Network Problem Analyzer
R&S®ROMES4 NPA
User Manual

1510927602
Version 40

ROHDE&SCHWARZ
Make ideas real

This manual describes the R&S ROMES4 NPA Version 23.2

The software contained in this product uses several valuable open source software packages. For information, see the "Open Source Acknowledgment" on the user documentation CD-ROM (included in delivery).
Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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The following abbreviations are used throughout this guide: R&S®ROMES4 is abbreviated as R&S ROMES4, R&S®TSMx is abbreviated as R&S TSMx, R&S®TSME is abbreviated as R&S TSME, R&S®TSME6 is abbreviated as R&S TSME6, R&S®ROMESCUBE is abbreviated as R&S ROMESCUBE.

Contents

1 Welcome to the Network Problem Analyzer

1.1 Introduction

The R&S ROMES4 Network Problem Analyzer (NPA) is an application used to automate the task of finding the problem spots in a radio telecommunication network. It scans the content of measurement files created with the R&S ROMES4 software.

Such files contain data recorded during drive-tests made with mobiles, network scanners and other devices. Each file that is analyzed with the R&S ROMES4 NPA application is processed using different units, so called Data Processors or Analysis Modules. These perform various tasks, like analyzing Voice Calls, Data Transactions, etc.

Results of the analysis process can be visualized in the R&S ROMES4 NPA application. Different visualizations are available for the different result types. Some of them show the problematic areas that have been detected. It is just one click to start R&S ROMES4 NPA and synchronize it to that position in the measurement file to drill down into deeper analysis. Others aggregate data from different files to get an overview of a whole set of measurements.

In summary, the tool should simplify repetitive tasks occurring in the operational network optimization business and boost your daily work with R&S ROMES4. The application supports you doing the following:

- Find problematic areas in radio communication networks faster
- Avoid manual analysis of measurement files where no problems exist
- Shorten file-scanning times in R&S ROMES4 by only showing parts of the measurement file
- Provide an overview over a set of files
- Combine data from various files to build KPIs summaries

Look at the following figure for both the R&S ROMES4 / NPA complete workflow description.

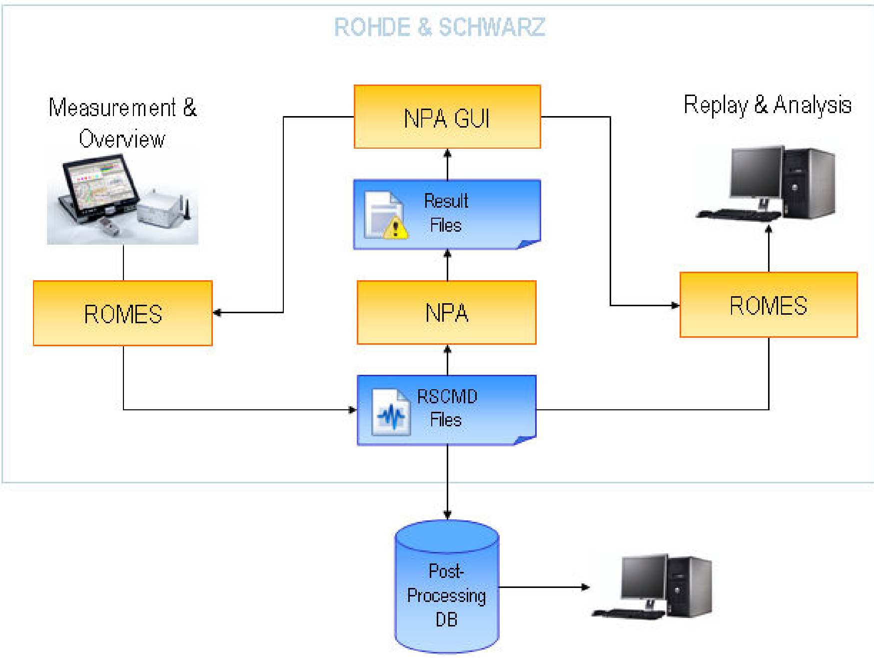


Figure 1-1: Workflow using R&S ROMES4 NPA and R&S ROMES4

1.2 Structure of documentation

This document is devided in following parts:

- Welcome (this chapter) provides a documentation overview and explains the R&S ROMES4 NPA purpose.
- Chapter 2, "Feature overview", on page 29 provides an overview of the latest R&S ROMES4 NPA software changes.
- Chapter 3, "Getting started", on page 30 provides necessary procedures to properly configure the R&S ROMES4 NPA for different analyses.
- Chapter 4, "Use cases", on page 38 provides an overview of the main workflows the R&S ROMES4 NPA supports.
- Chapter 5, "Common program settings", on page 133 provides an overview of the general program functionalities.
- Chapter 6, "Geographic view", on page 156, Chapter 7, "Chart view", on page 184, Chapter 8, "Tree view", on page 190 and Chapter 9, "KPI view", on page 193 provide a detailed description of the different views the R&S ROMES4 NPA offers for analysis purpose.
- Chapter 10, "R&S ROMES4 NPA filters", on page 195 provides a detailed description of the application filters.

- Chapter 11, "User interface reference", on page 205 provides a detailed description of user interface elements used as a reference.
- Chapter 12, "Data processors", on page 222 provides the standard analysis module packages of the R&S ROMES4 NPA.
- Chapter 13, "UE emulation", on page 487 provides an overview of the parameters used by UE to calculate the cell candidates for selection.
- Chapter 14, "R&S ROMES4 NPA version history", on page 489 provides a tour through the R&S ROMES4 NPA software changes during several versions.
- Chapter A, "Appendix", on page 505 provides some non-use case related issues.

1.3 R&S ROMES4 NPA mapping

The following table gives a quick overview of all analyses performed with corresponding processors of the R&S ROMES4 NPA.

Table 1-1: R&S ROMES4 NPA mapping

Sales Option	Processor	Views
R&S ROMES4 NPA	Basic Voice Call Analyzer	ETSI Telephony KPIs Speech Quality Speech Quality Downlink Speech Quality Uplink GSM Setup Time Requirements GSM UE Timing
	Basic TETRA Data Processor	TETRA Speech Quality TETRA Speech Quality Downlink TETRA Speech Quality Uplink TETRA Voice Call Load Overview
	DQA KPI Overview	Data Transaction KPIs E-Mail Downloads E-Mail Uploads FTP Downloads FTP DL UL Combined FTP Uploads HTTP Downloads HTTP Capacity Tests HTTP Uploads Network Performance Tests OOKLA ® Test Ping Streaming Youtube
	CSD KPI Overview	GSM Circuit Switched Data
R&S ROMES4N11 (Voice Call Analysis)	Voice Call Analyzer	Voice Call Load Overview Voice Call Analysis

Sales Option	Processor	Views
	TETRA Data Processor	TETRA Voice Call Analysis TETRA KPIs TETRA KPI Statistics - Single Call TETRA KPI Statistics - Group Call TETRA KPI Statistics - PSTN Call TETRA SDS Analysis
R&S ROMES4N15 (Coverage)	Coverage Analysis Data Processor	GSM Coverage TopN Raster & Statistics GSM Coverage Analysis Problem Spots GSM Coverage Analysis Cell Problem Statistics UMTS Coverage TopN Raster & Statistics UMTS Coverage Analysis Cell Problem Statistics UMTS Coverage Analysis Problem Spots LTE Coverage TopN Raster & Statistics LTE Coverage Analysis Problem Spots LTE Coverage Analysis Cell Problem Statistics TETRA Coverage TopN Raster & Statistics TETRA Coverage Analysis Problem Spots TETRA Coverage Analysis Problem Statistics CDMA/EvDO Coverage TopN Raster & Statistics EVDO Coverage TopN Raster & Statistics CDMA Coverage Analysis Problem Spots EVDO Coverage & Interference CDMA Coverage Analysis Cell Problem Statistics Coverage Cell Statistics Scanner Based Statistics

Sales Option	Processor	Views
	Mobile Coverage Analysis Processor	Mobile Performance Analysis Mobile Coverage Raster & Problems GSM Mobile Coverage Cell Statistics GSM Mobile Coverage Operator Statistics UMTS Mobile Coverage Cell Statistics UMTS Mobile Coverage Operator Statistics LTE Mobile Coverage Cell Statistics LTE Mobile Coverage Operator Statistics TETRA Mobile Coverage Cell Statistics TETRA Mobile Coverage Operator Statistics
	WLAN Analysis Processor	WLAN Scan analysis
R&S ROMES4N17 (HO/NH)	Neighbourhood Analysis Processor	GSM Handover Analysis GSM Neighbourhood Analysis UMTS Handover Analysis UMTS Neighbourhood Analysis LTE Handover Analysis LTE Neighbourhood Analysis TETRA Handover Analysis TETRA Neighbourhood Analysis
R&S ROMES4N18 (Spectrum clearance)	RF PowerScan Analysis Processor	Spectrum Analysis
R&S ROMES4N19 (BTS evaluation)	Base Station Evaluation Analysis Processor	GSM Base Station Evaluation Charts GSM Base Station Evaluation Problems UMTS Base Station Evaluation Charts UMTS Base Station Evaluation Problems LTE Base Station Evaluation Charts LTE Base Station Evaluation Problems TETRA Base Station Evaluation Charts TETRA Base Station Evaluation Problems

Sales Option	Processor	Views
R&S ROMES4N20 (2G, 3G, 4G, IP Analyzer)	EDGE Throughput Analyzer	EGPRS Throughput Analysis EGPRS DL KPIs EGPRS UL KPIs
	HSDPA Throughput Analyzer	HSDPA Statistics
	HSUPA Throughput Analyzer	HSUPA Statistics HSPA Throughput Analysis
	LTE Data Analyzer	LTE Mobile Statistics LTE Throughput Analysis
	IP Trace Analyzer	Data Transaction Analysis
R&S ROMES4N21 (DL_CA)	Mobile Coverage Analysis Processor	Mobile Coverage Analysis Aggregation
R&S ROMES4N22 (VoLTE)	Voice Call Analyzer	VoLTE and VoWiFi Telephony KPIs Voice Call Analysis
R&S ROMES4N23 (UL_CA)	Mobile Coverage Analysis Processor	Mobile Coverage Analysis Aggregation
R&S ROMES4N30 (Delta)	GUI Comparison Mode	All views
R&S ROMES4N31 (MIMO)	LTE MIMO Analysis Processor	LTE MIMO Charts LTE MIMO Problems LTE Downlink Allocation Charts LTE Uplink Allocation Charts LTE Allocation Problem Map
R&S ROMES4N34 (NB-IoT Scanner)	Coverage Analysis Data Processor	NB-IoT Coverage TopN Raster & Statistics
R&S ROMES4N35 (NB-IoT QC Mobile)	NB-IoT Mobile Analyzer	NB-IoT Mobile Statistics
	Mobile Coverage Analysis Processor	NB-IoT Mobile Coverage Cell Statistics NB-IoT Mobile Coverage Operator Statistics

1.4 Usage of documentation

To get started quickly with the application, we recommend reading the following chapters first:

- Introduction
- New Features
- Quick Start

If you need an explanation how to use this help system, refer to the Using Help.

2 Feature overview

There are no new features added in R&S ROMES4 NPA v23.2. For an overview of the R&S ROMES4 NPA previous versions, see Chapter 14, "R&S ROMES4 NPA version history", on page 489.

3 Getting started

The R&S ROMES4 NPA application starts with the following splash page, showing the loading progress.

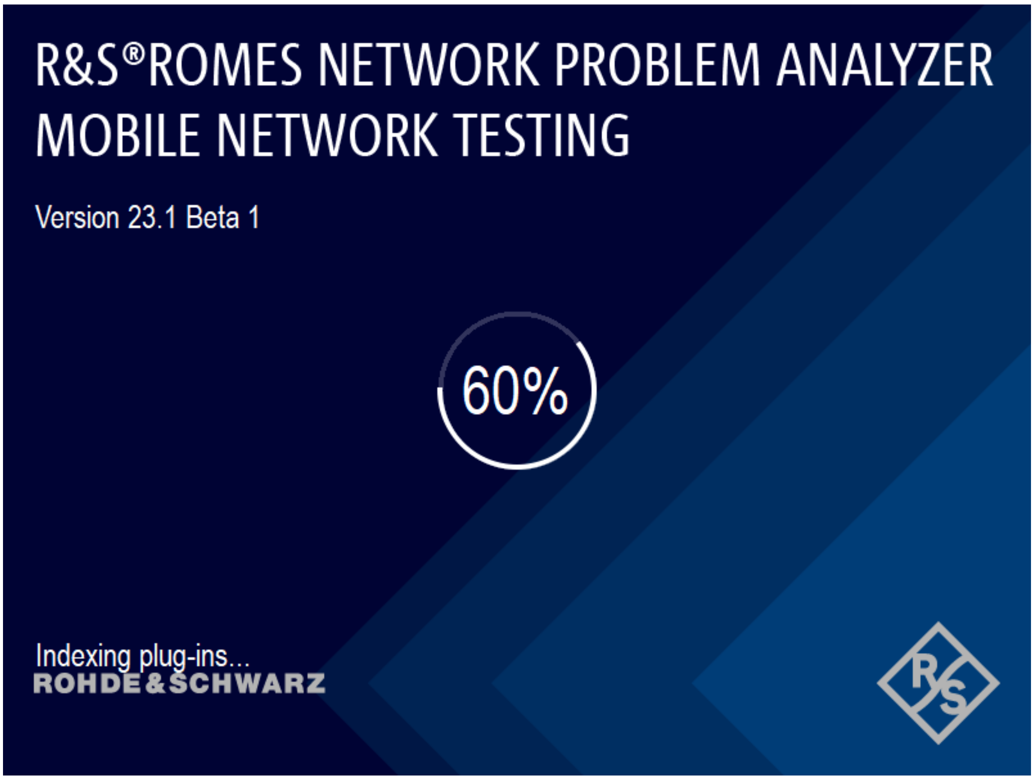


Figure 3-1: NPA opening screen

When loaded, the "R&S ROMES Network Problem Analyzer" page opens. The main part of the page is occupied by a tutorial page, which helps you getting used to the look & feel of the R&S ROMES4 NPA application.

The icons, shown in the html page, if clicked start the actions that are also available in the menu and tool bars of the "Data Source" window found on the left hand to the tutorial page.

The actions in the tutorial page are performed from top to bottom, that is, in the same sequence as they are shown in the page.

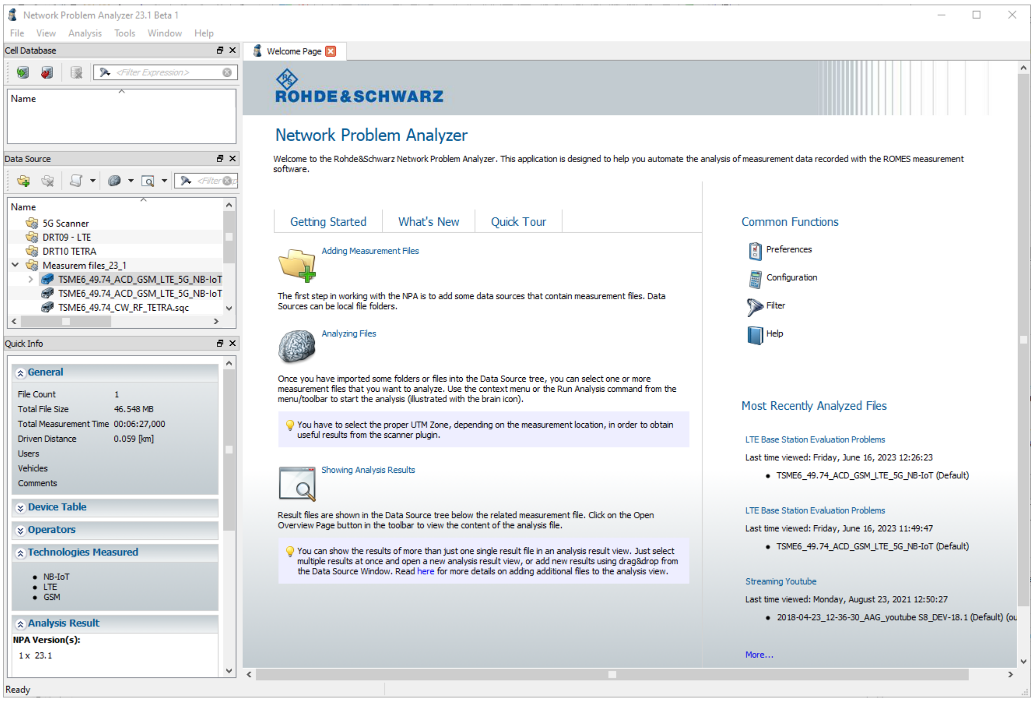


Figure 3-2: Welcome page of the R&S ROMES4 NPA

3.1 Adding data sources

Using the first icon, you can add folders that contain measurement data into the "Data Source" window. The R&S ROMES4 NPA can only work with data that is shown in that "Data Source" window. You can also drop folders and measurement files from your favorite file manager (the Windows Explorer, for example) into that window to add data sources.

Once you click that icon, a window opens in which you can select a folder that can be added to the set of data source locations. The initial selection is set to the installation of the `MeasData` directory in the R&S ROMES4 installation path. If you add that directory, the content of the "Data Source" window changes to look similar as shown below:

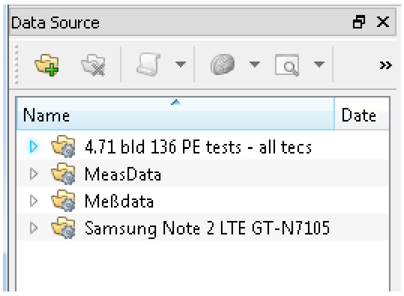


Figure 3-3: Data Source window

Folder hierarchies are imported as existing in the file system. Each time the content of a directory changes on the hard disk, the related element in the "Data Source" window is updated to reflect those changes.

Windows shortcuts (*.lnk) in the tree of measurement files are not handled by the R&S ROMES4 NPA.

Do not use the shortcuts but add the directory containing the measurement files to the data source. That means, click the "Adding Measurement Files" to get the browsing window "Add File Datasource" where from you can select in the `My Romes\MeasData`, a directory containing the measurement files for the NPA analysis.

3.2 Analyzing files

The next step is to run the R&S ROMES4 NPA analysis on one or more measurement files. Perform the following steps.

1. Select the files that you want to analyze and click the brain icon either in the tool bar or in the welcome page.

   A dialog opens that informs you about the current progress of the calculation process.

2. Once the analysis finishes, the dialog closes and the "Data Source" window updates again.

   A child entry is now visible below the measurement file.

3. Click the +-symbol shown at the mini-van icon to reveal the analysis results.

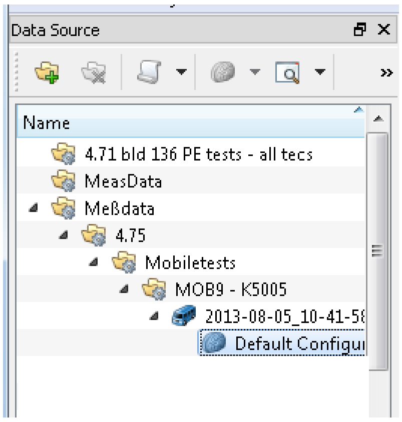


Figure 3-4: Result of analyzing files

Details of the analysis process are described in the Run Analysis chapter.

3.2.1 Handling XML-result files for analysis

The R&S ROMES4 NPA application is able to handle the XML-result files whose related measurement files are not available. The measurement files are only required the first time when the data gets analyzed.

This task requires the &S ROMES4 NPA UI and its features to be aware and prepared of the fact that the related measurement file is not available. For that the following applies:

- All the &S ROMES4 NPA UI elements and features which require the measurement file must be marked as not available and / or disabled.
- All the &S ROMES4NPA UI elements and features related to results information must be available and useable without the measurement file.

To implement these requirements, the &S ROMES4 NPA application is enhanced or modified so that:

- Analyzing files is possible for existing / accessible measurement files.
- A special data source tree element is created and marked with the icon for the XML-result files without related measurement files.
- It is possible to view in the "Data Source" tree a mixture of XML-result files with and without related RSCMD measurement files (blue and red car icon, respectively).
  The data source tree handles for analysis this mixture of files in a way that a group of files containing blue icons can be processed. For the entries with the red icon, no processing takes place.
  This following figure shows the data source tree view with data tree elements representing XML-result files. For some of them, the related measurement files are not available.

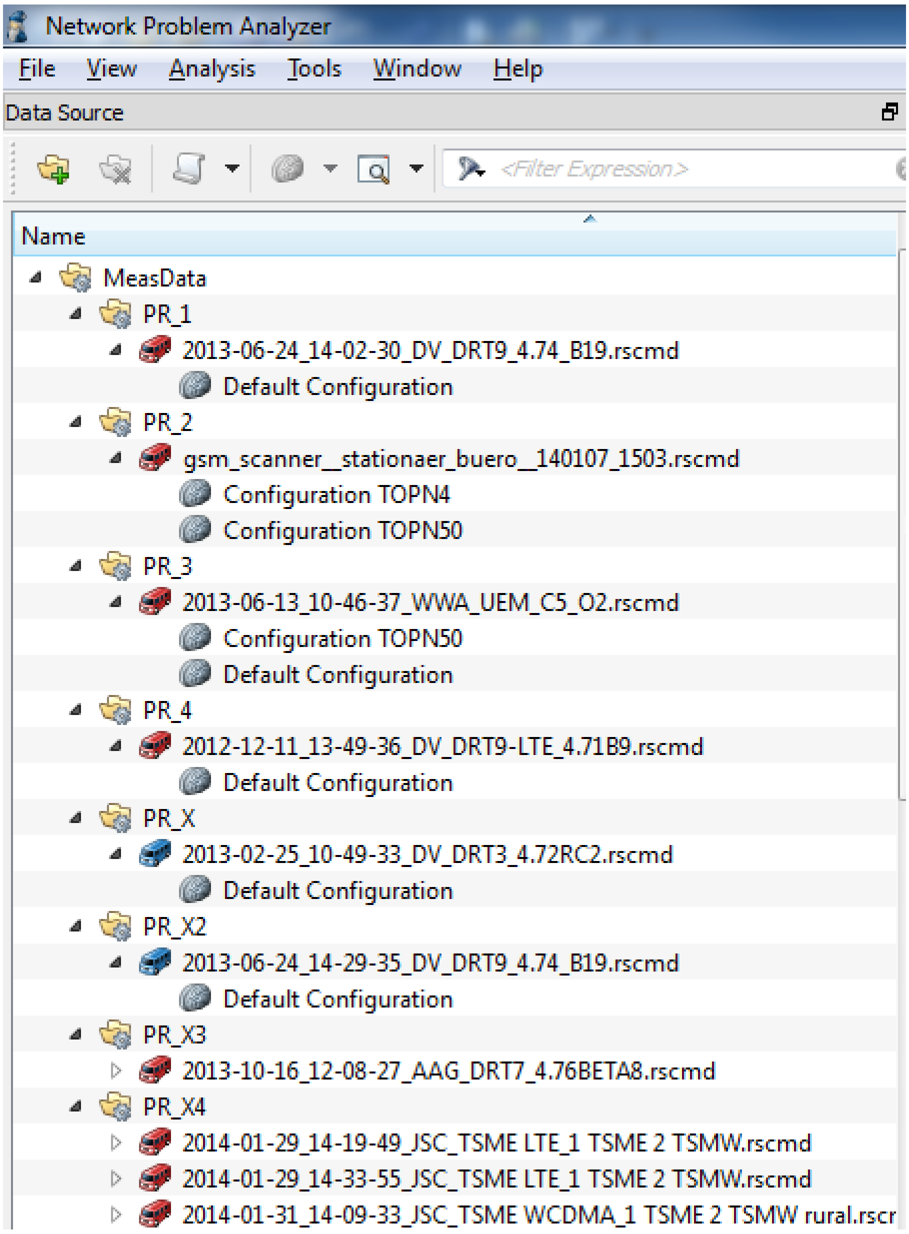


Figure 3-5: Enhanced Data Source window

The subitems of the special tree elements are created as usual and represent the available XML-result files. The "Data Source" tree is updated in case an RSCMD file is copied into or deleted from the data source folder.

- Menu items and toolbar buttons related to measurement files are hidden or disabled when the measurement file is not available but the XML-result file.
  The following figure shows the inactive "Synchronize ROMES to Location" and "Select Workspace for ROMES" menu commands.

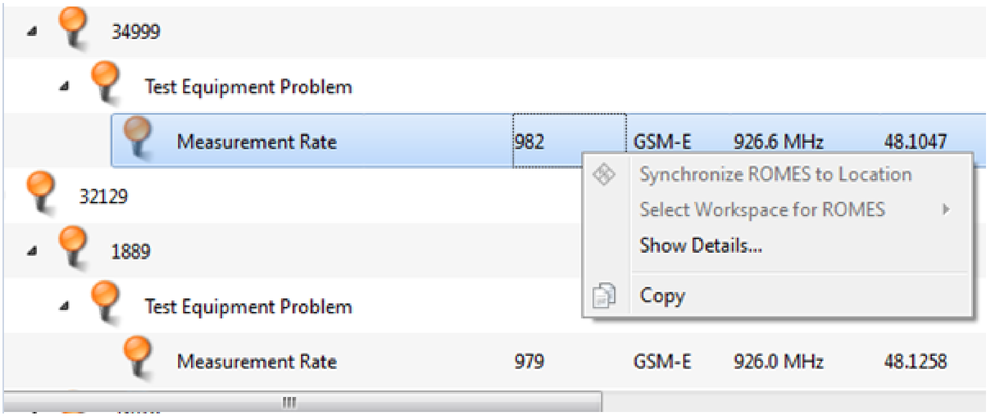


Figure 3-6: Inactive menu commands

- The "Show Measurement File Info" command is only available for existing / accessible measurement files.

All other commands, for example, the "Quick Info" and items like filter, data analysis, reports, result overview and result pages are unchanged.

If the "Analyzing Files" button is pressed, the following info message is shown.

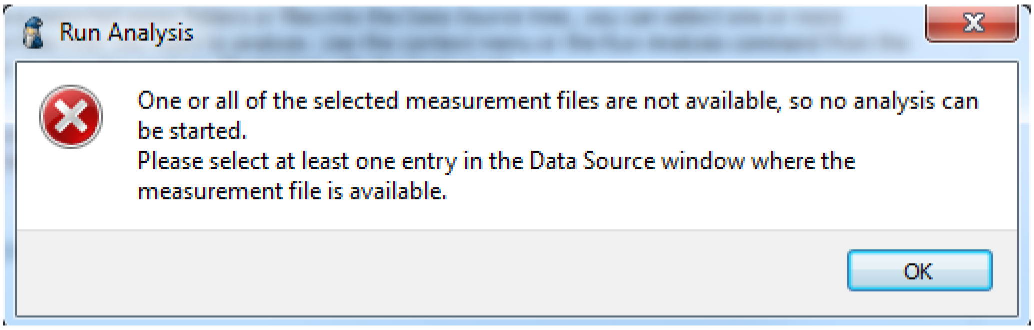


Figure 3-7: Warning message

3.2.2 Handling QualiPoc result files for analysis

R&S ROMES4 NPA can handle measurement files created with the QualiPoc software, that is, the `*.mf` and `*.szf` files.

These files are shown in the "Data Source" window with the gray bus icon, contrary to the blue one for the `*.rscmd` files.

The scanner measurement files of format MF or SQZ version 18.0 or earlier are shown in the "Data Source" window but cannot be converted to RSMD format. The QualiPoc converter refuses to convert them.

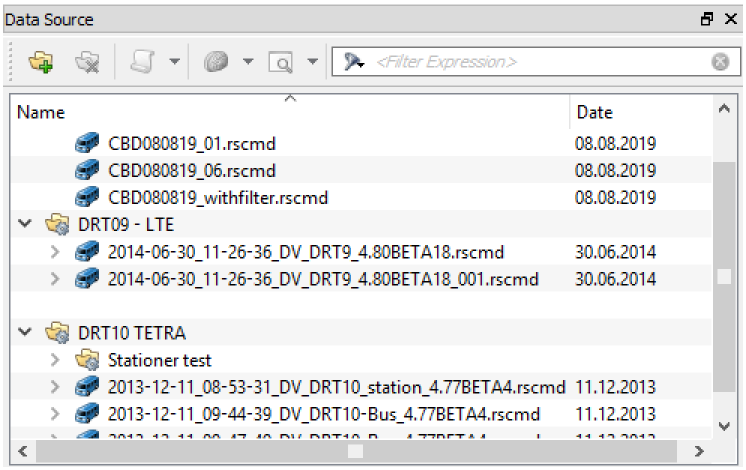


Figure 3-8: R&S ROMES and QualiPoc files

The conversion to a `*.rscmd` file is an additional step before the file analysis starts.

A QualiPoc file conversion to RSCMD format can be initiated in the following ways:

- Double click the file (default configuration)
- Using the menu on top of the window (default or selected configuration)
- Right mouse click the context menu (default or selected configuration)

The conversion starts and the steps are shown at the same progress bar information as the analysis information.

If a `*.mf` or `*.sqz` file is selected, only a limited number of values are visible in the "Quick Info" view.

Additional comment in "General" shows that a selected file is a test file.

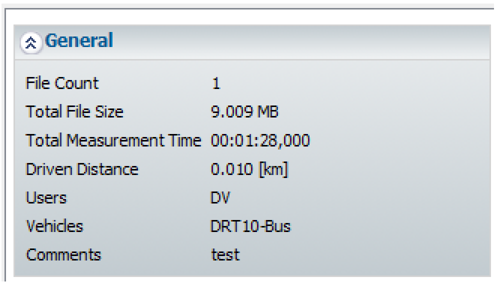


Figure 3-9: Comment - measurement file source

Handling `*.mf` or `*.sqz` files is the same as handling `*.rscmd` files. The only exception is that no measurement file info can be shown from the context menu of QualiPoc files after right click the file in "Data Source".

The decision to convert a `*.mf` or `*.sqz` file to a `*.rscmd` file is inside the QPConverter tool from the R&S ROMES4. This tool is available as a separate software tool.

3.3 Showing analysis results

To show the results of an analysis, perform the following steps:

1. Double-click the analysis result entry.
   Instead, click the related icon in the welcome page.
   The "Analysis Result Overview" opens.
2. The central element of the GUI shows all the analysis result views.

Results are shown by subject in several HTML pages. Therefore, navigation through the pages is similar to navigating in a web browser.

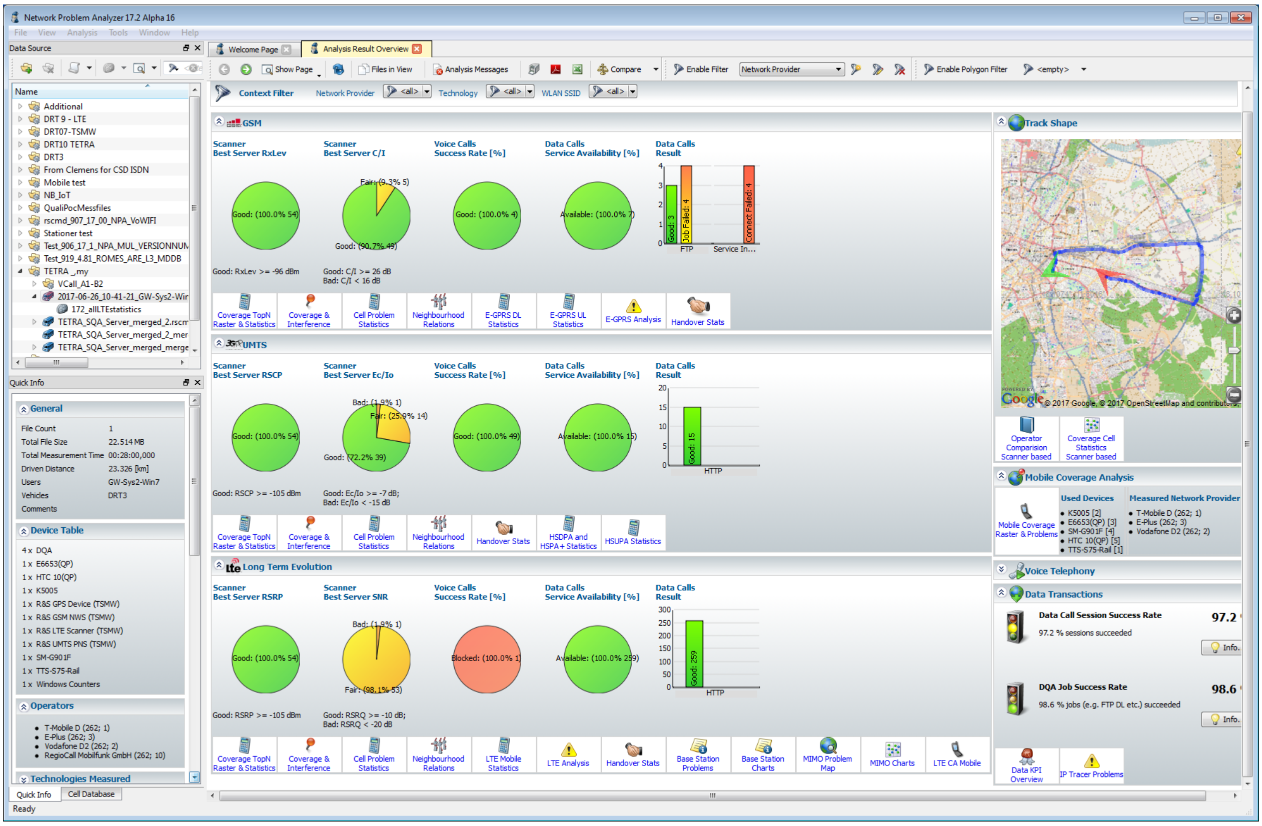


Figure 3-10: Overview of analysis result

More information on this topic can be found in the section Show Results.

4 Use cases

The main purpose of this application is to help you simplify your daily work. The application tries to reduce the work on configuration of processors required for some of the most tedious tasks occurring when analyzing R&S ROMES4 NPA measurement files. Optimizing the workflow is the key aspect here.

The main workflows supported by the R&S ROMES4 Network Problem Analyzer are described in this chapter.

Managing Data Sources	The process of making data available to the R&S ROMES4 NPA is described in this section.
Handling Cell Data	Starting with version 4.60 of the R&S ROMES4 NPA, cell data handling is supported to visualize cells in the map view. How to manage that kind of data is described in this section.
Analyzing Measurement Files	Analyze the raw measurement data before the R&S ROMES4 NPA runs to show meaningful results. How to do this task is described in this section.
Visualizing Analysis Results	HTML pages are used to visualize the analysis results. The usage of the internal browser showing these analysis result pages is described in this section.
Filtering analysis results	Data visualized in the analysis views and in the contained widgets can be filtered to reduce the amount of displayed information. How to manage filters is described in this section.
Drill-Down in ROMES	The R&S ROMES4 NPA provides a quick overview of the file content. If a detailed analysis is necessary, the powerful R&S ROMES4 application is used. How these two applications communicate is described in this section.
Configuring Analyzer Modules	Controlling the analysis process is one of the major configuration aspects the R&S ROMES4 NPA provides. The configuration of the processors is described in this section.
NPA usage for larger measurement files	How to use R&S ROMES4 NPA to cope with larger measurement files is described in this section.
Support of QualiPoc tests	How to use R&S ROMES4 NPA to analyze network performance tests, OOKLA ®, FaceboYouTubeok/ Dropbox, WhatsApp, SMS and Streaming tests from QualiPoc measurements. The pages show results per test and statistics over all tests.

4.1 Managing data sources

Adding data sources (i.e. folders that contain measurement files) is one of the first steps before starting the analysis process. The main place where these actions are performed is the "Data Source" window, initially placed on the left side of the main window.

