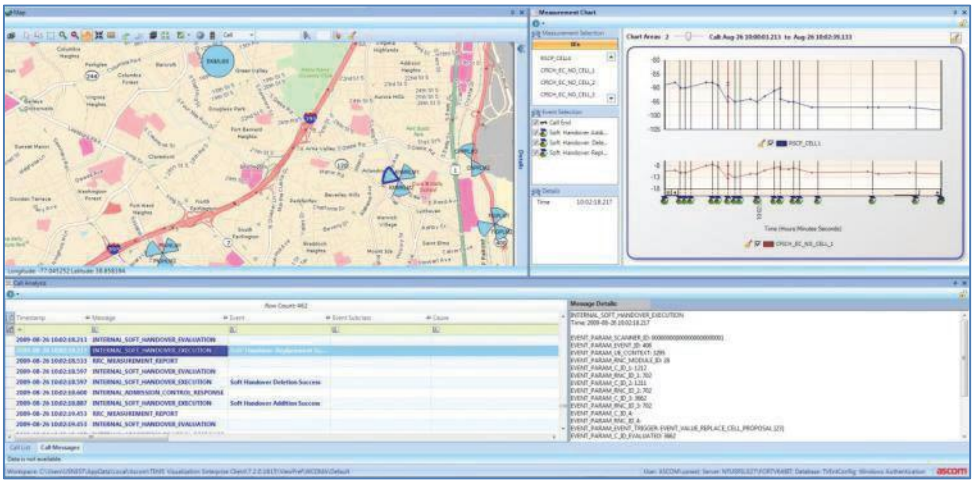


Figure 14 – Call Analysis and Measurement Views

6.10 Sequence Delay Histogram

Available for:

- Ericsson WCDMA GPEH Module
- Ericsson Subscriber Trace Module (WCDMA UETR, LTE UE Trace, and GSM MTR)
- Ericsson LTE Cell Trace Module
- NSN Megamon WCDMA GEO Interface Module

With the sequence delay histogram feature, the user can view the time between any two messages during a call. Analysis can be performed on the whole database or on a set of calls.

Questions such as, “How much time do customers spend in compressed mode?” and, “What is the average call set-up time?” can be answered using this feature.

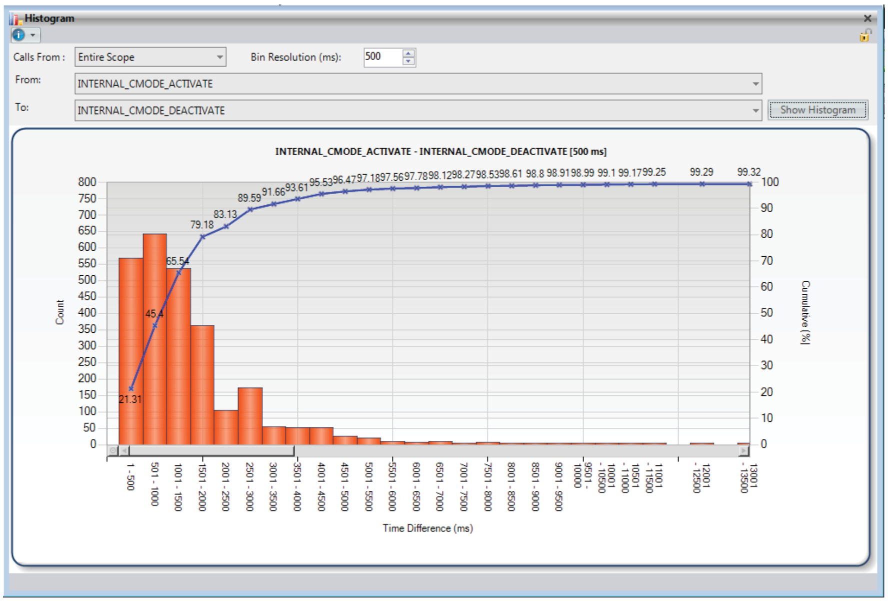


Figure 15 – Sequence Delay Histogram

6.11 RF Analysis Charts

Available for:

- Ericsson WCDMA GPEH Module
- Ericsson LTE Cell Trace Module
- Huawei WCDMA Call Trace
- NSN Megamon WCDMA GEO Interface Module
- Ericsson Subscriber Trace Module (WCDMA UTER, LTE UE Trace, and GSM MTR)

6.11.1 RF Distribution Chart

Statistics for the information elements in the radio measurement reports received during the recording (in one cell or in all listed calls) can be displayed in the RF charts.

The RF distribution chart shows the count for each value of the chosen information elements. Up to four charts can be defined by the user. Information elements are displayed by a simple drag-and-drop action into each chart.

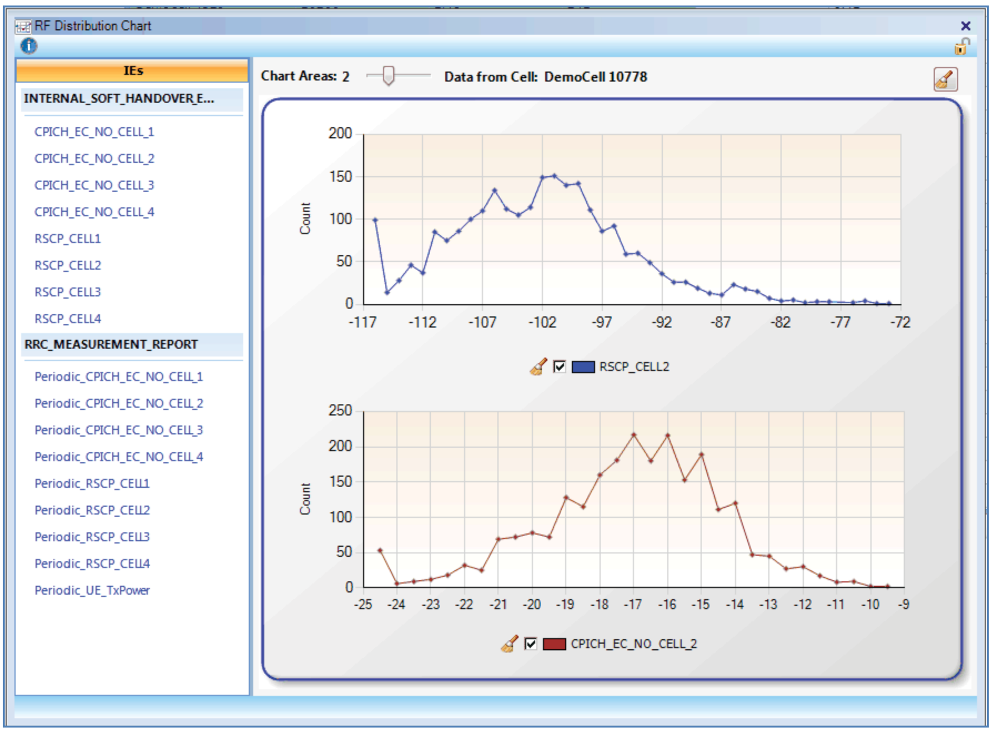


Figure 16 – WCDMA RF Distribution Chart

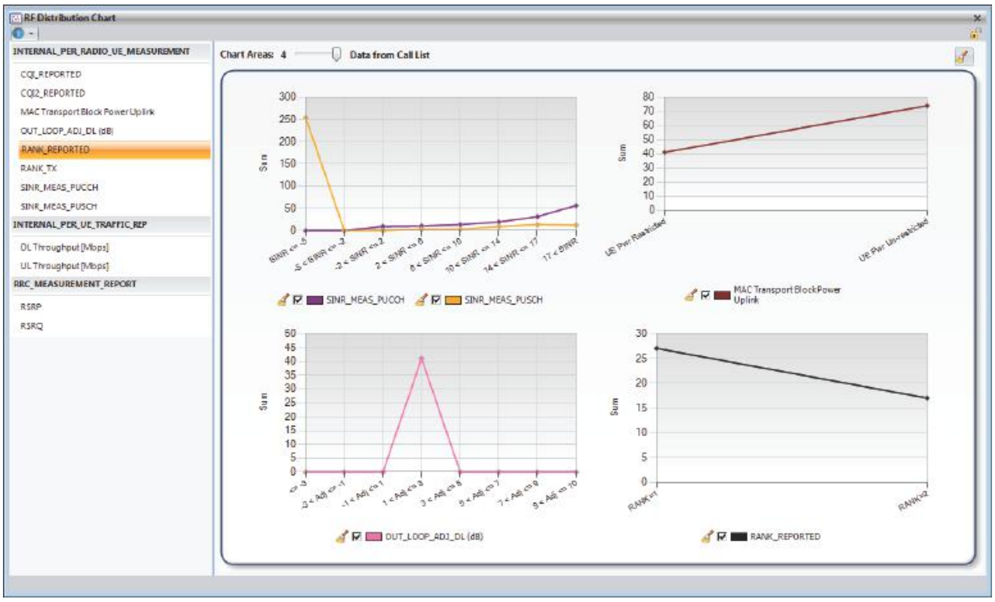


Figure 17 - LTE RF Distribution Chart

6.11.2 RF Scatter Chart

The scatter chart allows pairs of information elements from measurement reports to be compared. The size of the circle in the chart indicates the number of times the same combination of values occurred in a measurement report.

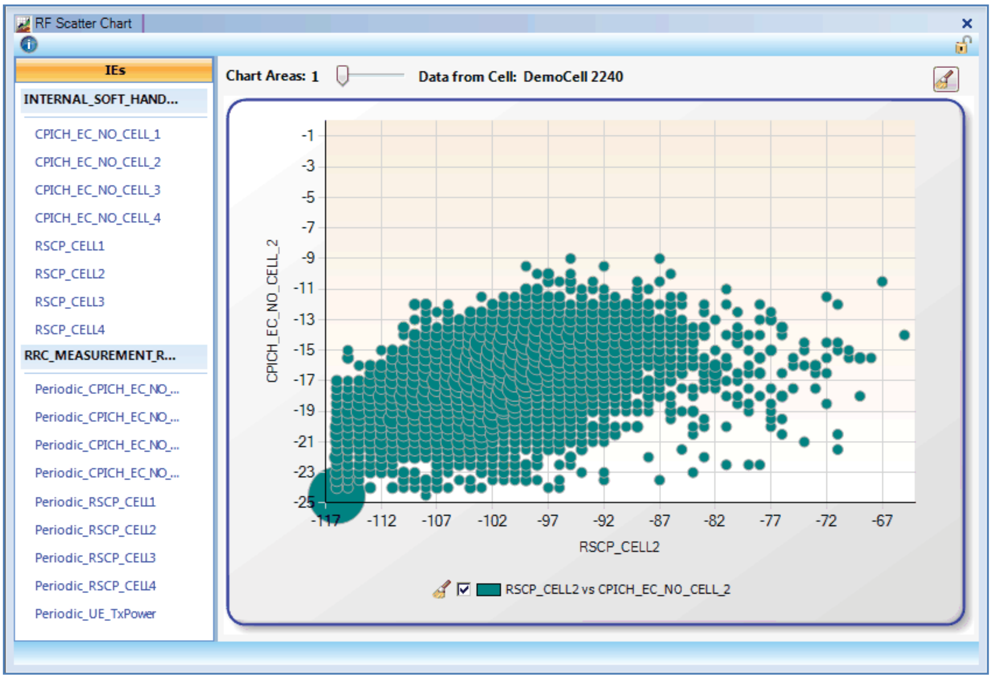


Figure 18 - WCDMA RF Scatter Chart

Figure 19 - LTE RF Scatter Chart

Scatter charts are extremely useful for correlating different information elements and answering questions like, “What values for Ec/No are considered typical when the RSCP is below -105 dBm?”

In WCDMA, the values in the radio performance charts are normally taken from the measurements performed for soft handover evaluations. However, periodic measurement reports generated through the use of the MRR-W feature in OSS-RC can also be displayed in the distribution chart and scatter chart views.

Additionally, the periodic measurements of UeTxPwr will be associated with the measurements for Ec/No or RSCP if they occur within a short time of each other.

A flat scatter chart (where the UeTxPwr is high even at good RSCP or Ec/No) can indicate uplink interference or other uplink problems such as LNA faults or swapped feeders.

6.12 Coverage Area Optimization

Available for:

- Ericsson WCDMA GPEH Module
- Huawei WCDMA Call Trace
- Ericsson LTE Cell Trace Module

Coverage area optimization includes features to identify and optimize the areas of wanted versus unwanted coverage:

- Overshooting cell identification
- Pilot pollution detection and geolocation (not available for Huawei WCDMA Call Trace)

6.12.1 Overshooting Cell Identification

Overshooting cells, which may be causing areas of pilot pollution and non-dominance, can be easily identified and corrective action can be taken.

During the configuration data import, each cell is assigned an estimated overshooting cell distance. This is calculated based on the site-to-site distance in the network area.

Then, during processing, each call establishment is identified and the following is stored:

- Distance from cell – from PRACH propagation delay
- CPICH Ec/No – from connection set-up

Finally, statistics for each cell are calculated for:

- The number and percentage of overshooting call establishments
- The number and percentage of calls established with poor quality (CPICH Ec/No)

These results are also broken down into a number of distance bands from the site. The highest possible resolution for the PRACH propagation delay, according to the 3GPP standard, is three chips = 234m. Therefore, multiples of 234m for the distance bands are used for the display close to the site.

Results are presented on maps and in charts for easy analysis. One of the most useful presentations on a map is to show the percentage of the total call establishments that occurred in each distance band.

Overshooting or poor-quality call establishments can be sent to the call list and analyzed further to see if they all come from the same user (IMSI) or a number of different users.

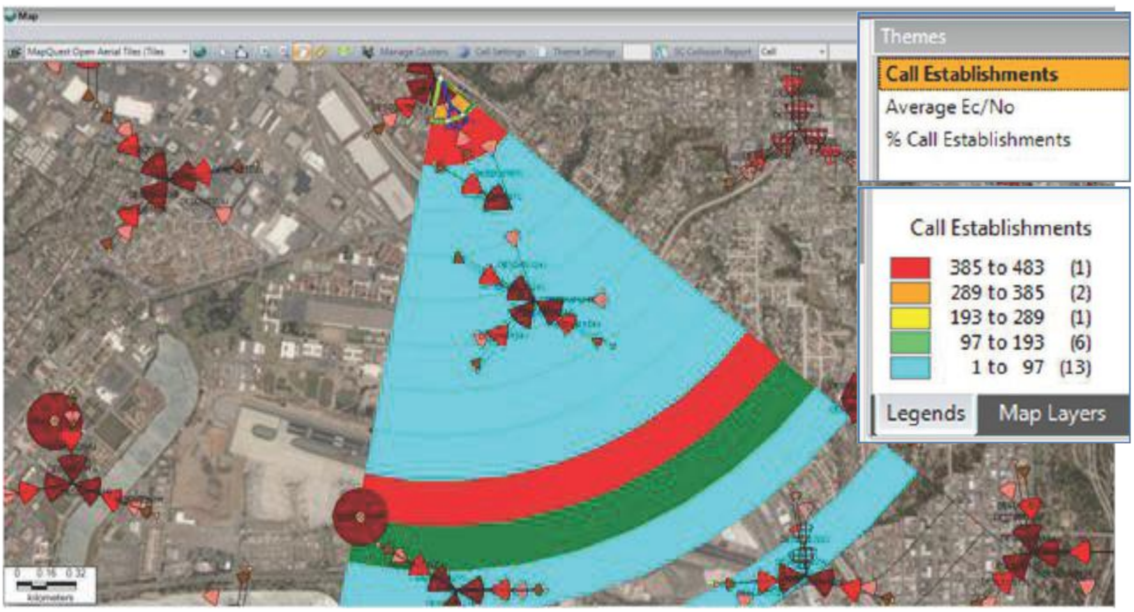


Figure 20 – Coverage Area Optimization

LTE Overshooting calculation uses Timing Advance, which is generated when optional feature 'Enhanced Cell ID' has been activated. The Timing Advance unit (Ts) is reported periodically every minute in 16Ts steps. One Ts is approximately 4.88m, which makes 78 meters as the Timing Advance band distance.

Timing Advance vs. KPI Measurement chart provides various measurements and KPIs plotted by distance. Issues such as low signal strength at a close distance can be detected.

Overshooting or poor-quality call establishments can be sent to the call list for further analysis.

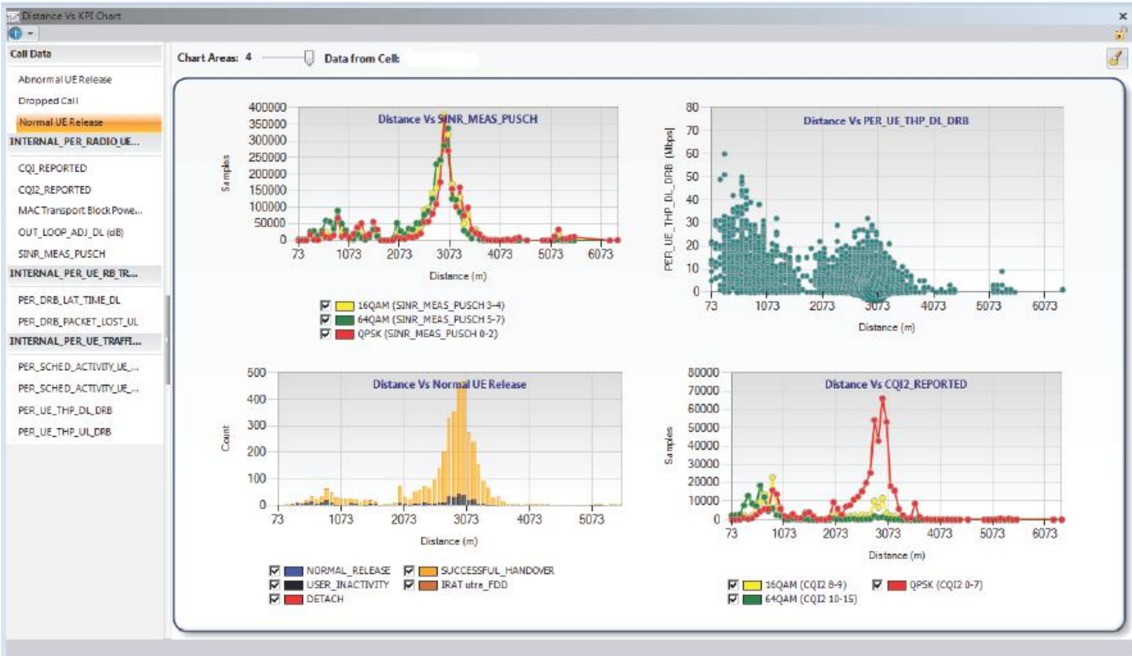


Figure 21. Timing Advance KPI Measurements

6.12.2 Pilot Pollution Detection and Geolocation

Pilot pollution detection features allow the engineer to isolate areas of detrimental overlapping coverage from live network traffic.

There are two different pilot pollution features that give different perspectives. Either can be used effectively depending on preferred engineering approaches:

1) Pilot pollution threshold-based
   - Uses all measurement reports for soft handover.
   - Based on number of cells within a dB threshold.
   - All involved cells are potential polluters.
   - Can be geolocated on the map.
2) Pilot pollution SOHO-based
   - Uses Internal GPEH event for soft handover.
   - Based on soft handover replacements.

- Assumes that the “best server” is being polluted by a replacement cell.

To allow the engineer to determine if pilot pollution is caused just by being out of coverage, the RSCP and Ec/No values associated with the pilot pollution occurrences are always presented.

The neighbor optimization and pilot pollution grids are dynamically linked so that both optimization aspects for one cell can be considered at the same time. This can help decide whether a missing neighbor cell should be added or if the cell needs to be down-tilted.

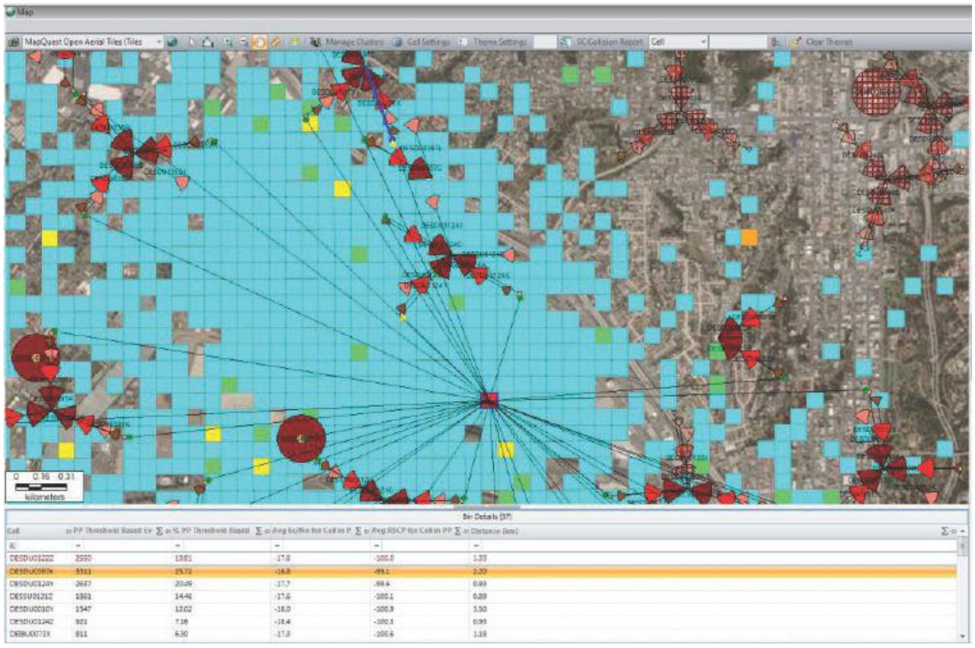


Figure 22 - Geolocated Areas of Pilot Pollution for a Selected Cell

7 Ericsson WCDMA GPEH Highlights

The figures below outline the major features available based on the Ericsson WCDMA GPEH data source. These features are available in TEMS Discovery Network (WCDMA, LTE, and Trace) application.

The features common across different modules (cell and cluster KPI, cell capacity analysis, call search, subscriber KPI, phone model KPI, exception analysis, sequence delay histogram and call-by-call analysis features) are described earlier in section 6.

The Geo Map (Google Maps Based Geo-Analysis) optional feature is described in section 5.

The remaining features are described in the following sections.

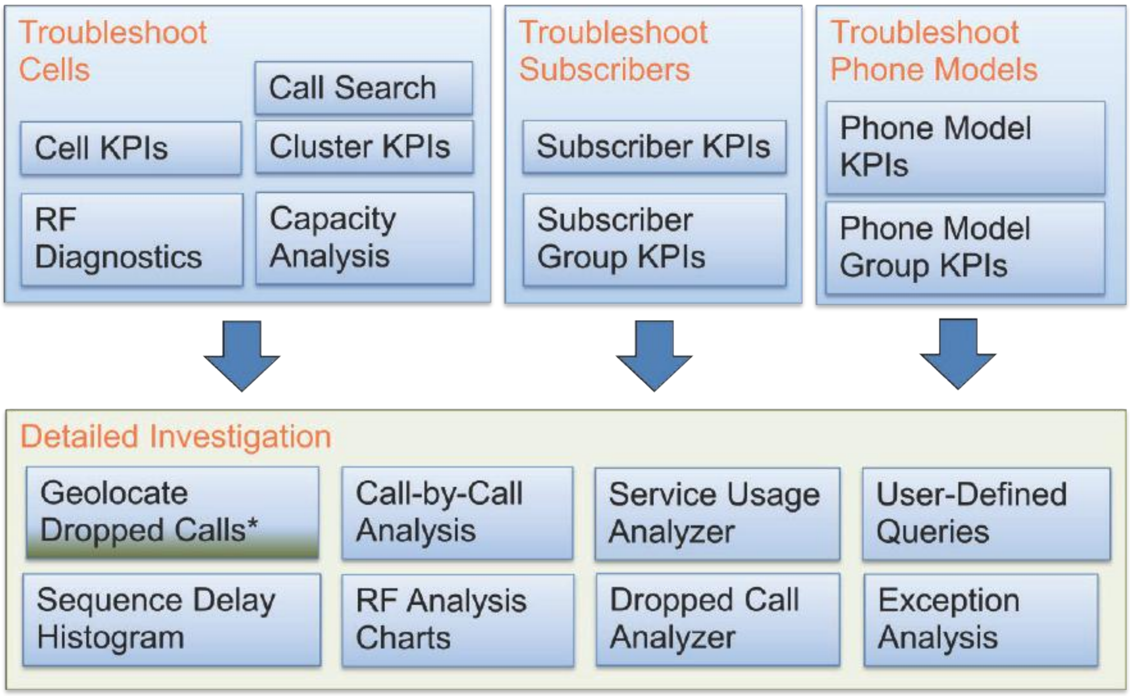


Figure 23 - Overview of WCDMA GPEH Module Troubleshooting Features

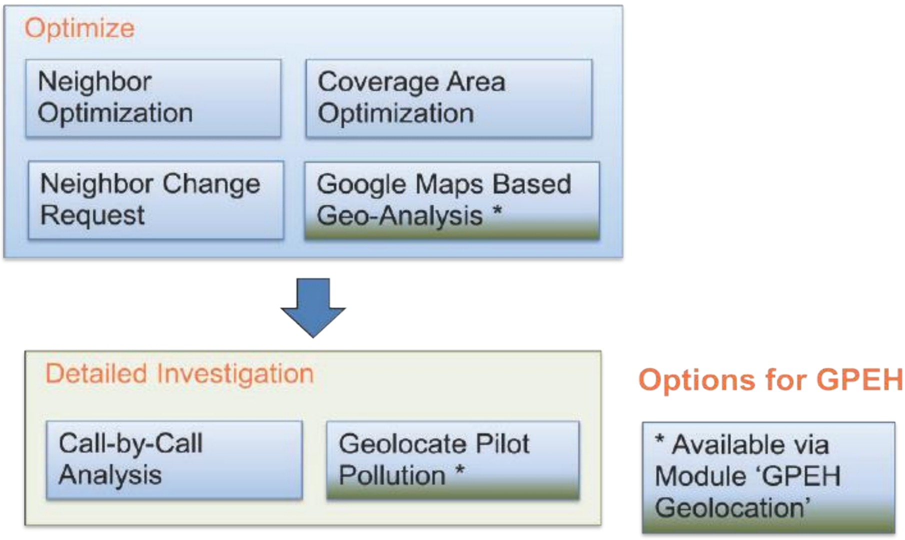


Figure 24 – Overview of WCDMA GPEH Module Optimization Features

7.1 Phone Model Group KPI

The phone model group KPI view presents a summary of some key performance indicators calculated for user-defined groups of IMEI-TAC for a selected scope.

The performance for a group of IMEI-TAC can be of interest when:

- Investigating performance for different issues of the same phone model
- Investigating performance of groups of phone models from the same manufacturer

From the group's overall performance, it is possible to drill down to individual IMEI-TAC performance.

7.2 Subscriber Group KPI

The subscriber group KPI view presents a summary of some key performance indicators calculated for user-defined groups of IMSI for a selected scope.

Examples where the performance for a group of subscribers can be of interest are:

- TEMS™ Automatic MTUs/RTUs
- VIP customers
- Corporate customer groups

From the group's overall performance, it is possible to drill down to individual subscriber performance.

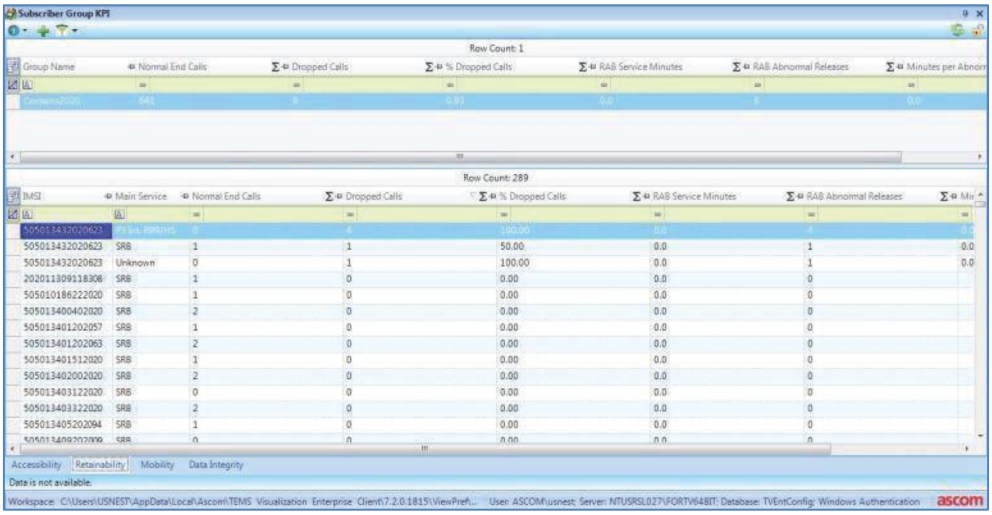


Figure 25 – Subscriber Group KPI View

7.3 Geolocation – for WCDMA Optimization

Available for:

- Ericsson WCDMA GPEH Module as separately licensed geo-location module

The TEMS Discovery Network Enterprise system can perform geolocation of selected events. The estimated positions for these events are based on measurements made by the mobile phone and reported to the RNC.

The features that currently utilize geolocation are listed below. This list will be expanded in future releases. Events can be geolocated for a selected cell or group of cells – or for an entire geographic area regardless of the cells involved.

A separate algorithm and accuracy description document is available on request.

7.3.1 Geolocating Pilot Pollution

Available for:

- Ericsson WCDMA GPEH Module as separately licensed geo-location module

Areas where several cells are involved in overlapping coverage are geolocated on the map. This allows engineers to determine if:

- Cells are providing coverage in unwanted areas and causing pilot pollution.
- Wanted cell coverage will still be good if, for example, the polluting cells are down-tilted.
- The reason behind pilot pollution is simply poor coverage.

For full details, see section **Error! Reference source not found.**.

7.3.2 Geolocating Dropped Call Events – Virtual Drive Tests

Available for:

- Ericsson WCDMA GPEH Module as separately licensed geo-location module

Dropped calls can be geolocated on the map. The number of dropped calls in each bin is displayed on the map. Clicking on a bin presents details for the drops in that bin and allows further drilldown.

An example use case is to select an area around a road and then utilize all subscribers as virtual drive testers to find locations of all dropped calls on the road.

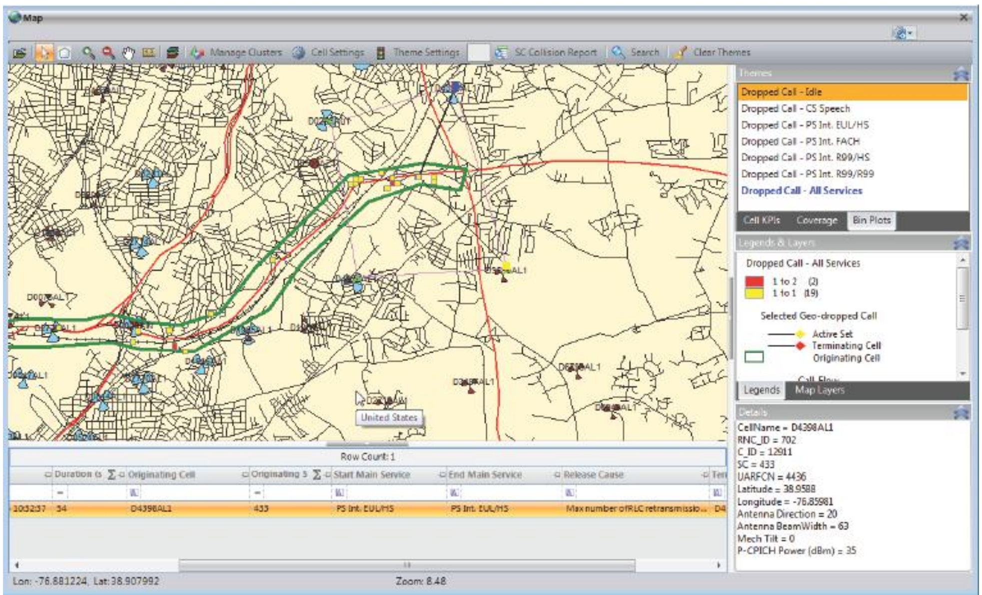


Figure 26 - Geolocation of Dropped Calls Virtual Drive Tests

Note that currently dropped calls can be geolocated only when a soft handover evaluation has occurred for the call.

7.4 Cell Analysis Features

Many of the reasons behind performance degradation are basic issues.

Congestion can push traffic to non-optimal cells, installation problems can cause swapped feeders or overshooting cells, real-life coverage can differ from predictions, equipment such as low-noise amplifiers can fail, and feeders can corrode.

Before any real optimization of a network can be performed, these basic issues must be addressed.

The cell capacity analysis and RF diagnostics features are designed to highlight cells suffering from the symptoms of these basic issues and then will try to identify the root causes as well as possible.

7.5 RF Diagnostics

The RF diagnostics feature is designed to automatically highlight cells in the network that are suffering from RF issues. Further analysis is then done to determine the potential causes of these issues.

The RF issues are identified by looking at combinations of values from the measurement reports and determining if cells are suffering from these symptoms:

- Out of coverage
- High UL interference
- High DL interference
- Uplink/downlink imbalance

The potential causes are investigated by searching for occurrences of certain conditions during the same time periods as when the RF issues occurred.

Some examples of these potential causes range from losses on the uplink path, admission control blocks, pilot pollution, overshooting cells, and missed handovers.

This is an expert system with detailed and proven knowledge of troubleshooting on WCDMA built into the algorithms.

All of the statistics are expressed in the number of calls affected by a particular RF issue and potential cause. This is important because it ensures that measurements from a few poorly performing mobile phones are not overrepresented in the results at the cell level.

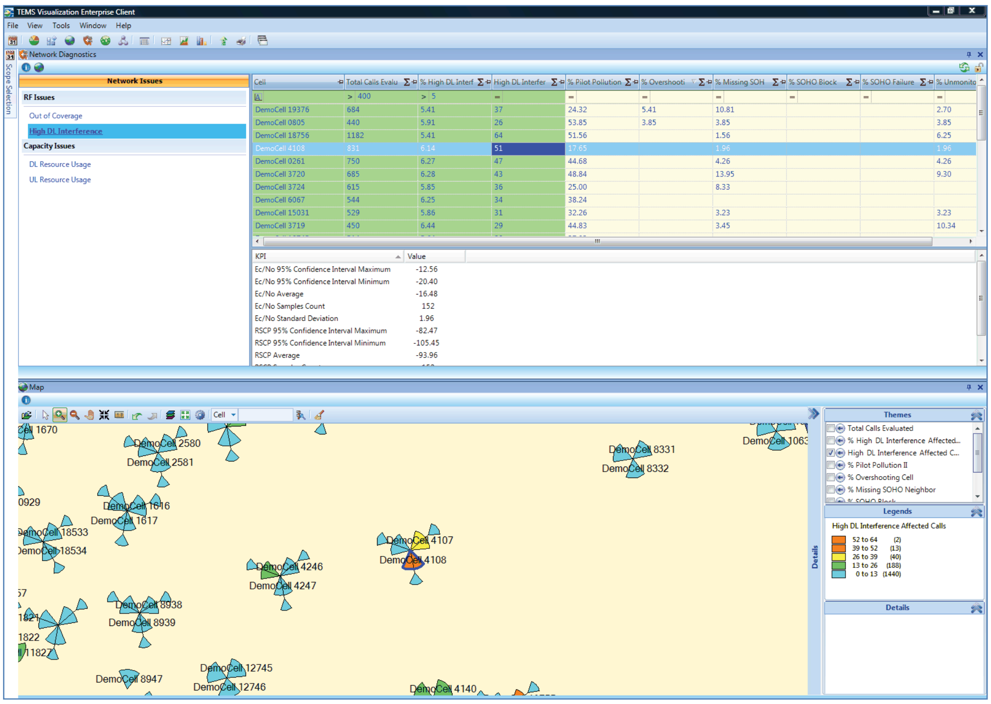


Figure 27 – RF Diagnostics Grid and Thematic Map

7.6 User-Defined Queries

The user-defined queries feature allows the user to create queries with complex conditions on the decoded GPEH event data. Users can:

- Query the raw data for all occurrences of a selected GPEH event.
- Associate call-level information to each occurrence of the GPEH event (e.g., IMSI, IMEI-TAC, duration, current cell).
- For each occurrence of the GPEH event, determine if one or more expressions are true or false – based on a set of conditions on the available information elements (for example, a specific failure reason, a specific RAB type, an RF measurement below a certain value).
- Filter the output based on these conditions.

Queries are stored on a server and can be shared with other users.

Examples:

- All abnormal releases of traffic RABs due to issues related to SOHO
- All channel switching failures caused by a lack of transmission resources
- All RRC connection requests in a cell with Ec/No < -10 dB

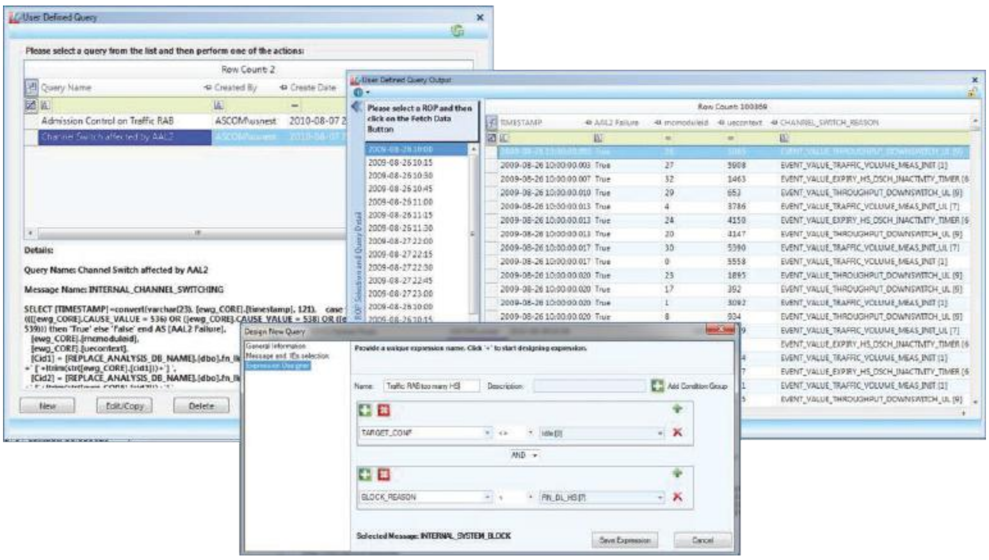


Figure 28 – User-Defined Queries Feature

7.7 Service Usage Analyzer

The Service Usage Analyzer allows the time spent in each service type (Signaling, CS Speech, CS + PS Multi-RAB etc) to be analyzed. It is possible to analyze a single call or all calls for a selected Subscriber or Phone Model.

To perform a comparison of the traffic patterns for different types of users or different Phone Models the Service Usage Analyzer view can be locked and then a new view populated.

7.8 HSPA Data Performance Analysis

In all of the KPI views (by cell, subscriber, and subscriber group), the performance statistics are split out per main service. So, for example, it is possible to separately monitor the number of dropped calls for packet switched interactive carried on HSPA connections.

In each KPI view, there is also a separate data integrity section. Here, average throughput statistics and other packet switched performance metrics such as channel switching failures are presented.

Also, when analyzing individual calls, the individual throughput measurements can be displayed in the measurement view.

7.9 Intra-frequency Neighbor Optimization

The intra-frequency neighbor optimization feature makes it possible to easily verify the neighbor plan and find both “missing neighbors” and non-utilized existing neighbors in a WCDMA network.

In WCDMA, an accurate neighbor plan is crucial for network performance. If a missing neighbor is too strong, the system will drop the call. If there are too many defined neighbors, there is a greater risk that the most important neighbors are not being measured due to lack of time. This makes optimizing the neighbor plan one of the most important tasks for a WCDMA optimization engineer. With TEMS Discovery Network, this can be done quickly and easily by using information from all users in one area of the network and representing this graphically in the map view.

In all views, the reciprocal information for the selected neighbor relation is highlighted. This is valuable information when deciding whether to add or remove relations. Normally, both directions for the neighbor relation should be evaluated before deciding if a mutual relation can be removed.