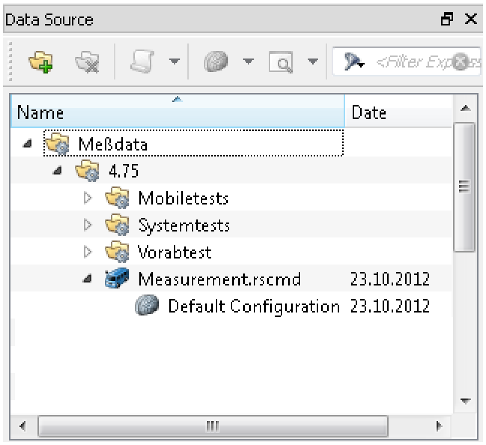


Figure 4-1: Data source window

4.1.1 How to add data source entries

When starting the application for the first time, the "Data Source" window is empty. To add some content, several possible ways exist:

- Use the "File > Add Data Source > Add Folder" menu entry (or press the related shortcut)
- Use the Add Data Source icon  in the Data Source Toolbar
- Use the "Add Folder" entry in the context menu
- Use drag and drop to add data from the Windows Explorer or your favorite file manager

When using one of the first three ways, a dialog to choose the folder is shown. Select the parent folder that you want to add to the "Data Source" window and click "OK" to confirm your choice.

Using drag and drop, both files and folders from the hard disk can be added. When a file is dragged into the "Data Source" window, the parent folder is imported anyway to represent the data.

4.1.2 How to modify the data source tree

When data is imported into the "Data Source" window, it is displayed in a tree-like structure. For each folder, the measurement files and subfolders that also contain measurement files are shown. Folders have the icon and measurement files are displayed using a blue mini-van. Analysis results have a small brain icon assigned to them, as shown in the Figure 4-1.

For a complete description of all the actions available in the "Data Source" window toolbar, refer to the Toolbar description.

4.1.2.1 Context menu

When using the right mouse to click into the "Data Source" window, the context menu of the view opens. This context menu contains the following actions: Also

- Add Data Source - This action contains a submenu to add a folder from the file system:
  – Add Folder
- Remove Data Source
- Delete Data
- Run Analysis - Starts the analysis process for the selected files. The analysis process can be started for different configurations from here as well.
- Show Measurement File Info - shows the measurement configuration details used to record the RSCMD file.
- Open Analysis Result- Opens a specific Analysis View for the selected result files.

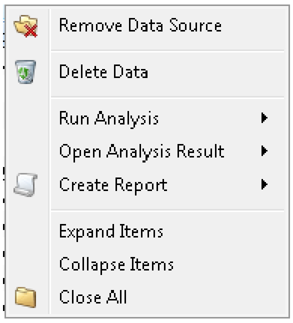


Figure 4-2: Context menu

On each item, a context menu can be opened where several commands are available. Since the tree supports multiple selections, some of the commands operate only on a subset of the current selection. For example, the Run Analysis command only works on measurement files. It is only available, if at least one measurement file is selected and only uses those items for the analysis process.

4.1.3 How to remove data source entries

Sometimes it can be necessary to remove data sources from the "Data Source" Window again, be it that the measurement files have been analyzed and do not need further attention, or just to get a better overview again.

In any case, removing the data is also possible using different approaches:

- Use the "File | Remove Folder" menu entry (or press the related shortcut)
- Use the "Remove Data Source" icon in the "Data Source" toolbar
- Use the related entry in the context menu

This only works on top-level data sources. Subfolders cannot be removed using this command.

4.1.4 How to delete data source entries

Using this feature it is possible to delete directly data from the data sources, i.e. from the file system. It works on folders, files and analysis results. An arbitrary set of data can be selected and deleted.

Confirm deletion in a special dialog first, which looks similar to the one shown below. In that dialog it is possible to restrict the deletion to a subset of the originally selected data nodes.

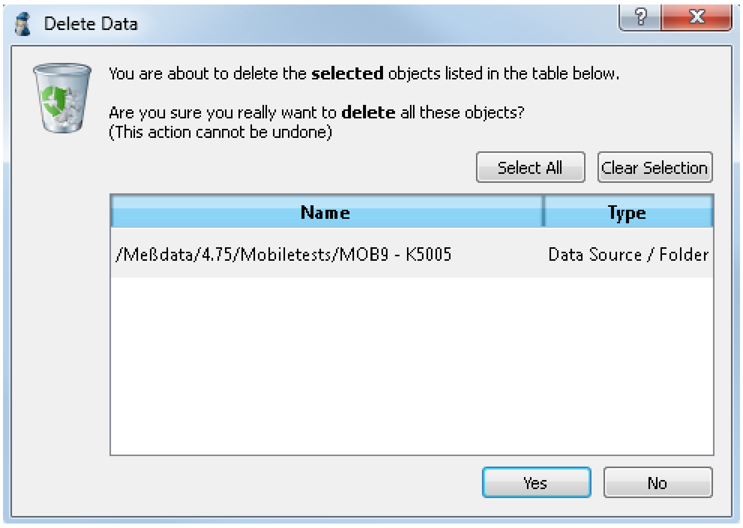


Figure 4-3: Delete confirmation dialog

4.2 Handling cell data

Many of the optimizations done in a modern radio network target the base station entity of the network, especially when analyzing the network with drive tests. Therefore, it is an essential part of a post-processing software to be able to handle cell data.

The R&S ROMES4 NPA can recognize the same formats as used in R&S ROMES4, which are the Rohde & Schwarz proprietary formats `ATD` and `CTDB`, and specialized formats `BUF` and `CDC`. The most common and preferred way of importing data into the cell database is the ATD format. Format details are described in the section below.

There is only one cell database automatically created and initially empty in the R&S ROMES4 NPA. By importing data into the database it gets populated, and over time a network element history is created. Managing the data in the database is explained in the section Data Management.

The database detects changes in the input data. It only stores changes with the defined time stamps to save space and to be able to analyze older measurement files with the related network state. In the analysis result display, that network state is displayed that relates to the current file displayed. More details can be found in the Network Element History section.

R&S ROMES4 measurement files format MF, SQC and SQZ older than version 18.0 cannot be handled by R6S ROMES4 NPA. The reported error in the "Command Report" indicates unsuccessful conversion of a file and the reason.

Figure 4-4: Reported error - file too old for conversion

Handling FEMTO cells with GeoPosition 0

Avoid importing cell data files which contain details of FEMTO cells with GeoPostion 0. In that case, the import process ends with a list of errors in the "Command Report".

The following figure shows FEMTO cells with GeoPosition 0 details.

```
UFEMTOA,E0-0-0.0,N0-0-0.0,,Femto-
NodeB,,,,,,,,,,,10000,65532,,,,,,,,,,,,,44500,,,,,,,UMTS,,,,,,,,,,,,,,,,,,,,WXN450,,[illegible],[illegible],508,Ericsson,,,,
UFEMTOB,E0-0-0.0,N0-0-0.0,,Femto-
NodeB,,,,,,,,,,,10000,65533,,,,,,,,,,,,,44500,,,,,,,UMTS,,,,,,,,,,,,,,,,,,,,WXN450,,[illegible],[illegible],509,Ericsson,,,,
UFEMTOC,E0-0-0.0,N0-0-0.0,,Femto-
NodeB,,,,,,,,,,,10000,65534,,,,,,,,,,,,,44500,,,,,,,UMTS,,,,,,,,,,,,,,,,,,,,WXN450,,[illegible],[illegible],510,Ericsson,,,,
UFEMTOD,E0-0-0.0,N0-0-0.0,,Femto-
NodeB,,,,,,,,,,,10000,65535,,,,,,,,,,,,,44500,,,,,,,UMTS,,,,,,,,,,,,,,,,,,,,WXN450,,[illegible],[illegible],511,Ericsson,,,,
```

Figure 4-5: Cell database file containing the FEMTO cells with GeoPosition 0

The following figure shows the result of importing a cell file containing such cells.

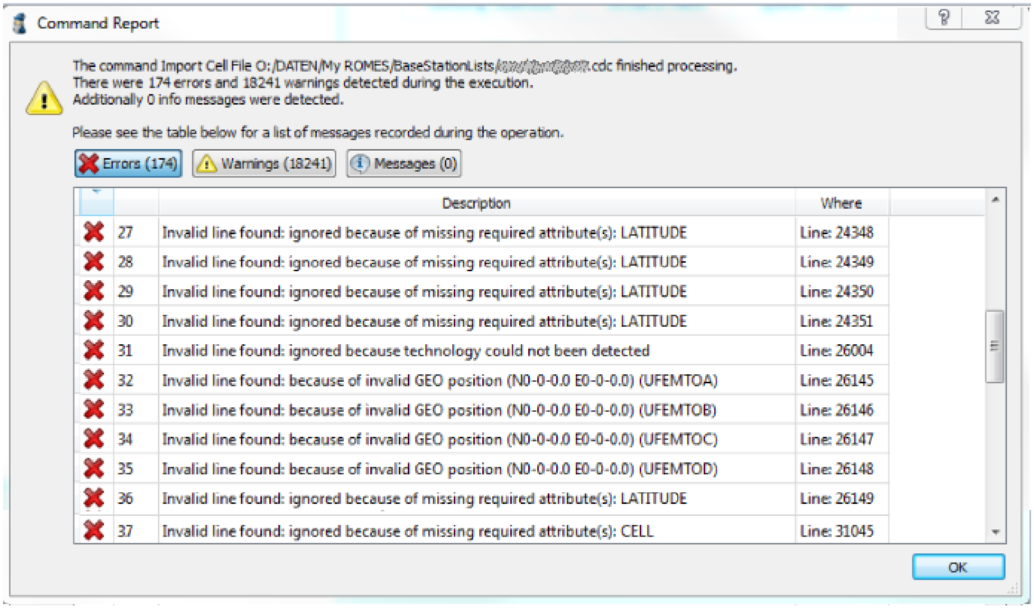


Figure 4-6: Reported errors due to invalid GeoPosition

4.2.1 Unique cell identifier: txid

To find changes in the cells across different cell data files, it is necessary to have a unique identifier for a cell, that also provides uniqueness in the technology domain. Such an ID is created automatically for each cell during import and is called TxID. This TxID is derived from a set of technology-specific parameters, for example, from MCC, MNC, LAC and CI in GSM. Also an identifier for the technology is added. Therefore, the overall TxID of the cell with CI 12345 in LAC 456 assigned to an operator with MCC 262 and MNC 99 is *G262:1:456:12345*. Based on that TxID, the history is tracked and the cells are identified throughout the R&S ROMES4 NPA.

4.2.2 Network element history

All cell data from different technologies and operators are managed in a central data-base of the R&S ROMES4 NPA and is also organized by network state. In other words, each cell stored in the database has a history consisting of a set of configurations where each configuration has a start and an end date.

Differential import

The network element history is created by importing the data into the database over time. Each time a file is imported, the start date of that new data is defined. The importer then checks which cells changed their configuration and only imports the delta. It adapts start and end dates of the existing cells and adds new history entries if necessary. This import is called differential import.

Please note that once a differential import is finished, the delta cannot be removed from the database anymore. It is only possible to delete sets of cells, but not specific history entries.

Overwrite import

Sometimes it cannot be desirable to use the differential import. For example, the input data can already contain history information, or managing history data is not considered a top-priority item. In that case, it is possible simply to omit the start during import (see the following section) and the imported data overwrites existing entries.

4.2.3 Data management

Manipulating the content of the cell database can be done using the actions described in the following subsections. These manipulations are actions to display cell data and the history data, filter, import, export and delete cell data.

The mentioned display actions are available in the cell database window when hovering the pointer over the selected cell. Other mentioned cell database actions are available from the "Cell Database" toolbar or from the "File" menu.

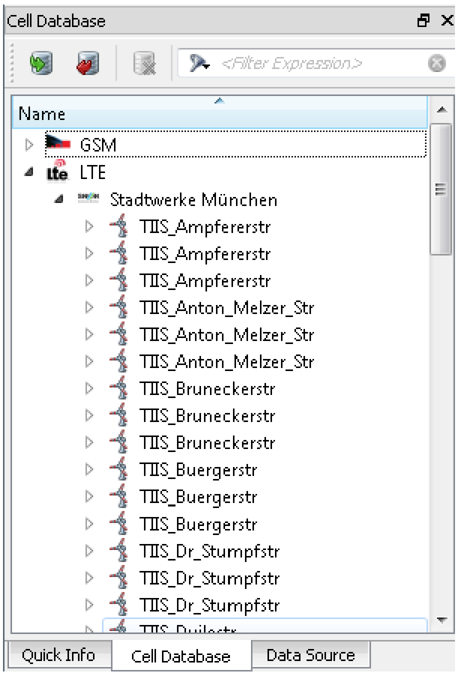


Figure 4-7: Cell database list

Displaying data

Imported data is shown in the "Cell Database" tree located nearby the "Data Source" window. The technology and the operator organize data in a tree structure. Below the operator's name, all cells available can be found, and each cell contains the complete change log of its configuration as history child entries.

History data

Apart from the change history of a cell, all the available attributes of it can be viewed in the Tooltip. Each time a differential import is done and a difference in the cells configuration is detected, a new history entry is created. The changes between the single history entries are shown in the Tooltip, as illustrated in the following figure.

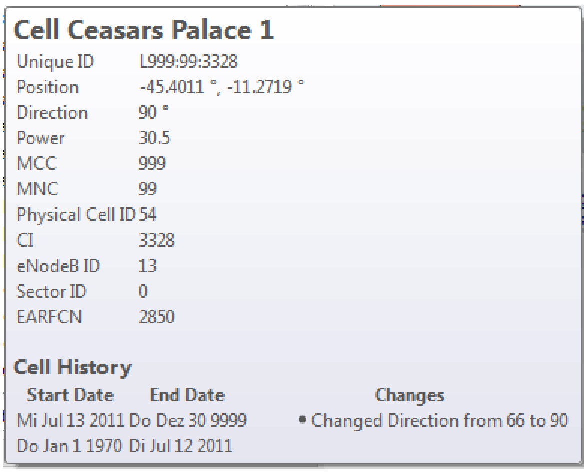


Figure 4-8: Changes of the history data

Neighborhood data

Information about the neighbors of a cell is also provided in the Tooltip shown when hovering over the cell. The neighbors are listed with their unique TxIDs that have been derived from the input data during import.

The Tooltip displays details of all inter-RAT neighbor cells, see the following figure where the details of two RATs cells are dimmed.

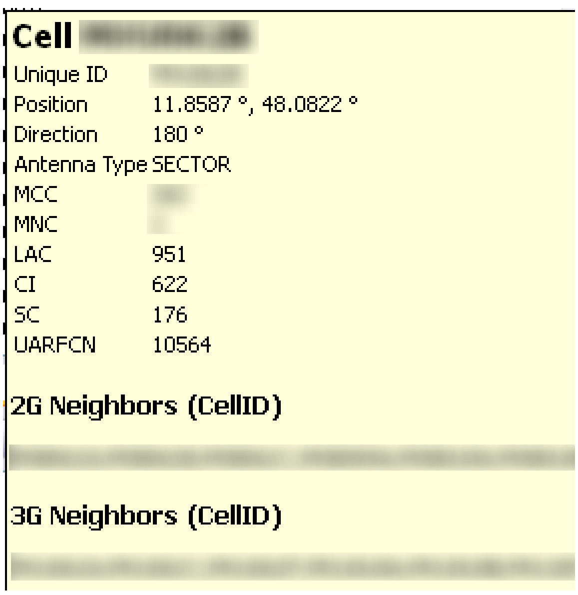


Figure 4-9: Neighbor cell data

The following figure shows the Tooltip of the selected TETRA cell data. It includes previously mentioned entries of the cell.

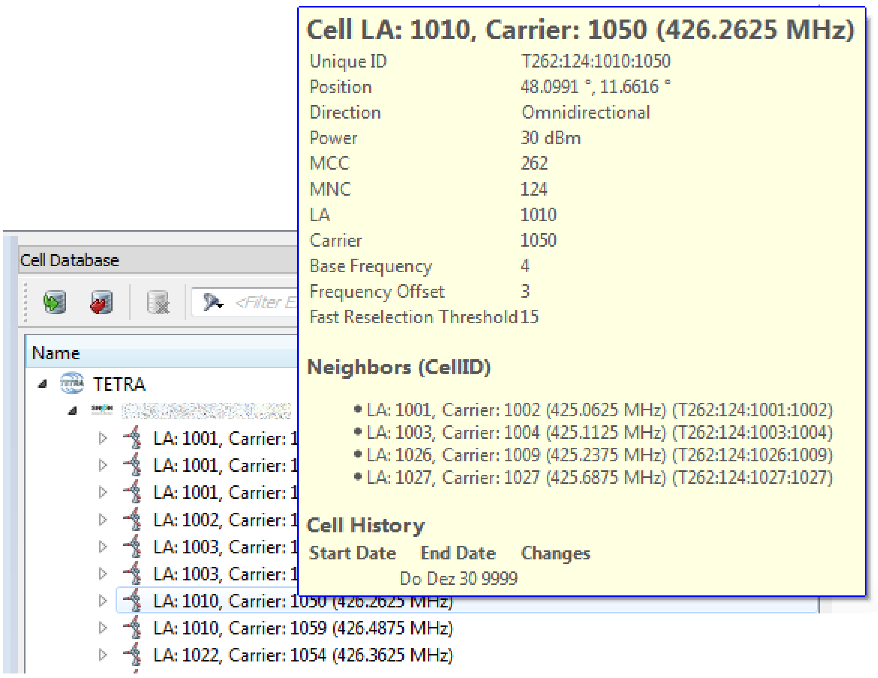


Figure 4-10: Neighbor cells of the TETRA cell

Base station import for TETRA cell database supports ATD/TXT file formats with neighbor definitions without channel number. Only LAC is required from the neighbor. The algorithm searches for base stations with the LAC. If multiple base stations are found, the nearest one is selected.

Quick filter

The cell database window offers the possibility to reduce the amount of data shown in the tree to those elements that match a set of filter criteria. Therefore the "Quick Filter" edit field can be used. Entering a filter in that field filters the content of the tree to those elements that match the given input.

The fields that are compared to the filter string are listed when clicking the funnel icon, which opens a context menu. Their filtering can be reduced to test specific fields of the cell elements, like TxID or validity date.

The "Quick Filter" field is also used in the "Data Source" window and its general usage is described in the related Quick Filter section. Refer to that section to find out more about the usage of that filter mechanism.

4.2.4 Format details

The open base station formats ATD and CTDB supported by R&S ROMES4 and R&S ROMES4 NPA are described in the following subsections. Several operator-specific formats can be imported as well, but those formats are not explained here since they are proprietary formats.

4.2.4.1 ATD format

ATD is a Rohde & Schwarz proprietary format that consists of a pair of two files, an `ATD` and (normally) a `TXT` file. The `ATD` file basically is an `INI`-file. The file defines the columns that are contained in the related `TXT` file. Both files are simple text files, which do not contain binary data, but can be edited with a standard text editor (like Notepad).

ATD file

The ATD file contains the description of the data layout used in the related data file. It also contains a relative or absolute path to the data file. The `ATD` format is simply a derivate of the `INI`-file format used in many Microsoft Windows programs. It must contain two sections:

- The *Main* section, indicating a simple key-value pair *Type=ATD*.
- The *Table1* section, describing the input data format. The following table shows which attributes are interpreted from the table definition section when an *ATD* file is imported into a cell database.

Attribute	Count	Description
File	1	Specifies a relative or absolute path to the data file.
Columns_Size	1	Number of columns. All additional available columns in the data file are ignored.
Columns{ColumnIndex}_Name[1]	1	This attribute defines what value is stored in the column. This information is used to map the input data to the database schema described in the Data Content section.

[1]The {ColumnIndex} field is a counter from 0 up to "Column_Size-1". The columns in the data file are interpreted in exactly that order as described in the ATD file, i.e. the first column name mapping is derived from "Columns0_Name", the second from "Columns1_Name" and so on. The values assigned to the columns are used to find a mapping to the database fields described in the Chapter 4.2.5, "Database content", on page 50.

The following example shows the content of an `ATD` file definition for LTE.

```
[Main]
Type=ATD
[Table1]
File=file.txt
Columns_Size=9
Columns0_Name=eNodeB_Name
Columns1_Name=PosLongitude
Columns2_Name=PosLatitude
Columns3_Name=PhyCellID
Columns4_Name=EARFCN
```

```
Columns5_Name=IsDirected
Columns6_Name=Direction
Columns7_Name=Power
Columns8_Name=CellID
```

Data file

The data file contains the content of a table described within the ATD file. Rows in the data file are separated by new line characters (\n), where columns are either separated by tabulator (\t) or semi-colons (;). Lines starting with a hash character (#) are ignored during import. Each line is split into columns, and the columns content is mapped to the database field derived from the column name. If no such field is found, the data is stored in the database as user-defined attribute. The technology of a line is automatically detected based on the data stored in the line. So it is possible to import into different technologies with just one file.

Using many user-defined attributes can slow down the import and export processes of the data, so it is normally the best way to import only data that contains fields.

Name; Long; Lat; PhyCI; EARFCN; Directed; Direction; Power; Cell Identity

Munich Central Station 1;48.1;11.6;123;6310;1;0;19.1;65112

Munich Central Station 2;48.1;11.6;124;6310;1;120;19.1;65113

Munich Central Station 3;48.1;11.6;125;6310;1;120;19.1;65114

4.2.4.2 CTDB format

The CTDB format is an ASCII text format for multi-technology handling. Data is organized in rows, where each row contains the data assigned to a single cell, and each cell has a set of attributes organized in columns. A ';' character separates columns.

The first line describes how to map the data to the Fields described below. The first column must be the "Tech" column to indicate which technology is described in the remaining part of the current line. The other columns are described by their name, which is used to map to a database field, and the supported technologies in brackets [ ], separated by #.

The following paragraph shows a sample CTDB file.

```
Tech;Name[CDMA#GSM#LTE#WIMAX];IsDirected[CDMA#GSM#LTE];Direction[CDMA#GSM#LTE];
Power[CDMA#GSM#LTE];Longitude[CDMA#GSM#LTE#WIMAX];Latitude[CDMA#GSM#LTE#WIMAX];
PosErr1[CDMA#GSM#LTE#WIMAX];PosErr2[CDMA#GSM#LTE#WIMAX];
Err1Axis[CDMA#GSM#LTE#WIMAX];UniqueId[CDMA#LTE#WIMAX];CellID[LTE];EARFCN[LTE];
PhyCellID[LTE];BandWidth[WIMAX];BaseStationID[WIMAX];CentreFrequency[WIMAX];
IdCell[WIMAX];PreambleIndex[WIMAX];Segment[WIMAX];BASE_ID[CDMA];
BandClass[CDMA];Channel[CDMA];EVDO[CDMA];LOCAID[CDMA];NID[CDMA];PN[CDMA];
SID[CDMA];BCC[GSM];CI[GSM];LAC[GSM];MCC[GSM];MNC[GSM];NCC[GSM];C0[GSM];
C1[GSM];C2[GSM];C3[GSM];C4[GSM];C5[GSM];C6[GSM]
CDMA;"BTS-01";1;100;50.00;-122.840162;45.468102;0.000000;0.000000;0.000000;1;
;;;;;;;;;0;1;550;1;0;0;64;30;;;;;;;;;;;;
```

```
CDMA;"BTS-02";1;139;50.00;-122.818886;45.503444;0.000000;0.000000;0.000000;2;
;;;;;;;;;0;1;550;1;0;0;388;30;;;;;;;;;;;;;
GSM;S262_001_34055_48034;0;0;30.00;10.862753;48.032868;0.000000;0.000000;
0.000000;;;;;;;;;;;;;;;;;;;3;48034;34055;262;1;3;47;98;0;0;0;0;0
GSM;S262_001_34055_48033;0;0;30.00;10.882643;48.031675;0.000000;0.000000;
0.000000;;;;;;;;;;;;;;;;;;;2;48033;34055;262;1;7;34;21;23;44;85;0;0
LTE;LTE-Demo-1;0;0;30.00;10.186667;50.864444;11.000000;22.000000;0.000000;1;1;
16;11;;;;;;;;;;;;;;;;;;;;;;;;;;;
WIMAX;WIMAX-1;;;;11.100000;48.200000;0.000000;0.000000;0.000000;1;;;;5000000;
010203040506;1100000;1;3;1;;;;;;;;;;;;;;;;;;;;;
```

4.2.5 Database content

In the following table all data fields are described that are stored in the cell database. Data from input files is mapped into that table, using the format description in the imported file. Data columns marked with one of the entries listed in the Names column are mapped to the related field.

The names in the imported files are compared case-sensitive with the mapping names, so be careful with capital and small letters.

Each field has a pre-defined type and value range specified in the column.

Basically these types are distinguished:

- Text - A sequence of characters, not including the format-specific delimiters (tabulators, new lines, semi-colons etc.)
- Number - A signed integer number. Some values have a valid sub-range defined like 0... for 0 and positive numbers.
- Date - A single date. Can be derived from integer numbers that represent the number of seconds since 1.1.1970 (UNIX timestamps)
- Floating Point - Decimal numbers
- Enum - A list of values, specific to each field. For example, the Technology field is an enumeration that can take one of the values listed below

4.2.5.1 Technology-independent data

The "Count" column describes how many times a mapping to the given field can be defined in an input file. 0 means that this column is filled automatically during import if enough data is available. 0 to 1 means that a value isthat optional and 1 means that a mapping to that field must be in the file. These mandatory fields are also printed in bold letters.

Table 4-1: Technology-independent data

Field	Type	Count	Names	Technology	Description
TxID	Text	0	n/a	*	Automatically assigned from technology-specific identifiers. Used to identify a cell uniquely in the database (all history entries of one cell refer to the TxID).
Technology	Enum	0/1[1]	n/a	*	Radio Access Technology of the Cell (GSM, UMTS, LTE, TETRA, CDMA, WIMAX). Technology type is derived from the input records automatically in ATD and must be specified explicitly in the CTDB format (see above).
Technology Extension	Enum	0...	GPRS[2], EDGE[2], HSDPA[2], HSUPA[2], EVDO[2]	GSM, UMTS, CDMA2000	One of GPRS, HSDPA, HSUPA, HSPA-Plus, EvDO. The fields used to derive the technology extension normally used flags.A non-zero value in the related column means that the technology extension is available in the current cell record.
TxName	Text	1	Cell, NodeB_Name, BSC, Cell_Name, eNodeB_Name, Name, BTS_Name, SITENAME, Longname	*	Name of the cell. Used in the GUI to identify the cell or the location of the tower.

Field	Type	Count	Names	Technology	Description
Valid Start	Date	0 to 1	StartDate	*	Start date when the cell configuration was valid for first time.
Valid End	Date	0 to 1	EndDate	*	End date when the cell configuration becomes outdated (exclusive).
Longitude	Floating Point -180 to +180	1	PosLongitude, LONGITUDE, Longitude, L_WGS84	*	WGS84 longitude of the cells site.
Latitude	Floating Point -90..+90	1	PosLatitude, LATITUDE, Latitude, B_WGS84	*	WGS84 latitude of the cells site.
Altitude	Number 0..	0 to1	PosAltitude, ALTITUDE	*	Altitude in meters of the cells site.
Direction	Number 0..359	0 to 1	IsDirected[3], Antenna[3], Direction, Dir, CELL_DIR, AZI	*	Direction of the antenna in ° (0-359). If omitted, the cell is interpreted as omni-directional cell.
MCC	Number 1..999	1[4]	MCC	GSM, UMTS, LTE, TETRA	Mobile Country Code. Part of TxID.
MNC	Number 0..999	1[4]	MNC	GSM, UMTS, LTE, TETRA	Mobile Network Code. Part of TxID
LAC	Number 0..	0 to 1/1[5]	LAC, lac_pic	GSM, UMTS, TETRA	Location Area Code. Used in TxID of GSM cells and interpreted as LA in TETRA cells.
Cell Identity	Number 0..	1	CI, CellID, CellIdentity	GSM, UMTS, LTE	Cell Id of a cell. Used in TxID of all supported technologies. It is LA in TETRA and CellIdentity in LTE.
Electric Tilt	Floating Point	0 to 1	ELEKTR_TILT	*	Electric tilt of the antenna.
Mechanic Tilt	Floating Point	0 to 1	MECH_TILT, Tilt	*	Mechanical tilt of the antenna.

Field	Type	Count	Names	Technology	Description
Antenna Height	Floating Point	0 to 1	HEIGHT, height high	*	Height of the antenna in meters
Antenna Type	Text	0 to 1	Ant, Antenna-Type, ANTENNA, AntType	*	Type of the antenna.
Manufacturer	Text	0 to 1	Manufacturer, VENDOR	*	Manufacturer of the antenna.
Power	Number	0 to 1	Power, BSPWR, primaryCpich-Power, PWR	*	Sending power of the antenna.
RxLevAccess-Min	Number 0..	0 to 1	RxLevelAc-cessMin	GSM, TETRA	Minimum access level for a cell.
Neighbors2G	Text	0 to 1	2G Neigh-bors2G, HO3G2G_out, Neighbors		The list of 2G neighbors. It matches the list transmitted in related L3 messages. The neighbors are specified by the tuple CellID,LAC,MCC,MNC, where the latter three are optional. Neighbors are separated by # characters. A valid neighbor list is for example 1234,5678,262,1#1238,5678,262,1#1240,5678,262,1.

Field	Type	Count	Names	Technology	Description
Neighbors3G	Text	0 to 1	3G Neighbors, HO3G3G_out	*	The list of 3G neighbors. Each neighbor is specified by MCC,MNC,LAC,CI, where all elements are required. Neighbors are separated by # characters. A valid example would look like: 262,1,1234,5678#262,1,1234,5679#262,1,1234,5680 Used in the Neighborhood Analysis for LTE and TETRA.
Neighbors2GProcessed	Text	0	n/a	*	Automatically calculated from Neighbors2G, containing the TxIDs of the cells specified in the related list.
Neighbors3GProcessed	Text	0	n/a	*	Automatically calculated from Neighbors3G, containing the TxIDs of the cells specified in the related list.

[1]Optional in `ATD` files, required when importing `CTDB` files.

[2]The Technology Extension field is derived from flags in the file. If, for example, the GPRS column in the file contains a value not equal to zero, the GSM cell is interpreted to support GPRS.

[3]The Directed column in an input file and is interpreted dependent on a value. If the value is 0, the cell is considered to be omnidirection. All other values required the Direction to be specified as one of the column names - Direction, Dir, CELL_DIR, AZI.

[4]MCC and MNC must be set in any case. If the technology does not support MCC and/or MNC directly, the data has to be specified explicitly during import. The same applies if the input data simply has no operator information. The lack of information must be also set in the Import Data dialog.

[5]Optional for UMTS, required for TETRA and GSM.

4.2.5.2 GSM

The TxID for GSM is made of the following parameters:

- The letter 'G'
- MCC
- MNC
- LAC
- Cell Identity

Additional (optional) GSM-specific parameters are given in the following table.

Table 4-2: GSM technology - optional parameters

Field	Type	Names	Description
NCC	Number 0..	NCC	Network Color Code, part of the BSIC
BCC	Number 0..	BCC	Base station Color Code, part of the BSIC
BCCH	Number 0..	BCCHNO	Broadcast Channel
ARFCN	Number 0..	ARFCN	Channel frequency number of the cell
TCHS	Text	TCHNO_0-TCHNO_15, C0-C15	List of traffic channels

4.2.5.3 UMTS

The TxID for UMTS is made of the following parameters:

- The letter 'U'
- MCC
- MNC
- Cell Identity

Additional (optional) UMTS-specific parameters are given in the following table.

Table 4-3: UMTS technology - optional parameters

Field	Type	Names	Description
SC	Number 0 to 512	SC, SC_pcpi, primaryScramblingCode	UMTS Scrambling Code
Center Frequency	Number 0..	UMTS, CDMA2000	Center frequency of the UMTS band used in DL.
UARFCN	Number 0..	UARFCN, ARFCN, uarfcnDL	Channel frequency number of the cell.
RAC	Number	RAC	

Field	Type	Names	Description
MSC	Text	MSC	Name of the MSC
RNC	Text	RNC	Name of the RNC

4.2.5.4 TETRA

The TxID for TETRA is made of the following parameters:

- The letter 'T'
- MCC
- MNC
- LAC
- Carrier

Additional TETRA-specific parameters are given in the following table.

Table 4-4: TETRA technology - optional parameters

Field	Type	Names	Description
Carrier	Number 0..3999	Channel	Channel Number of the Carrier of the Cell. This carrier is not the main carrier, but the carrier on which the base station really communicates.
Base Index	Number 1..9	BaseIndex	Frequency Base Index (1..9)
Frequency Offset	Number 0..3	FreqOff	Frequency Offset
Fast Reselection Threshold	Number 0..31	FastReselThreshold	Handover details.
Fast Reselection Hysteresis	Number 0..31	FastReselHysteresis	Handover details.
Slow Reselection Threshold	Number 0..31	SlowReselThreshold	Handover details.
Slow Reselection Hysteresis	Number 0..31	SlowReselHysteresis	Handover details.

4.2.5.5 LTE

The TxID for LTE is made of the following parameters:

- The letter 'L'
- MCC
- MNC
- Cell Identity

Additional LTE-specific parameters are given in the following table.

Table 4-5: LTE technology - optional parameters

Field	Type	Names	Description
Physical Cell ID	Number 0..503	PhyCellID	The physical cell id (0-503 possible values). Used to resolve neighbor cells from SIBs in the Neighborhood Analysis for LTE.
EARFCN	Number 0..	EARFCN	The radio frequency channel number of the LTE channel.
e-NodeB ID	Number 0..	eNodeBId	The eNodeBId. Together with the Cell Sub ID, eNodeBId is the overall CellIdentity in LTE (CellIdentity = e-NodeB ID * 256 + Cell Sub ID). If CellID is specified in the file, the value can be omitted.
Cell Sub ID	Number 0..	n/a[1]	The Sector ID. Together with the e-NodeB ID this ID is the overall CellIdentity in LTE (CellIdentity = e-NodeB ID * 256 + Cell Sub ID). If CellID is specified in the file, the value can be omitted.

[1]This field cannot be specified during import, but is derived from the CellIdentity automatically, if that is available.

4.2.5.6 CDMA2000/EvDO

The TxID for base stations in CDMA2000, respectively EvDO networks when managed in the NPA, is made of the following parameters:

- The letter 'C'
- SID
- NID
- BaseID/SectorID (24-bit)

Additional CDMA-2000 or EvDO specific parameters are given in the following table. Both technologies are treated in similar ways, the main difference is made by the technology extension field described in the common section.

Table 4-6: CDMA 2000/EvDO technology - optional parameters

Field	Type	Names	Description
PN Offset	Number 0..512	PN	The PN Offset of the cell.
Sector ID	Number 0..		This ID is the BaseID in CDMA2000 and the SectorID24 in EvDO networks. Used in TxID. Internally, it is also used as value when the CellID is requested.
Channel	Number 0..		Channel number.
SID	Number 0..		System ID. Used in TxID.
NID	Number 0..		Network ID. Used in TxID.
LocalD	Number 0..		Location ID.
Band Class			

When CDMA2000 resp. EvDO specific data is managed in the NPA Transmitter Database, the SID is used to find the actual operator of a cell. This assignment is important for the NPA since the operator fields MCC and MNC are mandatory and are derived from the automatically detected network operator. If the NPA cannot automatically derive such the MCC and MNC values, the user is asked to provide these settings manually. In other words, the file is then treated as if there were no MCC and MNC values as described above.

4.2.6 How to import cell data

Importing a cell data can be started using the "Import Cell File" button. Press that button to open a dialog that provides the possibility to choose a file for importing and simplifies the selection of an explicit operator.