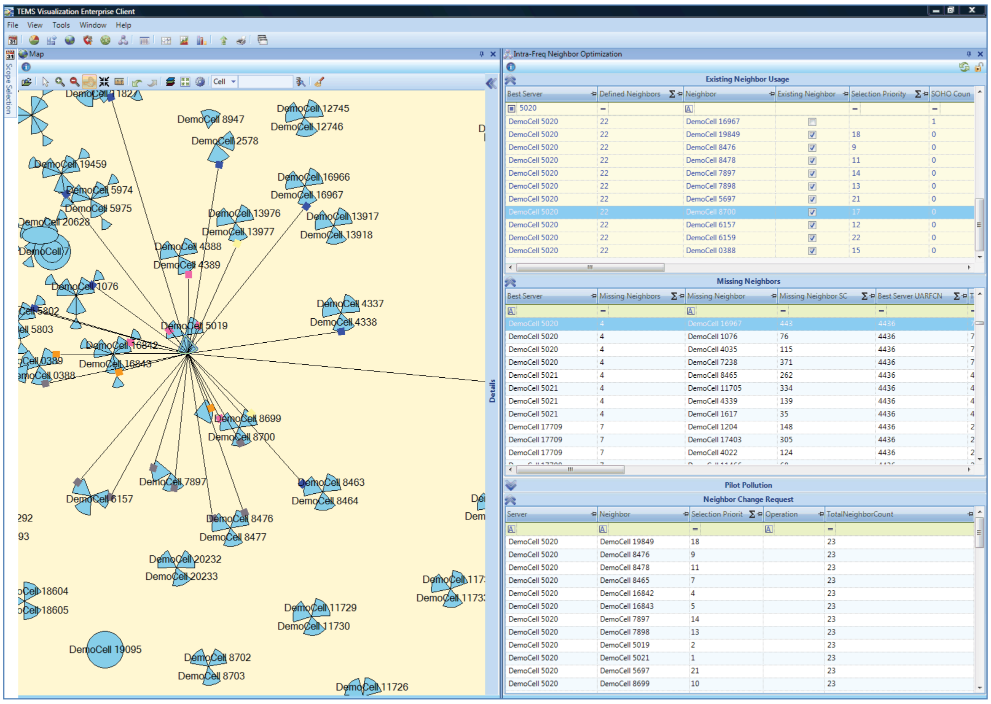


Figure 29 - Intra-frequency Neighbor Optimization

7.9.1 Existing Intra-frequency Neighbor Usage

The usages of existing defined neighbor relations are counted by TEMS Discovery Network. These are categorized as follows:

- All SOHOs – where cell A was the “best server” and cell B is added or replaced into the active set in any position
- SOHO 1 to 2 cell – where cell A was the only cell in the active set and cell B was added

If there are SOHOs between cells but none of these is a SOHO 1 to 2 cell, then this relation may still be a candidate for removal.

Unmonitored neighbor statistics are also provided. These show when a defined neighbor was strong enough to come into the active set but had not previously made it into the monitored set. The selection priority column (extracted from the Bulk CM file) can be used together with these statistics to help decide if the correct priority has been set for the relation.

7.9.2 Missing Intra-Frequency Neighbors

TEMS Discovery Network’s intra-frequency neighbor optimization tool analyzes and displays the missing neighbors as reported by the UE to the system. TEMS Discovery Network allows analysis of the reported missing neighbors for possible further action.

This is a very powerful feature based on real customer behavior and not only on test equipment, thus allowing examination of scenarios not looked at during the initial tuning.

The algorithm matches the reported scrambling code with the cell name. This matching can be checked by searching for all cells with the same UARFCN and scrambling code from the map view.

Statistics for the number of calls and also the number of individual subscribers (IMSIs) that generated the missing neighbor events are presented. This is extremely useful when deciding if a missing neighbor problem is a real network issue or was caused by a single poorly performing mobile phone.

A missing neighbor is reported as one of the following types:

- No action
- Release

“No action” means that the missing neighbor was reported but the call continued. “Release” means that the call was dropped.

Through a feature unique to TEMS Discovery Network, virtual dropped calls are also counted. A high setting for the real “release connection offset” parameter can be kept in the live network, while the number of virtual dropped calls that **would** have occurred from a low **virtual** setting of the release connection offset parameter is presented in TEMS Discovery Network. This allows users to prioritize the addition of missing neighbors.

7.10 Inter-frequency Neighbor Optimization

With the introduction of second and third carriers becoming common practice in many WCDMA networks, the accuracy of the inter-frequency neighbor list planning has a direct impact on network performance.

Again, this feature is based on real customer traffic and not only on test equipment, thus allowing examination of scenarios not looked at during the initial tuning.

TEMS Discovery Network uses an algorithm to identify candidate inter-frequency neighbor relations. These candidates are either:

- Missing inter-frequency neighbor relations which should be defined, or
- Existing inter-frequency neighbor relations where the selection priority should be increased.

Statistics are also presented that allow the performance of existing defined inter-frequency neighbor relations to be evaluated. Unused inter-frequency relations can be found and removed.

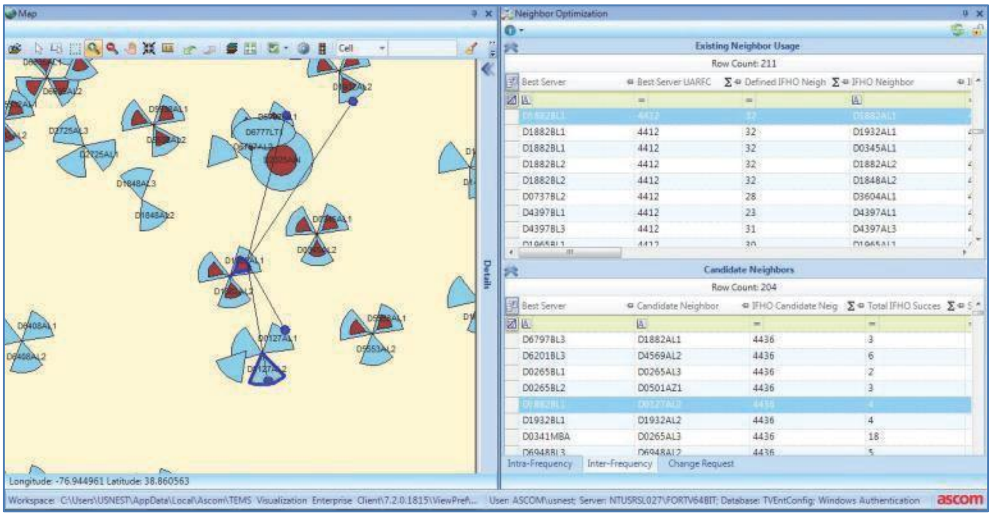


Figure 30 – Inter-frequency Neighbor Optimization

7.11 IRAT Neighbor Optimization

A crucial network optimization activity is to ensure that subscribers have continuation of service if they leave the WCDMA coverage area.

TEMS Discovery Network presents statistics that allow:

- Unused GSM neighbors to be identified using the number of IRAT handovers and cell changes
- Poorly performing GSM neighbors to be identified through the number of IRAT handover and cell change failures and dropped calls.
- Missing GSM neighbors to be identified through analyzing IRAT handover patterns through existing defined GSM neighbors.

Results are synchronized with geographical representation on the map for easy analysis.

Normally some basic level of manual GSM neighbor relation planning must be performed before using this feature. After this, however, the live customer traffic can be very effectively used to find problems not considered during the initial planning.

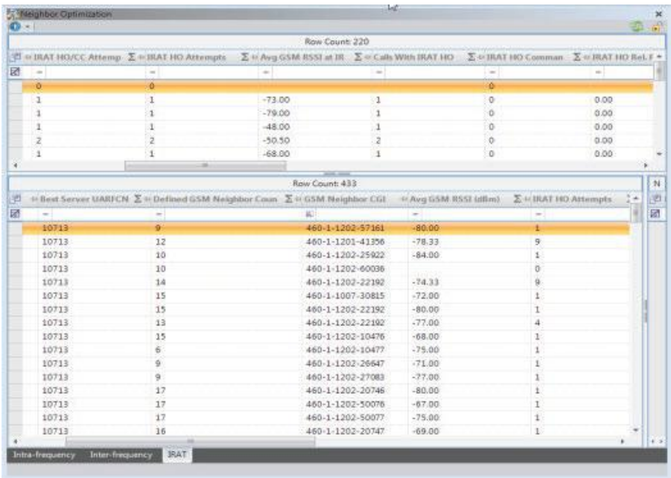


Figure 31 – IRAT Optimization Statistics

7.12 Neighbor Change Request

After analyzing and deciding which neighbor relations need to be created, deleted, or modified (with the selection priority feature), a change request can be created. The change request can be created in XML format for export to a planned area in the Ericsson OSS-RC.

It is possible to:

- **Create a mutual neighbor relation** – Right-click on “Relation” in “Missing Neighbors.”
- **Delete an existing mutual neighbor relation** – Right-click on “Relation” in “Existing Neighbors.”

When added neighbor relations are included, the next available selection priority is automatically used. This can then be modified for the newly added relations or other existing relations.

Note that currently GSM neighbor relations are not supported in the neighbor change request tool.

8 Ericsson LTE Cell Trace Highlights

The figure below outlines the major features available for LTE Cell Trace. These features are available in the TEMS Discovery Network (WCDMA, LTE, and Trace) application.

All available features are common across vendors and are described in section 6.

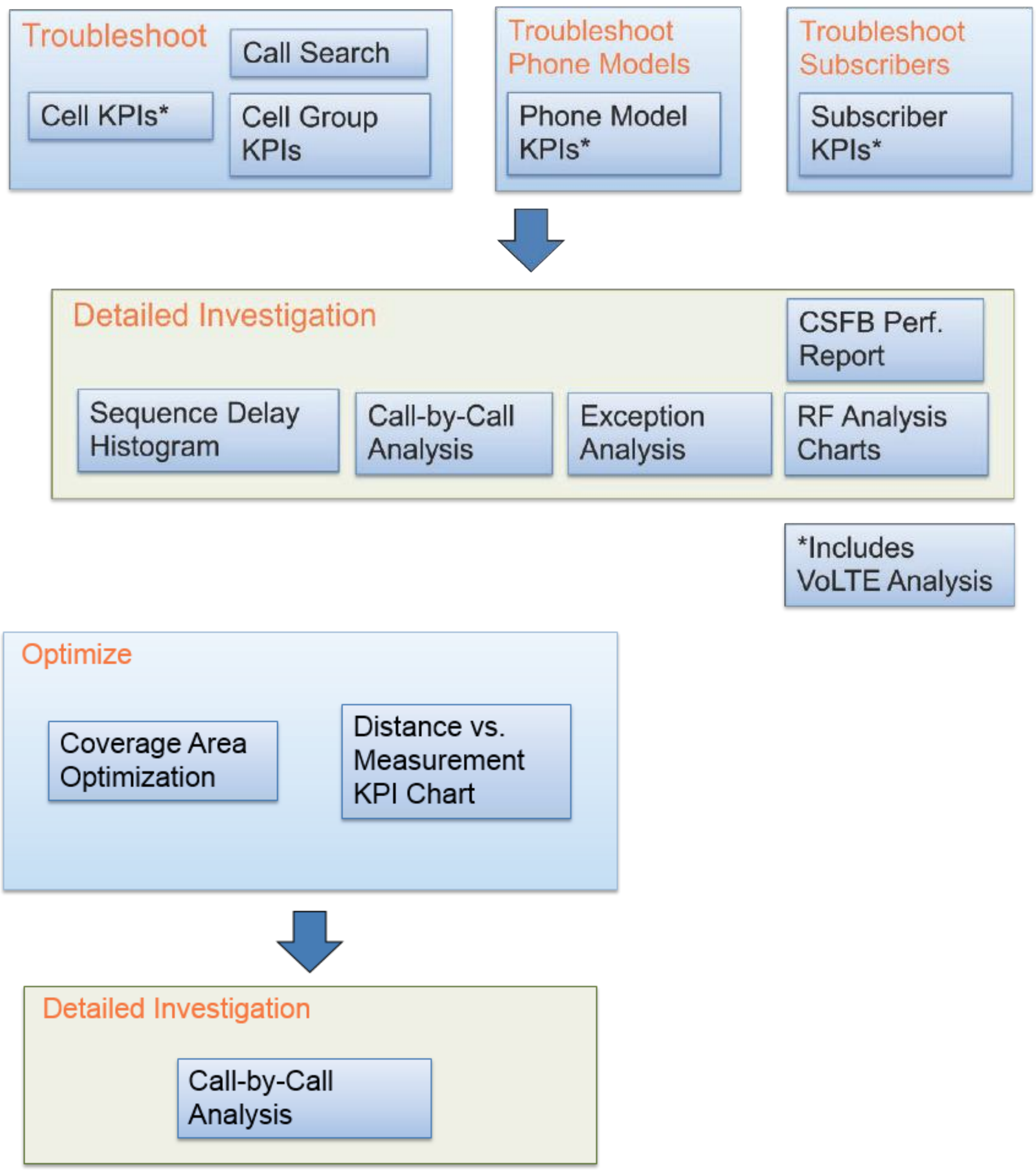


Figure 32 - LTE Cell Trace Highlights

9 Huawei WCDMA Call Trace Highlights

The figure below highlights the major features available based on the WCDMA Huawei Call Trace format. These features are available in the TEMS Discovery Network (WCDMA, LTE, and Trace) application.

All features are common across vendors and are described in section 6. Samples of screenshots from the Huawei WCDMA module are provided below.

The Geo Map (Google Maps Based Geo-Analysis) optional feature is described in section 5.

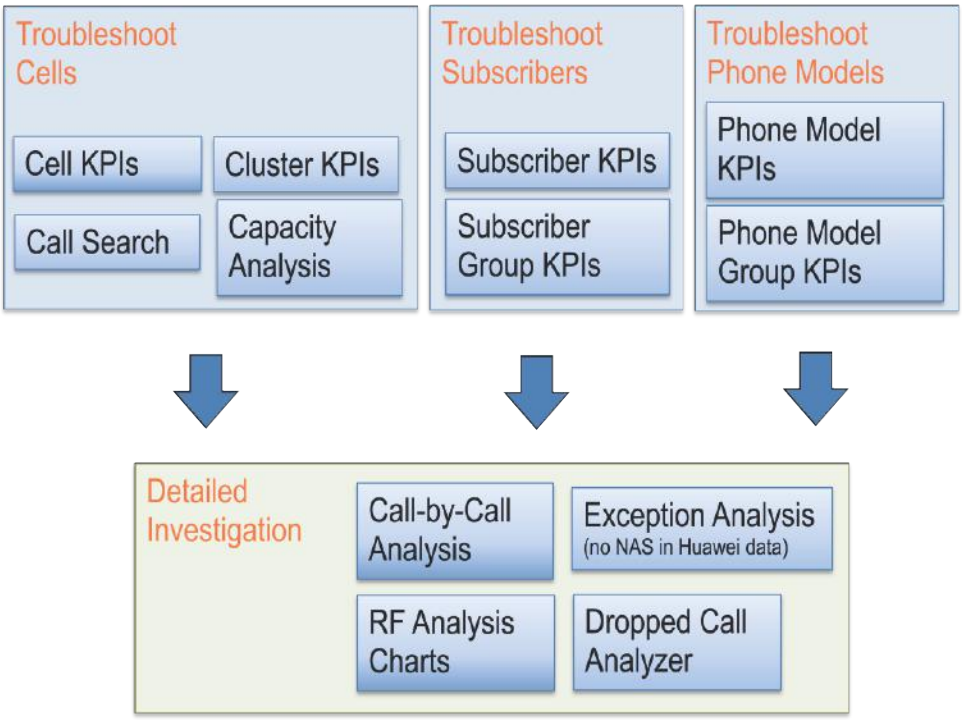


Figure 33 - Huawei WCDDMA Call Trace Troubleshooting Highlights

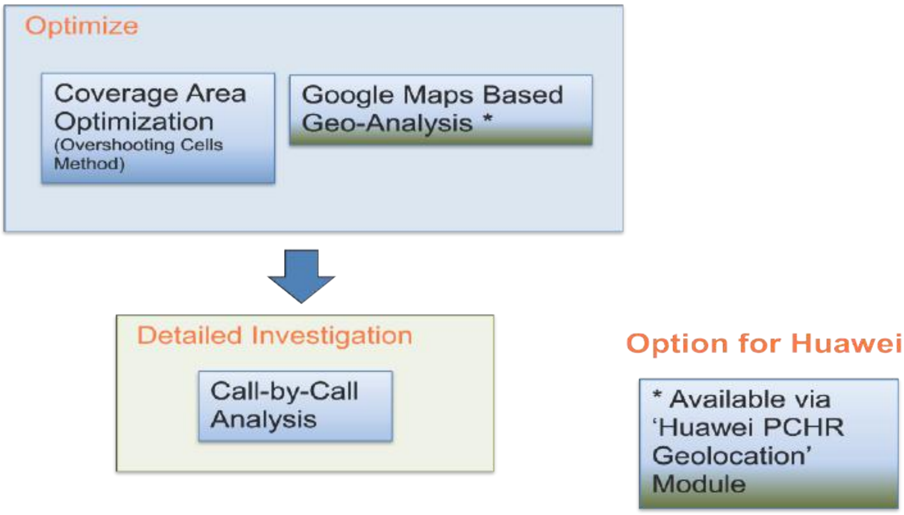


Figure 34 - Huawei WCDMA Call Trace Optimization Highlights

Figure 35 - Investigating cells with high dropped call number, also showing RF Distribution Chart for poorly performing cell

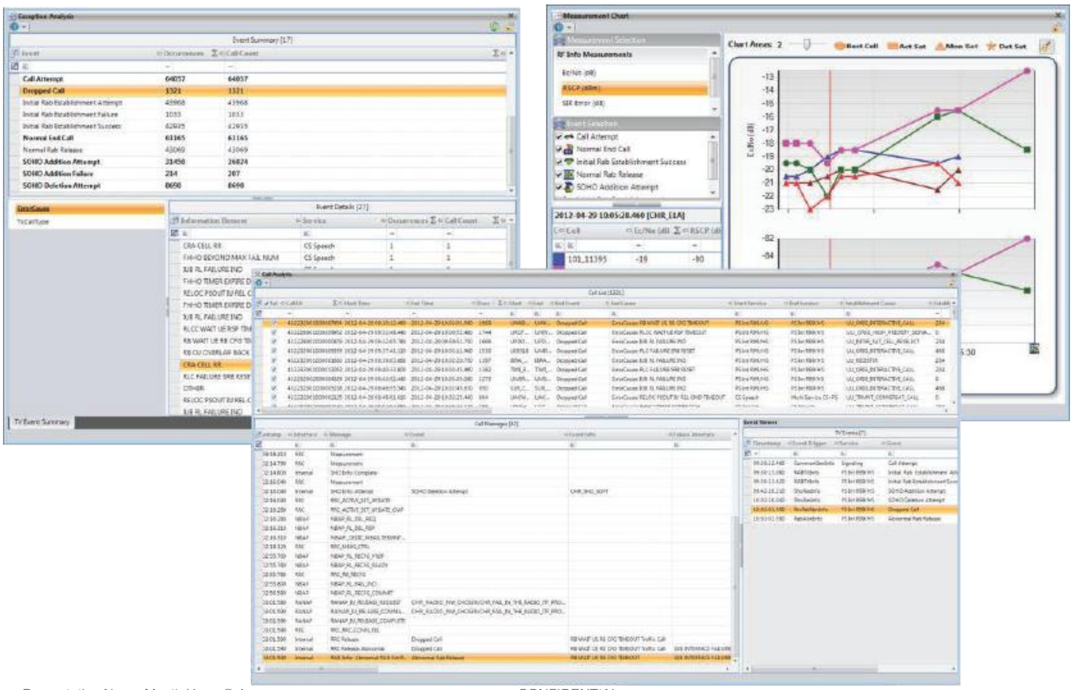


Figure 36 - Investigating calls with specific exceptions in Exception Analysis with drilldown to detailed call-by-call analysis

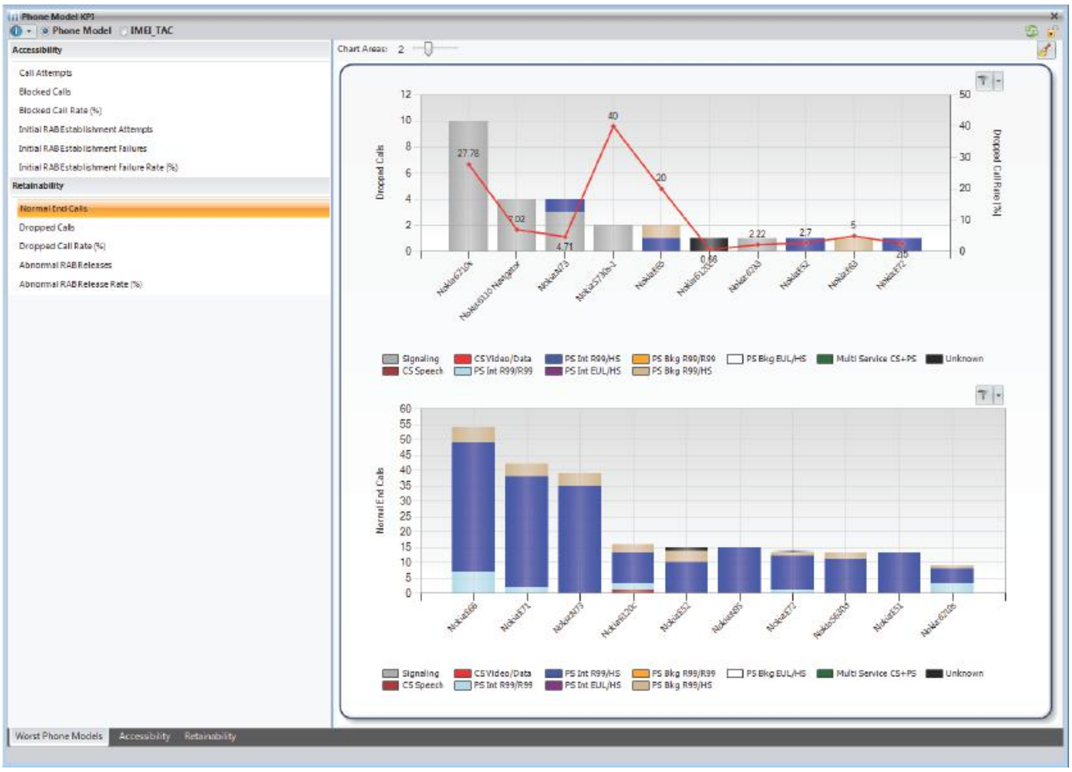


Figure 37 - KPI View example: Analyzing worst performing Phone Models

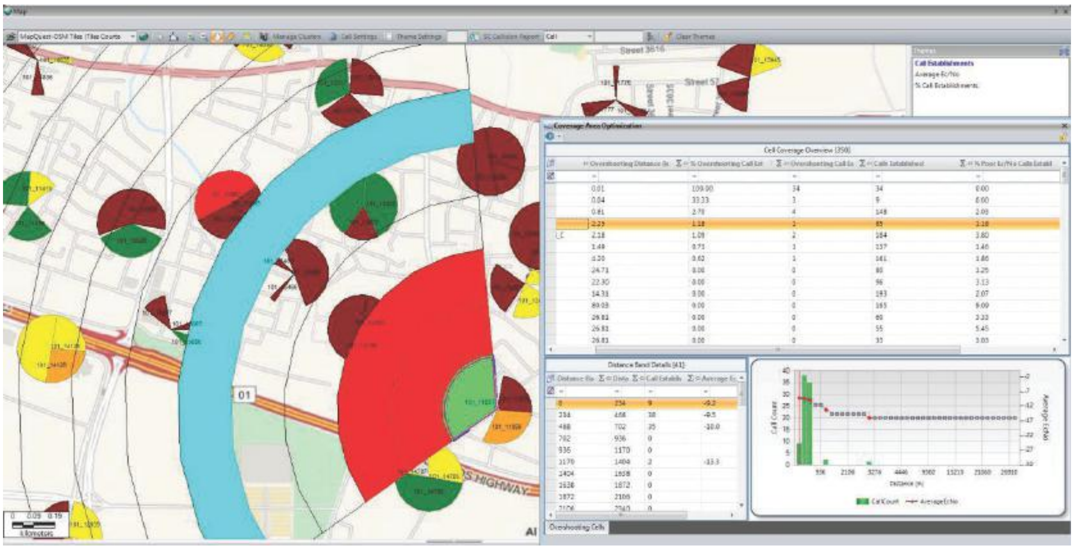


Figure 38 - Identifying Overshooting Cells

10 Subscriber Trace Highlights

The figure below outlines the major features available based on the Ericsson Subscriber Trace formats.

The features common across different modules (call search, call-by-call analysis, exception analysis, sequence delay histogram, and RF analysis charts) are described in section 6. The remaining features are described in the sections below.

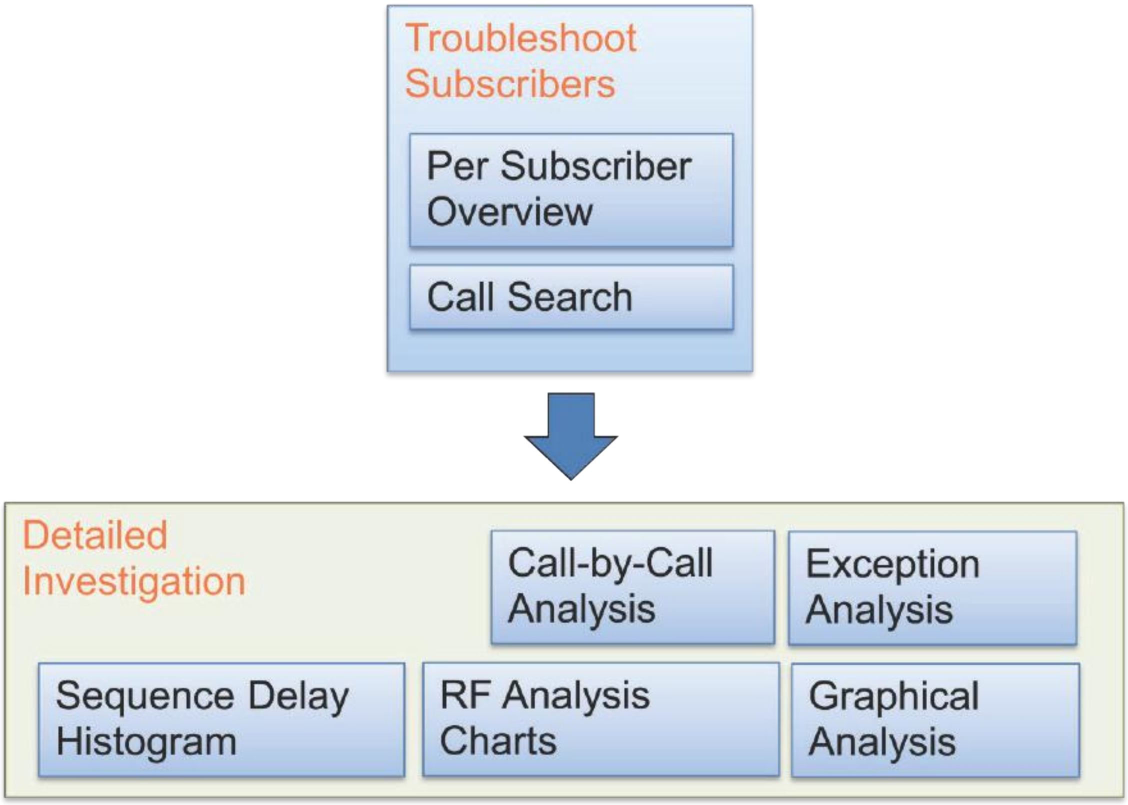


Figure 39 – Overview of Features Available for Ericsson Subscriber Trace Recordings

10.1 Per Subscriber Overview

A summary of the available data is given in the overview grid.

Each row shows a summary of KPIs per subscriber for the selected scope. When clicking on selected values in this grid, the pie chart gives a more detailed breakdown.

Clicking on one slice of the pie chart sends all calls for that subscriber containing the event to the call-by-call analysis feature.

Exception events such as dropped calls and blocked calls for VIP subscribers can be traced and investigated in detail.

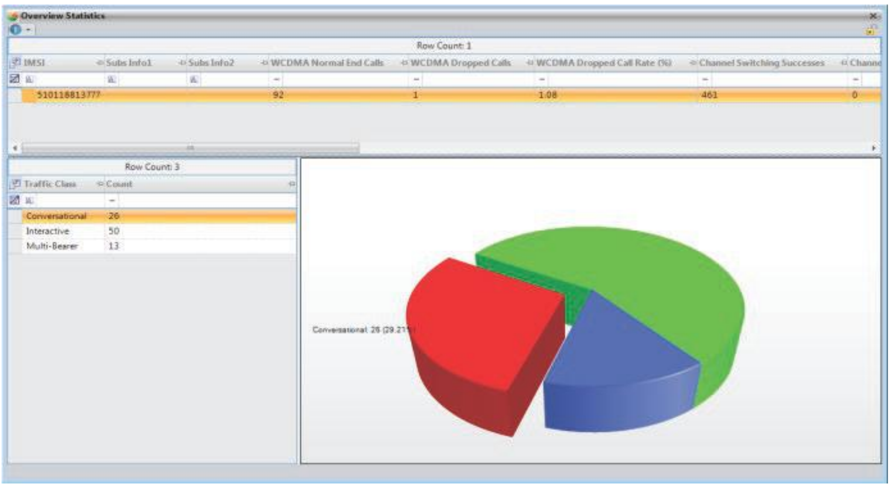


Figure 40 – Per Subscriber Overview for WCDMA UETR

11 NSN WCDMA Megamon GEO Highlights

The figure below highlights the major features available based on the WCDMA Megamon GEO Interface. These features are available in TEMS Discovery Network Enterprise and the TEMS Discovery Network (WCDMA, LTE, and Trace) application.

All features are common across different network vendors and are described in section 6. Samples of screenshots from the NSN WCDMA module are also provided below.

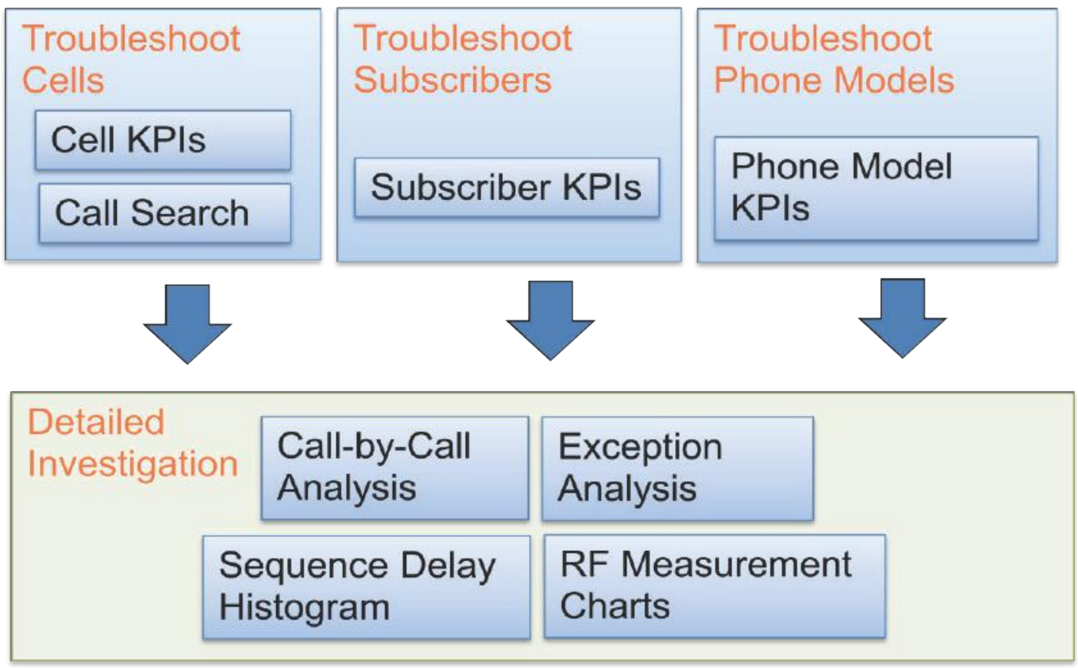


Figure 41 – Overview of Features Available for NSN WCDMA Megamon Geo Module

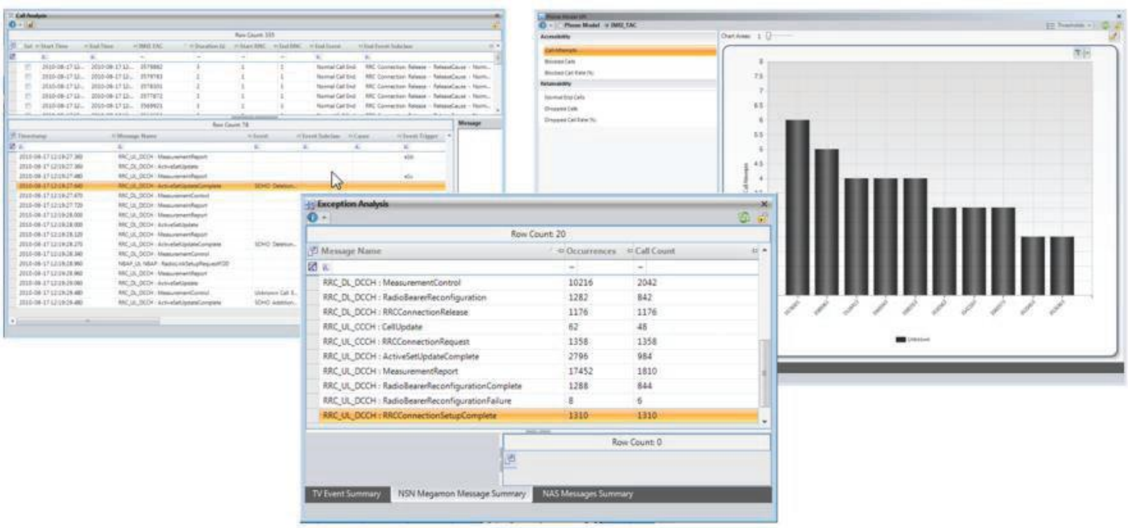


Figure 42 – Sample of NSN WCDMA Megamon Geo Features

12 Reporting

Reports provide a collection of information presented in a format such as Microsoft Excel or Word, or PDF.

The reporting functionality in TEMS Discovery Network (WCDMA, LTE, and Trace) is built on SQL Server Reporting Services.

Reports can be created 'ad hoc' in the client for a selected project and scope.

After the initial deployment and configuration of SQL Server Reporting Services, there is no need for further manual configuration. The deployment of the pre-defined report templates is handled automatically within TEMS Discovery Network.

Currently the following pre-defined report templates are available:

Ericsson WCDMA GPEH

- Performance Summary Report

Ericsson LTE Cell Trace and Ericsson WCDMA GPEH

- CSFB Performance Report (in development)

Huawei WCDMA Call Trace

- Performance Summary Report

Subscriber Trace

- Subscriber Trace Report (currently does not include LTE UE Trace)

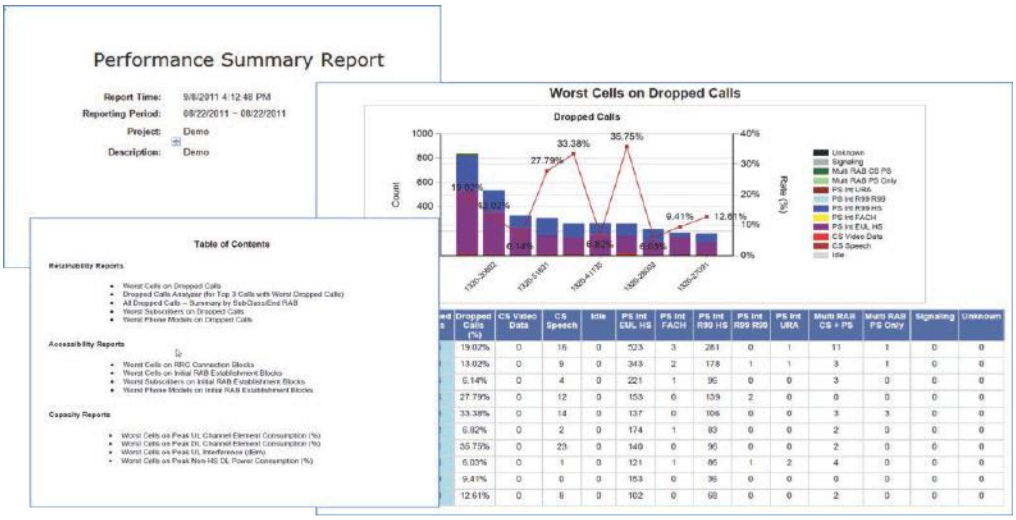


Figure 43 – Samples from the Performance Summary Report

13 Huawei WCDMA PM Counters

The figure below outlines the major features available based on the Huawei PM counter formats.

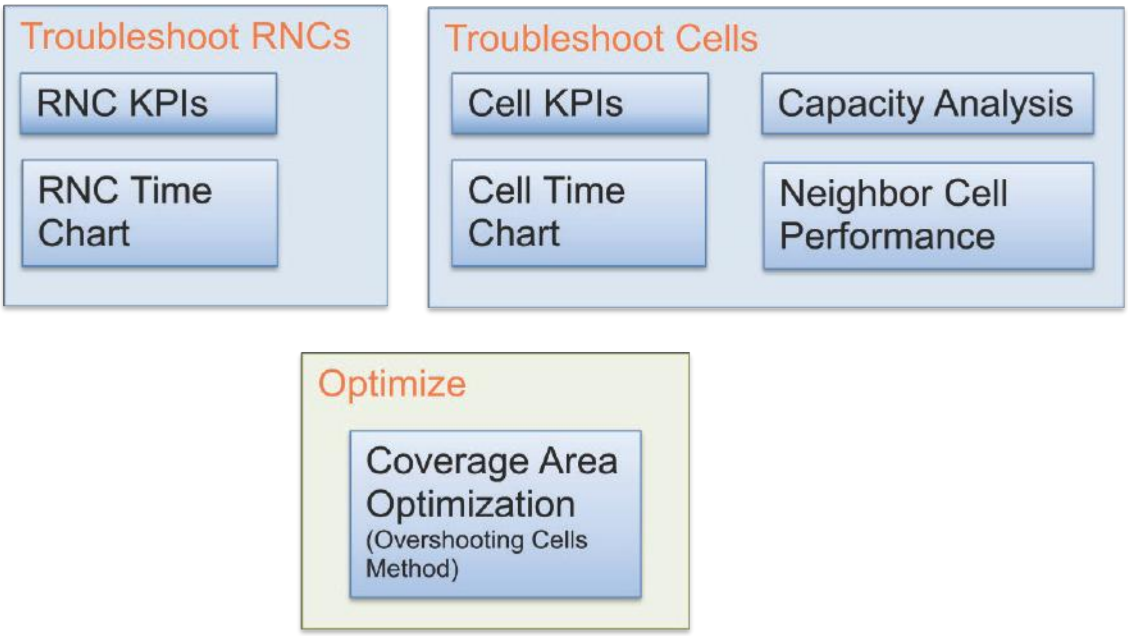


Figure 44 – Overview of Features Available for Huawei WCDMA PM Counters

KPIs are presented for multiple RNCs – calculated over the entire time period selected. Several KPIs in the following categories are presented:

- Availability
- Accessibility
- Retainability
- Service integrity
- Mobility
- Traffic

An overview with some selected KPIs is also available which allows the engineer to quickly find the worst performing RNCs. The engineer can then drill down to analyze the Cell KPI in the selected RNC and quickly identify the main contributors to the poor performance.

All the Huawei WCDMA PM counter based features have strong interactions with the map – cells on the map can be colored by any selected KPI to allow efficient identification of problem geographical locations.

There are further drilldowns to KPI time charts which show the trend in performance and also allow the exact time period of poor performance to be identified. The resolution for the time charts can be selected to show the KPI calculated per: base period (i.e., 15min or 30min); hour; day.

In addition the performance for the neighbors of a selected cell can be shown on the map. For example, the specific time period during which a cell experienced a high call drop rate can be selected and the unavailability of neighbor cells during this time period easily analyzed.

The Capacity Analysis feature presents, in a separate view, some common cell capacity related KPIs such as Downlink Transmit Power, Uplink interference and

Channel Element usage. Cells that are affected by capacity limitations can be quickly identified.

The Coverage Area Optimization feature is based on counters for the number of call establishment and average Ec/N0 within certain distance bands. Overshooting cells and areas of poor quality call establishments can be isolated. The information presented in the charts and maps can help to optimize areas of wanted versus unwanted coverage.

Some examples of workflows from the Huawei WCDMA PM counter module are shown below.