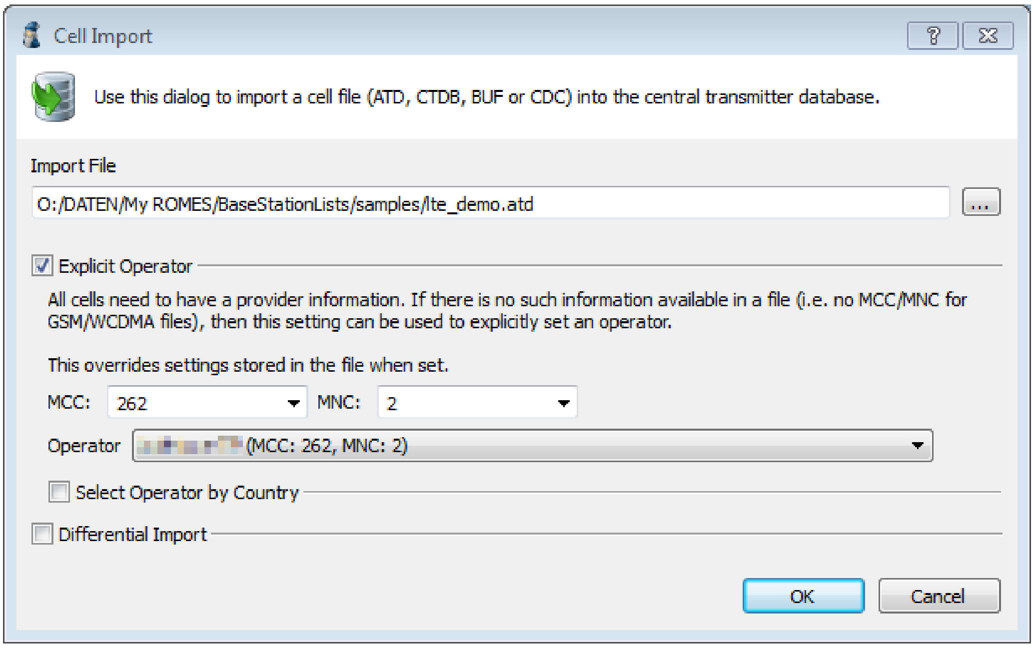


Figure 4-11: Cell import dialog

The "Import File" entry of the opened dialog offers a direct link to Desktop when pressing ... . The action opens the "Import Cell Database File" window. On the left side of the window, a desktop icon is added to file selector.

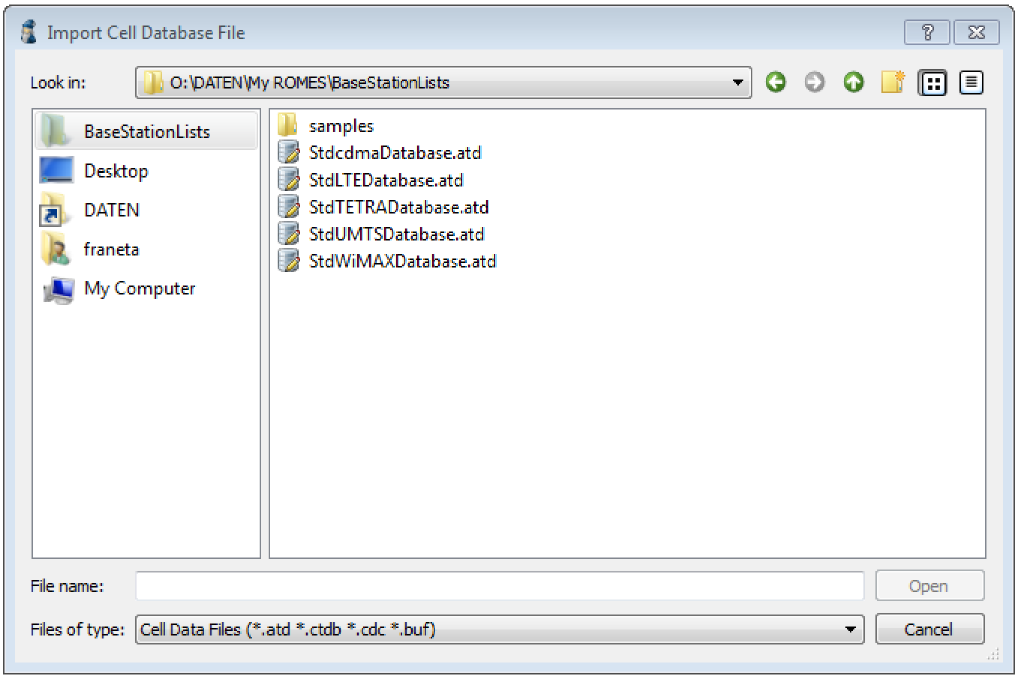


Figure 4-12: Add desktop icon to file selector

The default "BaseStationList" directory contains some practical links in addition, as shown in the previous figure.

There are three possibilities to set/select the MCC and MNC.

- Set the MCC and MNC with their numbers
- Set the MCC and MNC by selecting the operator from the operator list (the "Operator" combo box)
- Set the MCC and MNC by selecting the operator by country from the list which pop-ups, if the "Select Operator by Country" combo box is checked

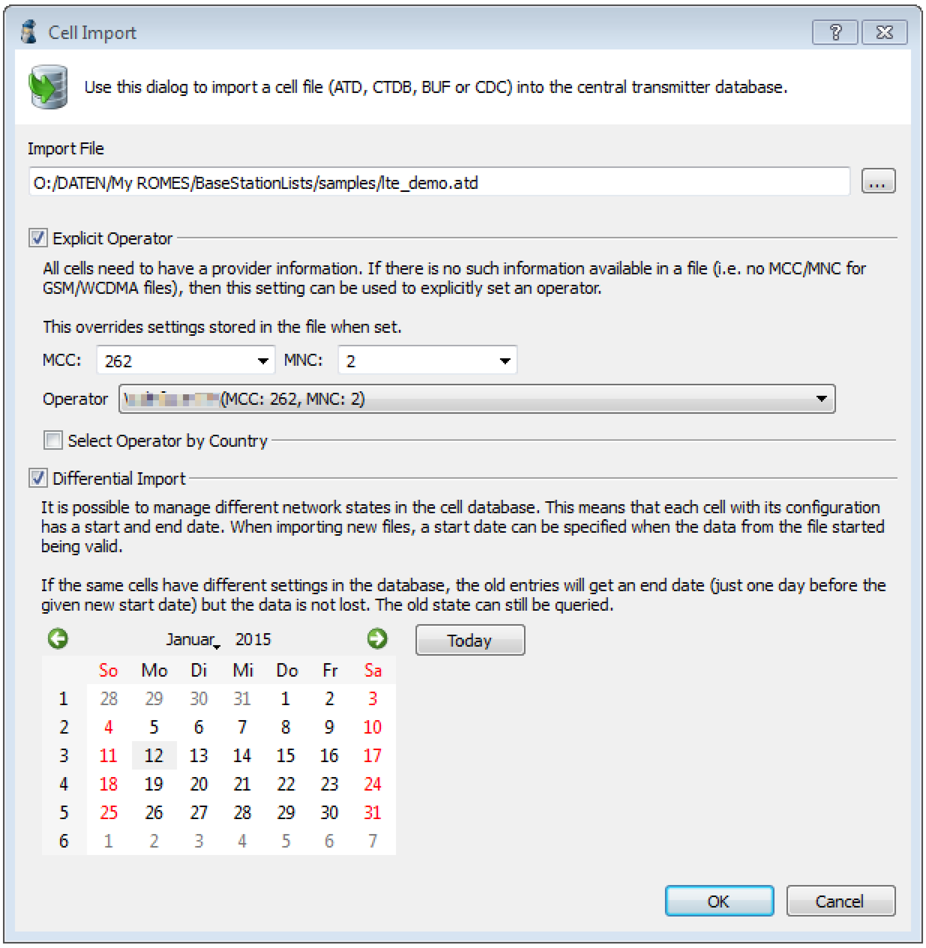


Figure 4-13: Importing cell data

The "MCC" and "MNC" edit fields allow users to enter these network parameters directly instead of selecting them from the combo box list. The edit fields must contain numeric values, otherwise the OK button is disabled.

For convenience, the edit fields are updated with the MCC and MNC values when the operator selection is made via "Operator"/"Select Operator by Country".

The import of cell files supports the ATD, CTDB, CDC and BUF formats. The former two formats are open, generic formats that are described in the related sections below, whereas the latter two are operator-specific formats and not explained here.

Cell data files in BUF format contain added LAC for neighbor cells. In the following string the numbers after the first comma are neighbor cells' LAC.

```
2419,17352 2424,17352 5747,17352 23689,17353 36615,17352
39197,17353 39201,17353 39638,17352 40308,17352 47648,17355
52752,17353 62260,17352 64561,17352
```

These values cannot be imported in the R&S ROMES4 NPA. The import feature needs for this purpose some extension.

4.2.6.1 Missing operator

Due to the internal organization of the cell database it is necessary to link all cell data to a specific network operator. In many technologies the parameters MCC/MNC are used to specify such a specific network. When this information is missing in a file, the operator can be set explicitly in the import dialog. If cells of different operators are imported, the information which cell belongs to which operator must be put into the cell file. If the MCC/MNC is not set explicitly and there is no such information found in the imported file, the user is asked to provide this information manually.

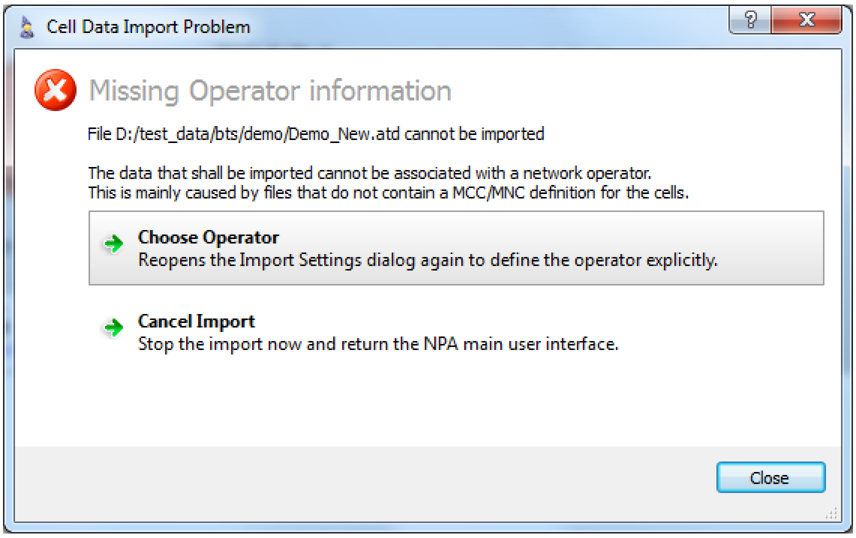


Figure 4-14: Operator data unknown

Specifying a start date for the differential import is also possible in the import dialog. If such a date is provided, the newly imported data becomes valid from exactly that date on. The measurement data recorded before that date is not linked to the cell information imported in that step. Data valid before the import but different to the newly imported data becomes invalid from that date. It is however still available in the database to be linked with older measurement files.

Once the import details are specified and confirmed using the "OK" button, the import process starts. Progress is reported during the import process, which can take some time depending on the input data size and the already available history.

4.2.7 How to export cell data

Cell data stored in the database can be exported into the ATD or CTDB format again, using the button in the cell database window or the "Export Cell Data" entry in the "File" menu. A dialog is shown that is similar to the one depicted below.

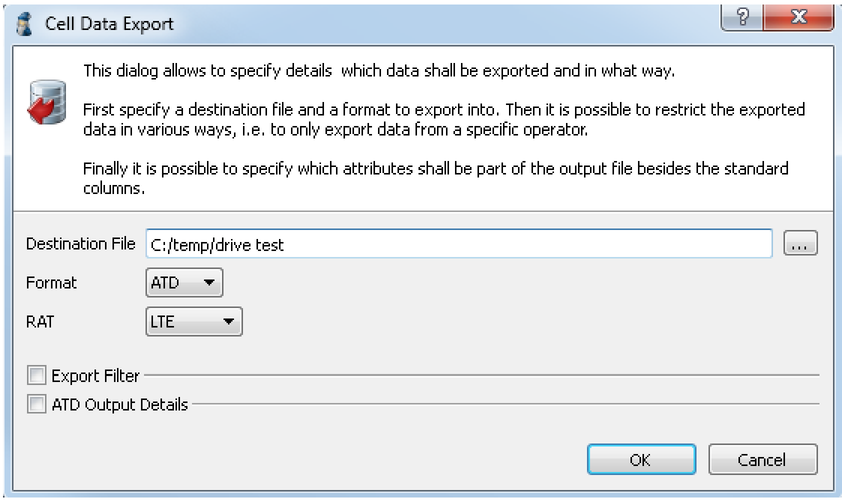


Figure 4-15: Exporting cell data

Besides the destination file, it is mandatory to define which output format is to be used and which technology is exported. The ATD format is a one-technology format, and this restriction also applies to the CTDB format, although that can handle multi-technology information.

Also it is possible to restrict the exported data to a specific operator and/or a network state at a specified time. The format simply reduces the number of records to the ones matching the operator, whereas the second only exports those cells states with start and end validity dates that have a valid configuration at the given date.

If the ATD format is exported, it is possible to define the delimiter type used to separate different columns from each other. It is possible to choose between a tabulator character and a semi-colon.

Pressing the "OK" starts the actual data export process. Before an existing file is overwritten, the NPA asks what to do in such a case.

4.2.8 How to select cells

It is possible to select single cells or whole sets of cells using the standard selection mechanisms of windows. Clicking a single cell selects only that cell. When holding the SHiFT key while clicking, ranges large are selected. When holding the Control button while clicking, the cells selection state is toggled.

When one or more cells in the cell database tree are selected, these cells become visible in all map views currently opened. The map view furthermore zooms to a rectangle where all those cells can be seen. This approach is part of the view synchronization mechanisms described in more detail in the Synchronization chapter.

4.2.9 How to delete cell data

Selected data can be removed from the database again using the icon shown in the toolbar of the "Cell Database" window. It is possible to selected operators, whole technologies or single cells to delete from the database. However, it is not possible to delete single history entries from the database.

4.3 Analyzing measurement files

Analyzing the measurement files recorded with R&S ROMES4 is one of the essential jobs in the R&S ROMES4 NPA. A console application performs actually this job. The application can be also used in batch jobs to automate bulk processing.

4.3.1 Command-line interface

As described in the introduction, the analysis is started in a separate process and executed with a different application. The file name of the application is `npa.exe` and it can be found in the "bin" directory of the R&S ROMES4 NPA installation. It is a command line application, and it can therefore be used to automate the analysis process in situations where it is required.

The command-line arguments supported by the `npa.exe` application are shown in the table below. In the Argument Count column the number of additional arguments are listed. They have to be specified in a way to make a valid command.

Argument	Argument Count	Description
-h	0	Shows all the available command line options. If this flag is specified, no analysis is started, only the help information is displayed.
-v	0	Prints the version number of the R&S ROMES4 NPA and the R&S ROMES4 that is used for synchronization and from which the technology modules are loaded. If this flag is specified, no analysis is started.
-r	1	Explicitly specifies an R&S ROMES4 directory for the R&S ROMES4 installation to search for technology modules. This argument is an optional argument; normally the directory is read from the registry.

Argument	Argument Count	Description
-c	1	The argument must refer to a processor configuration file that is used to run the analysis. Optional argument; if omitted the default configuration is used.
-i	1..N	This argument is the only mandatory argument. Here the files that are analyzed can be specified using relative or absolute paths in a space separated list. This argument must always be the last in the list of arguments.

4.3.2 How to start the analysis process

When analyzing smaller datasets, the analysis is triggered from the GUI. Several alternative ways exist to run an analysis on one or more measurement files which are currently selected in the "Data Source" window.

- Use the "Analysis" > "Run Analysis" menu and select the appropriate configuration that is used to control the behavior of the data processors.
- Use the run analysis menu icon in the "Data Source" toolbar.
- Use the "Analyzing Files" entry in the context menu.

4.3.2.1 Starting with different configurations

Regardless of the way the analysis task is started, once you have set up some specific configurations for the analyzers (refer to section Chapter 4.7.1, "Configuration dialog", on page 111 for details), multiple entries can be found in the "Run Analysis" menus.

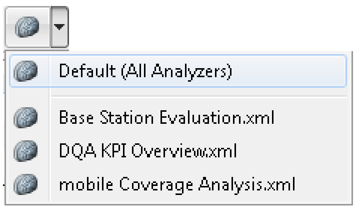


Figure 4-16: Running analysis

The first entry in the list is always available. It starts the analyzer in the default state. All processors that are available according to the license are utilized. Each processor uses its default configuration in the analysis process.

If any additional configuration has been defined, it is listed in the menu with the related file name. Clicking one of these menu entries, start the analysis process using the configuration specified in the file.

If a processor is specified in the configuration that cannot be used due to a missing license, the analysis process is stopped and an error message is shown.

4.3.2.2 Progress monitoring

When the analysis is started, a progress information is shown in a dialog similar to the one depicted below. The analysis task is executed in the background, you can continue working with the application in the meantime.

If an analysis has been started accidentally and has to be stopped, click the "Cancel" button. It immediately stops the analysis process.

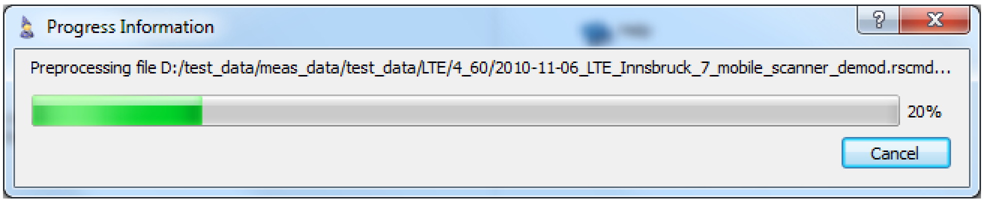


Figure 4-17: Processing progress information

Once the analysis is finished and results have been created, the results are automatically added to the "Data Source" window tree. The analysis results can be visualized and the drill-down can be started from there.

4.3.3 Analysis view

R&S ROMES4 NPA shows analysis results within so-called analysis view page. Each page contains subsets of the overall analysis results. The layout of such a page is shown in the following figure.

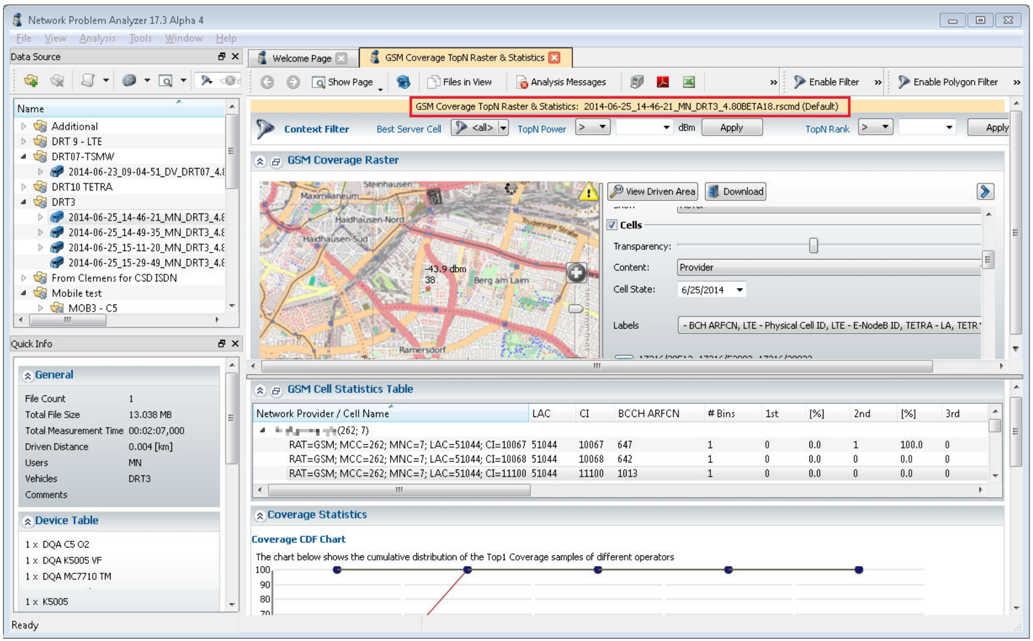


Figure 4-18: Analyses result overview - Coverage Raster

The name of a measurement file analyzed and visualized is added to the top of every result page.

Results are shown by subject in several HTML pages. Navigation through the pages is similar to navigation in a Web Browser. All the specialized subpages can be opened from there (for example, “UMTS” > "UMTS Coverage TopN Raster & Statistics").

How to: Chapter 4.4.1, "How to open a result", on page 70.

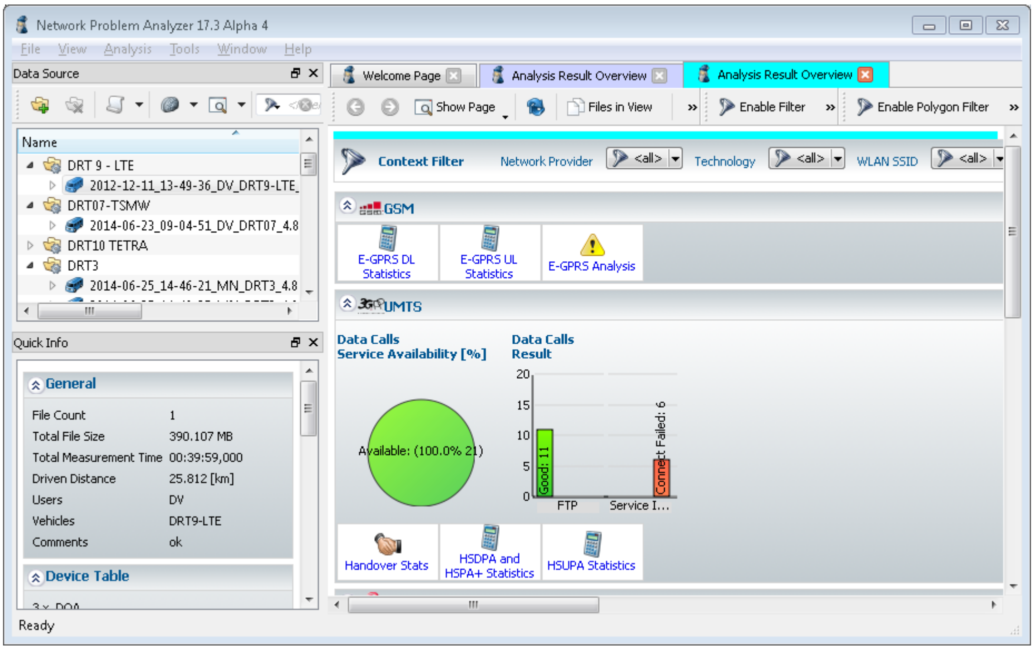


Figure 4-19: Two analysis result overview tabs

Each loaded "Analysis Result Overview" window is marked with a unique color. The color is also used for all subsequent specialized analysis view windows. These windows offer good visualization and some of them show a map view and result tables.

A map view is always on top, whereas the result tables are positioned below the map view, as shown in the following figure.

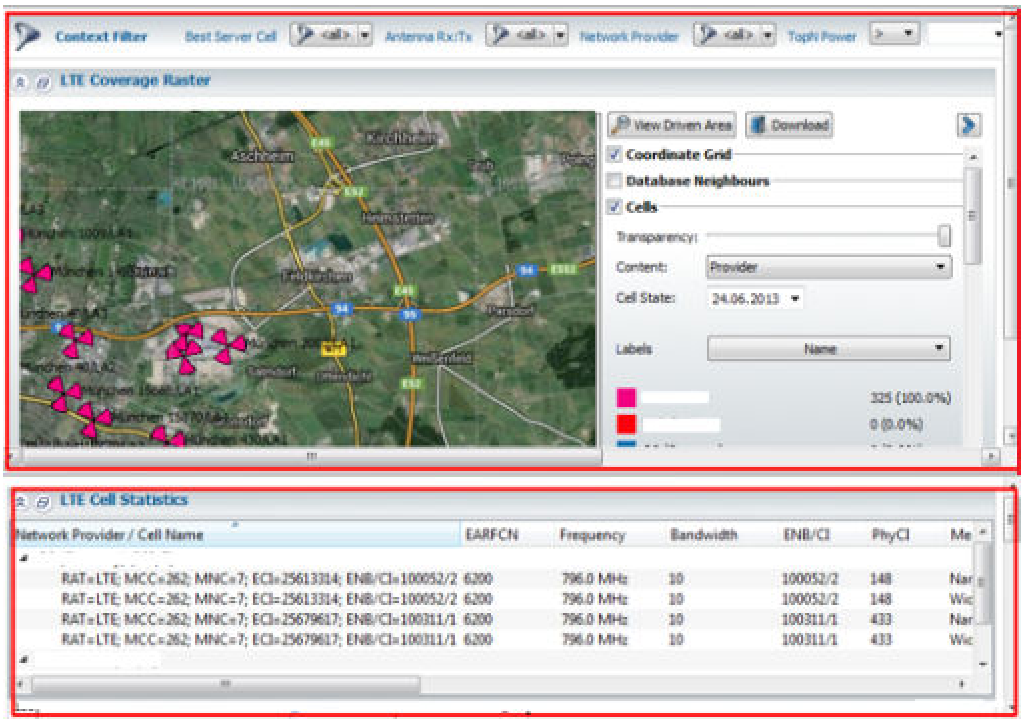


Figure 4-20: Specialized analysis results layout

4.3.3.1 Navigation

The previous and next buttons in the "Navigation Toolbar" are used to switch to the window previously visited and to the next one, like in browser. New windows can be opened by following the links in the currently active page. Links are shown similar to flat style buttons, as shown in the following figure.

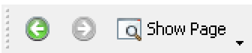


Figure 4-21: Link to the previous / next page

4.3.3.2 Multi-file view

Once the "Analysis View" is opened, its content is not fixed for all times.

Files can be added and removed on the fly to change the aggregated results.

Adding new analysis results is simple. The results that are to be added must be selected in the "Data Source" window and then moved per drag and drop into the view. Dropping such a single or multi-file selection on the view automatically refreshes its content to adapt the display to the new data. If clicking the "Files in View" button of the analysis view toolbar, the files included in the data-set are shown.

To remove the analysis files from the data-set, the "Files in Analysis View" must be opened. The sidebar is shown in the following figure.

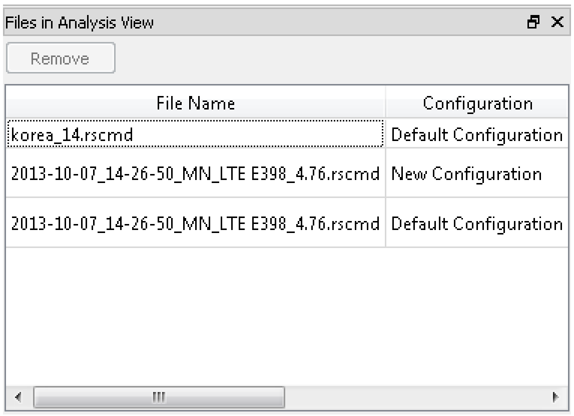


Figure 4-22: Files in the analyzer result view

Selecting files and pressing the "Remove" button removes the files from the data-set that the analysis view is based on and starts a refresh to update the display.

4.3.3.3 Analysis of errors

Sometimes, data found in the file cannot contain all required information to perform a specific analysis. This case can happen during the setup that certain measurements are not defined, or a file has been recorded with an R&S ROMES4 version that could not create the required information. If a data processing unit detects such a situation, it gives feedback that the data found is not sufficient to create the results.

The "Errors during Analysis" window shows description of a message either being error, warning or information and for the first two types of messages suggests the possible problem solution.

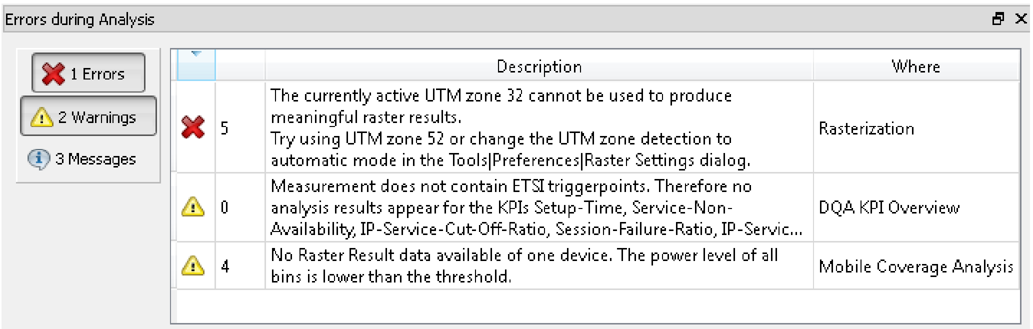


Figure 4-23: Reported errors

GSM coverage problem report related to test measurement rate

The problem of bins not containing all configured GSM channels in the measurements is reported as a message in "Errors during Analysis" instead of being reported as problem spot. The reason for reporting the problem in this way is that it is not related to a specific operator.

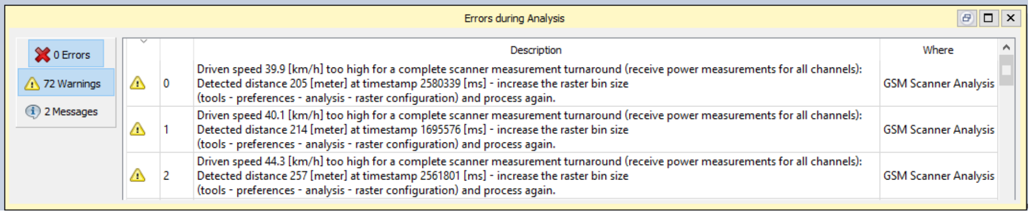


Figure 4-24: GSM coverage problems reported as an analysis message

4.4 Visualizing analysis results

After data has been analyzed, the next step is to get an overview of the content of the measurement files. The visualization of the analysis results is in the previously mentioned "Analysis Result Overview" windows.

4.4.1 How to open a result

To visualize an analysis result, several options exist. At least one analysis result file must be marked in the "Data Source" window before any of the approaches listed in the following is applied.

- Use an entry in the "View" menu to open the analysis results view at a specific position.
- Use the open analysis results icon in the "Data Source" toolbar.
- Use the related entry in the "Open Analysis Result" sub menu within the context menu.
- Double click an analysis result.
- Drag a selection containing analysis results from the "Data Source" window to an already opened "Analysis Results Overview" to add the selection.

4.4.1.1 Opening multiple results

The R&S ROMES4 NPA aggregates data of multiple analysis results (made for an arbitrary set of measurement files) into one single view. This aggregation is done by selecting more entries in the "Data Source" window before opening the "Analysis View", or by adding them once an analysis view has been opened by dropping those data elements into the view.

If some of the analysis results have been created for the same measurement file, a dialog is shown that requests to select the appropriate configuration to be used in the view. It is possible to use all such configurations, but can cause that the statistics and charts contain data from the same file multiple times.

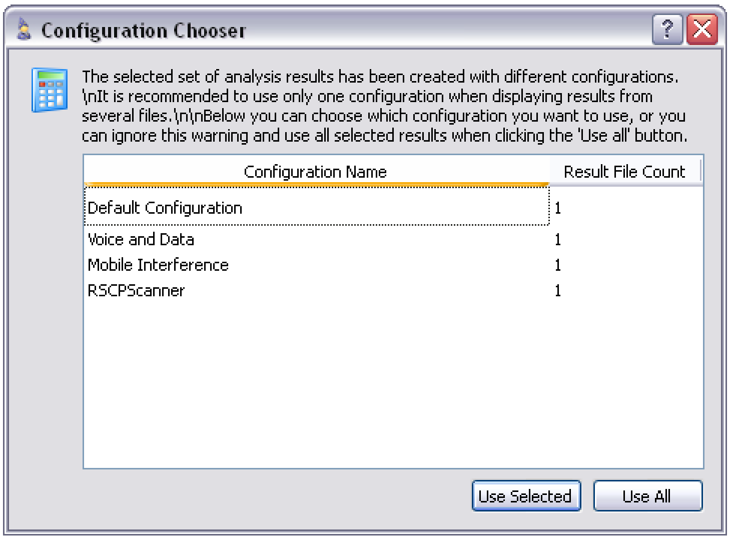


Figure 4-25: Selection of a file

This dialog basically offers two options:

1. Use all the configurations which probably cause duplication of data shown in the views.

2. Select one of the configurations.

The second column in the list of configurations shows how many files support that specific configuration out of the overall set of selected files.

That dialog is not shown when data is added to an existing analysis view via drag&drop operation. In that case, all the data from all configurations that is dropped into the view is used.

4.4.2 Map views and result tables windows

It is possible for each map view and result table of the specialized analysis view to dock these window parts within the specialized analyses views window or to show one or both as separated “floating” window.

The floating window mode allows splitting the analysis view into one window with map data and one or more windows containing result tables. In that way these windows can be positioned according to users need, e.g. side-by-side and/or shown on different/ other display.

The docking/floating window mode is only available for specialized analysis result views where a map view and result tables are shown.

Default is the “docked” view. A map view is then always on top, whereas result tables are shown below the map view.

The specialized analysis views, which contain a map view and the result tables, have them shown inside the separated “docking” windows, marked as the red rectangles in Figure 4-20. There is a splitter control between the windows, marked in red in the following figure.

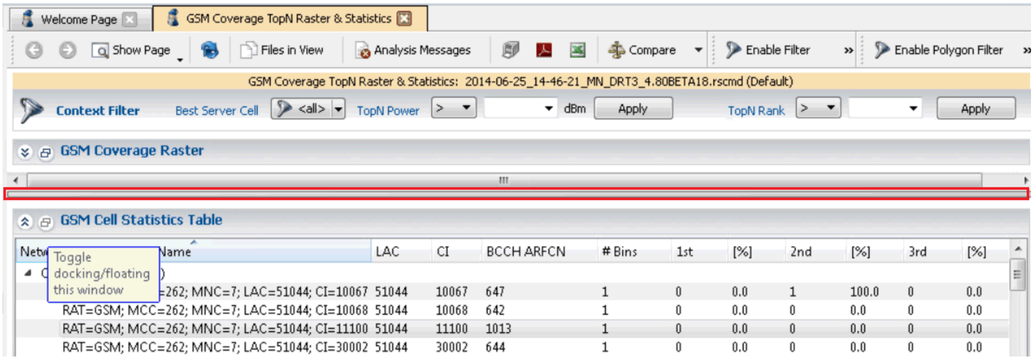


Figure 4-26: Splitter control

Switch between docking and floating window mode of a map view or result table can be done in two ways:

- Left-mouse click the  button. The button is positioned at the upper left corner of the window.
- Right-mouse click to open the context sensitive menu.

A Tooltip is displayed when hovering over the button, see the previous figure.

The floating mode of the map view or table result window is shown outside of the NPA main analysis view window and can be resized or moved (even to a second display) as needed.

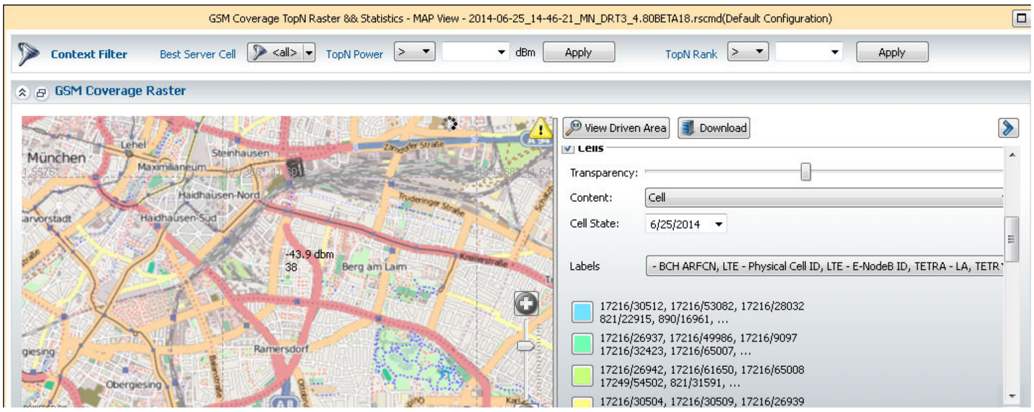


Figure 4-27: Floating map view window

If the "floating" mode is selected for one or both kind of windows, a title bar is shown and the window is marked with a colored frame. This frame color is the same for all related windows (the analysis main window, map, result tables, the "Files in View" and "Error during Analysis" window).

The ⧈ button in the upper right corner allows maximizing the floating window.

4.4.3 Files in analysis view window

The "Files in Analysis View" window is shown in docked or floating mode.

If the current specialized analysis view window is “floatable”, the "Files in Analysis View" is always opened in floating mode.

The following figures show the "Files in analysis View" window docked and in floating mode. Note the color of the specialized analyses view tab and the frame around the floating mode of the window.

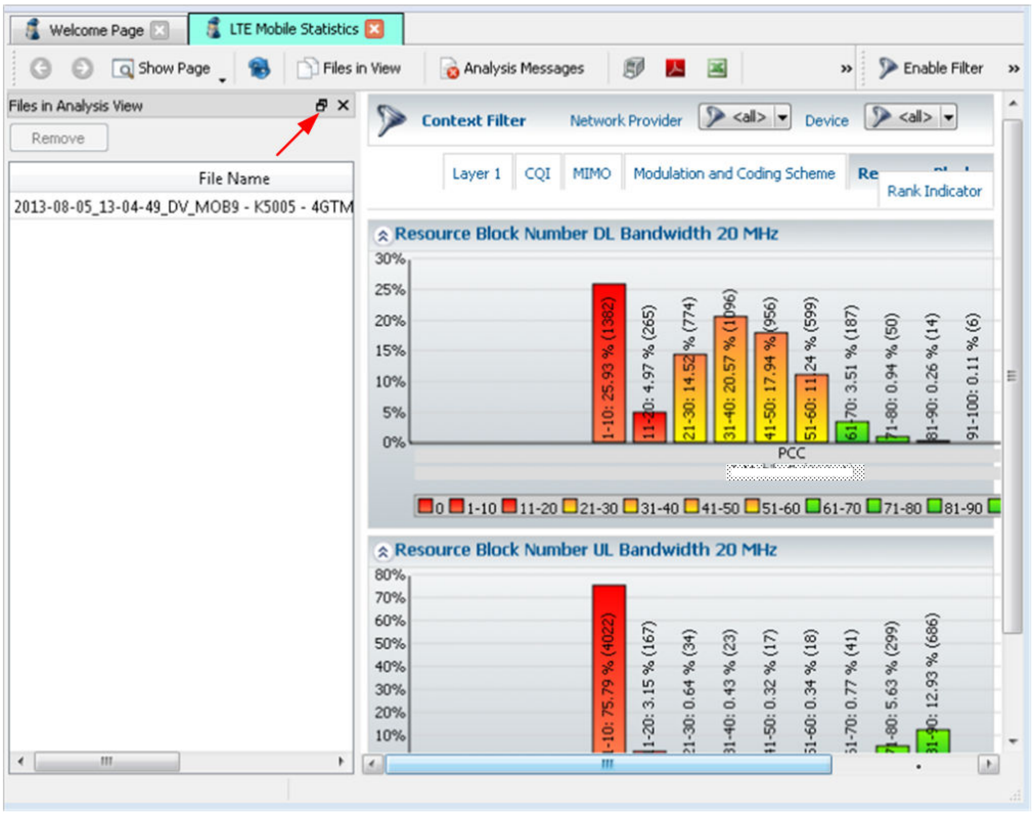


Figure 4-28: Docked files in analysis view window

Red arrow in the previous figure emphasizes the docking/floating button.

The docked "Files in Analysis View" window has two buttons:

- button to switch the window to floating mode
- button to hide the window

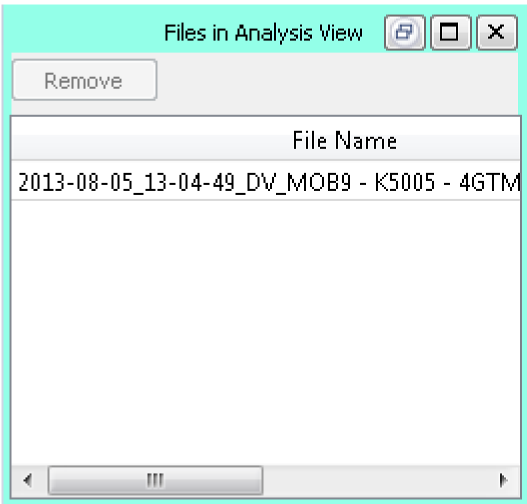


Figure 4-29: Floating files in analysis view

The floating "Files in Analysis View" window has three buttons:
- button to dock the window to the current analyses view window
- button to maximize the floating window
- button to hide the window

4.4.4 Errors during analysis window

The "Errors during Analysis" window is shown either in docked or floating mode.

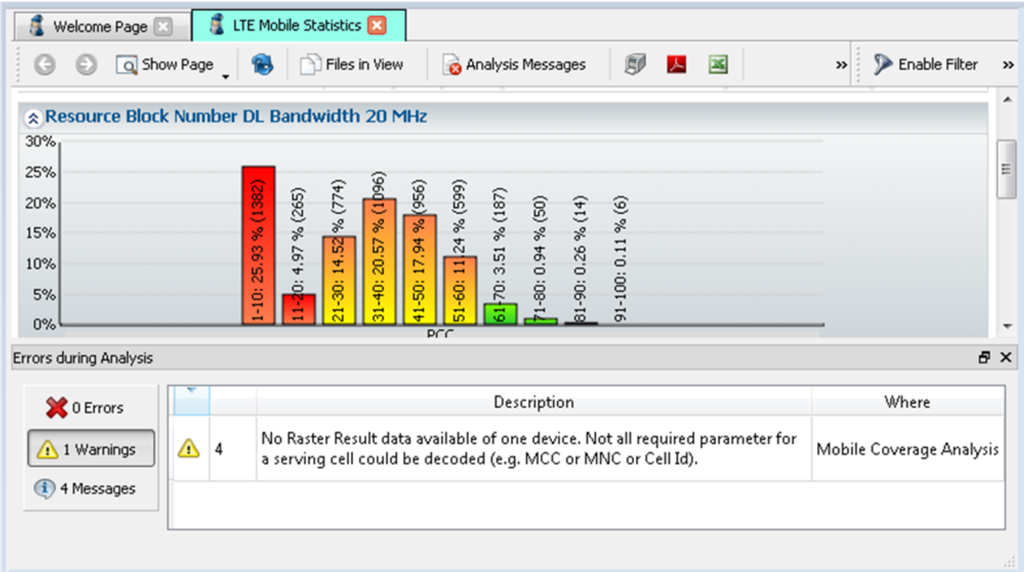


Figure 4-30: Docked errors during analysis window

When the current specialized Analysis View window is "floatable", then the "Errors during Analysis" window is always opened in floating mode.

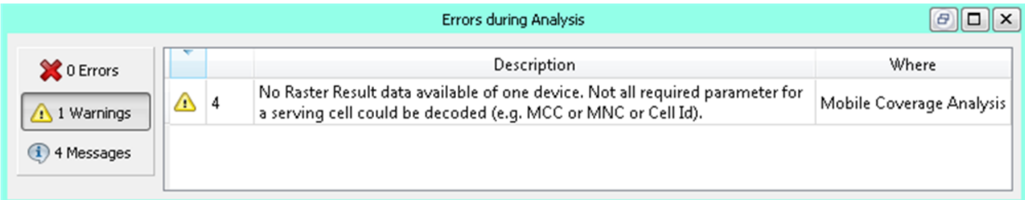


Figure 4-31: Floating errors during analysis window

The meaning of the upper right buttons in the "Errors during Analysis" window in both modes is the same as explained in Chapter 4.4.3, "Files in analysis view window", on page 73.

4.4.5 How to synchronize views

Several different types of objects exist in the R&S ROMES4 NPA application. Such objects are data entities like measurement files, cells or analysis results. Others are the result of an analysis process like Problem Spot, Neighbor Relations or KPIs. In many situations the same elements are visualized in several analysis views, like in a table or in a map. Then it is often required to see both elements at one time. This case is where view synchronization helps analyzing the data.

With view synchronization, every selection in one view sends messages to all potential views with the new selection. If all of that selection or parts of it are found in another view, that data is selected. This approach works within a single analysis page. It also works across different views, when some of the data is equal (for example, cell data can be used in different pages).

The process of synchronization always involves one transmitter and possibly an arbitrary number of receivers. If an element can emit a selection change, it supports Chapter 4.4.5.2, "Active synchronization", on page 77, whereas elements that can receive changes support Chapter 4.4.5.3, "Passive synchronization", on page 77. An element can support both modes, and in fact every element currently does.

4.4.5.1 Synchronization entities

Not all displayed data can be used for synchronization. The following section describes what elements can be synchronized and how that is done. The list is sorted by priority, i.e. if a selection contains elements of more than one type, the target view synchronizes to the top-most element.

Cells

Most analysis results are associated with at least one cell. Most of the KPIs and problem spots are, and if such an element is selected, the cell identifiers of the selected cells are transmitted to the target views.

To make full use of cell synchronization, it is necessary to have the related cell data imported into the "Cell Database". The Chapter 4.2, "Handling cell data", on page 42 window, for example, only synchronizes to cell selections if data is available.

Neighbor relations

As a result of the Chapter 12.18, "neighborhood analyzer", on page 392, missing and potentially wrong neighborhood relations are detected and listed in a table and a map view. When one such neighbor relation is selected in the table, the cells involved are marked in the map view. This cells marking is an example where the imported cell data is used. If no cell data is available for the Neighborhood Analysis, the neighbor relation is visualized as a problem spot and the same rules as described in the following section applies.

Problem spots

Problem spots are normally listed in tables, and their synchronization is not done on some internal identification of the spot, but uses the time interval associated with the problem spot. That time interval is sent to other views, together with a hash of the file and the list of involved devices to avoid synchronizing other spots.

The reason for this is that using such a time interval allows synchronization with a call table to find the call to which a problem spot belongs. This also works vice versa, i.e. problem spot is selected when the call in which they occurred is selected.

Calls

Calls are treated in the same way as problem spots are. They also are defined via the time interval in which the call was begun to the point where it terminated.

4.4.5.2 Active synchronization

Active synchronization is supported by the following views:

- Map View - Triggers selection changes on problem spots and cells
- Problem Spot Table - Sends the time intervals associated with the call as described above and the associated cell where the call terminated.
- Call Table - Sends the time intervals associated with the call as described above.
- TopN Statistics - Sends only cell selections.
- Cell Database Window - Sends only cell selections.
- Neighborhood Analysis Result Table - Transmits selected neighbor relation.

4.4.5.3 Passive synchronization

The following views support passive synchronization when an element like a problem spot or a cell is selected.

- Map View - Synchronizes on problem spots, calls, cells and neighbor relations.
- Problem Spot Table - Synchronizes on problem spots, calls and cells (if assigned to the spots).
- Call Table - Synchronizes on problem spots, call and cells (to the terminating cell).
- TopN Statistics - Synchronizes on cells only.
- Cell Database Window - Synchronizes on cell selections.
- Neighborhood Analysis Result Table - Synchronizes on cell selections.

4.4.6 How to print/export analysis views

The R&S ROMES4 NPA is only one tool in a chain to analyze and optimize network data. Some of the data presented within the application is required to be re-used in other applications. Where on a low level the resulting xml files can be processed to extract the data resulting from the RSCMD file analysis, the displayed data is also of interest to either be put into a management report or to form the input for some further processing logic in Excel. These requirements are supported via the printing and exporting functions made available either for currently displayed data in an analysis view, or by one-click report creation function based on data selected in the "Data Source" window.

4.4.6.1 Printing/exporting analysis views

The currently displayed analysis results can be exported to various data formats or printed to a printer device. The visualizations are converted internally so that not only currently visible content is shown in the print result, but also data that is, for example, in an invisible area of a scroll area.

The following functions all try to print or export the data so that the final result3 resembles the visible result on screen as close as possible. This has however specific limits for each format, which are usually tolerable. Differences to the on-screen content are described in the format-related sections.

These export formats and print modes are currently possible:

- Print to a Device
- Export to Adobe PDF Format
- Export to Microsoft Excel

When printing, the layout and contents of the output can be customized within the Page Setup dialog. This dialog is shown when one of the options below is clicked.

4.4.6.2 Reporting

Besides the capability of printing the content of a page currently displayed, the R&S ROMES4 NPA provides means to print data from a file selection in the "Data Source" window in a concise and focused form. The technology-specific reports provided by the R&S ROMES4 NPA gives both a quick overview of the contain measurement files and a comparison of different operators, if available.

The reporting function can be called either using the context-menu in the "Data Source" window or the related button in the toolbar. These buttons open a menu where the desired report can be selected. The report is then scanned for its content and the print configuration dialog as described above is shown. It also shows a tab page where the output format can be specified. The same formats are supported as in the standard print process.

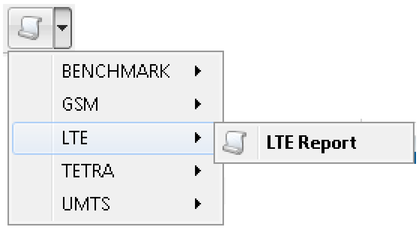


Figure 4-32: Create LTE report

Once the page setup dialog has been exited by clicking the "OK" button, the report is created. This action has to be put in the foreground at some points, so the user interface of the NPA can be not responding for some seconds up to half a minute. This delayed response is a known limitation of the software.

After the report creation has finished, the same post-processing actions are executed like the view printing routines as described below. I.e. exported data is opened with the associated application, or a print preview dialog is shown (refer to the following chapters).

4.4.6.3 Page setup

All print and export specific settings can be set in the "Page Setup" dialog, which is shown once a related action has been started. At the top of the dialog, a settings bar is shown that can be used to save or restore the different configuration details. Therefore the save and load buttons to the right of the settings combo box can be used.

All the possible settings are organized in different tabs, where the first tab contains details concerning the output format (not shown in every case), the second format and layout settings and the third content-specific configuration. The tabs are explained in detail in the following sections.

Format tab

Within the format tab, it is possible to select to what kind of device or output format the result is to be written. It is possible directly to print the content to a print device, or to write the data into a PDF or Microsoft Excel file. If one of the latter two options is selected (by pressing the appropriate button), a destination file has to be chosen.

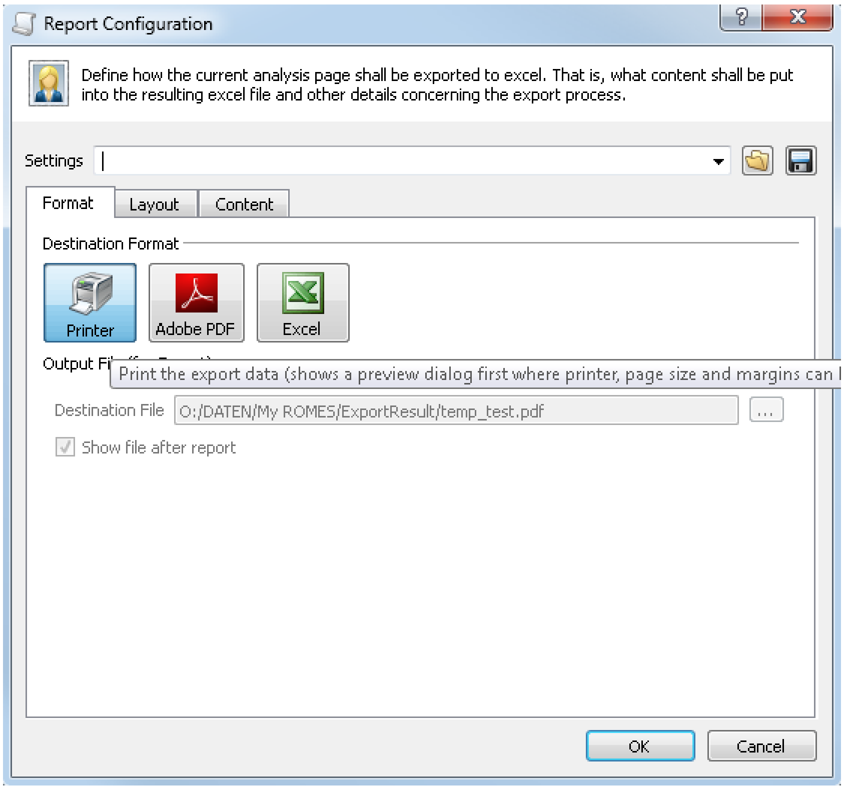


Figure 4-33: Exporting analysis page

If an export option is selected (PDF or Excel) and the dialog is confirmed using the "OK" button, the R&S ROMES4 NPA checks if the destination file already exists and shows a confirmation dialog similar to the one shown below if that is the case. From that dialog, it is possible to confirm that the selected destination file has to be overwritten, choose another file as export target or to cancel the entire export process.

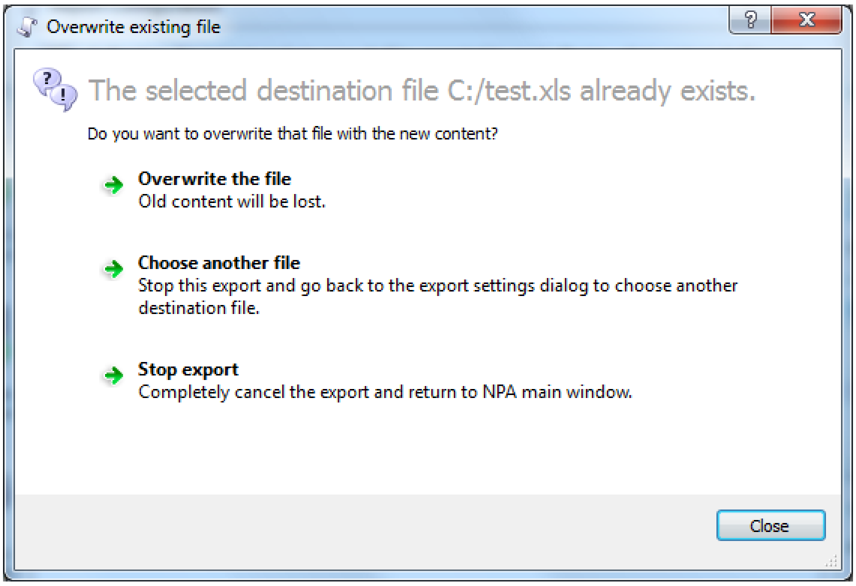


Figure 4-34: File's name exists warning

Layout tab

The layout of the output can be controlled with the tools provided by the layout tab. Here the header and footer of the resulting report can be defined, as some special formatting details for the Microsoft Excel export.

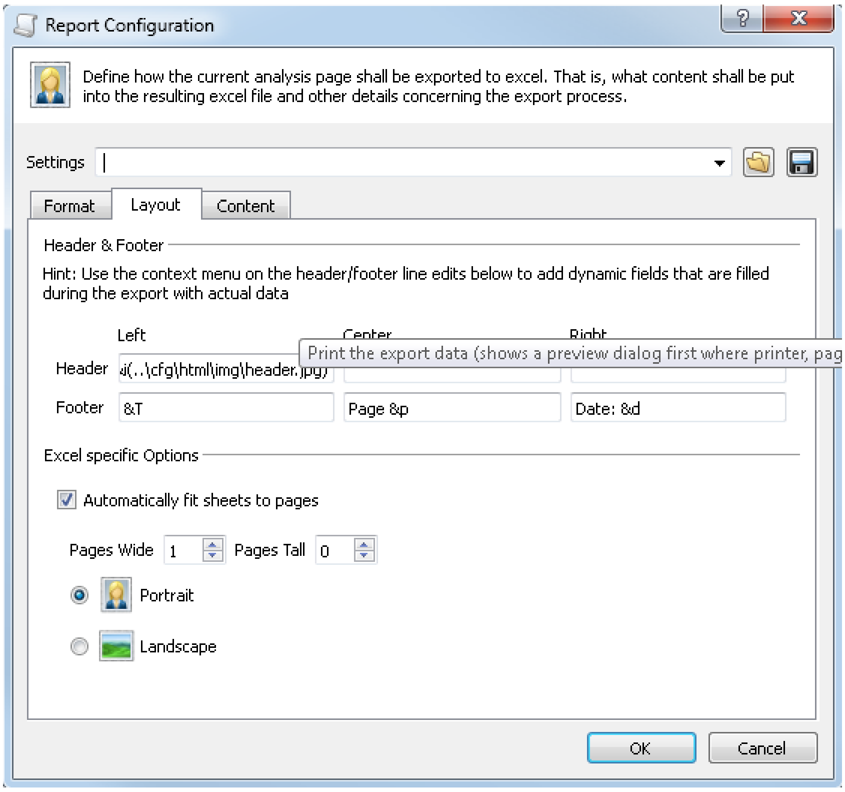


Figure 4-35: Layout tab page

Defining headers and footers can be done using the six text-fields, which hold the actual content displayed in the left, center or right part of the header resp. footer. Besides standard textual information, which can be entered directly, dynamic fields are supported (as known from Microsoft Excel and browser printing). These additional fields can be inserted easily using the context menu (see picture below), which opens if the right mouse button is pressed over one of the fields. Otherwise, they can be entered directly using their related acronyms.

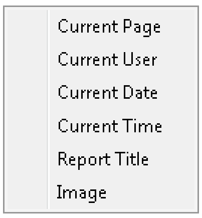


Figure 4-36: Header/Footer definition

The following fields are supported by the NPA:

- &p - Inserts the current page number
- &d - Inserts the current date, formatted as specified in the system settings
- &t - Inserts the current time, formatted as specified in the system settings
- &l - Inserts a line
- &i - Inserts the image stored in the file in brackets (example: &i(C:\\myimg.png))

- &T - Inserts the report title

If the result shall be printed from within Microsoft Excel, it might make sense to fit the output to a predefined width/height and paper orientation so that all data is shown within the given constraints. This can also be done in Excel on a per-sheet basis, but it might be more convenient to let the R&S ROMES4 NPA set those configurations for all exported sheets (especially when multiple pages are exported).

Content tab

The content of the print result consists of a set of so-called widgets. These widgets visualize the actual data in some specific way. For example, a map widget shows data geographically, whereas a scatter plot shows data in an x-y-graph. The list of widgets contained in the current view or a report is shown in the "Content" tab in a tree structure. Each "page" is shown as a separate tree root element, and the widgets in such a page are listed as children of that node. A page here is an organizational entity, grouping analysis widgets together. Each page is also the start of a new page in the final output result, but there might be more pages depending on the internal structure of a page (tabs for example are displayed on separate output pages).

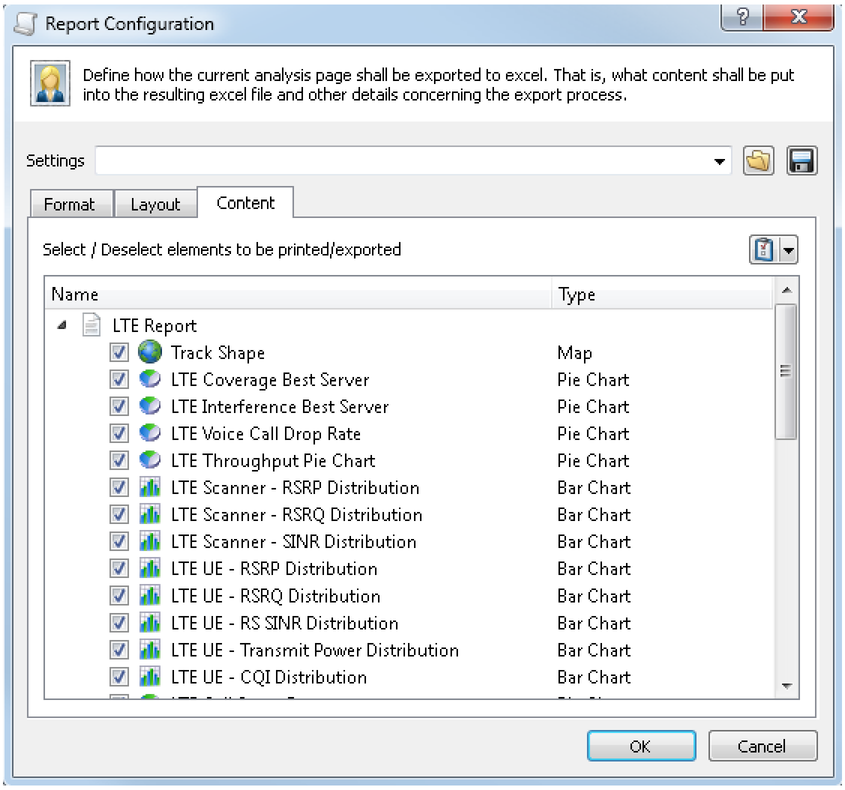


Figure 4-37: Content tab page

Initially only widgets of the current page are selected when analysis views are printed, or all widgets are selected that have been selected before (in case of a report). The set of exported widgets can be changed by marking the entries in the tree with a check mark or removing it. To mark/unmark multiple entries of the same type, the drop-down menu at the top of the widget tree offers several functions to do such. This includes the following actions:

Figure 4-38: Widget drop-down menu

- Select All - Adds a mark to every widget
- Clear Selection - Removes all marks of every widget. Useless if no further selection is done.
- No [Widget Type] - Removes the mark at every widget of the specified type. Useful to unselect maps for example when printing multiple pages.
- Select [Widget Type] - Adds a mark to every widget of the specified type.

The filtering defined here is stored in the general settings as blacklist filter. This means that the widgets that have not been marked are recognized the next time the dialog is loaded and again set to be not marked.

4.4.6.4 Printing the view content

Click the related print button in the toolbar to open the print preview dialog, shown in the following figure. The print preview shows on each page an image in the header and the page number in the footer.

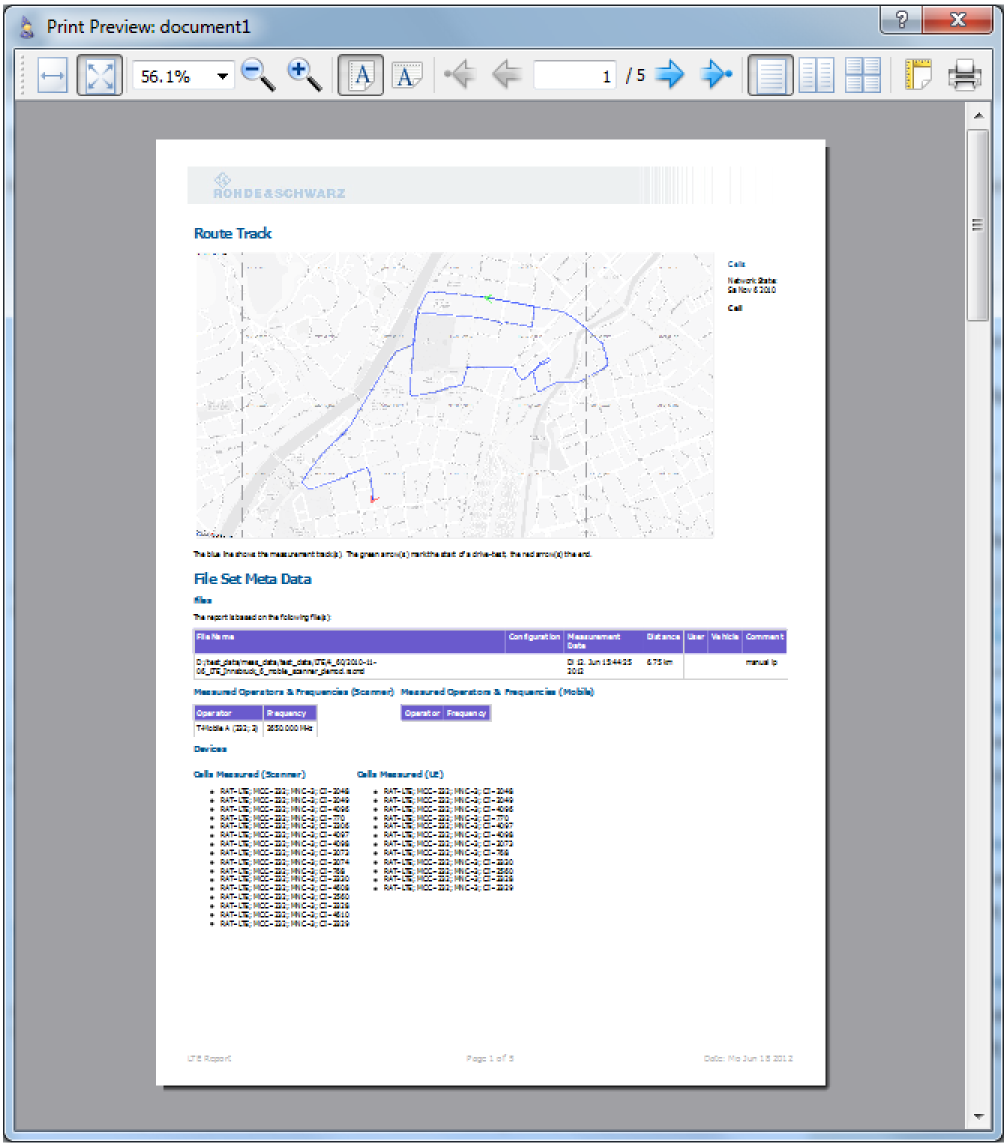


Figure 4-39: Print preview

The functionality offered by the toolbar in the preview dialog is described in the table below. Icons and edit fields are described starting from left to right.

Title	Description
Adjust Page Width	Adjust displayed page width to the width of the preview dialog
Fit Page Size	Scale the page to make it completely visible in the preview dialog.
Zoom Level	Choose a scaling factor to display the page in the preview dialog. Note that the quality in the final printout will be higher than in the preview dialog, which uses a low resolution to improve performance.
Zoom Out	Decrease scaling factor one step.

Title	Description
Zoom In	Increase scaling factor one step.
Portrait	Set the paper orientation to portrait mode.
Landscape	Set the paper orientation to landscape mode.
Begin of document	Jump to first page of the document.
Previous page	Show the page before the currently displayed one.
Page Number	Jump to a page directly.
Next page	Show the page after the currently displayed one.
End of document	Jump to the last page of the document.
Show one page	Set the display mode to show only one page at once.
Show double-sided	Set the display mode to show odd and even pages of the document as if they were printed in a book.
Show multiple pages	Show as many pages at possible at a glance.
Page setup	Define the paper size and other properties of the document to print.
Print	Choose a printer and send the document to the device.
Close	Close the preferences dialog.

4.4.6.5 Print to PDF

Instead of printing the views content to a printer, it is possible to put the same result into a PDF document. To do that, click the button located next to the print button. It is then possible to specify a destination file that shall receive the print result in the Page Setup dialog.

Printing to a PDF always creates documents in the A4 format.

After a successful export, the resulting PDF is automatically opened in the Adobe Acrobat Reader application, if installed on the target machine.

4.4.6.6 Microsoft excel export

The currently visible data can be exported into Microsoft Excel™, if a recent version of Excel is installed on the local machine. In such a way, it is possible to prepare that data for reports and to do additional processing on that data.

The excel export is started using the button in the toolbar of the Analysis window. This leads to the Page Setup dialog described above.

Export result

The result of the export process will closely resemble the content of the analysis pages. If the "Follow links" option or the map view export was selected, the resulting workbook will contain multiple spreadsheets.

All these spreadsheets has a pre-defined header and footer associated with them, so that printing the result to paper or another digital format will result in a report-like look. That layout can be shown when using the "Print Preview" functionality offered by Excel, as show in the screenshot below.

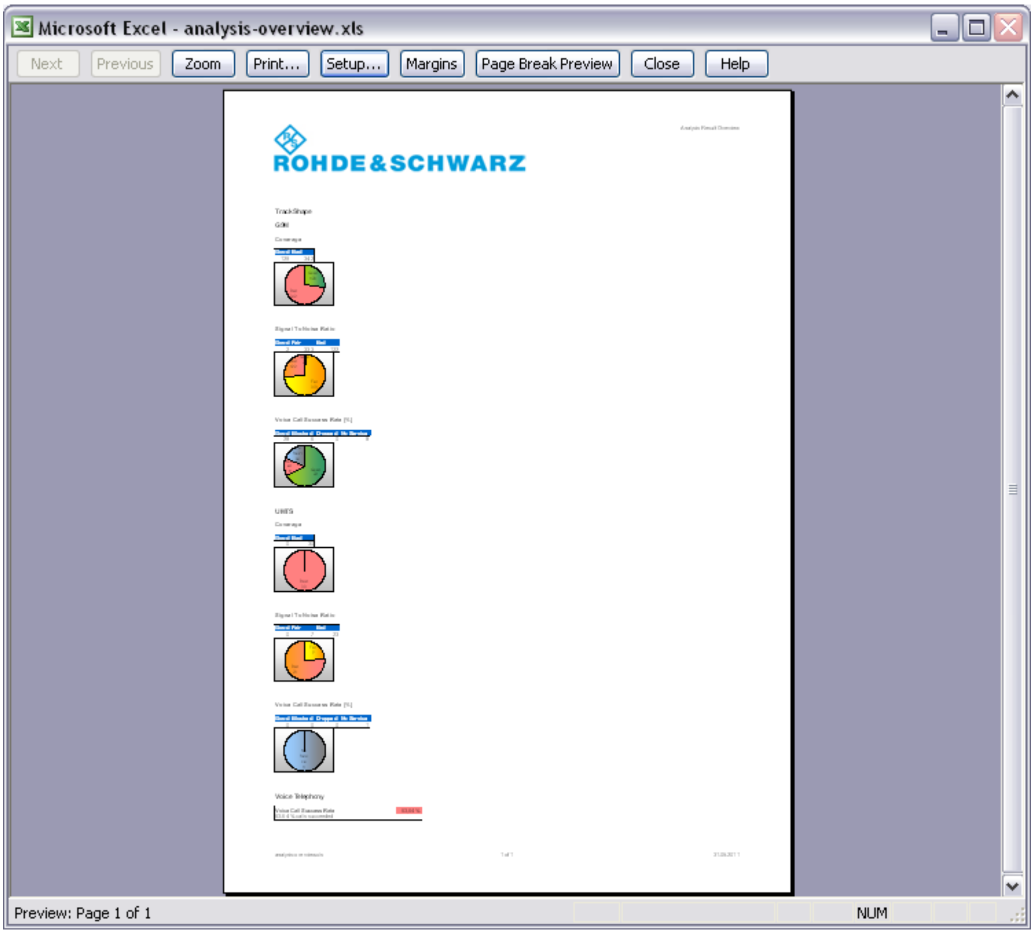


Figure 4-40: Analysis overview - Microsoft Excel®

4.5 Filtering analysis results

Data visualized in the analysis views and in the contained widgets can be filtered to reduce the amount of displayed information. Such filters can be defined, modified and deleted either directly in the analysis views or through the filter manager in the "Tools" menu.

The R&S ROMES4 NPA offers two different ways of filtering the data shown in the analysis pages: A Generic Filter that can be used to filter data based on fields common to most or all results. It is activated once and stay valid until disabled again regardless of the page shown. An example is the "Network Provider" filter that will only show data from a set of selected operators on each page.

The second option is more specific and operates on a single analysis page and offers focused filters on the type of data displayed. These filters are called Context Filters. For example, showing only data from raster scanner data which has average power above a certain level is possible only with the page specific filters.

4.5.1 Generic filter

A generic filter is applied to each single information unit displayed in a view. Such a unit can be a problem spot (shown in the map and/or the problem spot table), a call item or a coverage raster element in the map view, to name a few. Filter expressions can contain place holders that can be defined upon a filter execution, and in general filtering, is possible on a whole set of attributes.