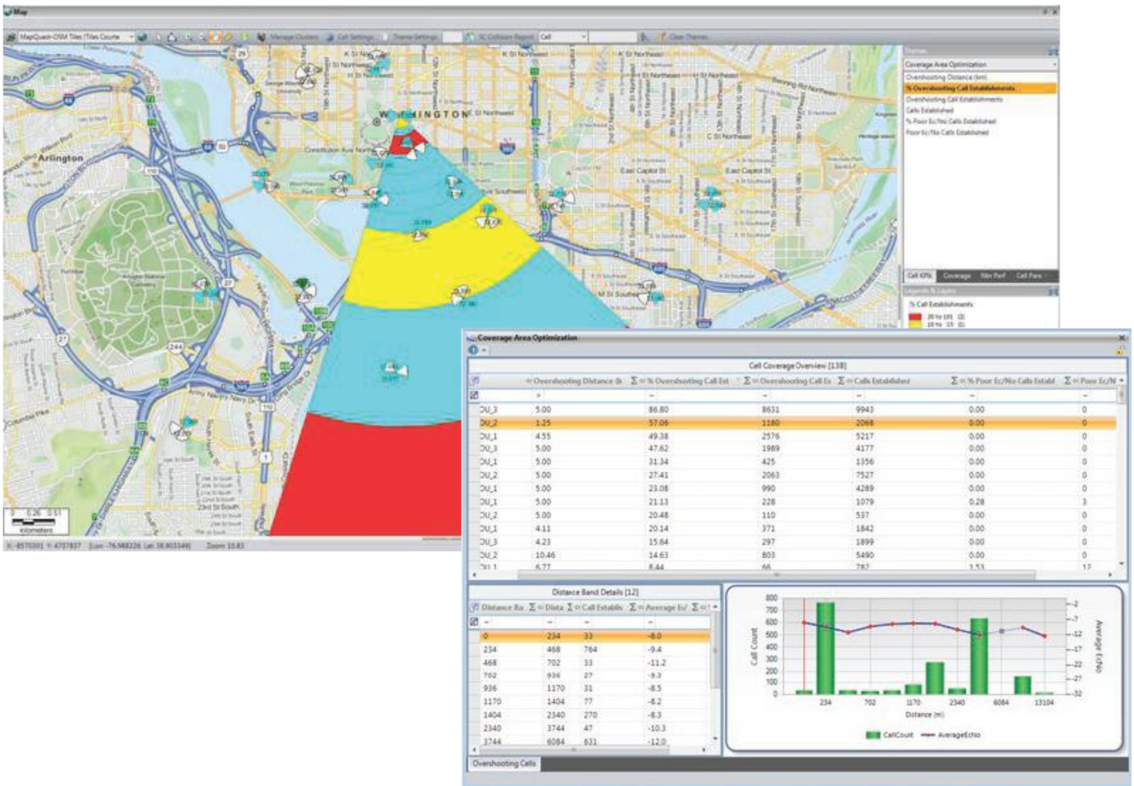


Figure 45 – Analyzing Overshooting Cell Coverage

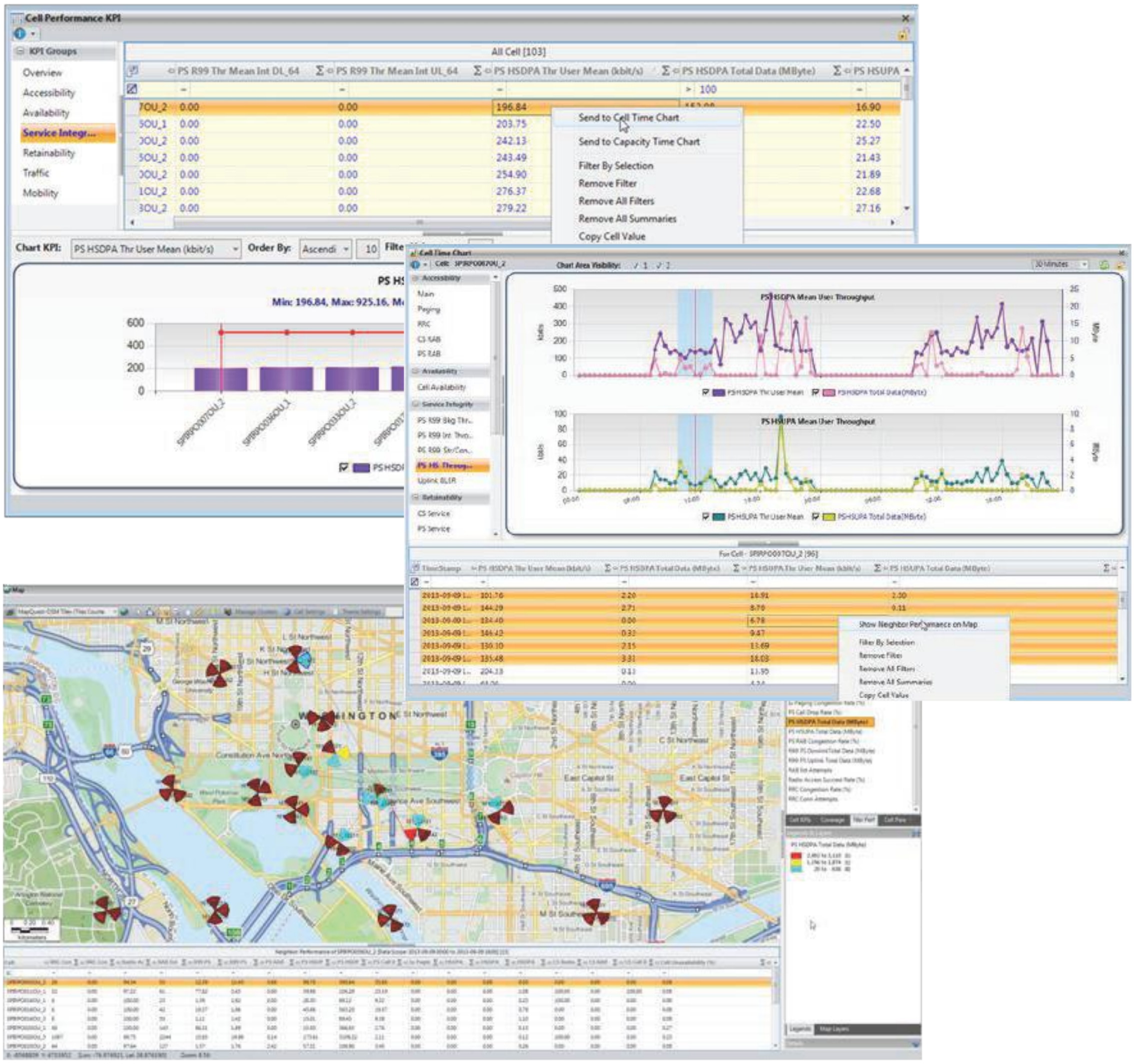


Figure 46 – Drilling Down From Cell Performance KPI (for entire scope) to KPI Time Chart, and Analyzing Neighbor Cell Performance for a selected time period on the Map

14 Basic Feature Review

14.1 Multitechnology and Vendor Cell Configuration Support

To get the most out of TEMS Discovery Network, it is crucial that cell configuration information always be kept up-to-date.

TEMS Discovery Network can take in the Bulk CM and CNAI export formats directly from the Ericsson OSS-RC and CFGMML formats direct from the Huawei OSS and store the required information in a multitechnology cell configuration database. This can include information on all WCDMA, LTE and GSM cells in the network area.

Neighbor cell relations and selection priorities and other cell parameters required for the TEMS Discovery Network features are extracted and stored.

Any missing information, such as latitude, longitude, antenna direction, and beam-width, can be taken from a reference file. It is possible to choose if the values in a reference cell file or configuration file should take priority from these two sources.

Whenever cell configuration data is changed, via the cell configuration or reference cell file, this change can be updated in the cell configuration database. Processing of the cell configuration data can be automated to ensure that changes are quickly updated in TEMS Discovery Network.

14.2 Map View

For the standard map view, TEMS Discovery Network includes the most widely used map engine in the world, MapInfo MapXtreme. This makes it possible to reuse all of the maps currently used in TEMS™ Investigation and MapInfo.

The functionality in the standard map view includes thematic mapping displays from all of the advanced TEMS Discovery Network features.

Integrated Google™ Maps is also available with the optional Geo Maps functionality.

14.3 Workspace Management

Users can save workspaces to a configuration file and then reload. Different workspace arrangements can be set up for different features and ways of working. A number of different default workspaces for various features are available.

14.4 Cell Display on Map

TEMS Discovery Network makes it simple to differentiate between cells for different technologies and carriers at the same site location. This information is taken from the cell configuration information, and separate display filters for each WCDMA UARFCN, LTE eUARFCN and GSM bands are automatically created.

These display filters have separate display properties that make it possible to customize color, azimuth, radius, and anchor point for different carriers.

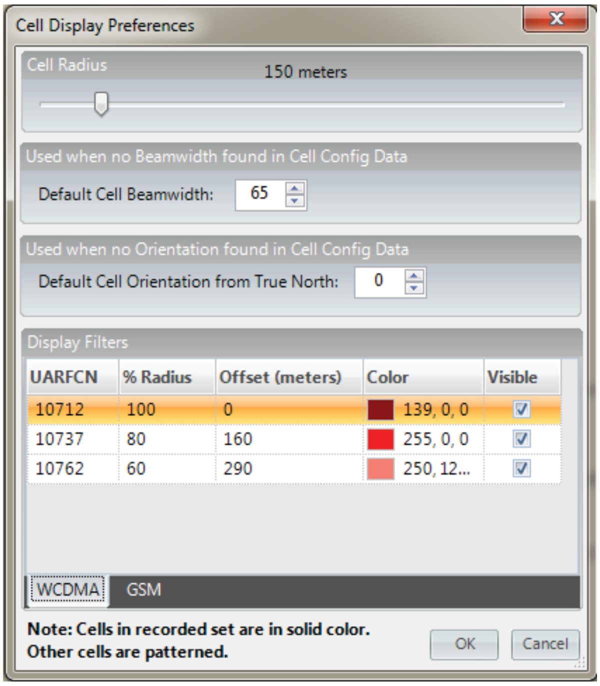


Figure 47 – Automatic UARFCN Detection and Cell Display Settings

15 TEMS Discovery Network GSM Application

This section describes features that are available in the TEMS Discovery Network (GSM) application.

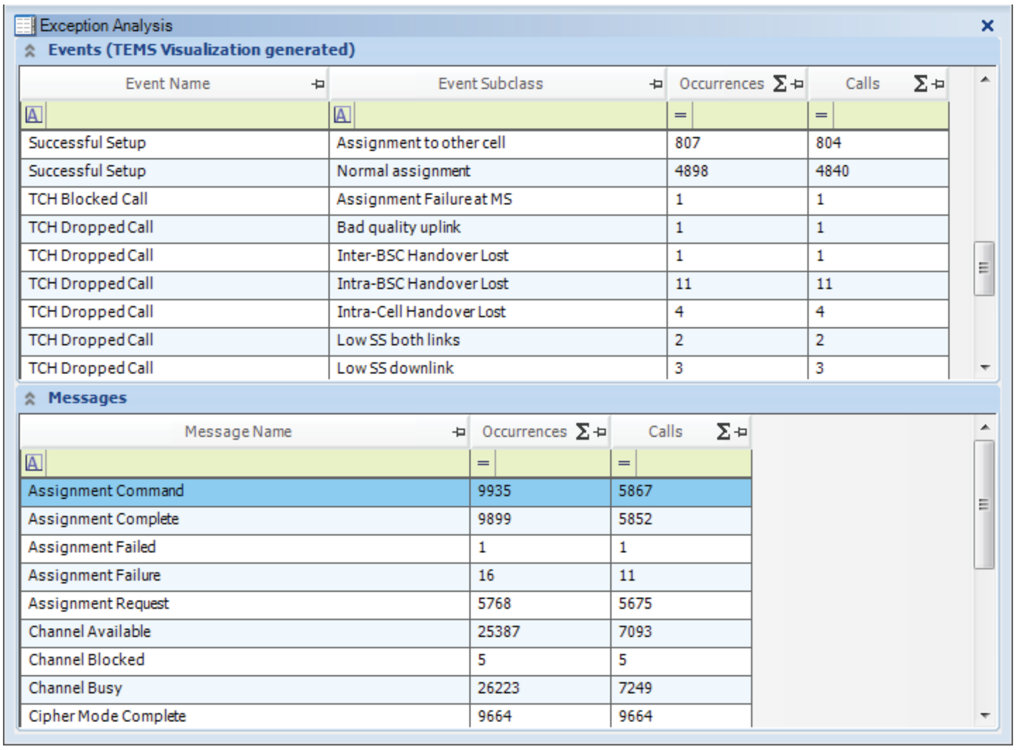
15.1 General Highlights

The following features are available for both the R-PMO and MTR/CTR modules.

15.1.1 Exception Analysis

The exception analysis view is a good place to start analyzing the contents of a database.

It is included for the GSM R-PMO and GSM Tracing modules and gives a summary of **all** of the messages that occurred for calls in the logfiles and **all** of the TEMS Discovery Network events generated during the parsing of the logfiles. Any calls that contain exceptional messages or events that need to be analyzed in greater detail (e.g., dropped calls, location update reject, and attach reject) can be sent to the call list view with a right-click.



Event Name	Event Subclass	Occurrences	Calls
Successful Setup	Assignment to other cell	807	804
Successful Setup	Normal assignment	4898	4840
TCH Blocked Call	Assignment Failure at MS	1	1
TCH Dropped Call	Bad quality uplink	1	1
TCH Dropped Call	Inter-BSC Handover Lost	1	1
TCH Dropped Call	Intra-BSC Handover Lost	11	11
TCH Dropped Call	Intra-Cell Handover Lost	4	4
TCH Dropped Call	Low SS both links	2	2
TCH Dropped Call	Low SS downlink	3	3

Message Name	Occurrences	Calls
Assignment Command	9935	5867
Assignment Complete	9899	5852
Assignment Failed	1	1
Assignment Failure	16	11
Assignment Request	5768	5675
Channel Available	25387	7093
Channel Blocked	5	5
Channel Busy	26223	7249
Cipher Mode Complete	9664	9664

Figure 48 - Exception Analysis View for R-PMO

15.1.2 Radio Measurement Charts

Statistics for the information elements in the radio measurements received during the recording (in one cell or in all listed calls) can be displayed in charts.

These radio measurement charts are available in the GSM R-PMO and GSM Tracing modules. Two different types of charts are available: distribution and scatter.

The distribution chart shows the count for each value of the chosen information element(s). Up to six charts can be defined by the user with up to two (related) information elements in each chart.

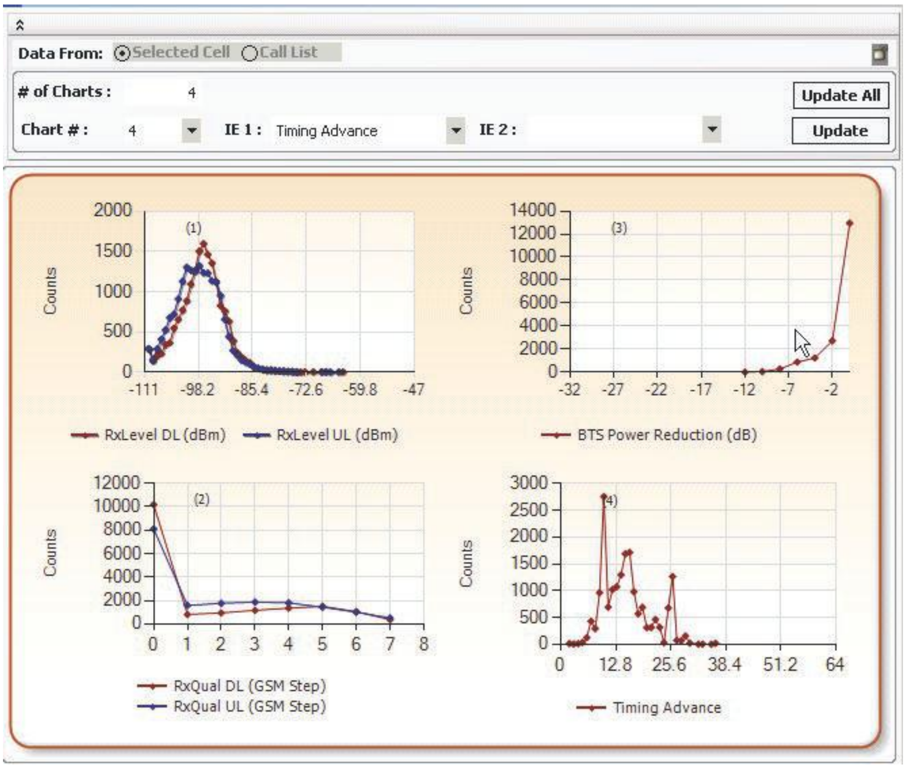


Figure 49 - Distribution Chart

This is extremely useful when, for example, comparing the RxLev downlink against the RxLev uplink or looking at the distribution of traffic per timing advance value.

The scatter chart allows pairs of information elements from the measurement results view to be compared. The size of the circle in the chart indicates the number of times the same combination of values occurred as a measurement result.

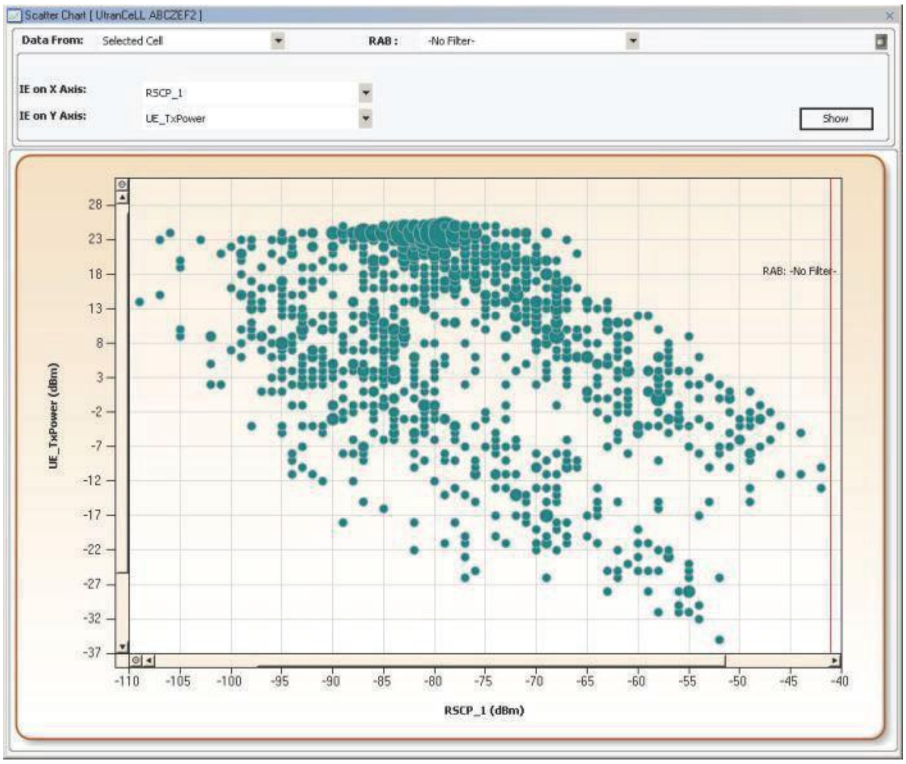


Figure 50 – Scatter Chart

Scatter charts are extremely useful for correlating different information elements and answering questions such as:

- In GSM, how bad is the uplink speech quality when the timing advance information element indicates that users are more than 10km away from the site?
- In GSM, does a cell have poor quality even at high signal strength (normally from interference)?

15.1.3 Sequence Delay Histogram

TEMS Discovery Network includes a very powerful time measurement feature that opens up the door for a completely new type of analysis: response time. With the sequence delay histogram feature, the user can view the time between any two messages in the database. Analysis can be performed on the whole database or on a set of calls.