Default filtering is possible for the following attributes:

- Network Provider
- Specific Cell
- Specific RAT
- Busy Time
- WEB Protocols
- Device
- Three Specific Cells
- Frequency Interval
- Speech Quality Sample DL

4.5.2 How to manage filters

4.5.2.1 Filter manager

Filter Manager allows create, duplicate, modify and delete a filter.

Select the "Tools > Filter Manager" entry to get the "Filter Manager" dialog where you can perform the aforementioned actions. The following figure shows a default filters.

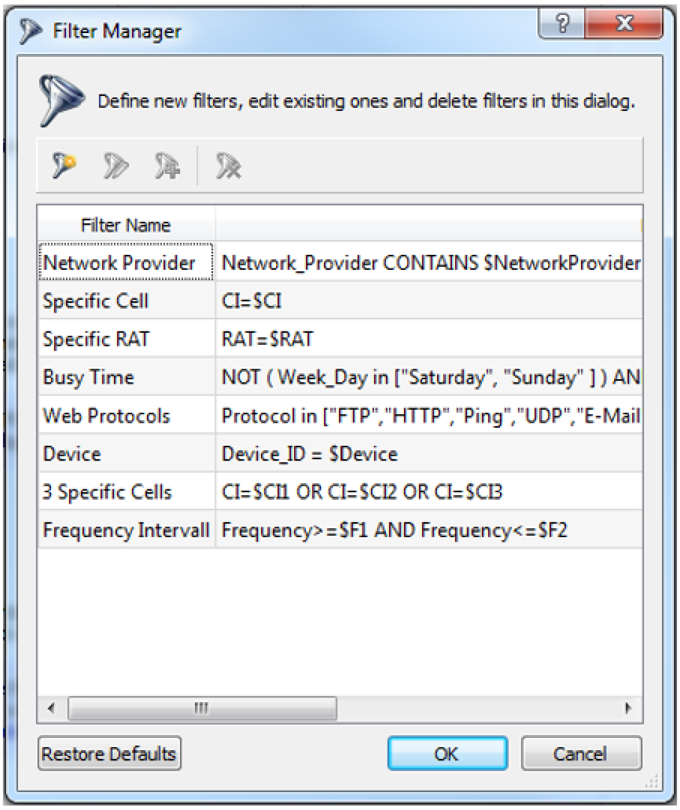


Figure 4-41: Filter Manager dialog

There is a default possibility to filter results for three specific cells apart from filtering results of one specific cell.

A mobile filtering of specific cell tower containing three sectors (with three distinct cell IDs) can be a case.

To activate, for example, filtering three cells perform the following steps.

1. Click ">>" of the "Enable Filtering" button in the top toolbar.

   The list of the configured filters pop-ups.

2. Choose the "3 Specific Cells" entry from the list.

   The "Filter Placeholder Definition" window opens.

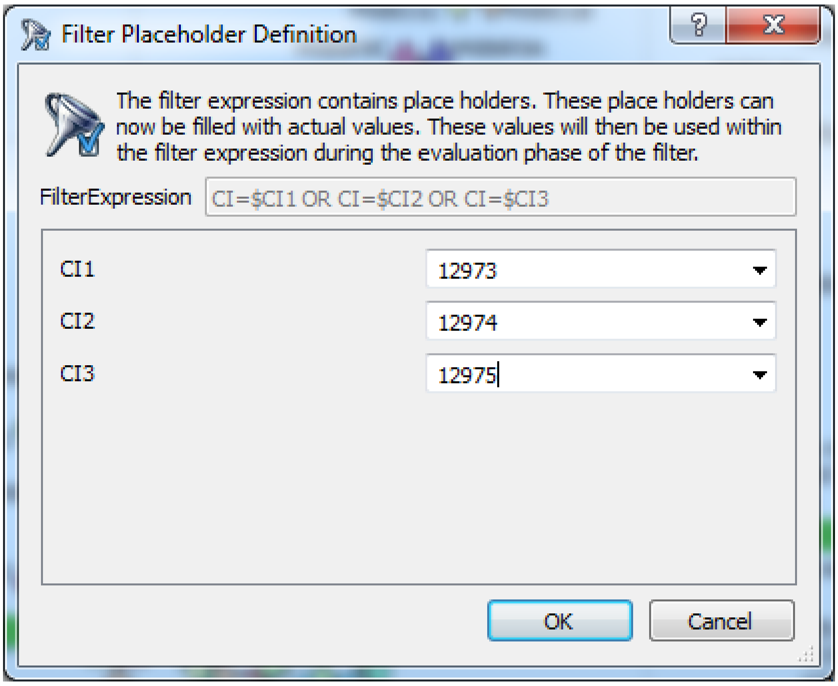


Figure 4-42: Placehoder Definition of three cells

3. Select the cells by their IDs in the opened window and click "OK".

   The displayed results are updated.

The central element of the dialog contains a list with all the filters that are currently defined. Each filter is displayed with the name and the textual filter expression.

Above the list, a toolbar offers the following functionalities:

- Creating new filters using the icon.
- Changing existing filters using the icon.
- By selecting one or more entres, the set of entries can be used to create copies of them to start a new filter from an existing one. This is done using the icon.
- Deleting the selected filter entries using the icon.

After creating or modifying filters using the previously mentioned actions, the filter editor dialog opens. The actual changes to the filter are visible in the dialog, as displayed in the following figure.

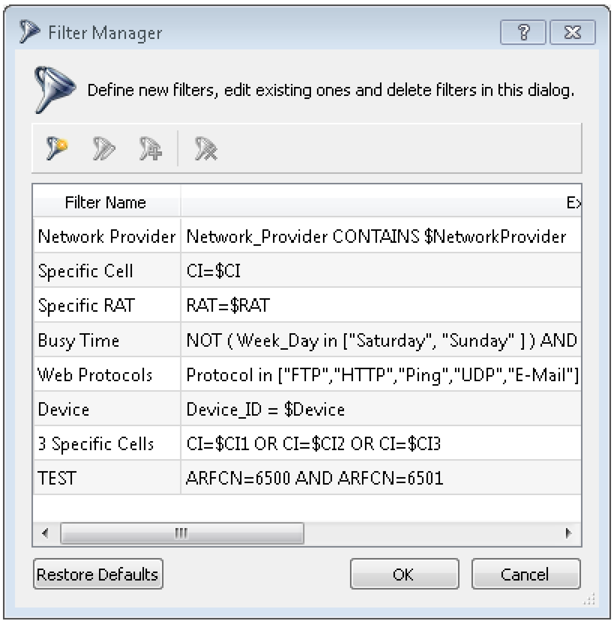


Figure 4-43: Added filter TEST (not default filter)

After an upgrade of the R&S ROMES4 NPA, press "Restore Defaults". Select the "Add Missing Expressions" option to keep your existing specific filter definitions.

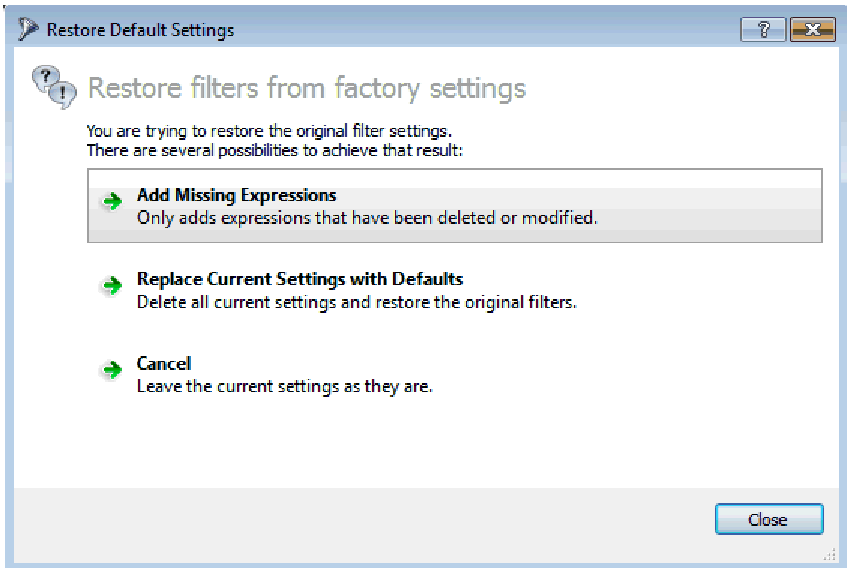


Figure 4-44: Restore filters

4.5.2.2 Managing filters from the analysis view

It is also possible to perform some of the previously mentioned actions related to data filtering directly in the analysis views.

The filter toolbar in an analysis view offers the possibility to add, edit or remove filters in the same way as previously described.

Example: Frequency interval filter definition

1. Click the "Enable Filter" in the top toolbar of the R&S ROMES4 NPA analysis view and select the "Frequency Interval" entry.

2. Add the values for F1 and F2 in the placeholder fields of the "Filter Placeholder Definition" window and press "OK". Only the frequencies available in the measurement file can be selected.

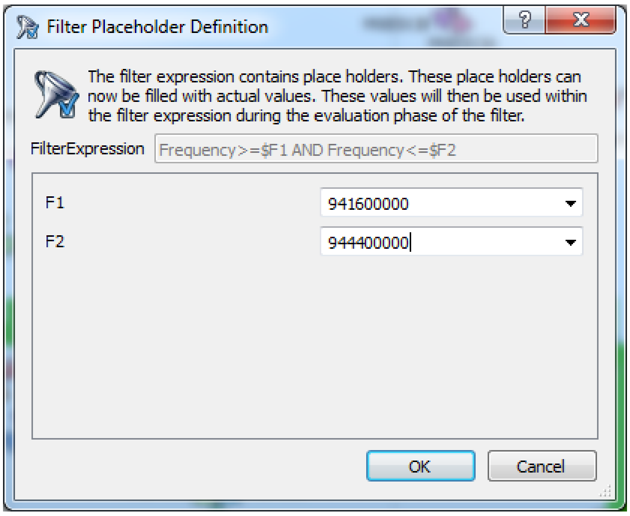


Figure 4-45: Defining the frequency interval

4.5.3 How to define filters

Basically, a filter consists of a set of comparisons, where multiple comparisons can be combined in a tree-like structure using Boolean operators. Each comparison normally tests a specific attribute to match or not match some value. The value can be a fixed constant or it can be queried dynamically when the filter is applied to a data-set, using so-called placeholders.

4.5.3.1 Filter fields

The analysis results shown in the R&S ROMES4 NPA are normally built from a set of data entities. For example, the problem spot list contains single spots, and the power raster in the coverage pages contain raster grid elements. Each such entity has some specific values assigned to a subset of the available grouping criteria, such as MCC, MNC, RAT, CI and many others. These grouping criteria elements build the filter fields that can be used to query the input data for some information and to compare that information with other data in the filter.

Available grouping criteria, which are assigned to most of the available results, are:

- Band - GSM, UMTS, LTE band (like "GSM 900" or "UMTS Band I")
- CI - Cell ID of a cell. Some entities have a start and end CI, in which case only the end CI can be filtered since it is used as the grouping criterion. The Cell ID is a single number.
- Codec - Voice codec used. Only available in some results (in Voice Call related ones), for example, "GSM Half Rate", "AMR 12.2 kbps" or "WBAMR 12.56 kbps".
- Device Name - Name of the device used to record the data. Can be something like "Nokia N95", "Z500" or R&$ GSM NWS".
- Device Type - The type of the device, such as "GPS", "Scanner", "Mobile", "DQA "or "SQA".
- Direction - Transfer direction if FTP or UDP. Can either be "UL" for upload, "DL" for download or one of "Both"
- ETSI - ETSI Standard used to calculate KPIs in the data transfer part of the R&S ROMES4. The options are: "ETSI A", "ETSI B" or "n/a".
- Frequency - Frequency on which the measurement data has been detected.
- Hour - The hour (0-23) of the day where the data has been recorded. If an element lasts over a longer period of time, this value contains the hour of the end of the element.
- Month - Month in which the data has been recorded. Available in the language of the underlying operating system.
- MCC - Mobile Country Code associated with the analysis result.
- MNC - Mobile Network Code associated with the analysis result.
- Network Provider - The name of the network provider associated with the MCC and MNC assigned to the analysis result.
- Protocol - Protocol used in a data transfer with the ROMES DQA module. Such protocols are "FTP", "HTTP", "UDP", "EMail", "Ping".
- RAT - Radio Access Technology used in the data set. This can take on of the following values: "GSM", "UMTS", "LTE", "TETRA".
- SC - Scrambling code of a cell. Only available in results that contain data measured in WCDMA networks.
- TEC - A more specific descriptor of the technology used to perform data transfer. Can be one of "EGPRS", "HSDPA", "HSUPA", "GSM" or "UMTS".
- Weekday - The weekday of the recording date. The weekday is the available in the language of your operating system, so on a German Windows 10, "Tuesday" would become "Dienstag".
- Year - The year in which the measurement data was recorded.

4.5.3.2 Data types

Two data types exist in the filter: numbers and text.

Text values, like the ones listed in the set of filter fields have to be embraced by quotation marks "". For example, if only data from FTP transfers are used, the protocol field has to be compared to the term FTP in the following way: `Protocol="FTP"`

Do not embed numbers into the embracing quotation marks. They can simply be written without any further restrictions.

The results of comparison operations are so-called Boolean values, i.e. they can take one of the two values *true* or *false*.

4.5.3.3 Placeholders

A more flexible way to specify values manually is to use placeholders, see the Placeholder Definition Dialog.

Placeholders can be used instead of constant values to add a dynamic component to a filter. Each time the filter is applied to a result set, the placeholders used in a filter expression can be filled with specific values. In that way, it is possible to avoid repeated modification of a filter if different values are used.

Placeholders are named variables, where the names always start with a $ and they must only consist of characters and digits. For example, `$MyPlaceHolder1` is a perfectly valid name for a placeholder, but `$My_Place Holder1` is not.

Such placeholders are queried for the specific value, which shall be used in the evaluation of a filter upon execution of that filter expression.

For example, the filter expression `CI=$CI1 OR CI=$CI2 OR CI=$CI3` would open a dialog like one shown in the Placehoder Definition of three cells when applied to a dataset. The actual values defined for the placeholders, which are listed under the "Filter Name" in the left column, can be entered in the right column of the table.

4.5.3.4 Comparison operators

Fields, specific constant values and values of placeholders can be compared with each other using different comparison operators. Many of them only work on a specific data type, so be sure to create comparison expression according to these rules.

The single operators are listed and explained in the following way:

- = - Equality operator, checks if both operands have the same value. Handles both strings, numbers and Boolean values. If values of different types are compared, they are always considered to by unequal. For example "1"=1 will never be true.
- != - Opposite operator for the equality operator =. Checks if two values are not equal.
- < - Less than operator. Works on number values only and checks if the first operand is less than the second one.
- <= - Less than or equal operator. Works on number values only and checks if the first operand is less than or equal to the second one.
- > - Greater than operator. Works on number values only and checks if the first operand is greater than the second one.

- >= - Greater than or equal operator. Works on number values only and checks if the first operand is greater than or equal to the second one.
- Contains - Compares if the second string operand is contained in the first string operator. For example, `Network_Provider contains "T-Mobile"` finds a network provider called "T-Mobile USA", for example.
- In - Checks if the first operand has one of the values contained in the array defined by the second operator. Arrays are defined using square brackets [and] and by separating all array elements with a comma. For example, `Protocol in ["FTP","HTTP"]` is a filter expression with the in operator. Works on all data types.
- Is empty - Evaluates one field only and checks if the field does not have a value assigned. Some results cannot have all the generally available fields assigned to some values, so this can be used to avoid complete filtering of such results when those fields are otherwise also part of the filter expression.

4.5.3.5 Boolean operators

Expressions that are more complex can be built from single comparisons using Boolean operators to combine those. Since the result of a comparison is always a Boolean value, the Boolean operators only process such values.

The filter supports four different Boolean operators: AND, OR, XOR and NOT. The first three operators take two Boolean arguments and evaluate them into a single Boolean value. The NOT operator only inverts the single argument that it expects.

The following table shows the relation between the input parameters (bold letters) of the three former operators and the calculated result.

Table 4-7: Boolean operators

AND	**true**	**false**	**OR**	**true**	**false**	**XOR**	**true**	**false**
true	true	false	**true**	true	true	**true**	false	true
false	false	false	**false**	true	false	**false**	true	false

For the usage of the Boolean operators to filter some parameters, see "Filter definition" on page 95.

4.5.3.6 Filter definition dialog - general handling

Creation and modification of a filter is done in the "Filter Definition" dialog shown when one of the actions described above is executed. Depending on whether a new filter is created or an existing filter is modified, the dialog can look similar to the one shown below.

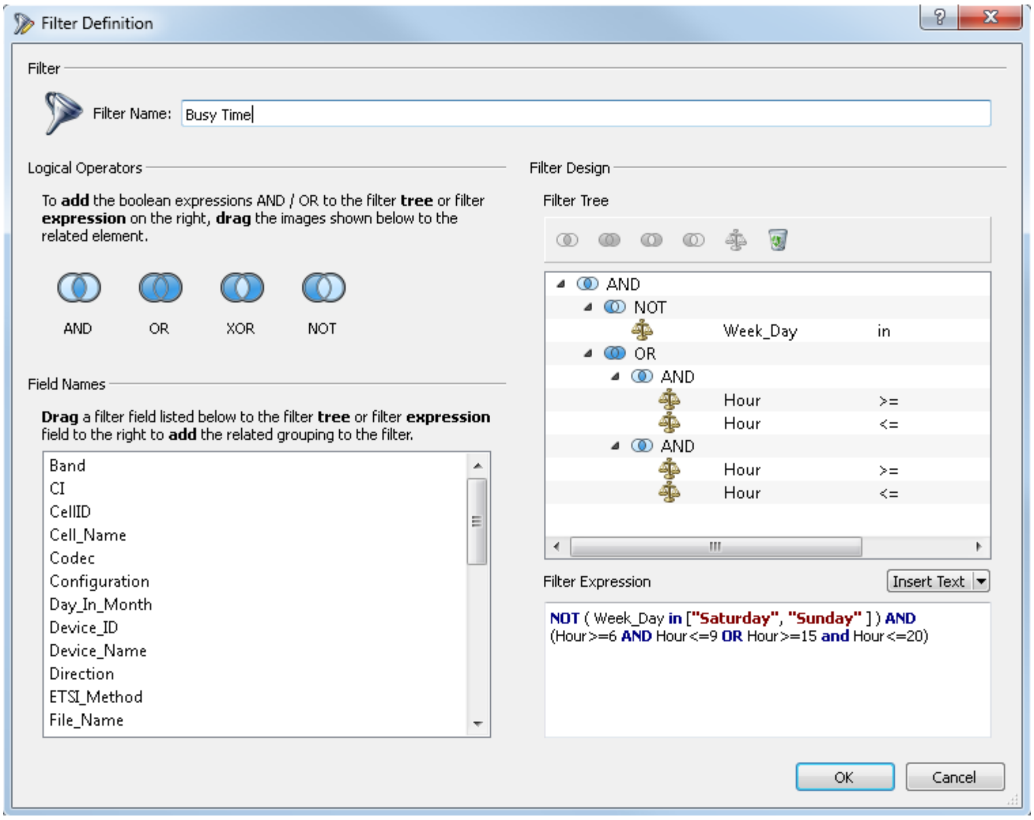


Figure 4-46: Filter Definition dialog

The filter definition dialog is made of several sections. Each section either contains source elements, like Boolean operators or field names, or it contains editable fields.

The main field to edit shown at the very top is used to give the filter a name that is used to identify the filter in the GUI. It must be unique to avoid confusions.

On the left side of the dialog, the source elements are found in the sections "Logical Operators" and "Field Names". All of the elements shown there can be dragged and dropped into the edit fields shown on the right-hand side of the dialog.

Creation and modification of a filter expression is done in the two editable elements on the right side (below the "Filter Design" section). The upper on shows the filter as a tree, and can be used as convenience editor and to play around with the filter expressions. The lower widget in the "Filter Expression" section is used to write directly a filter expression string. This is useful once more experience has been gathered with filters. Both fields are synchronized, so if one field is edited, changes are reflected immediately (if meaningful) in the other field.

Filter definition

The R&S ROMES4 NPA global filter dialog allows filtering based on the fields listed in the "Fields Name" pane of the "Filter Definition" dialog.

The following figure shows the selection of narrowband PCI (NPCI) filter field as one to be added in the user map. In "Filter Placeholder Definition" you can choose an NPCI you want to inspect.

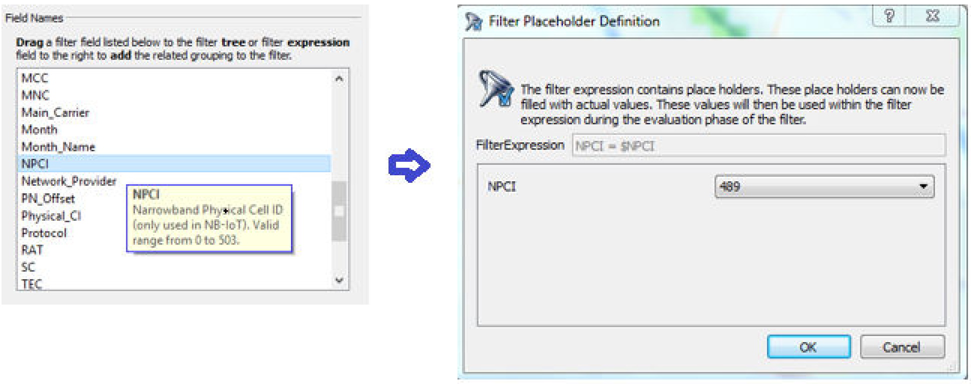


Figure 4-47: NPCI selection for filtering

As most of the filter fields are unique on the measurement data (there is only one frequency, one Cell ID, one MNC, one MCC, and so on) the operators AND and XOR can only be used for the combinations of different filter fields, for example, frequency and bandwidth.

The following is valid when defining the filter operators and the filter fields:

- AND filter operator for two cells defined by their IDs leads to an empty result. The set of values after applying filter of one Cell ID does not contain any other Cell ID. The second filter criterion cannot find any value in the set and the result is empty in this case.
- OR filter operator can be used for the same filter field multiple times as the filtered sets are combined to final resulting set.

4.5.3.7 Editing the tree

The complete filter expression can be managed in the filter tree part of the dialog. The filter tree creates nodes, where the Boolean operators combine comparisons and leave where the comparisons are found. To edit the tree, drag new elements from the data source part of the dialog into the tree view and to drop them in the appropriate place. The same can be done from the context menu, respectively toolbar operations.

4.5.3.8 Drag & drop operations

It is possible to drag the four Boolean operator icons shown in the left side of the dialog into the filter tree. Dropping such an operator on a comparison node makes it become the parent of that comparison node. Dropping on another Boolean node makes it become the last children of that node. A special case is when a second element is dropped into the free area of the tree. The node is then used as a new root node (if it is a Boolean node and the current root is a comparison) or is appended to the root node as a new child.

The filter field names can be dropped into the tree view to create comparisons. A comparison normally consists of a field, an operator and a value. The field stands for the related grouping value in the data set. The operator defines how the actual field value is compared to the value and the value is either a constant or a place holder. It is important to respect the data types of the field, the value and what data types the comparison operator can handle.

4.5.3.9 Filter toolbar

Another way to modify the structure of the filter expression tree is to use the toolbar above the filter tree edit field or the context menu. Both offer the same functionality. The functions listed in the toolbar resp. the context menu are:

- - Insert a new AND operator at the selected position. If a comparison is selected currently, the new AND operator becomes the parent of that comparison, otherwise it is appended as child.
- - Insert a new OR operator at the selected position. Behaves the same as described for the AND operator (see above).
- - Insert a new XOR operator at the selected position. Behaves the same as described for the AND operator (see above).
- - - Insert a new NOT operator at the selected position.
- - Insert a new comparison as child of the currently selected element (if a Boolean node is selected).
- - Delete the selected item.

4.5.4 How to write filter expressions

Writing filter expressions directly is recommended once the syntax for doing so is well known. It then offers a faster way to create new and manipulate existing filters. It is however possible to add new elements in that field using the drag and drop mechanisms described for the filter tree.

New elements can also be added using the "Insert Text" button places above the filter text edit field. It basically uses the same terminology as shown in the filter edit tree.

The keywords used in the filter editor field are shown in a bold blue font and are not case-sensitive ("OR", "or" and "Or" for example can be used for the OR-Operator).

4.5.4.1 Applying a filter

Defining filters is one side of the story, applying them the other one. Filters can be applied in analysis views to reduce the amount of information shown there. To do so, the filter toolbar is located at the top of the analysis view. For more information, see Chapter 11.3.4, "Tool bar - filter", on page 220.

4.5.4.2 Placeholder definition dialog

When a filter is applied that contains at least one placeholder, the user is asked to enter specific values for the placeholders. Entering a placegholder value is done in a dialog shown in the following figure.

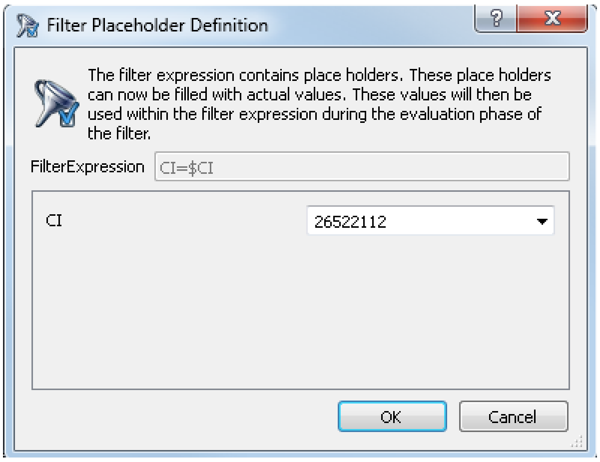


Figure 4-48: Placeholder Definition dialog

For each place holder, there is one row in the table. The second column in those rows can be filled with the actual value. String values can be here entered without " character; the data type is automatically detected.

It is not possible to define empty values in that dialog. All placeholders must have a valid value assigned to them. As long as that requirement is not fulfilled, the "OK" button is not enabled.

4.5.5 Context filter

Whereas the generic filters described previously are applied to every page in an analysis veiw, the context filters are specific to the currently displayed page. Therefore, a context filter cannot be controlled using the standard view toolbar, but is shown inside the page itself. Usually, it only offers to filter in two or three different ways according to the type of result shown.

Figure 4-49: Context Filter

The context filter offers three different types of control to define the constraints:

- Drop-down field to select a subset from a set of several available values
- Switch on/off button bar for few different values
- Numerical comparison editor to define restrictions on numbers

Different control mechanisms are explained in detail in the following sections.

Settings made in the context filters are not stored in the registry. Instead, filter settings remain active within the current analysis view. Some pages share the same filter and the same settings will then be applied to all of them (for example, filtering on network operator or radio access technology are offered in many pages).

Context filter - TETRA only

When running TETRA analysis, the context filter is a drop-down combo box. With this box, you can filter per problem title and you can easily choose several titles with one click.

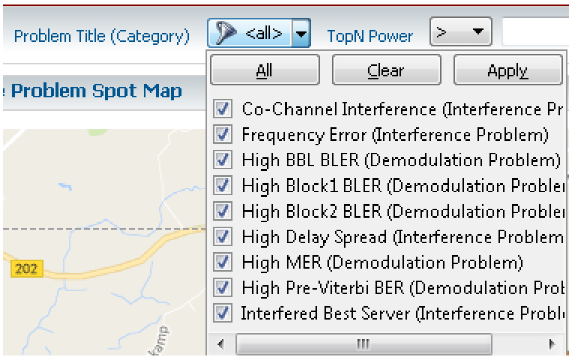


Figure 4-50: TETRA context filter combo box

4.5.5.1 Drop-down field

The drop-down filter allows selection of a subset from a list of available values, those values that are visible. Initially, that filter shows the currently selected values in a list (or "<all>" resp. "<none>" when all resp. none items are selected). Clicking the button or the small arrow on the left opens the list of all available entries as depicted below. From that list, each entry can be selected or deselected by clicking the checkbox left to that entry.

The buttons at the top of the expanding menu can be used as short-cuts to select/reselect all entries ("All"), to clear the selection ("Clear"). The "Apply" button is used once the settings are as desired settings for new filter criterion. If that is not intended, clicking outside of the menu or pressing the escape button closes the menu without changing the filter settings.

Figure 4-51: Drop-down field

4.5.5.2 Cell filtering

Filtering on specific cells can be done in different ways, depending on the type of result. To visualize the TopN coverage raster results, filtering on cells can be done in one of these two ways:

- Cell Foot print to show only - Shows only the values of a single cell. The cell foot print can be achieved using the general filter "Cell Id" data for that cell.
- Best Server Cell - Reduces the raster elements so that only those raster elements are kept where a specific cell (or a set of such) is the best server. The raster elements that are kept are not reduced by any other means. This can be done using the "Best Server" filter in the "TopN Raster Statistics" page.

The "Labels" drop-down box in the "Scanner TopN Raster Statistics" > "Scanner TopN Raster" pane offers to activate a number of additional cell information.

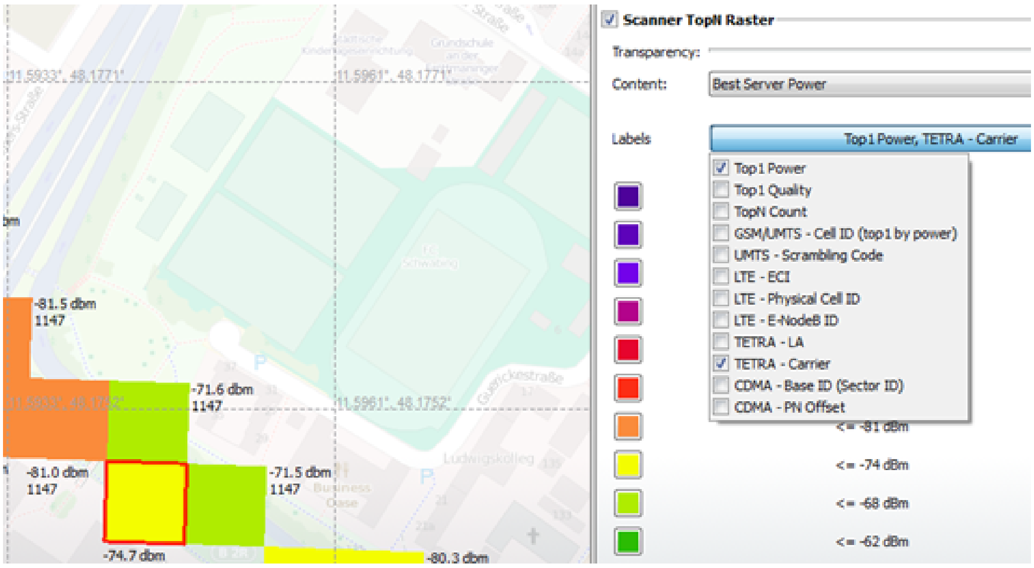


Figure 4-52: Additional cell information

4.5.5.3 Network provider filtering

Filtering on a specific network provider changes the map layout.

The following figures illustrate the case.

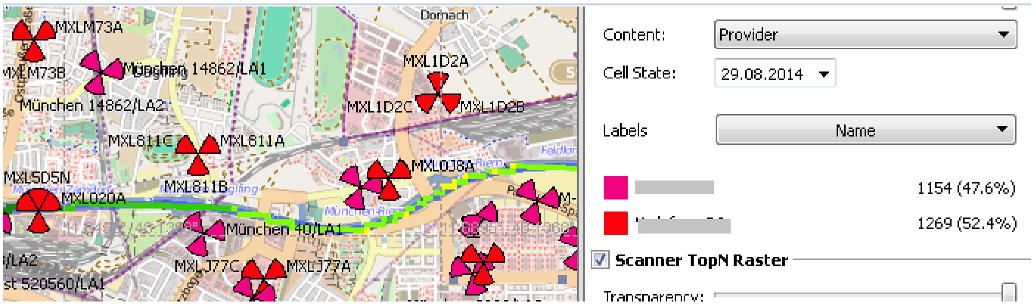


Figure 4-53: Map view before filtering

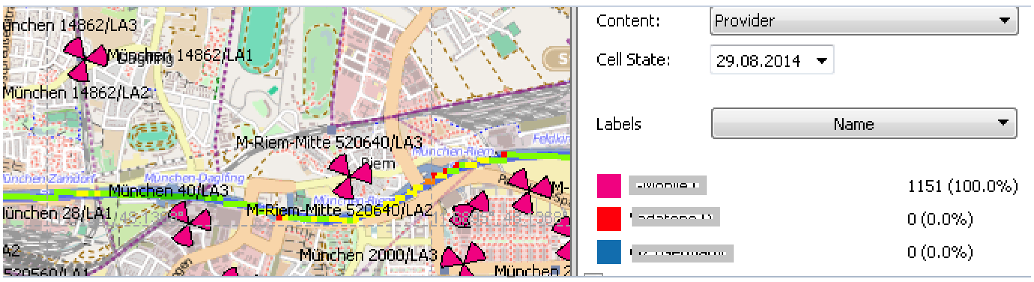


Figure 4-54: ...after filtering

4.5.5.4 The option selector

Similar in the effect to the Drop-Down filter previously described, is the option "selector". Being made as a list of buttons, the selector offers more direct way to filter the displayed data. Mostly used to restrict the display on a subset of problem types, the filter settings are changed with each click one of the buttons. Clicking a button changes the toggle state of that button - not toggled elements are not displayed (like the "Interference" button shown in the figure below), while the toggled elements are not filtered and remain visible.

Figure 4-55: Problem Type selection for viewing

If all buttons are toggled, no filter is applied to the selected parameter. This might lead to the effect that not toggling the first button will lead more elements to disappear than just the unselected ones.

4.5.5.5 Comparison filter

To filter numerical values properly, a comparison based filter is made available. Usually, this filtering can be used to restrict the displayed information to elements above or below a certain threshold, like a minimum power or maximum throughput rate.

The comparison filter consists of a comparator chooser combo box, offering the operators for equality (=), inequality (<>), less than (<) and greater than (>) together with their more relaxes companions (<= and >=), and a value text field where the actual threshold can be entered (in the given unit). clicking the "Apply" button will use the currently configured filter settings and adapt the currently displayed data accordingly. The drop-down list used to enter the threshold contains the most recently entered values.

Figure 4-56: Comparison filter

4.5.5.6 Band filter

The spectrum analysis page contains the context filter buttons for filtering on predefined frequency bands.

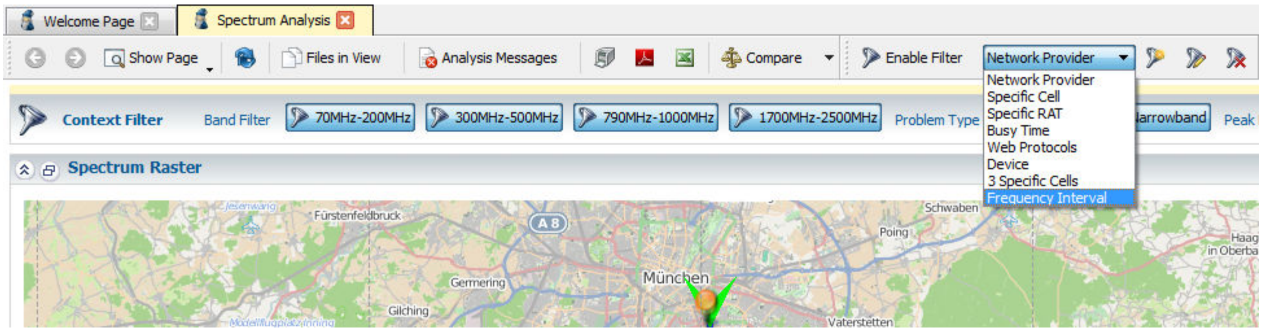


Figure 4-57: Context filters on the spectrum analysis page

Select the "Frequency Interval" and select wanted frequency interval in the "Filter Placeholder Definition".