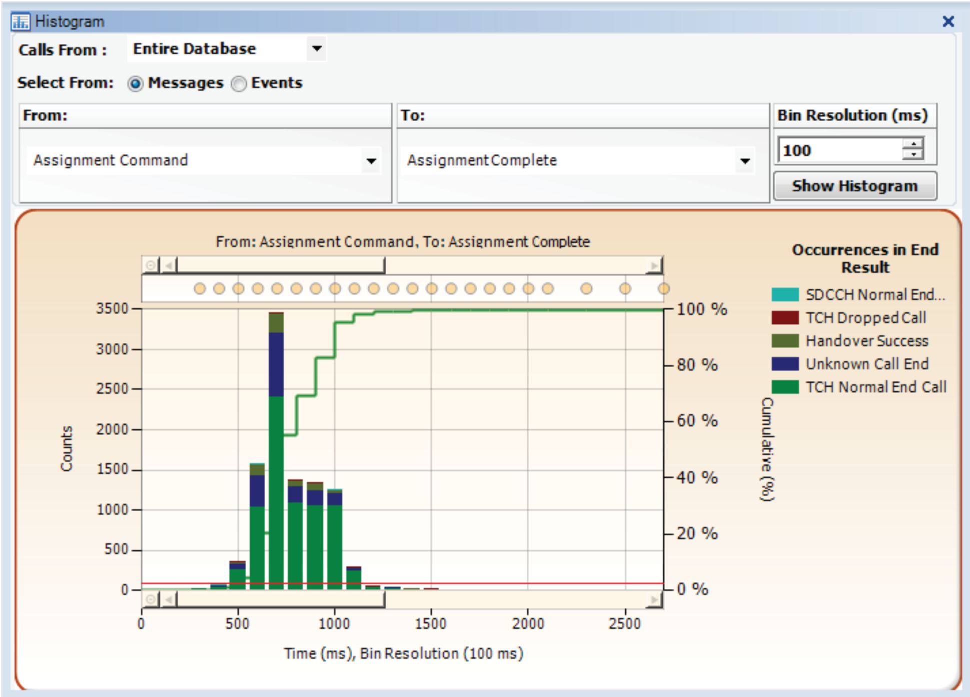


Figure 51 - Time Difference Histogram

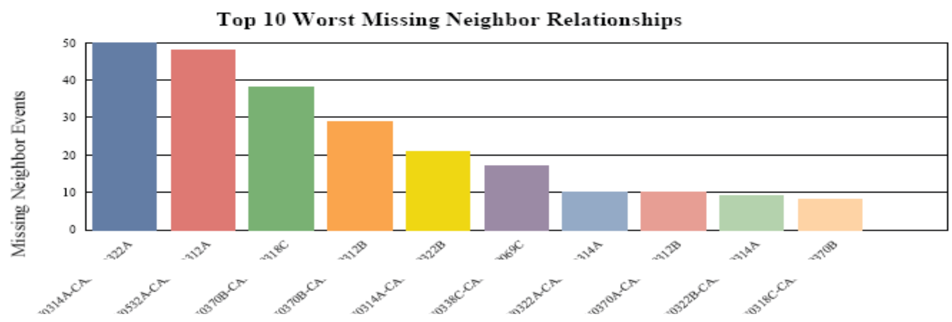
The histogram displays the number of occurrences of the message pair or event pair in each call, separated by the end result of the call.

15.1.4 Report Generator

The TEMS Discovery Network GSM application comes with a Crystal Reports Viewer and a set of predefined reports.

- **GSM Cell Performance Report** – includes information about traffic and dropped call distribution over timing advance, cell dominance information, codec usage, and much more.
- **EGPRS Cell Performance Report** – includes information about radio and traffic conditions for EGPRS in the cell.
- **GSM Find Faulty Antenna eXpert Report –** shows the measurements of signal strength made on different receive branches (RxLev A – RxLev B) at cell and RX level. Also shows if these differences increase with timing advance to help detect vertical misalignment of antennas.
- **GSM Speech Quality Report –** shows distribution graphs of the uplink speech quality experienced by the subscribers and also the estimated speech quality if the AMR codec set had not been available.
- **GSM R-PMO Summary Report** – shows key performance indicators (mainly on cell level) for an entire database.
- **GSM MTR Summary Report** – gives a summary per subscriber of key performance indicators such as dropped calls and blocked calls.

The summary reports can be created automatically for a parsing task in the task manager and stored in a selected folder. They can also be created manually from the tools menu within TEMS Discovery Network GSM.



Relation		Missing Nbr Events	Distance	Best Server SC	Missing Nbr SC
U0314A-	U0322A	50	4.85	340	148
U0532A-	U0312A	48	1.59	288	312
U0370B-	U0318C	38	7.00	201	238
U0370B-	U0312B	29	6.24	201	320
U0314A-	U0322B	21	4.85	340	156
U0338C-	U0069C	17	5.47	428	21
U0322A-	U0314A	10	4.85	148	340
U0370A-	U0312B	10	6.24	193	320
U0322B-	U0314A	9	4.85	156	340
U0318C-	U0370B	8	7.00	238	201
Other		72	0.00	0	0

Figure 52 – Example of Report Generation

15.1.5 Task Manager

The task manager helps users optimize their time. The task manager can automatically connect to the OSS, collect the daily recordings, and parse the data into the databases. This can be done at night so everything is ready for the engineers when they arrive at work every morning, or can be performed more frequently as needed.

The task manager also automates the otherwise manual process of collecting, parsing, and archiving old data. Tasks that have traditionally taken hours of manual work can now be done automatically to improve efficiency and control.

Figure 44 – Task Manager View

The task manager supports seven task functions:

- **Connections** – manages the connections to different OSSs or other FTP servers (i.e., hostname/IP address and password). Also verifies login success after defining the connection. Normal or secure FTP using SSH2.
- **Download** – connects to the OSS to retrieve recordings and configuration files. Filter by specific filenames, days, or busy hours.
- **Parsing** – handles selection of recordings and parsing options for automatic creation of databases. A parsing task can be connected to a download task so that it starts automatically when the download task is finished. Cell file creation is also a parsing task.
- **Archiving** – moves old recordings and databases to separate folders, making it easy to find the most recent data.

- The **Scheduler** – handles the scheduling of all the other tasks.
- **Cleanup** – allows old file download history and error messages to be erased from the task manager database.
- **Utility** – allows databases containing old data to be deleted or to be saved in a different location to a backup file and then deleted.

Summary reports can automatically be generated as a result of a parsing task.

A single cell file (XML or text format) can be automatically created from several configuration files (CNAI old text format or Bulk CM XML format) and a reference file using a parsing task (connected to several download tasks).

15.2 Ericsson GSM R-PMO Highlights

15.2.1 Summary View

The summary view provides an easy way to get started. This is where TEMS Discovery Network displays the overall statistics for the event data file being analyzed, with information about the processed file as well as a list of all the cells from which data was collected.

Information in the summary view includes recording time, number of calls, total number of dropped calls, blocked calls, etc.

The logfile list in the summary view also contains important information on any lost events contained in the R-PMO recording. This information describes which types of events were lost and the reason (but not the total number of lost events). The validity of the parser output may be compromised if any events apart from measurement results have been lost.

15.2.2 Call Analysis Views

Specialized views allow the operator to further analyze the events in the file, depending on the type of problem.

The search call view makes it possible to search for calls fulfilling certain criteria. A wide range of search criteria include call result (drop, block, etc.), call ID, and originating or terminating cell. Problem areas/cells/calls are easy to pinpoint in this way.

The call list view provides detailed information about calls filtered out by the search function. Information provided includes the number of calls, dropped calls, and blocked calls (with the causes), number of handovers and handover failures, and more.

The message view is synchronized with the call list view and displays all messages corresponding to the cell selected in the call list view. Message details can be viewed by double-clicking on a specific message.

The measurement result view is also synchronized with all other views in the call analysis function. The measurement result view displays all call messages in a graph. There are graphs for both RxLev and RxQual to give the user an easy way of analyzing call progress and to verify handover and other events in a graphical view.

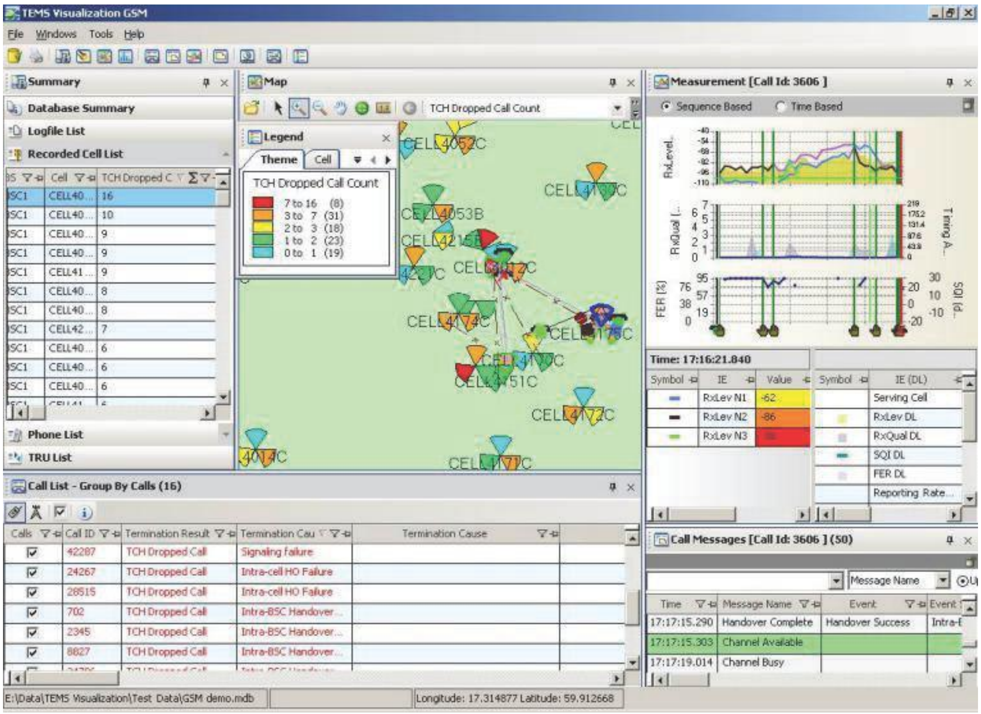


Figure 53 – GSM R-PMO Summary View and Call Analysis

15.2.3 Faulty Equipment Analysis

The faulty equipment analysis feature is implemented in two separate parts of the summary view:

- Non-air interface TCH drop per cell statistics, in the recorded cell list
- TX and RX statistics, in the TRU list

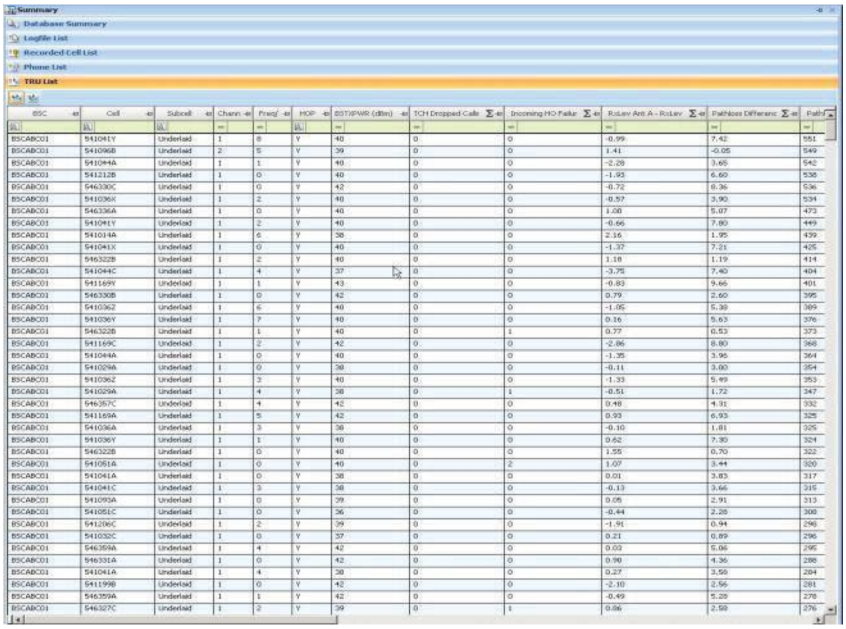
The non-air interface TCH drop statistics are drops which are caused either by equipment problems or manual O&M intervention. They are accumulated from the extended cause values included in the circuit-switched (CS) call release message.

This statistic allows the user to quickly identify any equipment problems, not related to the air interface, which are causing dropped calls. For example, cells that are dropping calls due to transmission problems can be quickly identified and the problem referred to that department for correction.

A problem with the radio equipment (TX and RX) will not be captured in the non-air interface drop statistics. In the TRU list, some key performance indicators useful in helping to identify problems with the radio equipment (related to dropped calls and incoming handover failures) can be shown grouped per TX (identified from the CELL+CHGR+ARFCN/MAIO) or per RX (identified from the TRXC MOI).

These statistics can help identify the specific piece of hardware that is faulty – saving time and money.

Statistics that allow the radio performance per TX or per RX to be investigated are also included. For example, mean, std dev and number of samples for Pathloss Difference and (RxLev A – RxLev B)[1] per TX or per RX are extremely useful for investigating problems related to antennas or other equipment.



BSC	Cell	Subcell	Chann	Freq/	HOP	BSTXPWR (dBm)	TCH Dropped Calls	Incoming HO Failur	RxLev Ant A - RxLev	Pathloss Differenc	Path/
BSCABC01	541041Y	Underlaid	1	8	Y	40	0	0	-0.99	7.42	551
BSCABC01	541096B	Underlaid	2	5	Y	39	0	0	1.41	-0.05	549
BSCABC01	541044A	Underlaid	1	1	Y	40	0	0	-2.28	3.65	542
BSCABC01	541212B	Underlaid	1	0	Y	40	0	0	-1.93	6.60	538
BSCABC01	546330C	Underlaid	1	0	Y	42	0	0	-0.72	6.36	536
BSCABC01	541036X	Underlaid	1	2	Y	40	0	0	-0.57	3.90	534
BSCABC01	546336A	Underlaid	1	0	Y	40	0	0	1.08	5.07	473
BSCABC01	541041Y	Underlaid	1	2	Y	40	0	0	-0.66	7.80	449
BSCABC01	541014A	Underlaid	1	6	Y	38	0	0	2.16	1.95	439
BSCABC01	541041X	Underlaid	1	0	Y	40	0	0	-1.37	7.21	425
BSCABC01	546322B	Underlaid	1	2	Y	40	0	0	1.18	1.19	414
BSCABC01	541044C	Underlaid	1	4	Y	37	0	0	-3.75	7.40	404
BSCABC01	541169Y	Underlaid	1	1	Y	43	0	0	-0.83	9.66	401
BSCABC01	546330B	Underlaid	1	0	Y	42	0	0	0.79	2.60	395
BSCABC01	541036Z	Underlaid	1	6	Y	40	0	0	-1.05	5.38	389
BSCABC01	541036Y	Underlaid	1	7	Y	40	0	0	0.16	5.63	376
BSCABC01	546322B	Underlaid	1	1	Y	40	0	1	0.77	0.53	373
BSCABC01	541169C	Underlaid	1	2	Y	42	0	0	-2.86	8.80	368
BSCABC01	541044A	Underlaid	1	0	Y	40	0	0	-1.35	3.96	364
BSCABC01	541029A	Underlaid	1	0	Y	38	0	0	-0.11	3.00	354
BSCABC01	541036Z	Underlaid	1	3	Y	40	0	0	-1.33	5.49	353
BSCABC01	541029A	Underlaid	1	4	Y	38	0	1	-0.51	1.72	347
BSCABC01	546357C	Underlaid	1	4	Y	42	0	0	0.48	4.31	332
BSCABC01	541169A	Underlaid	1	5	Y	42	0	0	0.93	6.93	325
BSCABC01	541036A	Underlaid	1	3	Y	38	0	0	-0.10	1.81	325
BSCABC01	541036Y	Underlaid	1	1	Y	40	0	0	0.62	7.30	324
BSCABC01	546322B	Underlaid	1	0	Y	40	0	0	1.55	0.70	322
BSCABC01	541051A	Underlaid	1	0	Y	40	0	2	1.07	3.44	320
BSCABC01	541041A	Underlaid	1	0	Y	38	0	0	0.01	3.83	317
BSCABC01	541041C	Underlaid	1	3	Y	38	0	0	-0.13	3.66	315
BSCABC01	541093A	Underlaid	1	0	Y	39	0	0	0.05	2.91	313
BSCABC01	541051C	Underlaid	1	0	Y	36	0	0	-0.44	2.28	308
BSCABC01	541206C	Underlaid	1	2	Y	39	0	0	-1.91	0.94	298
BSCABC01	541032C	Underlaid	1	0	Y	37	0	0	0.21	0.89	296
BSCABC01	546359A	Underlaid	1	4	Y	42	0	0	0.03	5.06	295
BSCABC01	546331A	Underlaid	1	0	Y	42	0	0	0.90	4.36	288
BSCABC01	541041A	Underlaid	1	4	Y	38	0	0	0.27	3.58	284
BSCABC01	541199B	Underlaid	1	0	Y	42	0	0	-2.10	2.56	281
BSCABC01	546359A	Underlaid	1	1	Y	42	0	0	-0.49	5.28	278
BSCABC01	546327C	Underlaid	1	2	Y	39	0	1	0.06	2.58	276

Figure 54 – TRU List in the Summary View (Grouped by TX)

After sorting these statistics to find the worst-performing TX and RX, it is then possible to investigate poor performers further by bringing up the radio performance charts for an individual TX, channel group, or RX.

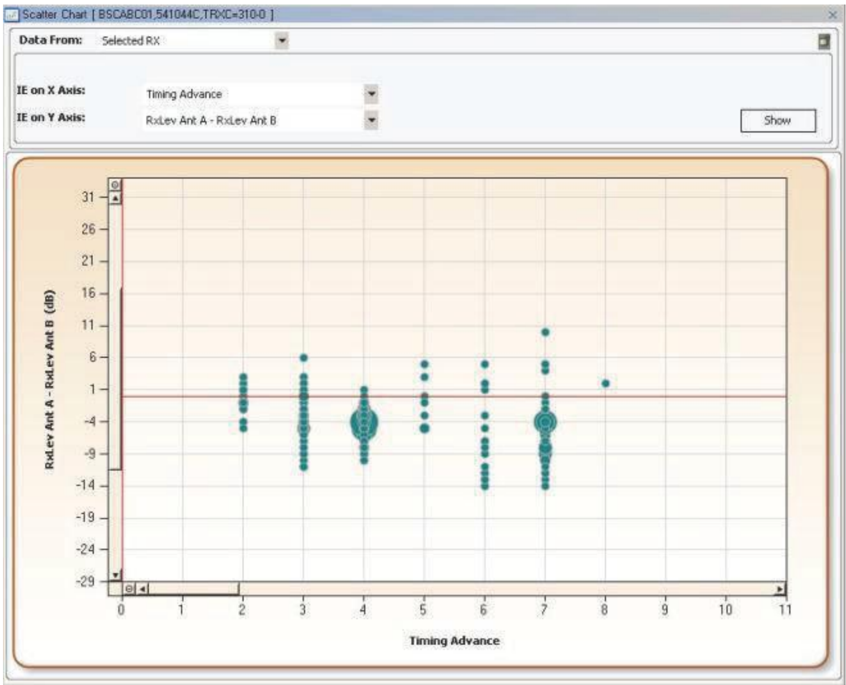


Figure 55 – Scatter Chart of TA Versus (RxLev A – RxLevB) for a Single RX

[1] Feature FFAX (Find Faulty Antenna eXpert) needed in OSS-RC

Note that the TX statistics should be used only for non-hopping or synthesizer hopping channel groups (where one physical TX correlates to one ARFCN or MAIO) and NOT for baseband hopping channel groups. This is because the effect of a single faulty TX in a baseband hopping channel group will be spread across all MAIOs in the channel group.

15.2.4 Cell Timeslot Monitor

The timeslot monitor contains two distinct features:

The first enables the user to step through all of the channel allocations (for both CS and on-demand PS data) in the selected cell, and makes it easy to analyze quickly the impact of new channel allocation settings or strategies. This is important because while the traffic in GSM networks is constantly increasing, more features are being added to the systems to handle this increase while maintaining quality of service. The problem now is that with all of these advanced features (channel allocation features, data, voice, coding schemas, etc.) it has become increasingly difficult to understand the impact each feature has on the others, and to optimize them together.

The second feature makes it possible to view key statistics at the timeslot level. The statistics available are:

- Dropped calls
- Incoming handover failures

Having access to statistics down to the timeslot level is important when looking for hardware problems in the network. With TEMS Discovery Network , this normally time-consuming job involving trial and error becomes quick and easy.

The cell timeslot monitor feature graphically displays the allocation of timeslots for a given cell. It allows the operator to step forward and backward through each allocation event made on the cell. It is possible to step through the allocations as they happened in time or replay them at the desired speed. Timeslots are colored depending on the type of call (FR/EFR/HR/AMR/GRPS/ HSCSD/Blocked/ Signaling) together with a call ID.

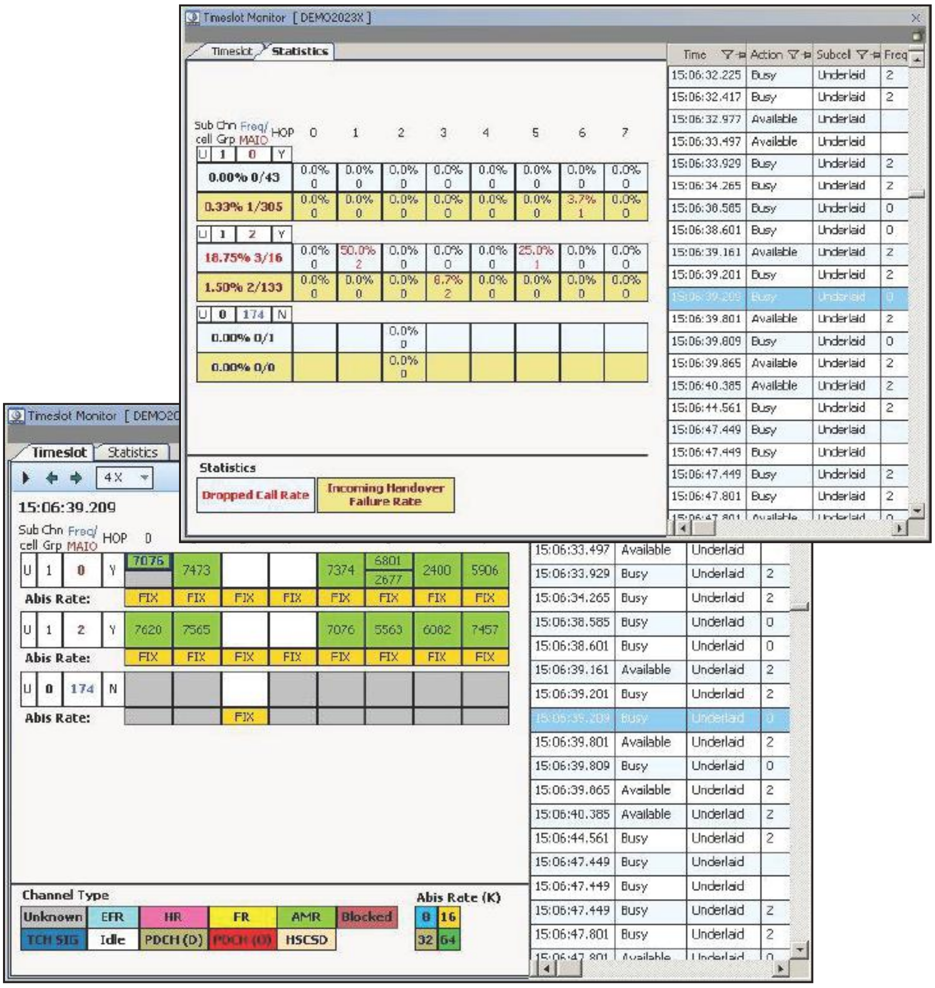


Figure 56 - Cell Timeslot Monitor Showing Statistics per Timeslot and Timeslot Allocation Playback

In addition to delivering many other benefits, this feature allows the operator to:

- Visualize what actually happens when full rate channels start to load the cell and the feature’s dynamic half rate adaptation and allocation begins.
- Provide input for multiband cell optimization:
  - Pathloss limit for the OL subcell
  - Timing advance limit for the OL subcell
  - Distance to cell border limit for the OL subcell
  - Subcell load distribution
- Visualize the interaction between the allocation of channels for CS and PS and effects such as preemption.

Note that display of VAMOS (4 calls per timeslot) for Ericsson G11B and later systems is currently not supported in the Timeslot Monitor.

15.2.5 Estimated Positioning

In the map view, it is possible to display estimated positions of measurement results and TEMS Discovery Network events (for example, a TCH dropped call).

Themes can be applied to the measurement results for a color-coded display of RxLev DL, RxLev UL, RxQual DL, RxQual UL, and SQI UL.

Measurement result positions can be displayed for selected calls (from the call list). This helps the user follow calls and see if several dropped or poor quality calls follow the same path of movement.

All measurement result positions in a selected cell can also be displayed (from the recorded cell list or map). This helps identify areas of unwanted coverage (for example, if a cell is covering too much area and should be down-tilted).

The estimated positions for TEMS Discovery Network events help the user quickly see if all TCH dropped calls in one cell, for example, are dropped in approximately the same geographical area.

The estimated positioning algorithm is a five-stage process:

- Some filtering of measurement results is carried out. Only measurement results where the strongest cell is the serving cell are used.
- The signal strength of the co-sited neighbors relative to the serving cell and the measured TA value are used to get an estimated position for each valid measurement result. This is called the ECGI+TA algorithm. If ECGI+TA cannot be used, then CGI+TA is used as the fallback.
- Each of these estimated positions is fed into a recursive smoothing filter. This is a dynamic model that tries to follow the speed of movement of the mobile device between estimated positions. The smoothed positions are the output from the algorithm.
- Interpolation or extrapolation (up to a certain number of seconds) is done to find the approximate estimated position of any TEMS Discovery Network event (such as a TCH dropped call).
- The final estimated positions are analyzed to determine if the user could be classified as stationary. If so, a single point is used for all the estimated positions in the call.

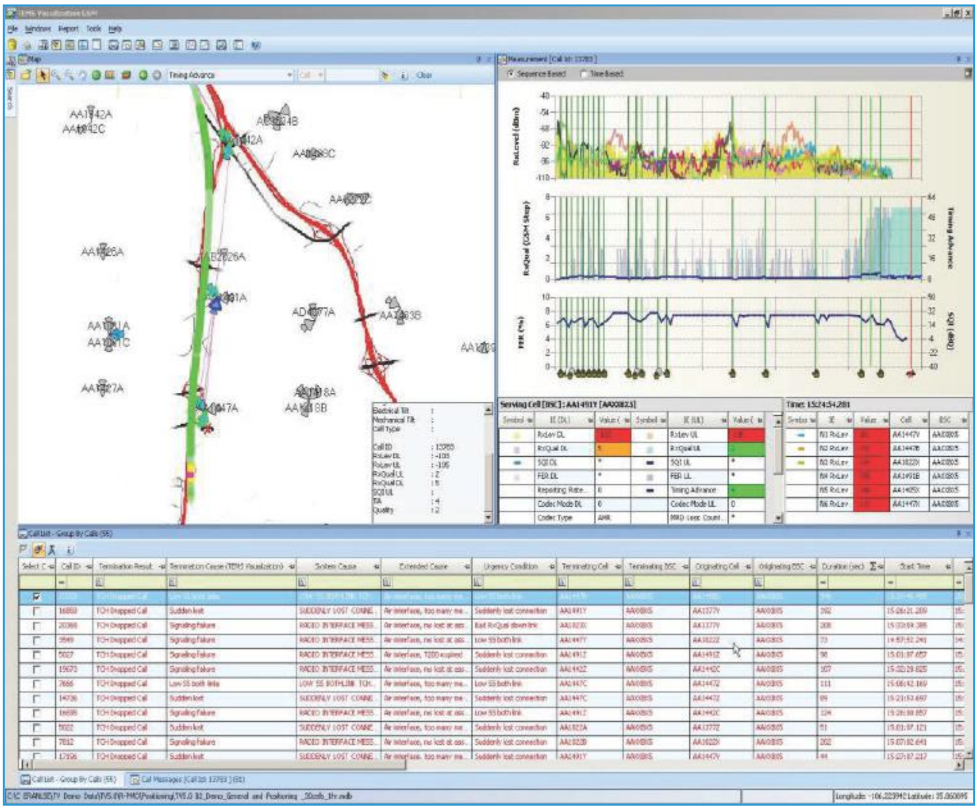


Figure 57 – Estimated Positioning of Measurement Results for One Call
(The TA theme shows where distant serving cells occur)

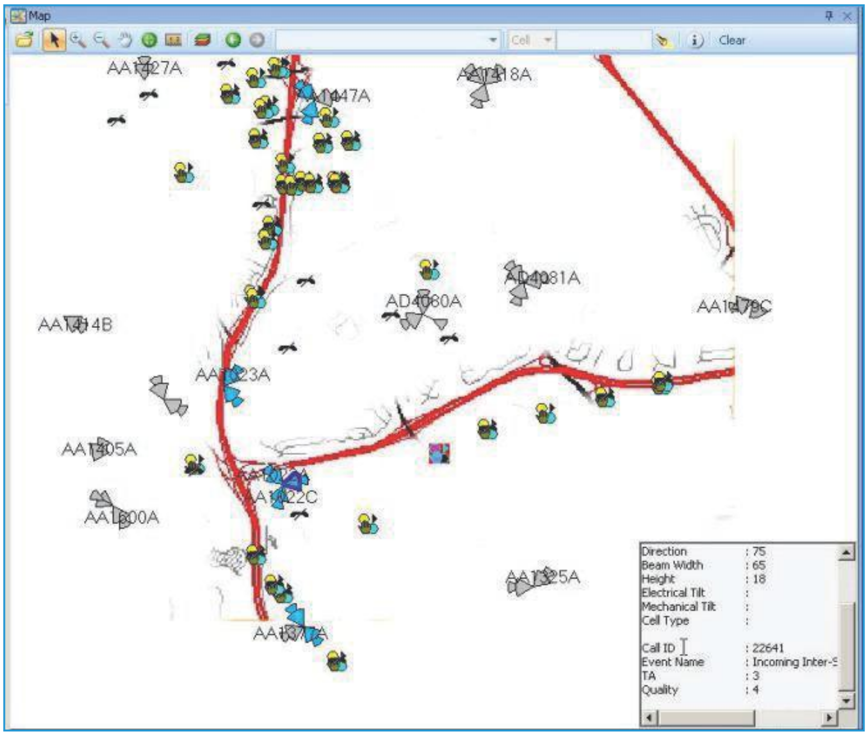


Figure 58 - Estimated Positioning of Events for Calls with Incoming Handovers From WCDMA

The accuracy of the algorithm is affected by a number of factors including the:

- Mobile phone’s distance from the cell during the call (such as site-to-site distance)
- Speed of the mobile phone during the call (highway accuracy better than stationary accuracy)
- Number of handovers during the call
- Accuracy of site latitudes and longitudes in cell file
- Possibility limited to measure on co-sited neighbors (for example, by number of 2-sector and omni sites, and by too-low signal strength of co-sited neighbors)

The conditions that give the most accurate results are fast-moving mobile phones on highways with short site-to-site distances. Typical accuracies in these conditions are less than 250m.

The algorithm also works with sampled measurements (from the event-type Measurement Result Medium); however, the accuracy is reduced since the geolocation is based on fewer samples and there is no information on neighbor cell measurements (so only CGI+TA positions can be used as input to the smoothing filter).

Note that there may be occasions where, because of insufficient input to the algorithm, it was not possible to show the estimated position for a TEMS Discovery Network event or a measurement result.

15.2.6 Binned Maps

When estimated positions have been calculated, one or more databases can be loaded into the tool and binned maps can be created.

These do not represent predictions but show the actual conditions as experienced by the live traffic in the network. Binned maps can be created for:

- Signal strength (downlink and uplink, percentage above target level)
- Interference (downlink and uplink, average value)
- Speech quality (uplink, percentage above target)
- Traffic density (call seconds)
- TCH dropped calls (number in bin)

A typical use case would be finding areas of poor signal strength and then using the traffic density maps to determine if the investment in a new site is worthwhile.

The bin size can be selected (default is 100m X 100m) and settings for all thresholds are also user-definable. These settings are stored per user in an XML file.

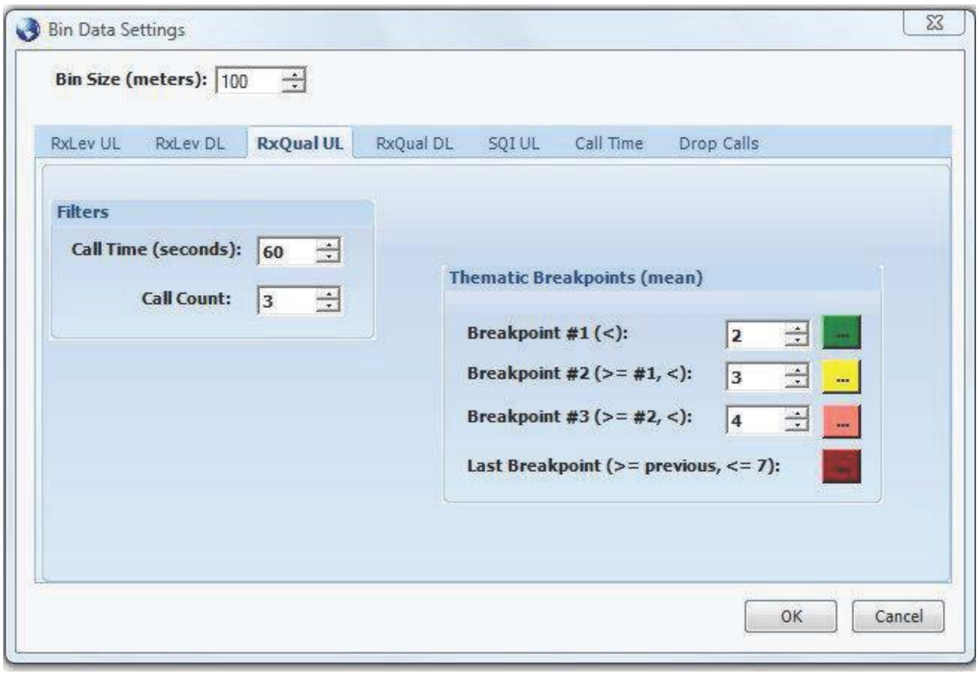


Figure 59 - Binned Map Settings

The maps can either be displayed directly in TEMS Discovery Network (MapInfo format) or exported to Google Earth (KML format). Please note the terms of use for Google Earth when using commercially.

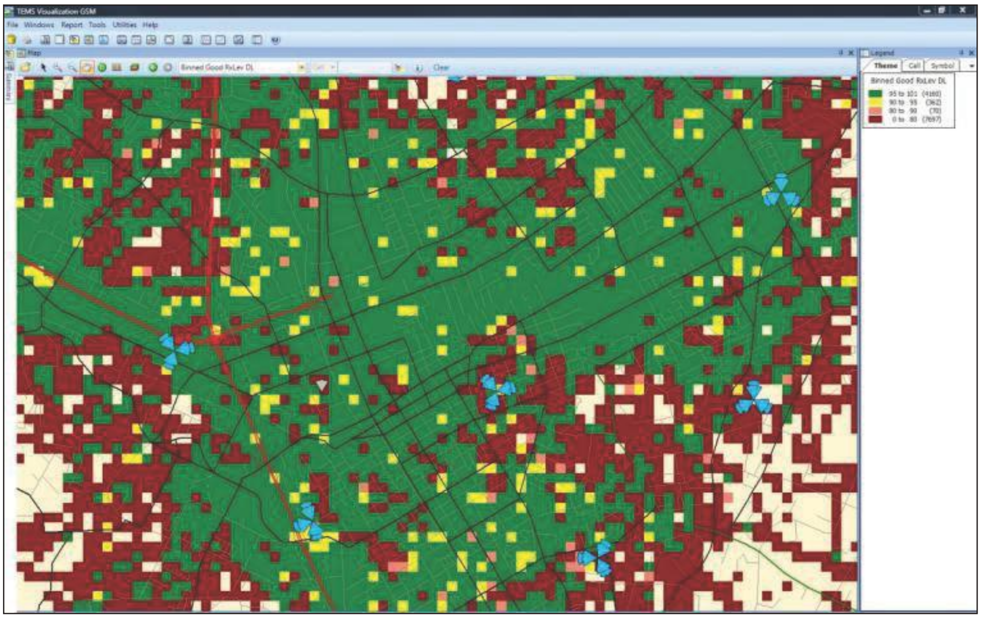


Figure 60 - Binned Map Showing RxLev DL (Colors show percentages above target signal strength level)

15.2.7 Phone Model Analysis

The operator can view statistics for each phone model used in the recording area to find phone-specific problems or to analyze phone usage in the network – a lookup table is used to transform the IMEI-TAC to a manufacturer and model.

Settings in the core network determine when the mobile phone is instructed to send its IMEI.

15.2.8 Advanced Search

Advanced search features make it possible to conduct the following types of call searches:

- **Call flow search** – Search for calls doing handover in a specified order (for example, calls with a call flow of Cell A to Cell B to Cell C)
- **Ping-pong handover** – Calls with X number of handovers within Y seconds
- **Handover related drop calls** – Calls that have performed a handover (intra- or inter-cell) within X seconds of drop

15.2.9 EGPRS Analysis

Summary statistics are presented per cell for EGPRS and GPRS performance. The engineer can identify poorly performing cells in terms of throughput, latency and buffer discards and then drill down into a report which identifies the causes for poor performance.

In the EGPRS Cell Performance Report a range of different statistics and charts are presented for analysis of radio and traffic conditions for EGPRS in the cell.

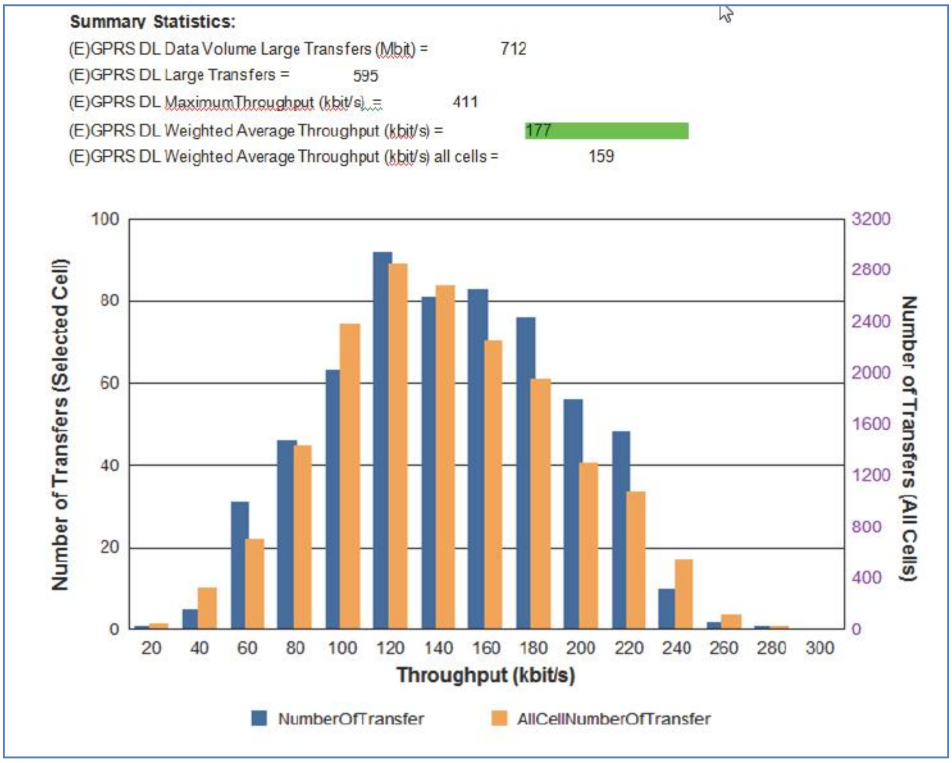


Figure 61 - Extract from the EGPRS Cell Performance Report

15.3 Ericsson MTR/CTR Highlights

The TEMS Discovery Network GSM application supports the analysis of traces for specific VIP subscribers using the MTR file format.

The CTR file format is also supported. Calls passing through a specific cell (up to 16 simultaneous) can be recorded and the resulting CTR file analyzed in TEMS Discovery Network. This makes it possible to investigate the performance for a single cell in great detail.

15.3.1 Summary View

The summary view provides an easy way to get started. TEMS Discovery Network displays the overall statistics for the recording file(s) being analyzed, with information about the processed file as well as a list of all IMSIs for which recordings were done. Information in the summary view includes recording time, number of calls, total number of dropped calls, blocked calls, and more.

15.3.2 Call Analysis Views

Specialized views allow the operator to further analyze the events in the file, depending on the type of problem.

- The **search call view** makes it possible to search for calls fulfilling certain criteria. Searches can be based on call result (drop, block, etc.), call ID, originating or terminating cell, etc. Problem areas/cells/calls are easy to pinpoint in this way. It is also possible to search on IMSI, which makes it easy to locate a specific user.