By selecting a band filter, you get immediately only the measurement results within that band. If you activate all filters, all results are displayed.

Figure 4-58: Band filter buttons

4.5.6 Data set comparison

In many cases, it is important to compare two different data-sets with each other to find improvements in the radio conditions or degradations, or to compare the performance of different operators, cells or other entities. Making the effect of changes to the network structure visible is of great help for the network optimization process, and it forms the need for special kinds of visualizations, and all these scenarios are handled using the Data Set Comparison tool.

4.5.6.1 Configuration of the comparison mode

The starting point to compare data is always an analysis view (see Analysis View chapter) filled with the analysis results of some measurement files. That data set serves as source data set to select two data sets that are compared with each other. These data sets are called "Left" and "Right" data set in the subsequent sections.

In the analysis view, an additional menu "Compare" is located in the main toolbar (as shown below). Pressing the "Compare" button opens the configuration dialog of the comparison mode. When the comparison mode is active, pressing the button again disables the comparison mode and restore the original result display. Additional options available during the comparison mode are available when clicking the arrow on the right-side of the button: With the "Swap Sides" command the left and right data set contents can be exchanged, and the "Configure" entry directly opens the configuration dialog again (which has the same effect as first disabling and then enabling the comparison mode).

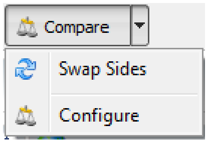


Figure 4-59: Compare menu

The comparison configuration dialog is divided in two main sections: The comparison mode selection, and the data set definition. The former part defines how data is compared and how those results are visualized, and the latter defines the actual content of the left and right data set.

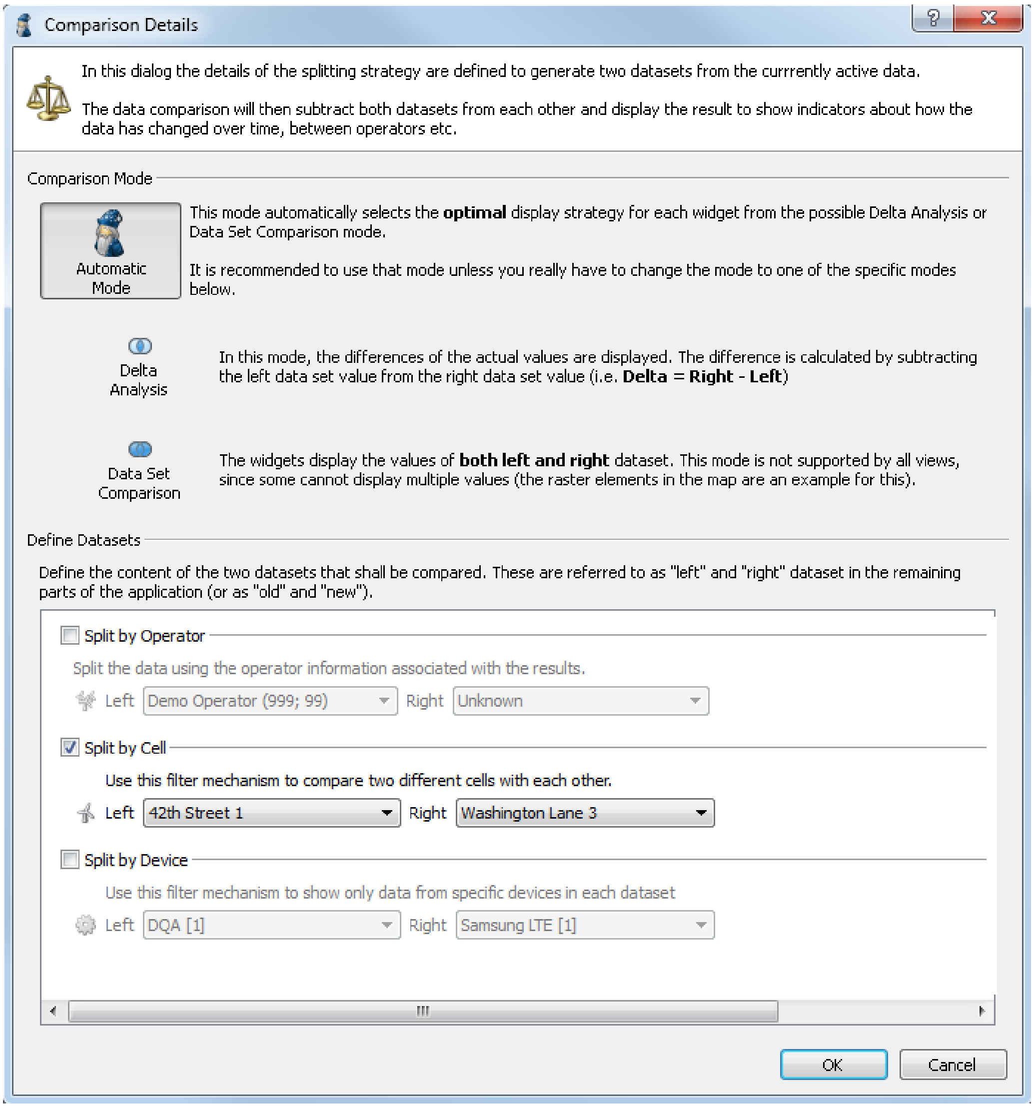


Figure 4-60: Comparison mode selection

Comparison modes

Comparing the results provided by the analysis process of the R&S ROMES4 NPA can be done in mainly two different ways:

- Subtracting the result of the left data set from the right one (which can lead to negative/positive results). It is delta mode.

- Showing both results at the same time. It is compare mode.

For some visualizations, only one of those ways actually makes sense, but for some it can depend on the actual information required.

Usually, there are meaningful defaults for each type of visualization that can be used. It is not important to care about using a delta or compare mode. It is the initial mode for the comparison function which selects automatically the most appropriate visualization.

In cases where a mode needs to be set explicitly, the mode can be specified by directly pressing one of the according buttons.

The two basic mentioned modes are explained below. Each of the different visualization techniques implements these modes in their own way. Some of the views are only capable of handling one of that modes. Details for each view can be found in the subsection Visualizations and in the Interpretation section.

Delta mode

As described above, the delta mode is used to calculate and show the difference between two values. In other words, for all displayed values the value from the left data set is subtracted from the value from the right data set. For example, if the coverage power at a specific position in the right data set is -80 dBm and -90 dBm in the left data set, the difference is +10 dB. If the data sets are built over time (i.e. the left is taken from an earlier measurement), then this difference indicates an improvement in the coverage conditions of that area. In the case where only one of the values is available, the other value is replaced with 0.

The main intention from the delta mode is always to show the changes between the two data sets. This mode is especially useful when comparing data sets over time, as described above, and in the map view this is the only possible visualization technique. An example of a screen when the delta mode is enabled us here shown.

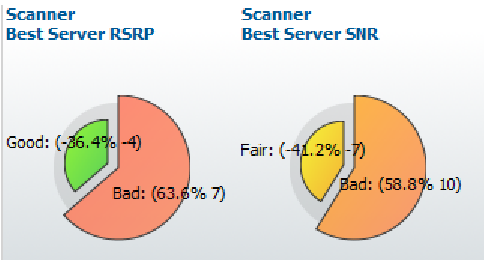


Figure 4-61: Illustration for Delta mode

Compare mode

In contrast to the delta mode, the compare mode shows the original values from both left and right data set at the same time. This mode makes the data comparison a more manual thing to do. However, it also emphasizes the context of the change (i.e. the absolute figures of the change). It is therefore the more natural way to visualize data in charts.

The same left and right data sets are used to produce the screen below, using the compare mode for visualization. Comparing that screen with the one from the delta mode shown above makes the difference between both modes more obvious.

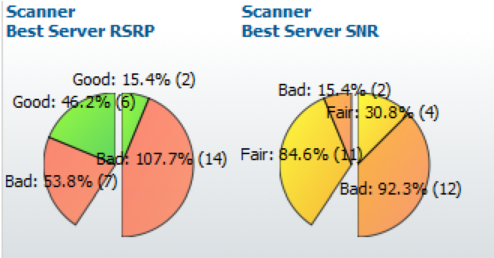


Figure 4-62: Illustration for Compare mode

Every type of widget has its own style in showing the different results from these two comparison modes. The strategies used in a widget are explained in the related description of the widget itself. See Visualizations chapter for a list of all used widgets and links to their detailed description.

Data set definition

Defining the left and right data set works in a similar way as a simple filter. There are different attributes that can be used to split the underlying data set in two groups. The attributes are listed below. Combinations of several split criteria can be defined as well.

- Split by Date - supports splitting by day. All data up to the specific data are gathered in the left data set. The remaining data (starting at the day after the specified date) builds the right data set.
- Split by Operator - If selected, two of the existing operators in the underlying data set must be chosen for the left and right data set.
- Split by Device - If selected, two of the available devices can be chosen for the comparison procedure.
- Split by Cell - The two cells for the comparison can be selected to compare characteristics of two such cells. If available, the splitting by cell uses the names of the cells from the cell database.
- Split by Configuration - To compare the results of different configurations, this mode can be used. In that case, it is assumed that multiple different configuration results are shown in the current analysis view, which is normally not a meaningful application. However, in this case it is required to initialize the analysis view with such a data.
- Split by File - Similar to the configuration setting, it can be used to build data sets for specific file contents. Splitting by files also allows using an arbitrary number of files in each of the data sets.

4.5.6.2 Comparing data

The actual comparison is shown in each of the displayed widgets depending on the selected mode and split strategy. Not all widgets support both visualization techniques (delta and comparison). The detailed comparison strategy on a per-widget basis is described in the sections dedicated to a widget. The sections are the ones listed below:

- Geographic View - supports the delta mode only
- Tree Views - supports both modes, default is "compare"
- Pie Chart - supports both modes, default is "compare"
- Bar/Line Charts - supports both modes, default is "compare"
- Scatter Plots - supports both modes, default is "compare"
- Problem Spot Lists - do not support the comparison mode at all
- KPI Widgets - supports both modes, default is "compare"

4.6 Drill-down

Drilling down into the data describes the task of going from aggregated data down into the technical details. This means that for example the first action is to check on a set of files if it is worth spending time on investigating the data. This can be done using some overview like a call result pie chart. Then the automatically detected problems are checked, if there are any anomalies that require manual rework. Finally, a detailed look into the signaling and message details can be required.

Manual analysis of measurement data is not part of the Network Problem Analyzer functionality. Instead, R&S ROMES4 is utilized to do this task. This approach ensures that the existing analysis tools provided by R&S ROMES4 can be used easily in combination with the overview capabilities of the R&S ROMES4 NPA.

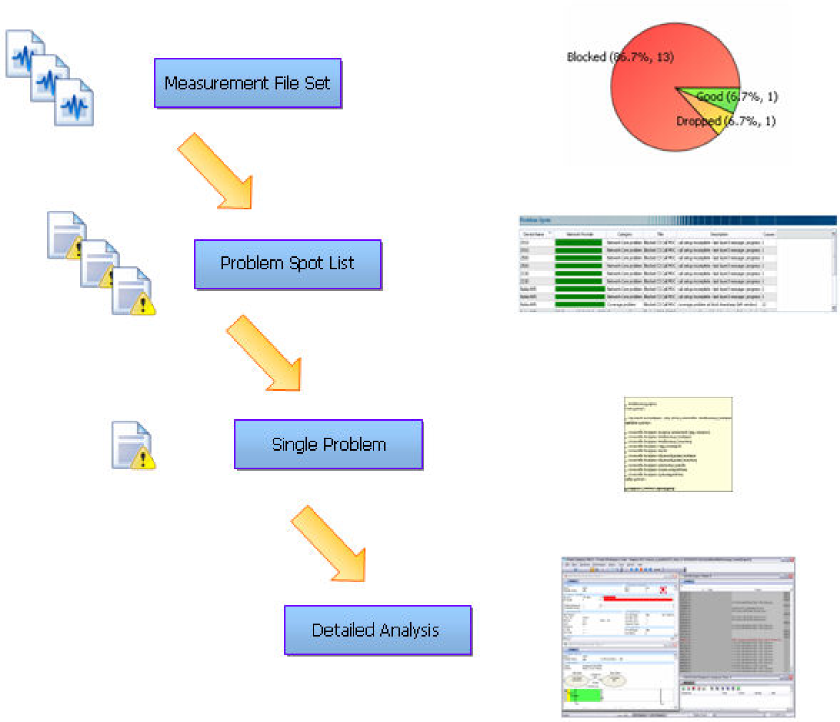


Figure 4-63: Drill-down into the data

The navigation in the "Analysis View" is some sort of drill-down. Starting at the overview page, a more detailed look is given when following the links to the other pages. In the remaining part of this section, the drill-down into R&S ROMES4 is described.

4.6.1 Starting a drill-down

Problem spot tables and call lists serve as starting point for a manual drill-down. A context menu opens when right clicking into the table, which provides several entries, as depicted below. Each entry tries to prepare the R&S ROMES4 in different ways, as described in the following paragraphs.

"Synchronize ROMES to Location" loads the workspace associated with the current analysis view into R&S ROMES4 if not already done. The default workspace is one of the workspaces stored in the "%NPA_HOME%/cfg/workspaces" folder.

The sub-menu "Select Workspace for ROMES" offers additional functionality to load also a specific analysis environment stored in a R&S ROMES4 workspace file into the synchronized R&S ROMES4.

The entries in the sub-menu offer different workspaces:

- "Keep current workspace"

Does not alter the workspace in a running version of R&S ROMES4. If no such a version is found, a new R&S ROMES4 is started with the default workspace related to the current analysis.

- "Workspace from file"
  Each R&S ROMES4 measurement file contains the workspace used to record the data. This workspace can also be used for analysis.
- "Manually configured Workspace"
  Using the Workspace configuration page in the preferences dialog it is possible to define manually a set of workspaces that are listed in this menu.

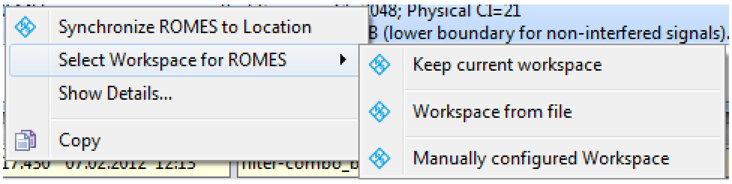


Figure 4-64: Drill-down configuration

Clicking such an entry causes the R&S ROMES4 NPA to search for an existing R&S ROMES4 instance. If such an instance is found, the R&S ROMES4 NPA attempts to load the measurement file in which the problem is detected. If no R&S ROMES4 is running, a new instance starts.

If the currently active R&S ROMES4 cannot be controlled by the R&S ROMES4 either because it does not support remote control (versions prior to R&S ROMES 4.11 SP1 have no such functionality), or because it is currently blocked by some other operation (measuring, for example), the drill-down is not possible and an error message is displayed.

Once a connection to R&S ROMES4 has been established, a so-called partial file scan is performed. A partial file scan is similar to the file scan performed when a file is directly opened in R&S ROMES4, except that it only uses the data from a given time interval. This scanning approach speeds up the file loading process when the synchronization with R&S ROMES4 is started. However, starting a replay afterward,s has similar limitations as the jump command in R&S ROMES4 if used without file scanning.

The partial file scan is performed on the time interval defined by either the problem spot interval or by the transactions start and end timestamp. Also, a fixed size of 5 seconds is prepended, respectively appended to the interval to show some information from before/after the currently investigated time interval.

If an existing R&S ROMES4 is used, the R&S ROMES4 NPA alters the currently active workspace or not, depending on the synchronization mode selected in the context-menu (see above). However, if a new instance is started, R&S ROMES4 is started explicitly in replay-only mode and is pre-configured with a workspace file to speed up the starting procedure.

Finally, the coupled cursor mode is activated and the cursor is set to the timestamp where the problem/call has been located finally/terminated. If everything goes right, the final result looks similar to that one shown in the following figure.

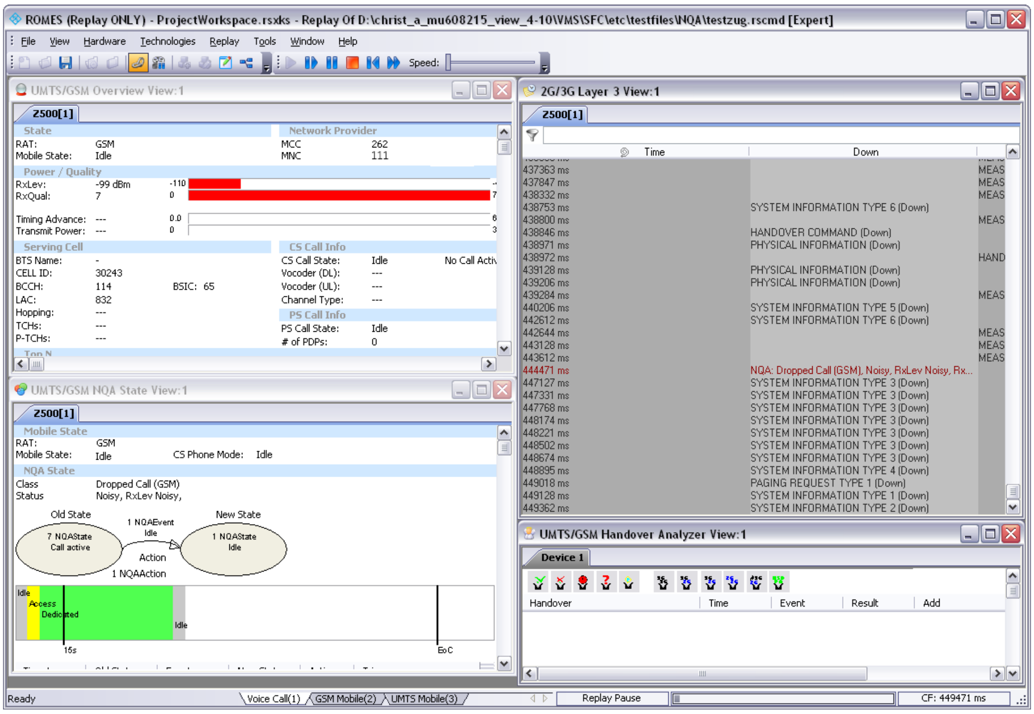


Figure 4-65: ROMES Overview View, Layer 3 and NQA State View pages

4.7 Configuring analyzer modules

Most of the analyzer modules can work in a flexible way. They use thresholds, for example, when finding coverage issues, or can use different time constraints to do further analysis of a problem. Since it is not useful to define all those values statically, the R&S ROMES4 NPA offers the opportunity to change the configuration of the analysis modules.

An analysis configuration is a set of analysis modules, each being configured to a specific set of values. It is possible to include the same analyzer module multiple times, with a different configuration for each instance.

Configuration management is performed in the data processor configuration dialog, which can be opened if selecting on of following commands:

- "Processor Configuration" in the "Analysis" menu.
- "Configuration" in the Welcome page

4.7.1 Configuration dialog

The configuration dialog is split into three sections organized in columns. On the left-most side, the list of available analysis modules is shown. Elements in this area can be dropped into the section in the middle, where all currently configured sets are shown as a tree. The property editor is placed on the right-hand side. This area is filled with the editable attributes of a processor configuration if such a processor is selected in the configuration tree.

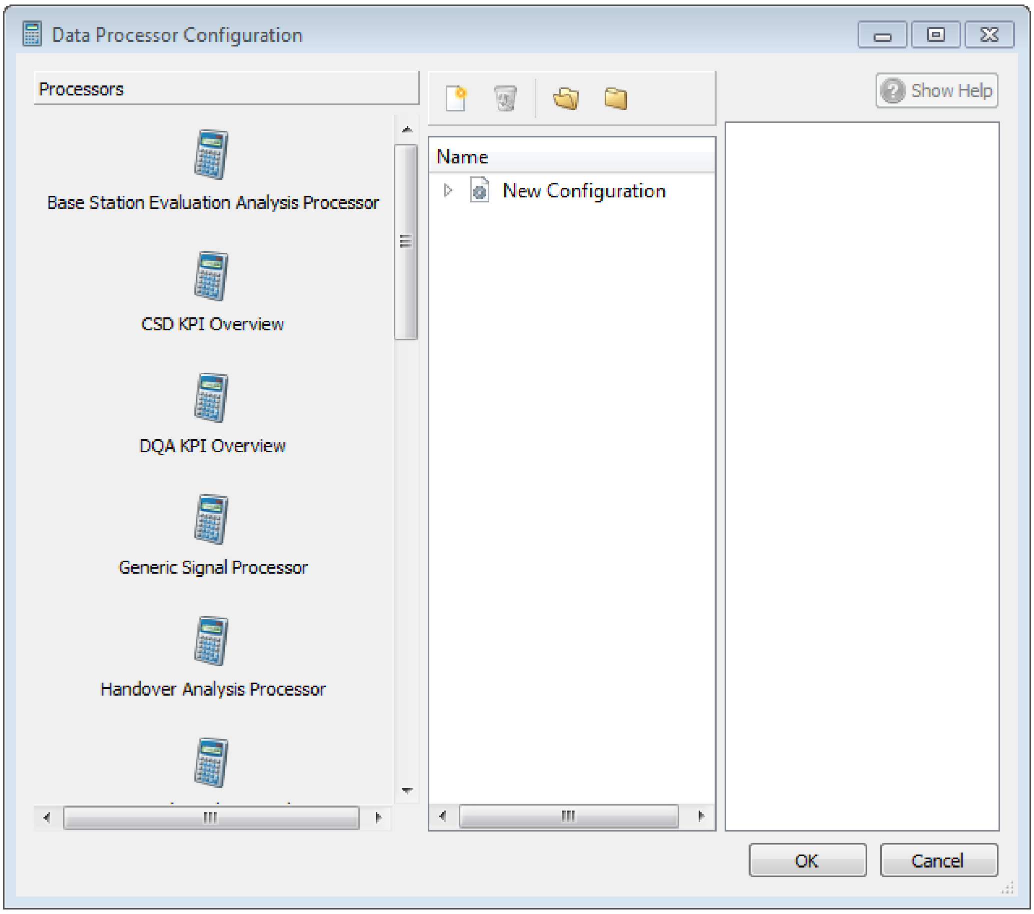


Figure 4-66: Configuration of Data Processing

The main tasks that can be done in this dialog are:

- Creating new configuration
- Modifying an existing configuration
- Deleting an existing configuration

These work flows are described in the subsequent paragraphs.

4.7.1.1 Creating new configuration

An analysis configuration can be done in various ways:

- Press the "Create a new configuration file" button in the toolbar

- Left mouse button click the "New" instance in the context menu of the configuration tree view
- Drag a data processor from the right side into the empty area of the configuration tree view

If one of the first two possibilities is chosen, a dialog opens showing the possible configurations and the contained analyzer modules. The dialog looks as shown in Figure 4-67. In the upper text field the user can enter the name of the configuration. The lower part of the dialog is a list of data processors. The user can select processors that it wants to be initially available in the configuration. Simply click once the wanted entry. Another click deselects the entry.

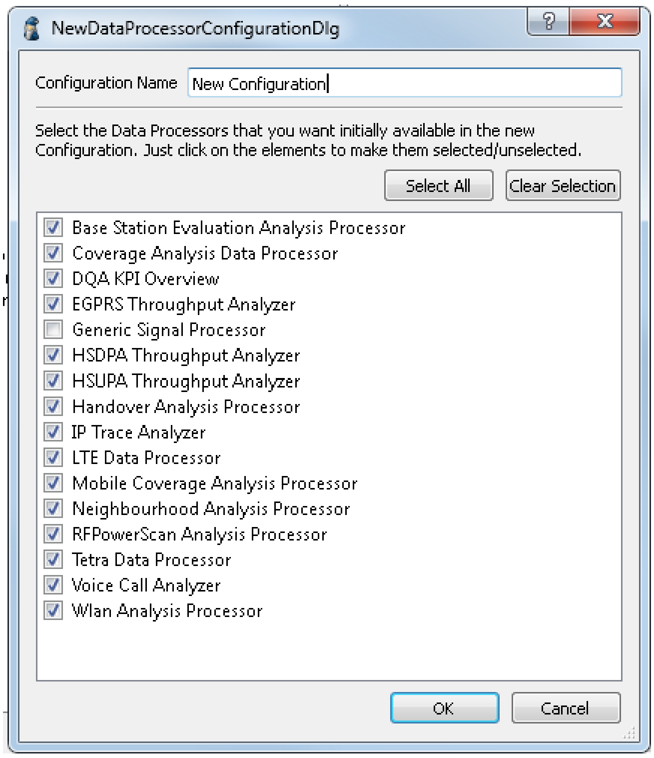


Figure 4-67: New analysis configuration

The third configuration way creates and displays a new configuration in the tree immediately.

4.7.1.2 Modifying configurations

Once a configuration is created, the settings of the contained analysis modules can be changed to modify the result created by the module. It is also possible to add or remove analysis modules, creating configurations that only perform a specific type of analysis. These actions are described in the subsequent sections.

Adding and removing analysis modules

New configurations can be added easily by either dragging them from the left side where all the configurations are depicted with the calculator symbol . Dropping them on an existing configuration element in the tree appends a new instance of the analysis module to the list of modules attached to that configuration. Dropping the item in the empty part of the tree view (below the last item), creates a configuration that holds only one instance of that module.

If the same type of data processor is used multiple times in a configuration set, some of the resulting entries are duplicated. This approach can be used to perform initial comparison of different configurations of the same processor. However, it can cause confusion later and is therefore only recommended for testing purposes.

Removing one or more analysis modules from a configuration set is done by clicking the "Delete Elements" trash bin icon, or using the related entry in the context menu.

Modifying the settings of an analysis module

Editing the attributes of the settings of an analysis module is done in the properties tree view on the right side of the dialog. Each editable property consumes one single line, where the left column holds the name of the property and the right side the current value. Clicking the cell holding the value starts editing the value.

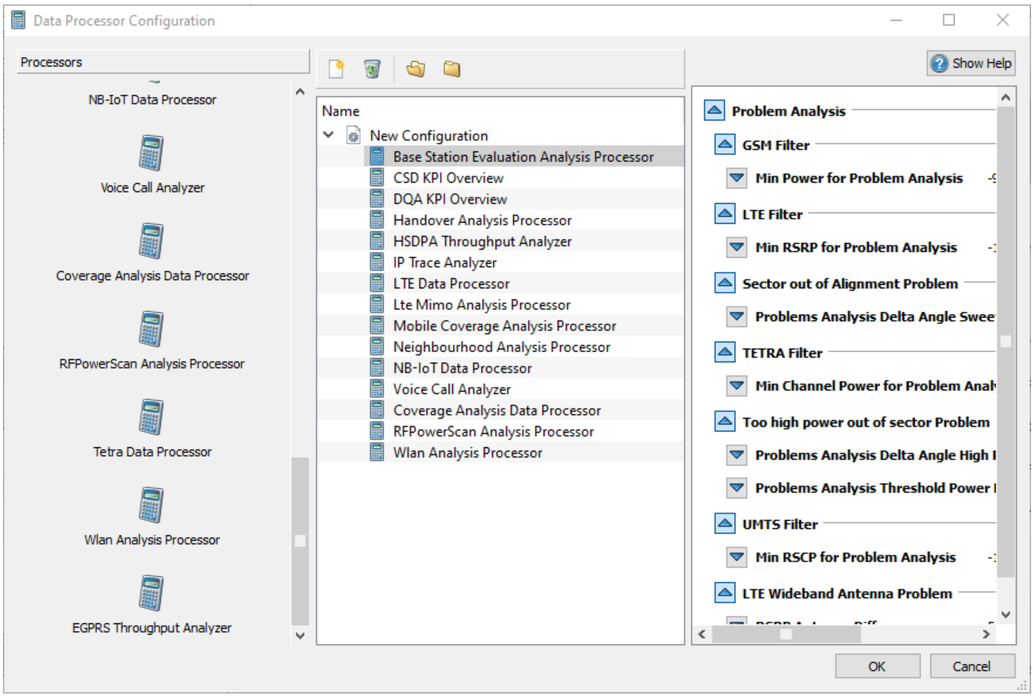


Figure 4-68: Editing the settings attributes

Each configuration contains the "Instance Name" property. It is used in the configuration tree for each property as identifier.

Extended configuration

Some elements cannot be configuration using a single-line editor. If such an element is available, the Value column in the properties tree shows the "Please click here to edit". A single click on the entry opens the extended editor.

4.7.1.3 Saving the configurations

Configurations are validated and saved automatically at closing the dialog. All the resulting processor configuration files are put into the "%Documents%\NetworkProblemAnalyzer\cfg\processor" directory. The files have the same name the contained configuration has.

4.8 NPA usage for larger measurement files

In the following described is how to configure the R&S ROMES4 NPA data processor for a single technology analysis if a measurement file contains scanner measurements for multiple technologies and is therefore large.

4.8.1 Configuration of the coverage plugin scanner for single RAT analysis

The coverage analysis processor configuration for the GSM measurements is described in this example.

1. In the R&S ROMES4 NPA menu "Analysis" select "Processor Configuration".
2. Create a configuration for a "Coverage Analysis Data Processor" (only for this processor).
3. Rename this configuration, for example, to "coverageOnlyGSM".
4. In the technology-specific details turn off the Bool value "Perform analysis for this technology - ON/OFF" for the technologies CDMA, LTE, TETRA, UMTS – but keep it on for GSM.
5. Save the configuration.

   The configuration is now saved and the processing can start.

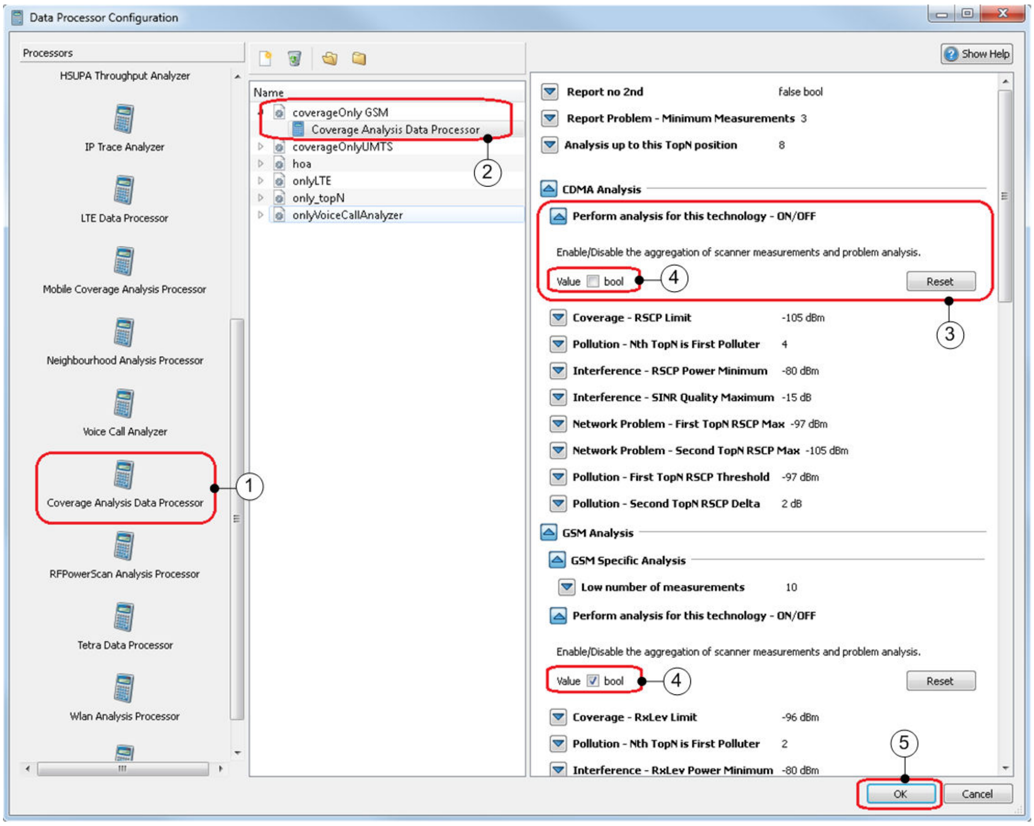


Figure 4-69: Scanner configuration for a single RAT analysis

① = Select data processor for configuration
② = Rename selected data processor
③ = Technology to be excluded from performing analysis
④ = Bool value switching a technology analysis ON/OFF
⑤ = Saving the configuration

4.8.1.1 Processing

Process a measurement file containing scanner measurements for multiple technologies, for example, GSM, UMTS and LTE with this configuration.

The resulting XML file with the analysis results (placed in the same folder as your measurement file) has an extension containing the configuration name, for example, `*.rscmd.coverageOnlyGSM.xml`.

The analysis result XML file in the example is smaller as it contains only results for GSM scanner.

4.8.1.2 Viewing

When viewing this result, the overview shows only the following GSM scanner results:

- "Coverage TopN Raster & Statistics"
- "Coverage & Interference" (if there are any problems detected)

- "Cell Problem Statistics"

It is possible to add results from other measurement files to the "Files in View" area.

4.8.1.3 Further technologies

For other technologies (UMTS, LTE) proceed in the same way and use a second instance of the R&S ROMES4 NPA GUI to view the results.

4.9 Support of QualiPoc tests

R&S ROMES4 NPA supports analysis of the following tests obtained from QualiPoc measurements:

- Network Performance Tests (NPT)
- OOKLA ® Test
- Facebook/Dropbox
- Whats App
- SMS Test

The tests are analyzed by the R&S ROMES4 NPA DQA module. The results per test and statistics over all the tests are shown in dedicated pages.

The results of the tests are as the icons and statistics shown in the "Data Transaction" page.

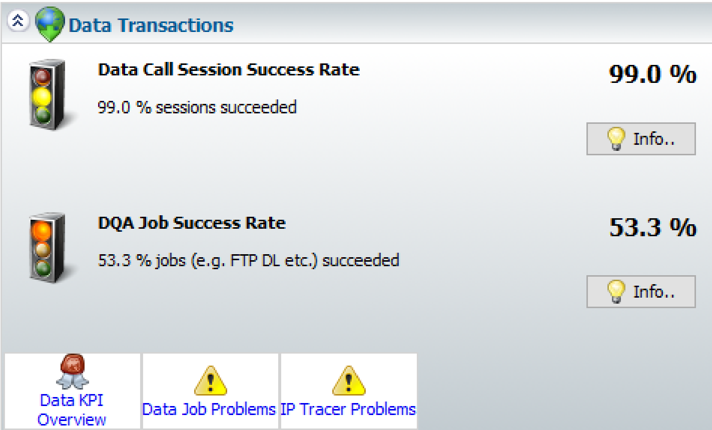


Figure 4-70: Data transaction page

The page lets you get an overview of the data KPIs and search for data job problems or IP tracing problems. For this purpose, click the available buttons in the bottom of the "Data Transaction" overview page. For more, refer to Chapter 12, "Data processors", on page 222.

4.9.1 Support of QualiPoc network performance tests

The main "Data Transaction KPIs" page of the DQA shows the KPI results.

The results obtained from the network performance tests (NPT) are shown in "Data Transaction Table". The jobs performed by the NPT are visible in the "Protocol" column, but without other results.

Data Transaction Table

Result	Start Time	End Time	Device	Network Provider	RAT	Protocol	Dial Up Time
Job OK	08/03/17 14:46:19	08/03/17 14:46:28	E5823(QP),DQA	[illegible]	LTE	PING	
Job OK	08/03/17 14:46:19	08/03/17 14:46:20	E5823(QP),DQA	[illegible]	LTE	FTP UL	
Job OK	08/03/17 14:46:20	08/03/17 14:46:24	E5823(QP),DQA	[illegible]	LTE	FTP DL	
Job OK	08/03/17 14:46:20	08/03/17 14:46:22	E5823(QP),DQA	[illegible]	LTE	FTP UL	
Job OK	08/03/17 14:46:22	08/03/17 14:46:24	E5823(QP),DQA	[illegible]	LTE	FTP UL	
Job OK	08/03/17 14:46:24	08/03/17 14:46:26	E5823(QP),DQA	[illegible]	LTE	FTP UL	
Job OK	08/03/17 14:46:25	08/03/17 14:46:31	E5823(QP),DQA	[illegible]	LTE	FTP DL	
Job OK	08/03/17 14:46:26	08/03/17 14:46:28	E5823(QP),DQA	[illegible]	LTE	FTP UL	
Job OK	08/03/17 14:46:28	08/03/17 14:46:29	E5823(QP),DQA	[illegible]	LTE	FTP UL	

Figure 4-71: Data transaction KPIs - NPT

The aggregation of the entries related to QP Parallel Session job is omitted in the "Data Transaction Table" from version 17.3 onwards. The processing info message informs the user about the deactivated aggregation.