- The **call list view** provides detailed information about calls filtered out by the search function. Information includes the number of calls, dropped calls and blocked calls (with the causes), number of handovers, handover failures and more.
- The **message view** is synchronized with the call list view and displays all messages corresponding to the cell selected in the call list view. Message details can be viewed by double-clicking on a specific message.
- The **measurement result view** is also synchronized with all other views in the call analysis function. The measurement result view displays all call messages in a graph, allowing the operator to analyze call progress and to verify handover and other events.

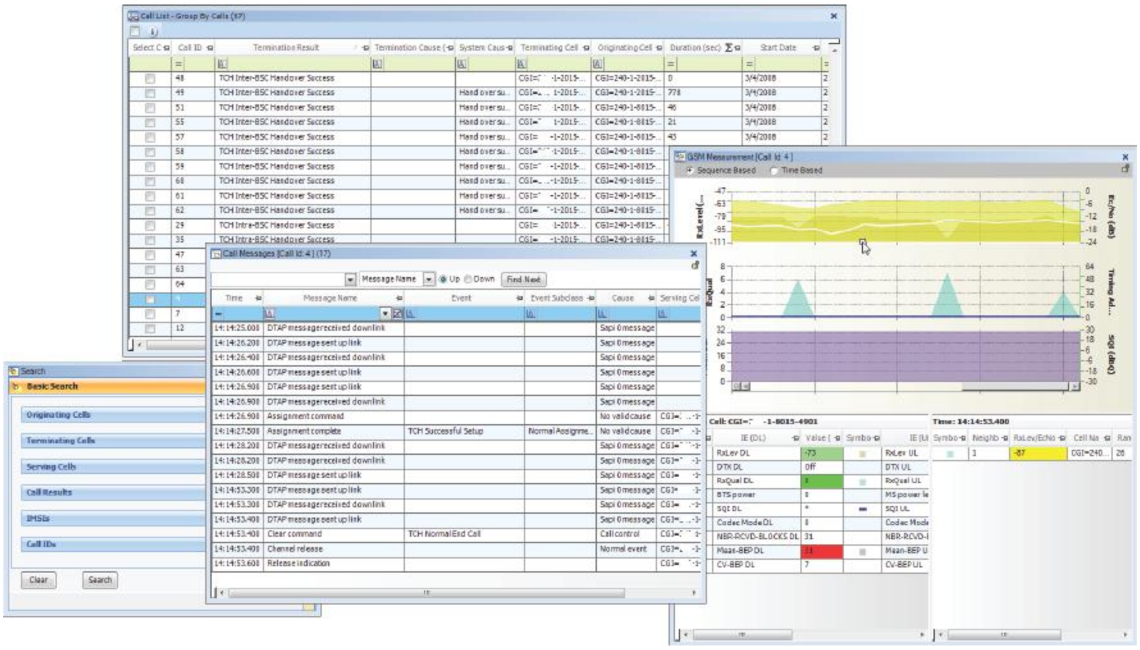


Figure 62 - Call Analysis Views

16 Licensing

The product licensing is structured as follows per user:

- Client license
- Data source licenses for WCDMA, LTE, and Trace application
  - Ericsson WCDMA GPEH
    - Optional Geo Map license for Ericsson WCDMA GPEH
  - Ericsson WCDMA UETR, Ericsson GSM MTR, Ericsson LTE UE Trace
  - Ericsson LTE Cell Trace
  - Huawei WCDMA Call Trace
    - Optional Geo Map license for Huawei WCDMA Call Trace
  - Huawei WCDMA PM counters
  - NSN WCDMA Megamon GEO Interface
- Data source licenses for GSM application
  - Ericsson GSM R-PMO
  - Ericsson GSM MTR/CTR

The licensing functionality can be provided by hardware keys which can be moved between machines or a soft key locked to one machine. Licenses can be single local licenses or a pool of floating licenses in the network.

The machine hosting floating network licenses can be any machine in the network but it must have the HASP driver software installed. Contact TEMS Support for more information.

17 Data Source Requirements

The sections below outline the radio network releases and data sources supported by TEMS Discovery Network. Each data source must be licensed within TEMS Discovery Network.

17.1 Ericsson WCDMA Network

Ericsson UTRAN releases:

- W11A-W14A.
- Support for EVO expanded capacity RNCs.
- Optional GPEH feature required in RNC and OSS-RC for the Ericsson WCDMA GPEH data source in TEMS Discovery Network.
- Optional MRR-W feature in the OSS-RC is also required for the TEMS Discovery Network RF diagnostics feature.
- Basic UETR feature required for the Ericsson WCDMA UETR data source in TEMS Discovery Network.

17.2 Ericsson LTE Network

Ericsson LTE releases:

- L12B-L14A.
- Optional Cell Trace feature required in RNC and OSS-RC for the Ericsson LTE Cell Trace data source in TEMS Discovery Network.
- Basic UE Trace feature required for the Ericsson LTE UE Trace data source in TEMS Discovery Network.

17.3 Ericsson GSM Network

Ericsson GSM releases:

- G07A-G13B.
- Optional R-PMO feature required in BSC and OSS-RC for the Ericsson R-PMO data source in TEMS Discovery Network.
- Basic MTR feature required for the Ericsson GSM MTR data source in TEMS Discovery Network.
- Basic CTR feature required for the Ericsson GSM CTR data source in TEMS Discovery Network GSM application.

17.4 Huawei WCDMA Network

Huawei UTRAN releases:

- R12 & R13. WCDMA Call Trace feature (e.g., PCHR) required. Precise releases supported will be determined as part of the integration service that accompanies a Huawei purchase.

- PM Counters. The files on the RNC level are required for the WCDMA PM counters supported in TEMS Discovery Network. NodeB level PM counters are currently not supported.

17.5 NSN WCDMA Network

The following optional features are needed in the WCDMA network:

- TSS3101 (3G) L3 Data Collector (**Megamon**)
- TSS3104 (3G) **GEO Interface**

The following hardware items are also needed. These items are included in new RNC deliveries from RN6.0 onwards. The cabling solution is needed in order to connect the L3 Data Collector to the RNC.

- RNC3386 Megamon cable and panel set RNC450 A-CAB
- RNC3387 Megamon cable and panel set RNC450 B-CAB
- RNC3388 Megamon cable and panel set RNC2600 A-CAB
- RNC3389 Megamon cable and panel set RNC2600 B-CAB

Additionally, IP Switch and PC/server is needed to run the solution. In the NSN ordering tools, there is a recommended solution for the hardware.

- OEMRNC0001-1.0 RNC data collector hardware (HP)
- OEMRNC0003-1.0 RNC data collector services

18 TEMS Discovery Network System Requirements

TEMS Discovery Network is supplied with the Microsoft SQL Server 2012 Standard database solution; this does not need to be ordered separately.

18.1 TEMS Discovery Network – WCDMA, LTE, and Trace Application

The following requirements apply to systems configured to run the WCDMA, LTE, and Trace application on a local computer.

Requirement	Minimum	Recommended
CPU Model	1X Dual Core, 32-bit	1X Quad Core, 64-bit, with hyper-threading (for 8 logical threads).
CPU Speed	2.66 GHz	2.66 GHz
Memory	4 GB RAM	16 GB RAM
Storage Space	50 GB free for installation and initial data creation.	
Operating systems	*Supported:* • Windows® 8 (64-bit) • Windows® 7 (64-bit or 32-bit) • Windows® XP with SP3 (32-bit only) *Installation under other operating systems is not supported. Not tested on Windows Vista.*	
Other	• **Internet Explorer 9 or later** is required for the **GeoMap feature.** IE9 is not supported on Windows® XP. • Graphics: 1024 x 768 (SVGA) with at least 16-bit color (high color) • TEMS Discovery Network supports dual monitors	

Notes:

1) Installation on 64-bit operating systems is highly recommended for performance reasons.
2) Windows® XP is only supported for upgrades of existing installations. New installations are not supported since Windows® XP does not support SQL Server 2012.
3) The application is licensed to run on a 4-core desktop machine with 8 logical threads; therefore, performance will not be significantly improved by running on a more powerful server.

18.2 TEMS Discovery Network – GSM Application

The following requirements apply to systems configured to run **only** the GSM application on a local computer (requirements are higher for the WCDMA, LTE and Trace application).

Requirement	Minimum	Recommended
CPU Model	Dual Core	Dual Core
CPU Speed	2 GHz	2.8 GHz or higher
Memory	2 GB	3 GB or higher*
Operating systems	*Supported:* • Windows® 8 (64-bit) • Windows® Server 2008 • Windows® 7 (64-bit or 32-bit) • Windows® Server 2003 R2 Standard Edition with SP2 • Windows® XP with SP3 (32-bit only) *Installation under other operating systems is not supported. Not tested on Windows Vista.*	
Other	• Graphics: 1024 x 768 (SVGA) with at least 16-bit color (high color) • TEMS Discovery Network supports dual monitors	

Note:

1) The application is 32-bit single threaded; therefore performance will not be significantly improved by running on a powerful server. Runs as a 32-bit application even under 64-bit OS.

2) Windows® XP and Windows® Server 2003 R2 are only supported for upgrades of existing installations. New installations are not supported since Windows® XP and Windows® Server 2003 R2 do not support SQL Server 2012.

The product has not been tested on the Windows® Vista operating system.

19 Edition Comparison – Network (Desktop) vs. Enterprise (Server)

The tables below detail the main differences between the TEMS Discovery Network and TEMS Discovery Enterprise with relevant modules.

Note: Only the system features are compared; the same troubleshooting features are available through TEMS Discovery Enterprise modules and TEMS Discovery Network WCDMA, LTE, and Trace.

System Feature Comparison

Feature	TEMS Discovery Network	TEMS Discovery Enterprise-Network Module	Comments
Automated data processing	Partial (through Daily Execution or Task manager)	Yes	In TEMS Discovery Network, automated data processing is achieved through the task manager (GSM) or daily execution (WCDMA, LTE, and Trace). Processing is scheduled for specific times with separate databases being created for batches of files (i.e., one database per day). With TEMS Discovery Enterprise, data can be continuously downloaded, processed, and accumulated within the same database.
Optimized for large memory usage and multi-threading	Partial GSM application 32-bit only. WCDMA, LTE, and Trace application 64-bit processing but limited to 4 core machines.	Yes 64-bit server 32-bit client	TEMS Discovery Enterprise can make full use of processing cores and memory available on 64-bit server installations to handle large data volumes. It is also a multithreaded application – both for the server processing and client queries.
Centralized data storage and remote access	No	Yes	TEMS Discovery Network is designed primarily for users' own desktop machines. However, TEMS Discovery Enterprise is a true client/server application.
User access control	No	Yes	In TEMS Discovery Enterprise, it is possible to allow access to projects based on user name. TEMS Discovery Network is designed to run on users' own local machines.
Data separation and user-definable data retention	No	Yes	In TEMS Discovery Network, all of the raw and statistical data is generated for the selected data. With TEMS Discovery Enterprise, separate primary and analysis databases are used and these can have different retention periods.

20 Feature Comparison – Ericsson GPEH vs. Huawei WCDMA Call Trace

WCDMA Radio Network Troubleshooting and General				
Feature	**Use Case**	**Ericsson WCDMA GPEH**	**Huawei WCDMA Call Trace**	**Comments**
Cell KPI, Cluster KPI	Identify worst performing cells and clusters through Accessibility, Retainability and Mobility KPIs.	Yes	Yes	Mobility KPI not yet available for Huawei. Coming in near future.
Phone Model KPI, Phone Model Group KPI	Identify worst performing individual Phone Models or IMEI-TAC or user-defined IMEI-TAC groups.	Yes	Yes	User-defined phone model groups not yet available for Huawei.
Subscriber KPI, Subscriber Group KPI	Identify worst performing individual subscribers and user-defined subscriber groups.	Yes	Yes	User-defined subscriber groups not yet available for Huawei.
Call-by-call Analysis	Analyze message sequences and RF Measurements for individual calls. Drill-down to call-by-call analysis quickly from all features.	Yes	Yes	Message flow available, but individual Message Details not available in Huawei data which is structured as a Call Record.
Exception Analysis	Identify and analyze exceptional events (Examples: Dropped Calls with specific Cause Codes)	Yes	Yes	NAS Messages not available in Huawei Call Trace data (format limitation)
RF Distribution, RF Scatter Charts	Analyze RF performance of cells phone models and subscribers (Examples: Distribution and Scatter charts of RSCP, Ec/N0)	Yes	Yes	Scatter Chart not yet available for Huawei Call Trace.
Reports	Reports available in PDF, Excel and Word formats (example overall and cell level performance summaries)	Yes	Yes	Performance Summary Report available for Huawei
Dropped Calls Analyzer	For a selected cell, determine if Dropped Calls are all from the same Subscriber, Phone Model, Location, Reason, Service Type.	Yes	Yes	ROP (15 min) dimension not available for Huawei.
Cell Capacity Analysis	Monitor Cell system utilization (examples: Channel Elements, Power, Codes)	Yes	Yes	Smaller set of available measurements in Huawei compared to Ericsson.
Sequence Delay Histogram	Analyze call sequence delays (example call setup delays)	Yes	No	On Roadmap.

WCDMA Radio Network Troubleshooting and General				
Feature	**Use Case**	**Ericsson WCDMA GPEH**	**Huawei WCDMA Call Trace**	**Comments**
Automated RF Diagnostics	Perform automated diagnostics of RF issues (Examples: Interference, DL/UL Imbalance, Out of Coverage)	Yes	No	On Roadmap.
User-defined Queries	Create user-defined queries on the raw event data.	Yes	No	On Roadmap.
Data Integrity KPIs	Analyze HS data performance.	Yes	No	Not identified in the Huawei Call Trace data (format limitation).

WCDMA Radio Network Optimization				
Feature	**Use Case**	**Ericsson WCDMA GPEH**	**Huawei WCDMA Call Trace**	**Comments**
Coverage Area Optimization – Overshooting Cells	Identify overshooting cells.	Yes	Yes	Exactly same feature in Ericsson and Huawei.
Geo Map and Geolocation	Perform geolocation for WCDMA optimization (Example: display dropped call estimated positions, and Pilot Pollution)	Yes	Yes	Pilot Pollution available only for GPEH. **Note:** Geo Map is an optional licensed feature.
Coverage Area Optimization – Pilot Pollution	Identify areas of Pilot Pollution.	Yes	No	On Roadmap.
Neighbor Optimization – intra-frequency	Optimize Intra-frequency neighbor relations, including Change Requests in OSS format.	Yes	No	On Roadmap.
Neighbor Optimization – inter-frequency	Optimize Inter-frequency neighbor relations	Yes	No	On Roadmap.
Neighbor Optimization – IRAT	Optimize GSM neighbor relations	Yes	No	On Roadmap.

21 Feature Comparison – TEMS Visualization 8.0 vs. TEMS Discovery Network 11.0

The tables below detail the main differences between the TEMS Visualization 8.0 professional and TEMS Discovery Network 10.0 releases. These tables are provided since the upgrade path from 8.0 to later releases is a major step which needs to be considered carefully. The major additions/changes are in the GPEH and Subscriber Trace modules.

21.1 GPEH Module Features

GPEH Feature Comparison

Feature	TEMS Visualization 8.0 Professional	TEMS Discovery Network 11.0	Comments
Neighbor Optimization – intra-frequency	Yes	Yes	The many improvements in TEMS Discovery Network 11.0 include virtual dropped call counts, per IMSI statistics, improved algorithm for detecting missing neighbor cells from scrambling code, addition of unmonitored neighbor statistics, and reciprocal neighbor information. However, only flat grid views (not tree views) are available in 11.0. Also, there is no automatic detection of a second carrier when adding/deleting neighbor relations.
Pilot pollution detector	Yes	Yes	The method used in TEMS Discovery Network is called “pilot pollution SOHO-based” in 11.0. An additional method is available in 11.0 based on the number of cells within a dB range; this is called “pilot pollution threshold-based.”
System utilization/ Cell capacity monitor and charts	Yes	Yes	Improved in TEMS Discovery Network 11.0 and name changed to cell capacity analysis. Main addition is calculation of peak values for cells in 15-minute ROPs for major resource types.
Call-by-call analysis	Yes	Yes	Very similar implementation in both editions.
Exception analysis	Yes	Yes	Main improvement in TEMS Discovery Network 11.0 is the ability to drill down for statistics on different cause values and RAB types.
RF distribution and scatter charts	Yes	Yes	Usability improved in TEMS Discovery Network 11.0. **Note:** Filtering per RAB type is currently not included in 10.0.
Phone list – Phone model KPI	Yes	Yes	TEMS Discovery Network 11.0 highlights the worst performing phone models with drilldown to dropped calls analyzer.

GPEH Feature Comparison			
Feature	**TEMS Visualization 8.0 Professional**	**TEMS Discovery Network 11.0**	**Comments**
Histogram	Yes	Yes	Very similar implementation in both editions. **Note:** Bars stacked by call end type or RAB type not yet available in 11.0. Also possible to search based only on GPEH messages – not TEMS Discovery Network events.
IRAT Analysis	Yes	Yes	Implementation differs in TEMS Discovery Network 11.0. Statistics on monitoring IRAT HO and CC performance are presented per defined GSM neighbor. Missing GSM neighbors are also identified. Compressed mode analysis to be implemented.
Reporting	Yes	Yes	In TEMS Discovery Network 11.0, reporting is based on SQL Server Reporting Services.
Geo Map and Geolocation	No	Yes	Not available in TEMS Visualization 8.0 Professional. **Note:** Geo Map is an optional licensed feature.
Automated RF diagnostics	No	Yes	Not available in TEMS Visualization 8.0 Professional.
Coverage Area Optimization – Overshooting Cells	No	Yes	Not available in TEMS Visualization 8.0 Professional.
User-defined queries	No	Yes	Not available in TEMS Visualization 8.0 Professional.
Subscriber group KPIs	No	Yes	Not available in TEMS Visualization 8.0 Professional.
Data Integrity KPIs (HS data performance analysis)	No	Yes	Not available in TEMS Visualization 8.0 Professional.
Neighbor Optimization – inter-frequency	No	Yes	Not available in TEMS Visualization 8.0 Professional.

21.2 Subscriber Trace Module Features

This matrix considers features for Ericsson WCDMA UETR, Ericsson LTE UE Trace, and Ericsson GSM MTR.

Subscriber Trace Feature Comparison			
Feature	**TEMS Visualization 8.0 Professional**	**TEMS Discovery Network 11.0**	**Comments**

Subscriber Trace Feature Comparison

Feature	TEMS Visualization 8.0 Professional	TEMS Discovery Network 11.0	Comments
Call-by-call analysis	Yes	Yes	Very similar implementation in both.
Exception analysis	Yes	Yes	Main improvement in TEMS Discovery Network 10.0 is the ability to drill down for statistics on different cause values and Service types. Also NAS messages included in TEMS Discovery Network 11.0.
RF distribution and scatter charts	Yes	Yes	Usability improved in TEMS Discovery Network 10.0. **Note:** Filtering per RAB type is currently not included in 11.0.
Histogram	Yes	Yes	**Note:** Bars stacked by call end type or RAB type not yet available in 11.0. Also possible to search based only on GPEH messages – not TEMS Discovery Network events.
Tracing Summary Report	Yes	Yes	TEMS Discovery Network 11.0 Reporting is based on SQL Server Reporting Services. Very similar report in both. Note that LTE UE Trace statistics not yet included.
Ericsson LTE UE Trace	No	Yes	Not available in TEMS Visualization 8.0 Professional.

22 Glossary

CPiCH	Common Pilot Channel
CSFB	Circuit Switch Fallback
CTUM	Cell Trace User Mapping
dB	Decibel
EGPRS	Enhanced General Packet Radio Service
ERAB	Evolved Radio Access Bearer (LTE)
GPEH	General Performance Event Handling
IMSI	International Mobile Subscriber Identity
LTE	Long Term Evolution
MRR-W	Measurement Result Recording – WCDMA
QCI	Quality of service Class Indicator (LTE)
OSS	Operations Support System
OSS-RC	Operations Support System – Radio Core from Ericsson
PRACH	Physical Random Access Channel
RAB	Radio Access Bearer
RF	Radio Frequency
RNC	Radio Network Controller
ROP	Result Output Period (15-minute period)
UE	User Equipment
UETR	User Equipment Traffic Recording
WCDMA	Wideband Code Division Multiple Access
VoLTE	Voice over LTE