		Description	
ⓘ	1	QP Parallel Session: deactivated aggregation of session results for UE E5823(QP)[1] to improve visibility.	DQA KPI Overview

The detailed results of the tests are visible at another page. The page is available via the link from the "Service Pages". If the network performance test results are unavailable, the icon is hidden.

Figure 4-72: Icon to access NPT details

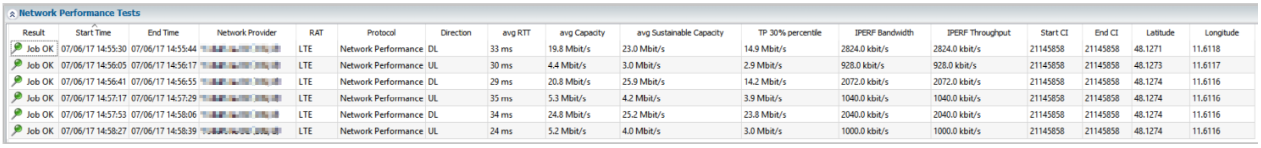
The alternative way to the page is via "Show Page" in the icon bar of the GUI, see Figure 4-82.

4.9.1.1 NPT result pages

The results of the NPT obtained by R&S ROMES4 NPA, when analyzing the QualiPoc measurements, are shown here.

The results of NPT tests analysis include the following pages:

- Table with an entry of each NPT test and the main results

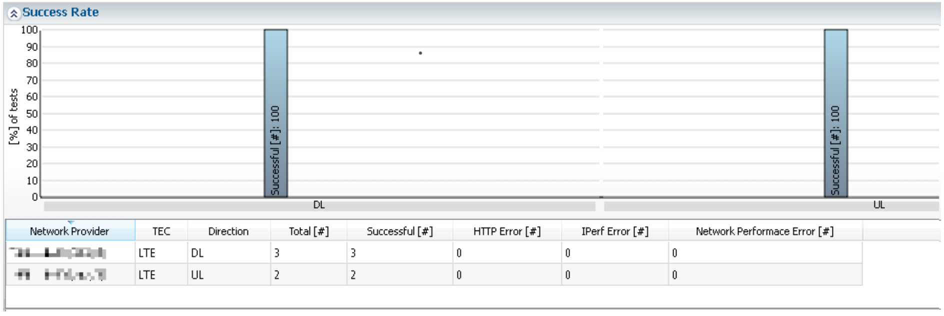


Network Performance Tests

Result	Start Time	End Time	Network Provider	RAT	Protocol	Direction	avg RTT	avg Capacity	avg Sustainable Capacity	TP 30% percentile	IPERF Bandwidth	IPERF Throughput	Start CI	End CI	Latitude	Longitude
Job OK	07/06/17 14:55:30	07/06/17 14:55:44	[illegible]	LTE	Network Performance	DL	33 ms	19.8 Mbit/s	23.0 Mbit/s	14.9 Mbit/s	2824.0 kbit/s	2824.0 kbit/s	21145858	21145858	48.1271	11.6118
Job OK	07/06/17 14:56:05	07/06/17 14:56:17	[illegible]	LTE	Network Performance	UL	30 ms	4.4 Mbit/s	3.0 Mbit/s	2.9 Mbit/s	928.0 kbit/s	928.0 kbit/s	21145858	21145858	48.1273	11.6117
Job OK	07/06/17 14:56:41	07/06/17 14:56:55	[illegible]	LTE	Network Performance	DL	29 ms	20.8 Mbit/s	25.9 Mbit/s	14.2 Mbit/s	2072.0 kbit/s	2072.0 kbit/s	21145858	21145858	48.1274	11.6116
Job OK	07/06/17 14:57:17	07/06/17 14:57:29	[illegible]	LTE	Network Performance	UL	35 ms	5.3 Mbit/s	4.2 Mbit/s	3.9 Mbit/s	1040.0 kbit/s	1040.0 kbit/s	21145858	21145858	48.1274	11.6116
Job OK	07/06/17 14:57:53	07/06/17 14:58:06	[illegible]	LTE	Network Performance	DL	34 ms	24.8 Mbit/s	25.2 Mbit/s	23.8 Mbit/s	2040.0 kbit/s	2040.0 kbit/s	21145858	21145858	48.1274	11.6116
Job OK	07/06/17 14:58:27	07/06/17 14:58:39	[illegible]	LTE	Network Performance	UL	24 ms	5.2 Mbit/s	4.0 Mbit/s	3.0 Mbit/s	1000.0 kbit/s	1000.0 kbit/s	21145858	21145858	48.1274	11.6116

Figure 4-73: Network Performance Test page

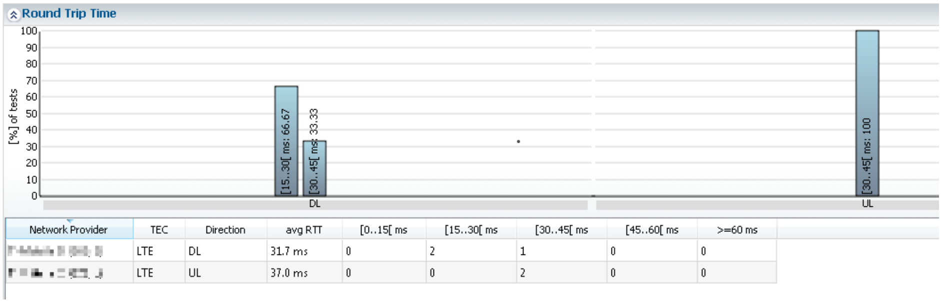
- Statistics over all NPT represented as bar charts and tables grouped by provider and test direction
  - Success rate



Network Provider	TEC	Direction	Total [#]	Successful [#]	HTTP Error [#]	IPerf Error [#]	Network Performace Error [#]
[illegible]	LTE	DL	3	3	0	0	0
[illegible]	LTE	UL	2	2	0	0	0

Figure 4-74: Success Rate page - NPT

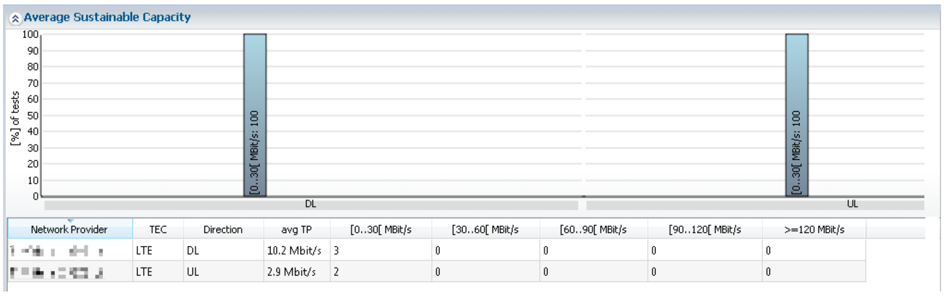
  - Round Trip Time of the QualiPoc network performance test



Network Provider	TEC	Direction	avg RTT	[0..15[ms	[15..30[ms	[30..45[ms	[45..60[ms	>=60 ms
[illegible]	LTE	DL	31.7 ms	0	2	1	0	0
[illegible]	LTE	UL	37.0 ms	0	0	2	0	0

Figure 4-75: RTT page - NPT

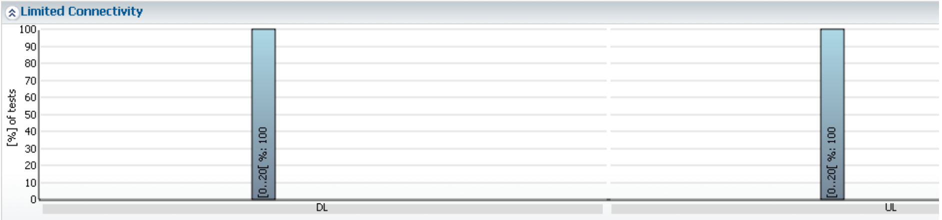
  - Average Sustainable Capacity from capacity tests as a part of the network performance tests



Network Provider	TEC	Direction	avg TP	[0..30[MBit/s	[30..60[MBit/s	[60..90[MBit/s	[90..120[MBit/s	>=120 MBit/s
[illegible]	LTE	DL	10.2 Mbit/s	3	0	0	0	0
[illegible]	LTE	UL	2.9 Mbit/s	2	0	0	0	0

Figure 4-76: Sustainable Capacity page - NPT

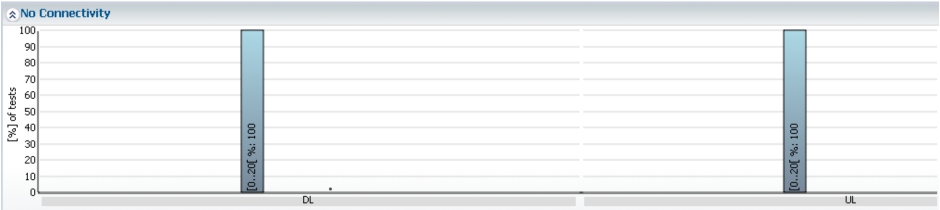
  - Limited Connectivity percentage from the tests



Network Provider	TEC	Direction	avg Connectivity	[0..20[%	[20..40[%	[40..60[%	[60..80[%	[80..100] %
[illegible]	LTE	DL	0.0%	3	0	0	0	0
[illegible]	LTE	UL	0.0%	2	0	0	0	0

Figure 4-77: Limited Capacity page - NPT

– No Connectivity percentage from the tests



Network Provider	TEC	Direction	avg Connectivity	[0..20[%	[20..40[%	[40..60[%	[60..80[%	[80..100] %
[illegible]	LTE	DL	0.0%	3	0	0	0	0
[illegible]	LTE	UL	0.0%	2	0	0	0	0

Figure 4-78: No Capacity page - NPT

Limited Connectivity and No Connectivity are the percentage of the test duration where the connectivity does not meet the requirements.

4.9.2 Support of QualiPoc OOKLA ® tests

The main "Data Transaction KPIs" page of the DQA (refer to Data Transaction Analyzer, figure Figure 12-95) shows the KPI results obtained from the OOKLA ® tests within the "Data Transaction Table".

Data Transaction Table

Result	Start Time	End Time	Device	Network Provider	RAT	Protocol	Dial Up Time [s]
Job OK	09/15/20 10:17:29	09/15/20 10:18:05	SM-G950F(QS_QualiPoc_136408) [1],QoS [1]	[illegible]	LTE	OOKLA ®	
Good	09/15/20 10:17:29	09/15/20 10:18:10	SM-G950F(QS_QualiPoc_136408) [1],QoS [1]	[illegible]	LTE	DQA Session	
Job OK	09/15/20 10:18:12	09/15/20 10:18:59	SM-G950F(QS_QualiPoc_136408) [1],QoS [1]	[illegible]	LTE	OOKLA ®	
Good	09/15/20 10:18:12	09/15/20 10:19:04	SM-G950F(QS_QualiPoc_136408) [1],QoS [1]	[illegible]	LTE	DQA Session	
Job OK	09/15/20 10:19:06	09/15/20 10:19:50	SM-G950F(QS_QualiPoc_136408) [1],QoS [1]	[illegible]	LTE	OOKLA ®	
Good	09/15/20 10:19:06	09/15/20 10:19:55	SM-G950F(QS_QualiPoc_136408) [1],QoS [1]	[illegible]	LTE	DQA Session	
Incomplete Session	09/15/20 10:19:57	09/15/20 10:20:35	SM-G950F(QS_QualiPoc_136408) [1],QoS [1]	[illegible]	LTE	DQA Session	

Figure 4-79: Data transaction table

The results of the OOKLA ® tests are visible as "OOKLA ®" in the "Protocol" column, but without result details.

The detailed results of the tests are visible at the other page. The page is available via the link from the "Service Pages". If the OOKLA ® test results are available, the icon is hidden.

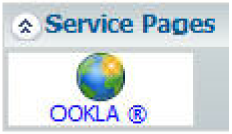


Figure 4-80: Icon to access OOKLA ® test details

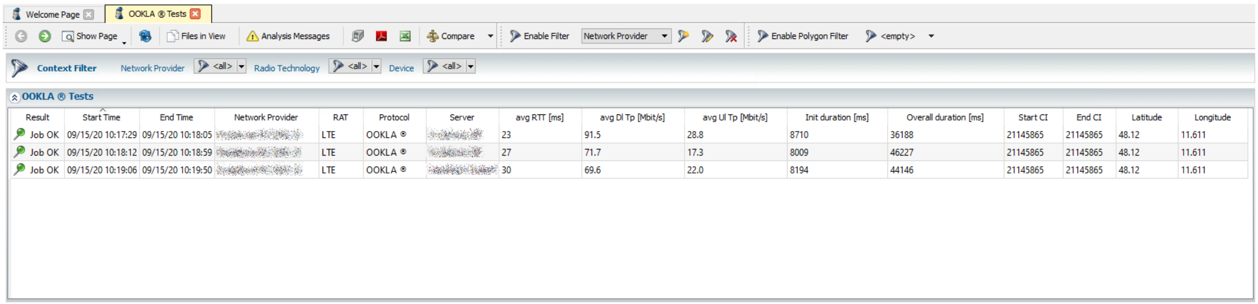


Figure 4-81: OOKLA ® test results

The alternative way to the page is via the "Show Page" in the icon bar of the GUI.

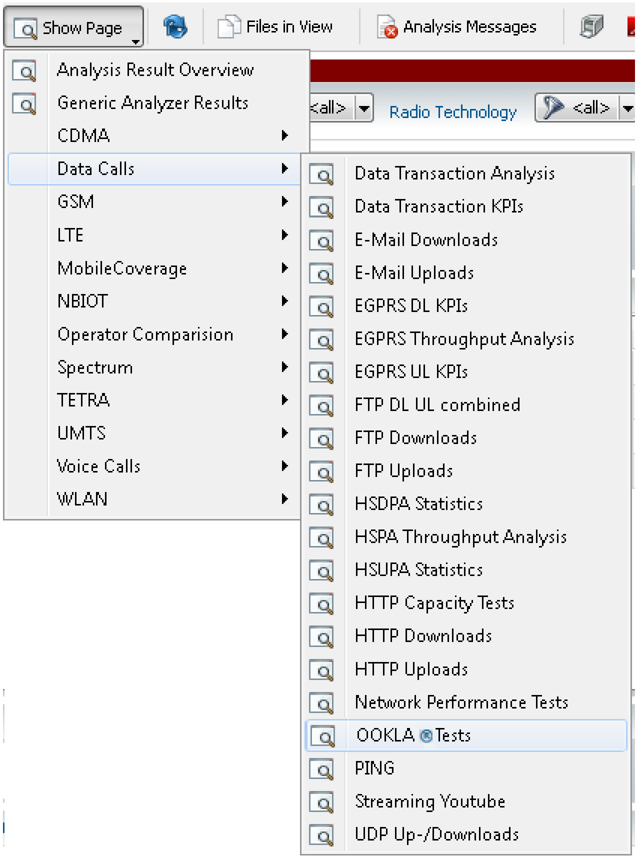


Figure 4-82: Alternative way to see QualiPoc tests

4.9.2.1 OOKLA ® test result pages

The results of the OOKLA ® tests obtained by R&S ROMES4 NPA, when analyzing the QualiPoc measurements, are shown here.

The results of the OOKLA ® tests analysis include the following pages:

- Table with an entry of each test and the main results, see Figure 4-81
- Statistics over all OOKLA ® tests represented as bar charts and tables grouped by provider and test direction
  - Success rate

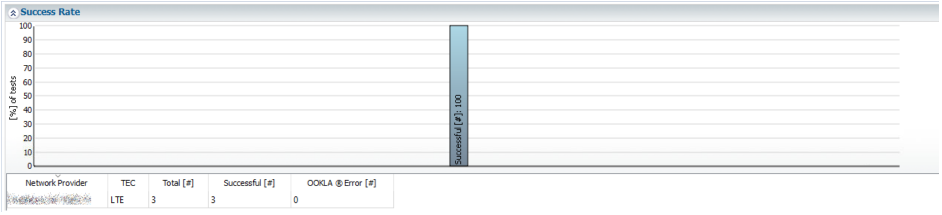


Figure 4-83: Success Rate page - OOKLA ® test

  - Average Round Trip Time from the OOKLA ® test

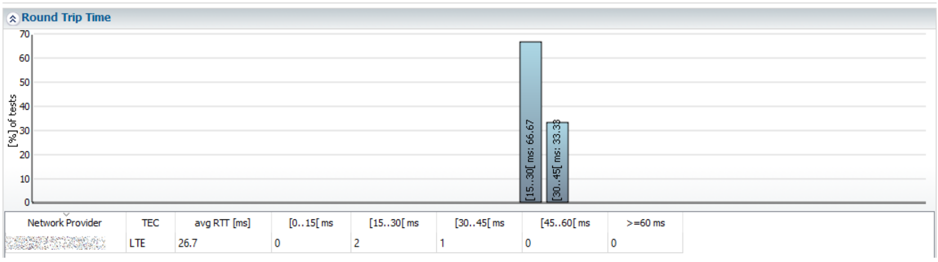


Figure 4-84: RTT page - OOKLA ® test

  - Average downlink throughput from the OOKLA ® test

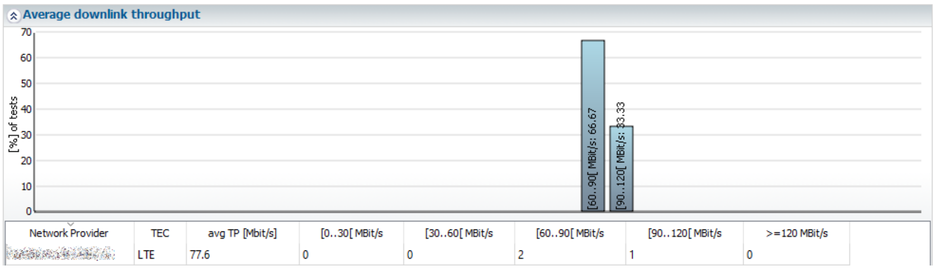


Figure 4-85: DL throughput page - OOKLA ® test

  - Average uplink throughput from the OOKLA ® test

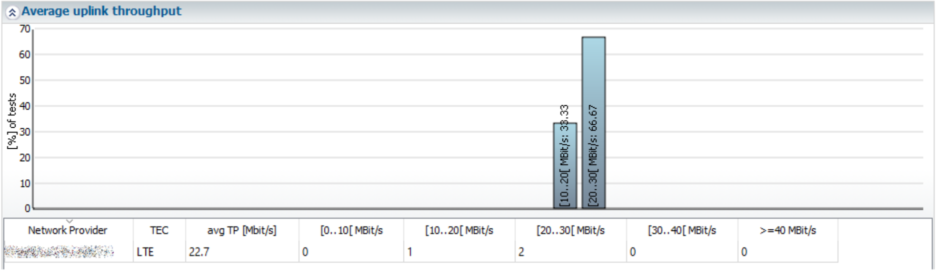


Figure 4-86: UL throughput page - OOKLA ® test

4.9.3 Support of QualiPoc Facebook/Dropbox test

The R&S ROMES4 NPA supports analysis of files obtained as the tests of Facebook and Dropbox with QualiPoc.

These tests are analyzed by the R&S ROMES4 NPA DQA module.

The "App tests" results page is created, providing the result of tests of both apps.

At the overview page, the icon and the statistics contain the results of the added Facebook and Dropbox tests, see Figure 4-70.

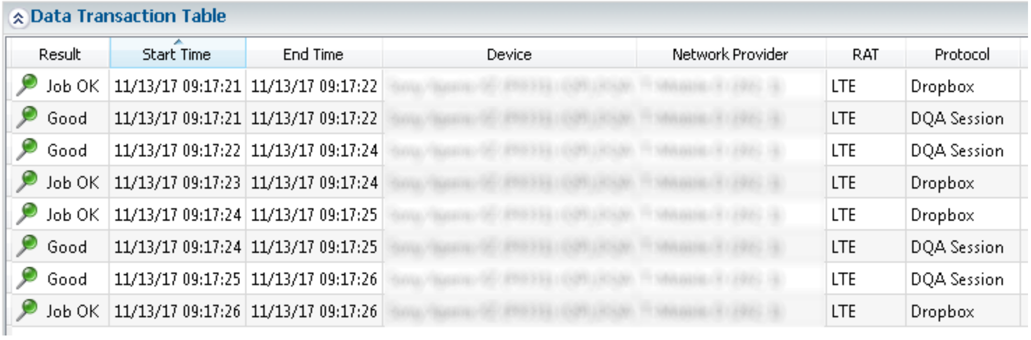
The main page of the DQA results, the "Data Transaction KPIs", includes the test results of Facebook and Dropbox.

These results are visible at the table with the protocol "Facebook" or "Dropbox", but without other values. See, for example, Figure 4-87.

Data Transaction Table

Result	Start Time	End Time	Device	Network Provider	RAT	Protocol	D
Good	11/16/17 12:33:11	11/16/17 12:33:32			LTE	DQA Session	
Job OK	11/16/17 12:33:12	11/16/17 12:33:27			LTE	Facebook	
Job OK	11/16/17 12:33:34	11/16/17 12:33:49			LTE	Facebook	
Good	11/16/17 12:33:34	11/16/17 12:33:54			LTE	DQA Session	
Good	11/16/17 12:33:56	11/16/17 12:34:16			LTE	DQA Session	
Job OK	11/16/17 12:33:57	11/16/17 12:34:11			LTE	Facebook	
Good	11/16/17 12:34:18	11/16/17 12:34:38			LTE	DQA Session	
Job OK	11/16/17 12:34:19	11/16/17 12:34:33			LTE	Facebook	
Incomplete Session	11/16/17 12:34:40	11/16/17 12:34:40			LTE	DQA Session	

Figure 4-87: Data transaction table - Facebook protocol



Result	Start Time	End Time	Device	Network Provider	RAT	Protocol
Job OK	11/13/17 09:17:21	11/13/17 09:17:22	[illegible]	[illegible]	LTE	Dropbox
Good	11/13/17 09:17:21	11/13/17 09:17:22	[illegible]	[illegible]	LTE	DQA Session
Good	11/13/17 09:17:22	11/13/17 09:17:24	[illegible]	[illegible]	LTE	DQA Session
Job OK	11/13/17 09:17:23	11/13/17 09:17:24	[illegible]	[illegible]	LTE	Dropbox
Job OK	11/13/17 09:17:24	11/13/17 09:17:25	[illegible]	[illegible]	LTE	Dropbox
Good	11/13/17 09:17:24	11/13/17 09:17:25	[illegible]	[illegible]	LTE	DQA Session
Good	11/13/17 09:17:25	11/13/17 09:17:26	[illegible]	[illegible]	LTE	DQA Session
Job OK	11/13/17 09:17:26	11/13/17 09:17:26	[illegible]	[illegible]	LTE	Dropbox

Figure 4-88: Data transaction table - Dropbox protocol

The detailed results of the tests are visible at the data transaction page.

The page is available via the link from the "Service Pages" icon. If no App test result is available, the icon is hidden.

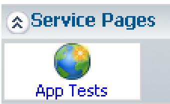


Figure 4-89: App test available

The alternative way to the page is via "Show Page" > "DataCalls" > "AppTest".

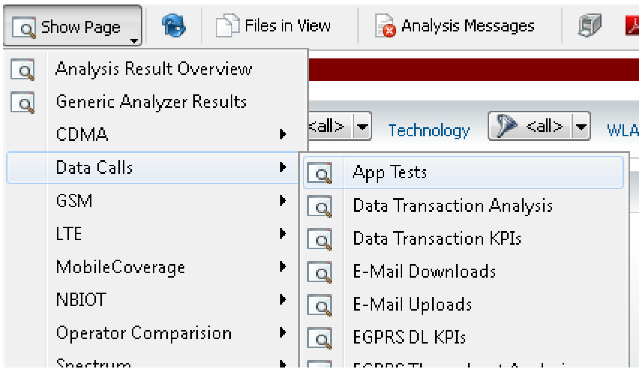


Figure 4-90: Way to the App Test page

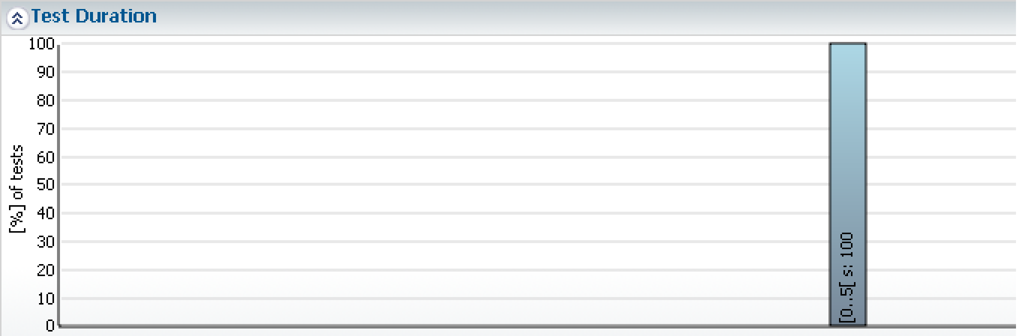
The result page consists the following items:

- Table with an entry of each test and the main results
- Statistics over all tests for:
  - Test duration
  - Success rate

Each statistic consists of a bar chart and a table which is grouped by provider and test direction.

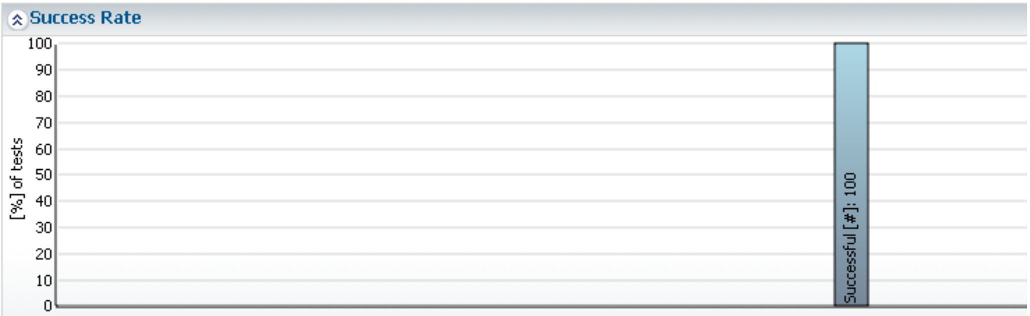
The following figures show the results of Dropbox and Facebook tests. If a measurement file contains both test types or the results are added to one result page, the charts show the cumulated values of both tests.

4.9.3.1 Results of Dropbox test



Network Provider	TEC	Duration	[0..5[s	[5..10[s	[10..15[s	[15..20[s	>20 s
[illegible]	LTE	0.81 s	4	0	0	0	0

Figure 4-91: Dropbox test duration



Network Provider	TEC	Total [#]	Successful [#]	Error [#]
[illegible]	LTE	4	4	0

Equation 4-1: Dropbox success rate

App Tests

Result	Start Time	End Time	Network Provider	RAT	Protocol	Actions	Duration	Start CI	End CI	Latitude	Longitude
Job OK	11/13/17 09:17:21	11/13/17 09:17:22	[illegible]	LTE	Dropbox	Download 100MB.dat	0.93 s			48.12	11.611
Job OK	11/13/17 09:17:23	11/13/17 09:17:24	[illegible]	LTE	Dropbox	Download 100MB.dat	0.83 s		26512642	48.12	11.611
Job OK	11/13/17 09:17:24	11/13/17 09:17:25	[illegible]	LTE	Dropbox	Download 100MB.dat	0.75 s	26512642	26512642	48.12	11.611
Job OK	11/13/17 09:17:26	11/13/17 09:17:26	[illegible]	LTE	Dropbox	Download 100MB.dat	0.72 s	26512642	26512642	48.12	11.611

Figure 4-92: Dropbox app test

4.9.3.2 Results of Facebook test

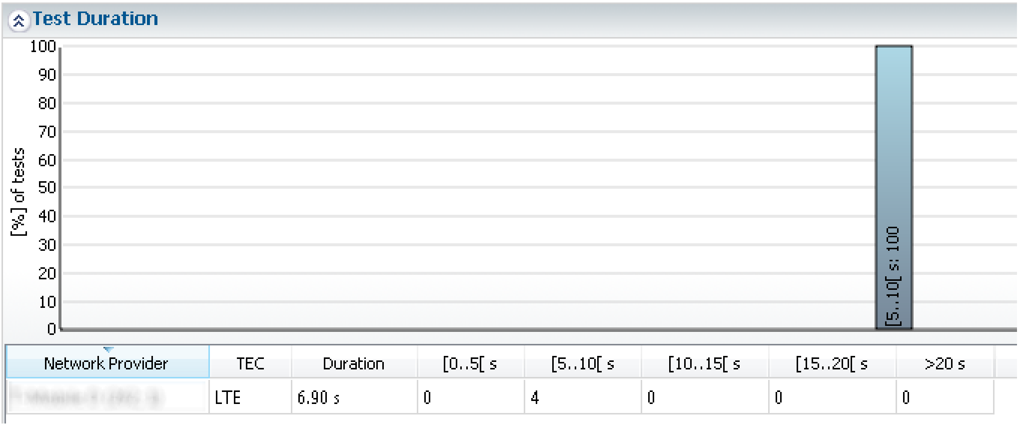


Figure 4-93: Facebook test duration

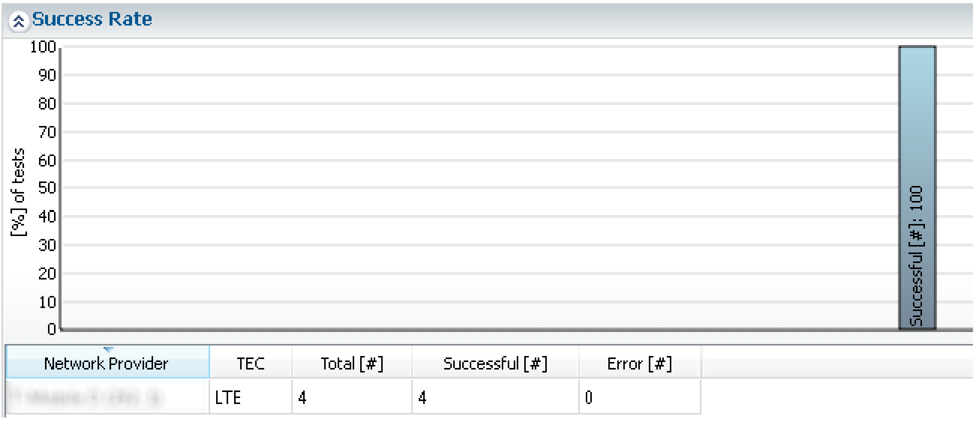
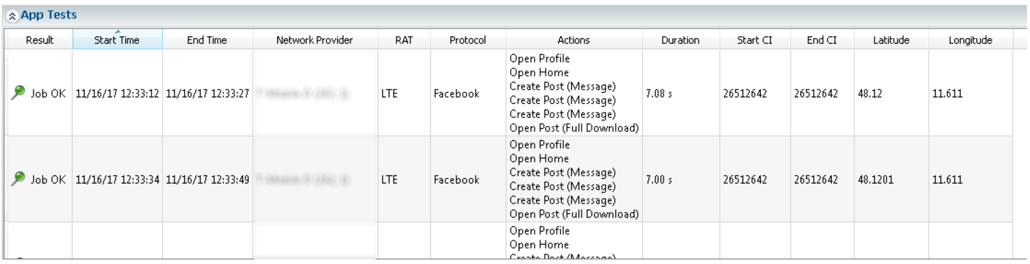


Figure 4-94: Facebook success rate


App Tests

Result	Start Time	End Time	Network Provider	RAT	Protocol	Actions	Duration	Start CI	End CI	Latitude	Longitude
Job OK	11/16/17 12:33:12	11/16/17 12:33:27		LTE	Facebook	Open Profile Open Home Create Post (Message) Create Post (Message) Create Post (Message) Open Post (Full Download)	7.08 s	26512642	26512642	48.12	11.611
Job OK	11/16/17 12:33:34	11/16/17 12:33:49		LTE	Facebook	Open Profile Open Home Create Post (Message) Create Post (Message) Create Post (Message) Open Post (Full Download)	7.00 s	26512642	26512642	48.1201	11.611
						Open Profile Open Home					

Figure 4-95: Facebook app test

4.9.4 Support of QualiPoc WhatsApp tests

The R&S ROMES4 NPA supports analysis of the files obtained as the tests of WhatsApp with QualiPoc.

These tests are analyzed by the R&S ROMES4 NPA DQA module.

The "App Tests" results page is created, providing the results of the app tests.

At the overview page the icon and the statistics contains the results of the added tests, see Figure 4-70.

The main page of the DQA results, "Data Transaction KPIs" includes the test results of WhatsApp. These results are visible at the table with the protocol “WhatsApp”, but without other values.

Data Transaction Table

Result	Start Time	End Time	Device	Network Provider	RAT	Protocol
Good	01/29/18 13:59:17	01/29/18 13:59:59	[illegible]	[illegible]	LTE	DQA Session
Job OK	01/29/18 13:59:18	01/29/18 13:59:54	[illegible]	[illegible]	LTE	WhatsApp
Good	01/29/18 13:59:18	01/29/18 13:59:59	[illegible]	[illegible]	LTE	DQA Session
Job OK	01/29/18 13:59:19	01/29/18 13:59:54	[illegible]	[illegible]	LTE	WhatsApp
Job OK	01/29/18 14:00:01	01/29/18 14:00:21	[illegible]	[illegible]	LTE	WhatsApp
Good	01/29/18 14:00:01	01/29/18 14:00:26	[illegible]	[illegible]	LTE	DQA Session
Good	01/29/18 14:00:01	01/29/18 14:00:26	[illegible]	[illegible]	LTE	DQA Session
Job OK	01/29/18 14:00:02	01/29/18 14:00:21	[illegible]	[illegible]	LTE	WhatsApp
Job OK	01/29/18 14:00:28	01/29/18 14:00:46	[illegible]	[illegible]	LTE	WhatsApp
Good	01/29/18 14:00:28	01/29/18 14:00:51	[illegible]	[illegible]	LTE	DQA Session

Figure 4-96: Data transaction table - WhatsApp protocol

The detailed results of the tests are visible at the common "App Tests" page. The page is available via the link from the "Service Pages" icon, see Figure 4-89. If no WhatsApp test result is available, the icon is hidden.

The alternative way to the page is via "Show Page" > "DataCalls" > "AppTest", see Figure 4-90.

Each statistic consists of a bar chart and a table which is grouped by provider and test direction.

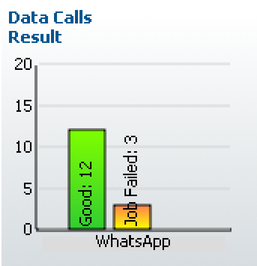
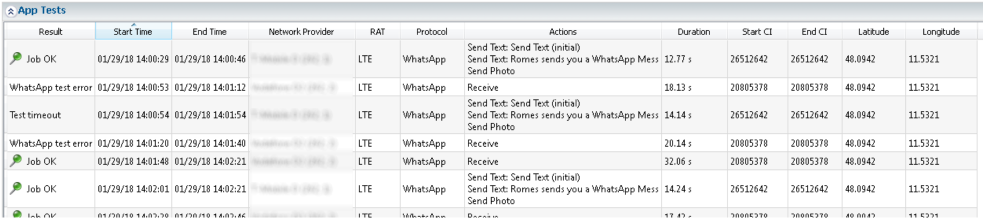


Figure 4-97: WhatsApp data cell results as bar chart

The result page consists the following items:

- Table with an entry of each test and the main results

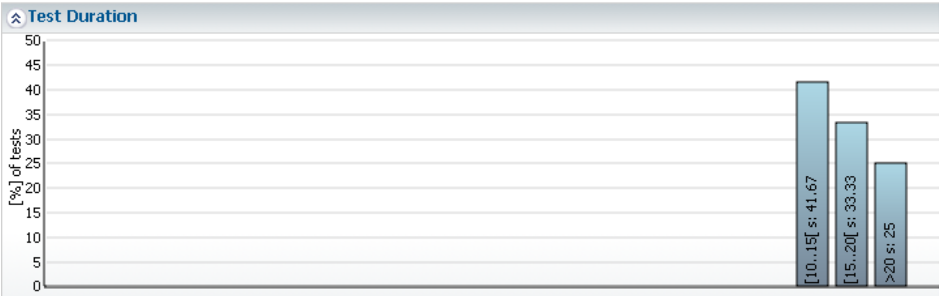


App Tests

Result	Start Time	End Time	Network Provider	RAT	Protocol	Actions	Duration	Start CI	End CI	Latitude	Longitude
Job OK	01/29/18 14:00:29	01/29/18 14:00:46		LTE	WhatsApp	Send Text: Send Text (initial) Send Text: Romes sends you a WhatsApp Mess Send Photo	12.77 s	26512642	26512642	48.0942	11.5321
WhatsApp test error	01/29/18 14:00:53	01/29/18 14:01:12		LTE	WhatsApp	Receive	18.13 s	20805378	20805378	48.0942	11.5321
Test timeout	01/29/18 14:00:54	01/29/18 14:01:54		LTE	WhatsApp	Send Text: Send Text (initial) Send Text: Romes sends you a WhatsApp Mess Send Photo	14.14 s	26512642	26512642	48.0942	11.5321
WhatsApp test error	01/29/18 14:01:20	01/29/18 14:01:40		LTE	WhatsApp	Receive	20.14 s	20805378	20805378	48.0942	11.5321
Job OK	01/29/18 14:01:48	01/29/18 14:02:21		LTE	WhatsApp	Receive	32.06 s	20805378	20805378	48.0942	11.5321
Job OK	01/29/18 14:02:01	01/29/18 14:02:21		LTE	WhatsApp	Send Text: Send Text (initial) Send Text: Romes sends you a WhatsApp Mess Send Photo	14.24 s	26512642	26512642	48.0942	11.5321

Figure 4-98: WhatsApp test results

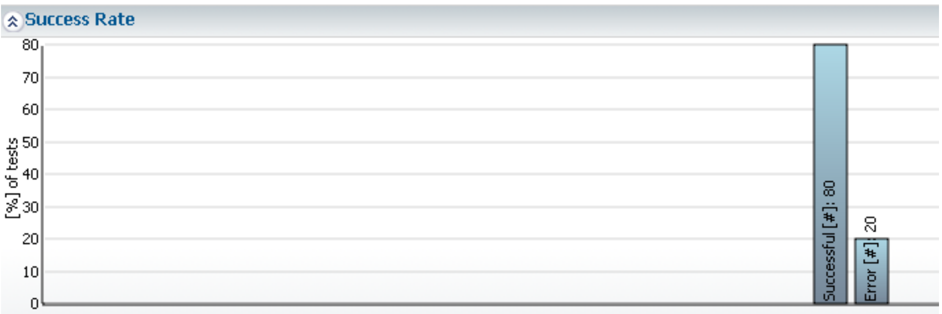
- Statistics over all tests for:
  – Test duration



Network Provider	TEC	Duration	[0..5[s	[5..10[s	[10..15[s	[15..20[s	>20 s
	LTE	23.04 s	0	0	0	4	2
	LTE	16.11 s	0	0	5	0	1

Figure 4-99: WhatsApp test duration

  – Success rate



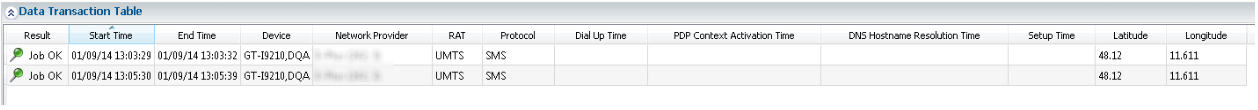
Network Provider	TEC	Total [#]	Successful [#]	Error [#]
	LTE	8	6	2
	LTE	7	6	1

Figure 4-100: WhatsApp test success rate

4.9.5 Support of SMS tests

The R&S ROMES4 NPA supports the collection of the results of the SMS tests and their QOS messages.

The main page of the DQA results "Data Transaction KPIs" includes the SMS test results. These test results are visible at the table with the protocol "SMS", but without other values.


Data Transaction Table

Result	Start Time	End Time	Device	Network Provider	RAT	Protocol	Dial Up Time	PDP Context Activation Time	DNS Hostname Resolution Time	Setup Time	Latitude	Longitude
Job OK	01/09/14 13:03:29	01/09/14 13:03:32	GT-I9210,DQA		UMTS	SMS					48.12	11.611
Job OK	01/09/14 13:05:30	01/09/14 13:05:39	GT-I9210,DQA		UMTS	SMS					48.12	11.611

Figure 4-101: Data transaction table - SMS protocol

The statistics at the technology-based part for data tests also shows the SMS tests.

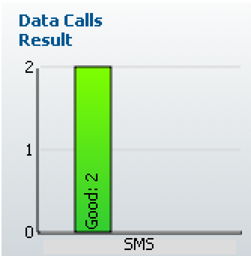


Figure 4-102: SMS data cell results as bar chart

The detailed results of the tests are visible at the own page. The page is available via the link from the "Service Pages". If no SMS test result is available, the icon is hidden.

Figure 4-103: SMS test available

The alternative way to the page is via "Show Page" > "DataCalls" > "SMS Test".

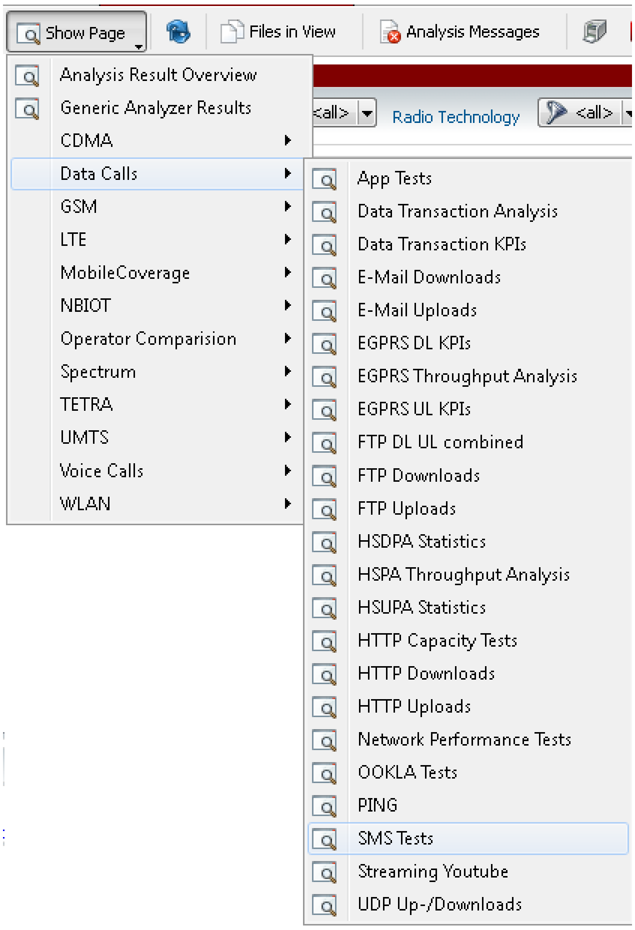
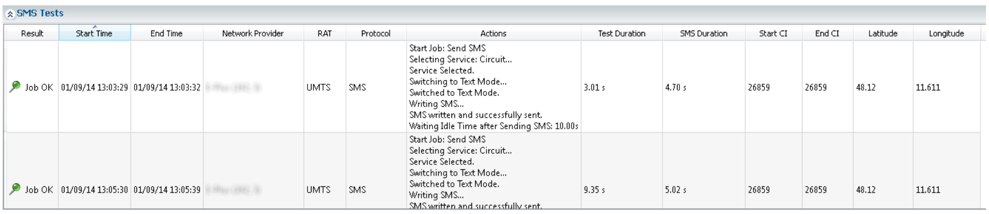


Figure 4-104: Way to the SMS Test page

The result page consists the following items:

- Table with an entry of each test and the main results



SMS Tests

Result	Start Time	End Time	Network Provider	RAT	Protocol	Actions	Test Duration	SMS Duration	Start CI	End CI	Latitude	Longitude
Job OK	01/09/14 13:03:29	01/09/14 13:03:32	[illegible]	UMTS	SMS	Start Job: Send SMS Selecting Service: Circuit... Service Selected. Switching to Text Mode... Switched to Text Mode. Writing SMS... SMS written and successfully sent. Waiting Idle Time after Sending SMS: 10.00s	3.01 s	4.70 s	26859	26859	48.12	11.611
Job OK	01/09/14 13:05:30	01/09/14 13:05:39	[illegible]	UMTS	SMS	Start Job: Send SMS Selecting Service: Circuit... Service Selected. Switching to Text Mode... Switched to Text Mode. Writing SMS... SMS written and successfully sent.	9.35 s	5.02 s	26859	26859	48.12	11.611

Figure 4-105: SMS table - main results

- Statistics over all tests for:
  – Test duration of the complete test

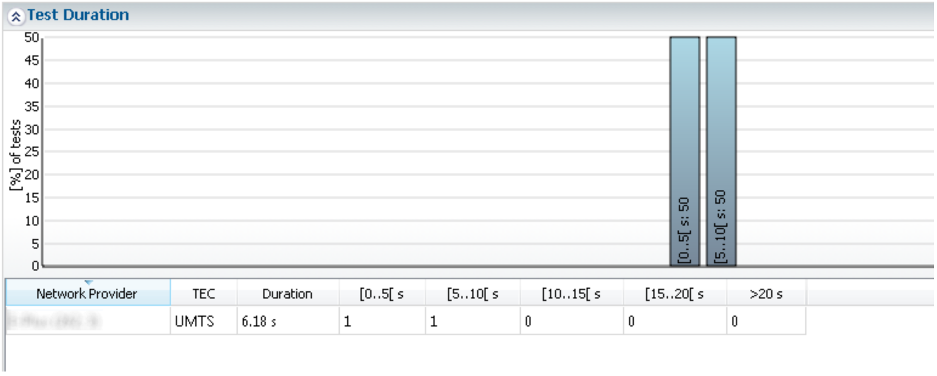


Figure 4-106: SMS test duration

– Success rate

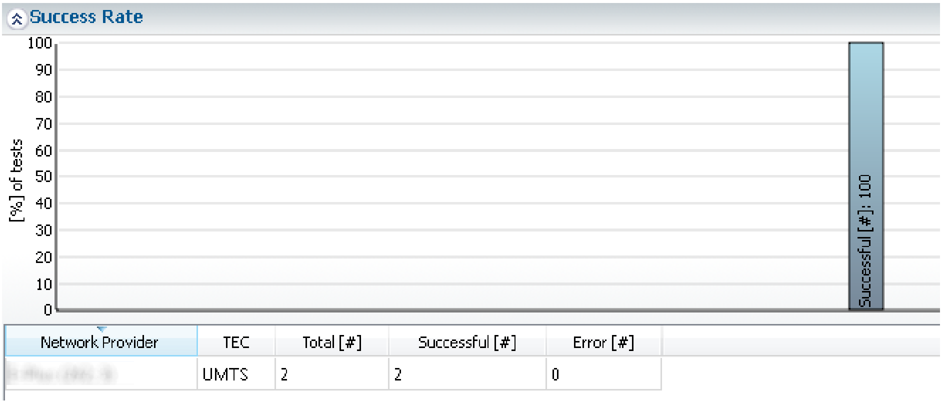


Figure 4-107: SMS test success rate

Each statistic consists of a bar chart and a table which is grouped by provider and test direction.

The following definitions differentiate the SMS duration from the Test duration:

- Test duration is a time between test start and test end
- SMS duration is the duration calculated between send and receive by the R&S ROMES4 if both mobiles (send and receive SMS) are connected to it.

4.9.6 Support of streaming YouTube tests

The R&S ROMES4 NPA supports the collection and analysis of the Streaming YouTube tests.

The main page of the DQA results, the "Data Transaction KPIs", includes the Streaming YouTube test results. These test results are visible in the "Data Transaction Table" with the protocol type "YouTube". To get the page, press the "Streaming YouTube" tab in "Service Page".

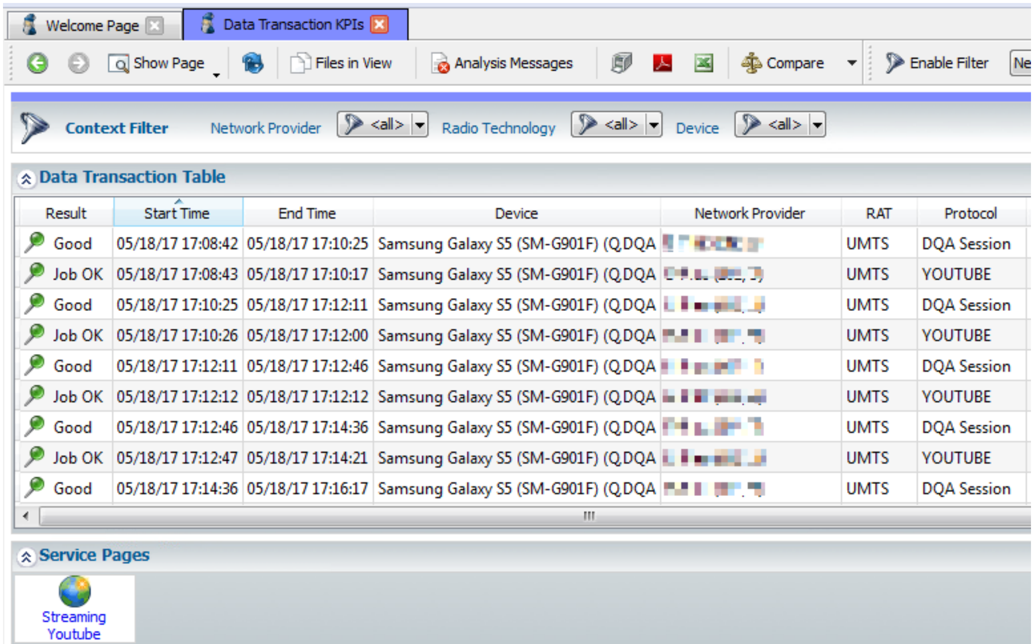


Figure 4-108: Data transaction KPIs - YouTube job

The streaming YouTube measurements are aggregated from QualiPoc and R&S ROMES4.

The following figure shows the YouTube job's aggregation from R&S ROMES4.

Parameter	[Unit]	DQA[1]
Current MOS		0.0
Current Progress	%	-
Youtube Result		Ok
Youtube Start Time	ms	107286
Youtube Stop Time	ms	113486
Movie Quality		medium
Movie Duration	s	307
Movie Size	Byte	3
Play Duration	ms	6200
Frame Jitter	ms	-
Session Quality (MOS)		1.0
Min. MOS		2.9
Max. MOS		2.9
Avg. MOS		2.9
Visual Quality (MOS)		0.0
Freezing Time	s	0.00
Freezing	%	0.0
Frame Rate	FPS	29.20
Jerkiness	%	0.0
Blurring	%	-
Blockiness	%	-
Tiling	%	-
PSNR	dB	-

Figure 4-109: YouTube job parameters from R&S ROMES4

The detailed "Streaming YouTube" result page shows the job statistics in "YouTube Jobs". Shown is average video MOS, the server URLs and the geographic position at the end of the job in the job list. The video MOS (VMOS) samples are aggregated to a bar chart and statistics.

The analysis is based on ITU J343.1 standard for Perceptual Video Quality measurement algorithm. Perceptual Evaluation of Video Quality (PEVQ) measurement algorithm is not supported.

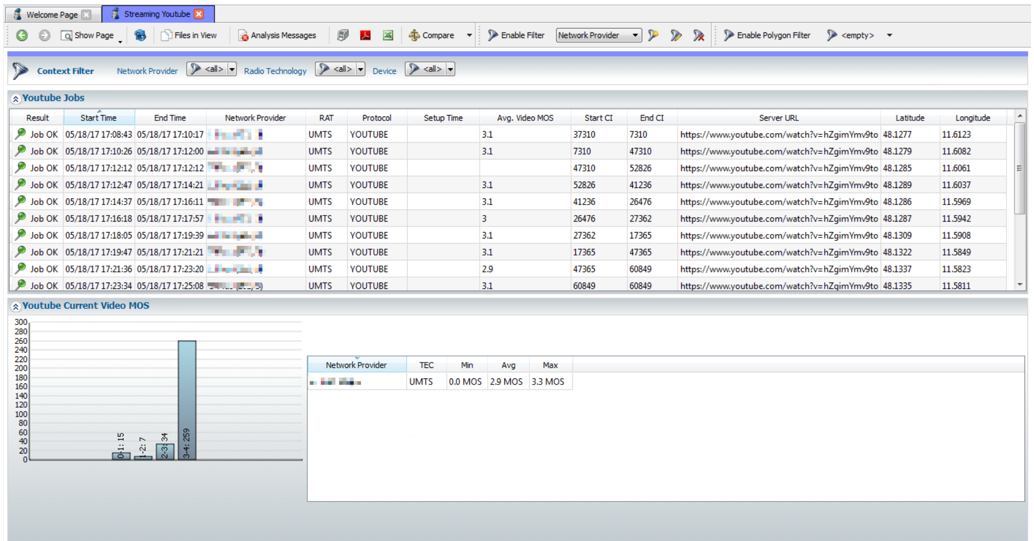


Figure 4-110: YouTube job statistics and MOS KPI

5 Common program settings

Common program settings can be changed in "Tools" > "Preferences" dialog. The settings and their changes affect the behavior of parts of the analysis views and the analysis modules.

Within the dialog, the different settings are organized in pages, where each page is placed in a section.

Sections and pages can be selected on the left side using the header bars and icons.

5.1 General

"Tools" > "Preferences" > "General" opens the section where the general program functionality can be influenced, like the synchronization with R&S ROMES4 and the internet connection settings.

5.1.1 Proxy

To connect to the Internet for queries of the OpenStreetMap service used to visualize problems and routes geographically, a proxy server must be used in many companies.

Available settings

- Use internet explorer settings
  The default setting for the proxy configuration is to use the same configuration as the internet explorer does. For many cases, this configuration is sufficient and the only further setting that has to be entered is the user name and password in the next group box (see Credentials).
- Use NPA settings
  Only if the internet explorer settings are not correct or different settings are used for R&S ROMES4 NPA, it is necessary to change the setting to "Use NPA settings". Then the other options in the dialog are enabled (see Automatic configuration and Proxy Server.

Credentials

Most proxies require some kind of authentication with a username and a password. Both settings must be entered in the dialog at this place.

The password is stored encrypted in the registry. If prohibited in your company, the password and username have to be entered in a session each time the Internet is accessed for the first time from the R&S ROMES4 NPA.

Automatic configuration

The remaining check boxes activate different strategies to find the appropriate proxy.

- Automatically detect settings
  With "Automatically detect settings", the internet explorer settings are tested if an appropriate connection can be established.
- Use automatic configuration script
  "Use automatic configuration script" requires the network address of a so-called `*.pac` script to be entered in the field next to it. If activated, the script is accessed and the proxy for the requested URL is evaluated.

Proxy server

The last option is directly to configure which proxy server to use to connect to the Internet. The configuration requires the hostname or IP address to be entered in the address field and the port number on which the server can be connected. These settings are normally in the responsibility of your system administrator.

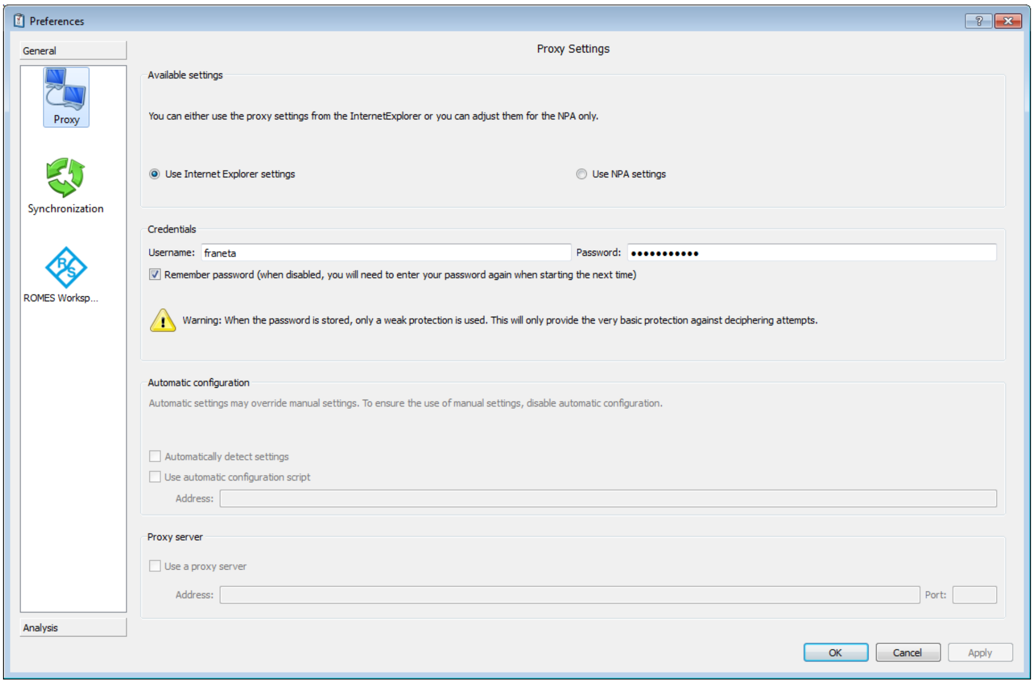


Figure 5-1: General - proxy settings

5.1.2 Synchronization

In this synchronization page, options can be set that influence the synchronization with R&S ROMES4 when choosing the related command from one of the analysis visualizations.

Both applications have to communicate with each other, and if communication fails this failure can mainly be detected with timeouts. This page offers the ability to change these timeouts and other related settings.

Startup

In this parameter group, all relevant settings for the start of a new R&S ROMES4 instance can be defined.

Setting	Description	Default
Number of connection attempts	If the first start of R&S ROMES4 fails (due to a timeout for example), the NPA constantly tries to start a new R&S ROMES4 instance.	5
Connection timeout	This setting defines how long the NPA waits to get the first contact with a new R&S ROMES4 instance. This configuration is used when a R&S ROMES4 process is active.	5 sec
Wait after start-up	If R&S ROMES4 is already started and communication has been set-up, but it does not respond immediately, the configured time is used to wait a short time since the next connection is attempted. In this way, it is assured that other operations can finish their request first.	5 sec
Loading a workspace	Time to wait after the load workspace command to finish successfully before the actual measurement file is loaded. The NPA always loads the workspace stored in `%NPA_HOME%\cfg\project\npa.rsxks`.	30 sec

Commands

Once the connection to an R&S ROMES4 instance is established, the synchronization command is sent. The R&S ROMES4 NPA expects the execution of that command to finish in the time specified in this setting, otherwise it shows a failure message.

Setting	Description	Default
Command timeout	Time to wait for the current synchronization command that consists of the steps File-Loading, Data-Spooling and Coupled Cursor Synchronization to finish successfully.	60 sec

Synchronization

A problem investigation is made easier by displaying the time interval of the problem spot itself and data from some time before and after the problem spot detection.

Setting	Description	Default
Pre synchronization interval	Time to shift the start time of the problem spot into the past to get more information about a problem.	5 sec
Post synchronization interval	Time to shift the end time of the problem spot into the future to get more information about a problem.	15 sec

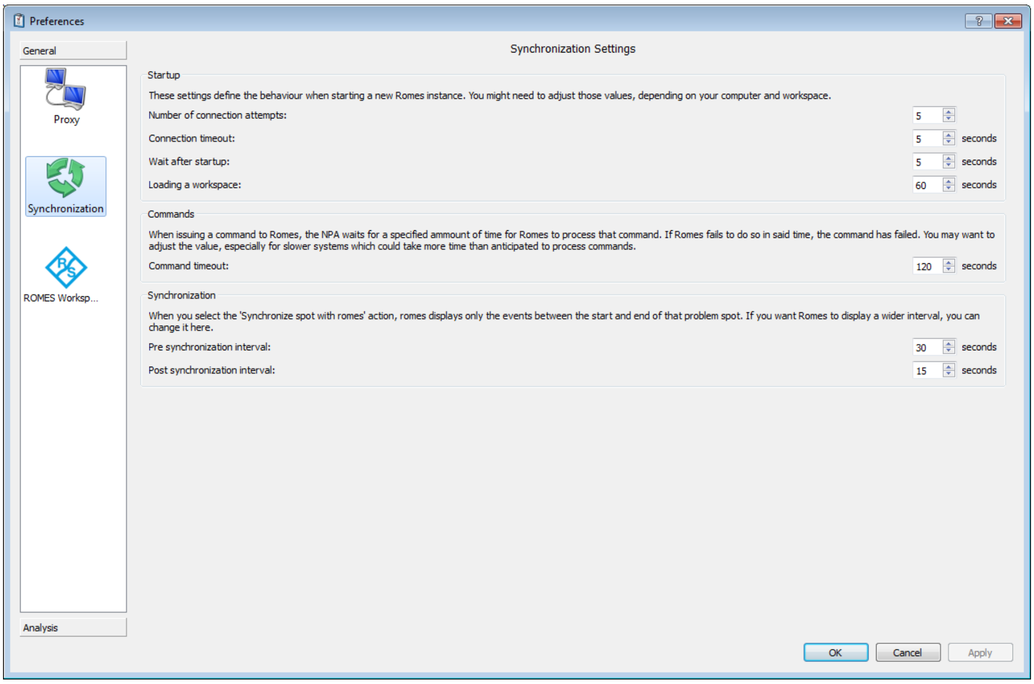


Figure 5-2: General - synchronization settings

5.1.3 ROMES workspace

It is possible to define a set of workspaces that are offered when showing data associated with a problem spot in the R&S ROMES4. This defining helps customizing the analysis process to the readers-specific needs.

Workspaces can be added and removed using the related buttons. If adding new workspace, the `*.rsxks` file can be selected from a file chooser that is opened when clicking "Add". This selection also supports adding multiple files from the file chooser.

Removing files can be done by simply selecting the files that you want to remove and clicking "Remove". Note that only the reference inside the R&S ROMES4 NPA is removed, the actual workspace files are not deleted.

If workspace files are not available any longer, they are marked with a warning sign. The state of the workspace files can be updated manually using "Update".

From the configured list, a workspace can be chosen when the R&S ROMES4 NPA is synchronized with R&S ROMES4. The workspaces are then displayed with the configured name, which can be found in the "Displayed Name" column. Clicking that column enables modification of the name, which is "Unnamed" when new files are added.

For more information on how to use these workspaces, refer to Starting a Drill-Down.

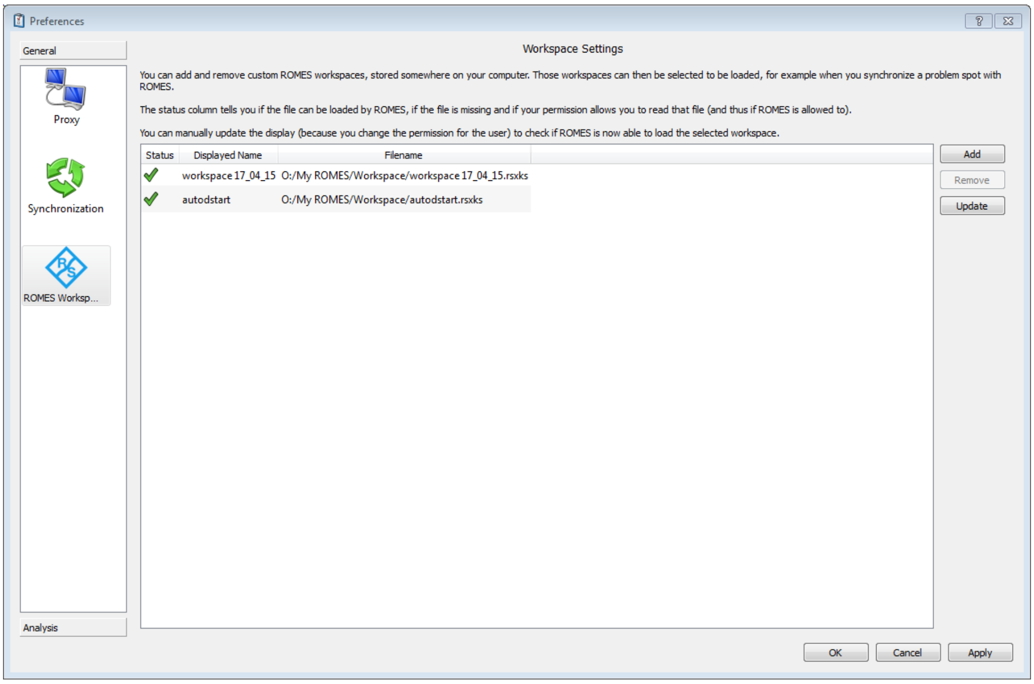


Figure 5-3: General - workspace settings

5.2 Analysis

The "ROMES Workspace" > "Analysis" tab offers the configuration of the following entries:

- Result Page Configuration
- TETRA Configuration
- Raster Configuration

The "Result Page Configuration" page is opened if clicking the "Analysis" tab.

5.2.1 Result page configuration

The "Result Page Configuration" page allows the customized thresholds for the "Analysis Result Overview" page to set-up and the zoom level for reports that are exported.

The thresholds for handover duration and the zoom levels of the map are configurable. The lower part of the page is intended to set-up the handover results pages and the zoom level affecting the export.

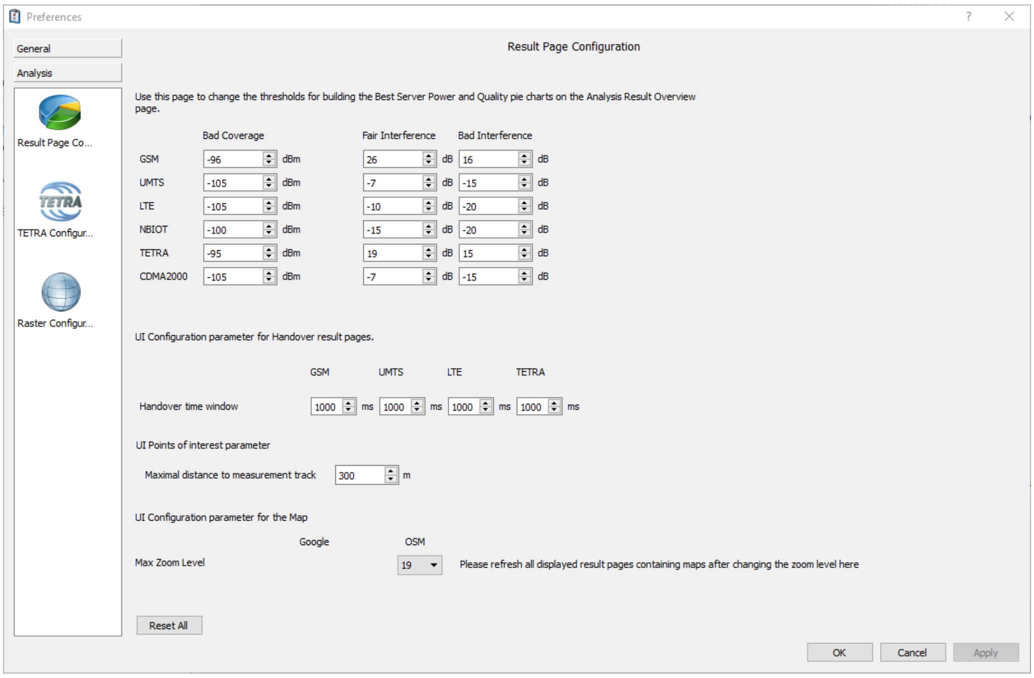


Figure 5-4: Result page configuration layout

- "Handover time window"
  It offers you to set the threshold for handover time window. You can edit the HO rate within defined time window, see Figure 12-200. The result page of a selected technology is based on defined threshold at this page. The threshold can be changed in rage of 1 ms up to 10000ms, default is 1000 ms.
  Click "Reset All" to store the configured thresholds, the time window values in the registry at “HKEY_CURRENT_USER\Software\Rohde & Schwarz\Network Problem Analyzer\Overview Configuration”.
- "Max Zoom Level"
  It offers you to set the maximum zoom level of a OSM map to a reasonable value. Click "Apply" to apply the changed zoom level. The setting helps by creating friendly reports of measurements performed on a small driven area where the map is zoomed to a level in which not enough information is available. See the Example at the end of the section.
  Note: Refresh the all displayed result pages after changing the zoom level.

The following figure shows the default registry entries related to analysis overview.

Name	Typ	Daten
(Standard)	REG_SZ	(Value not set)
CDMA2000_badCoverage	REG_SZ	-105
CDMA2000_badInterference	REG_SZ	-15
CDMA2000_fairInterference	REG_SZ	-7
GSM_badCoverage	REG_SZ	-96
GSM_badInterference	REG_SZ	16
GSM_fairInterference	REG_SZ	26
LTE_badCoverage	REG_SZ	-105
LTE_badInterference	REG_SZ	-20
LTE_fairInterference	REG_SZ	-10
TETRA_badCoverage	REG_SZ	-95
TETRA_badInterference	REG_SZ	15
TETRA_fairInterference	REG_SZ	19
UMTS_badCoverage	REG_SZ	-105
UMTS_badInterference	REG_SZ	-15
UMTS_fairInterference	REG_SZ	-7

Figure 5-5: Default thresholds stored in the registry

If the "Analysis Result Overview" page has not been loaded, the custom changes are applied on the first load of the html page.

If the page has already been loaded, click the refresh button on the top to apply the custom thresholds to the page.

Changes in the "Overview Configuration" page change the KPI pie charts and the description labels below the pie charts.

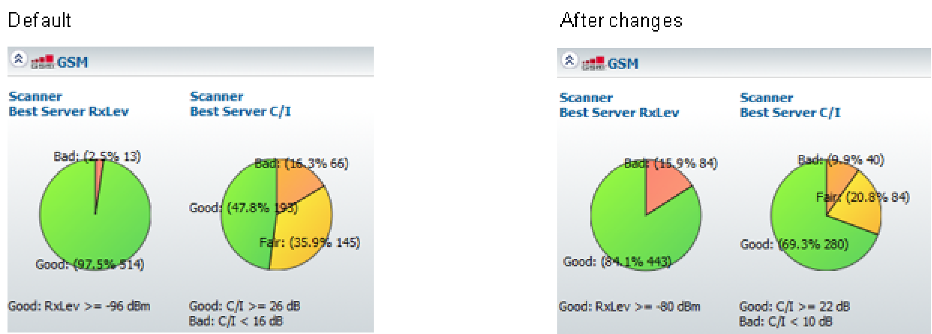


Figure 5-6: Effects of the overview configuration changes

In this way it is possible to customize the Overview KPI pie charts.

5.2.2 TETRA configuration

This configuration page allows you to change the global setting for the TETRA B-party merge process and to customize the overview page for TETRA results.

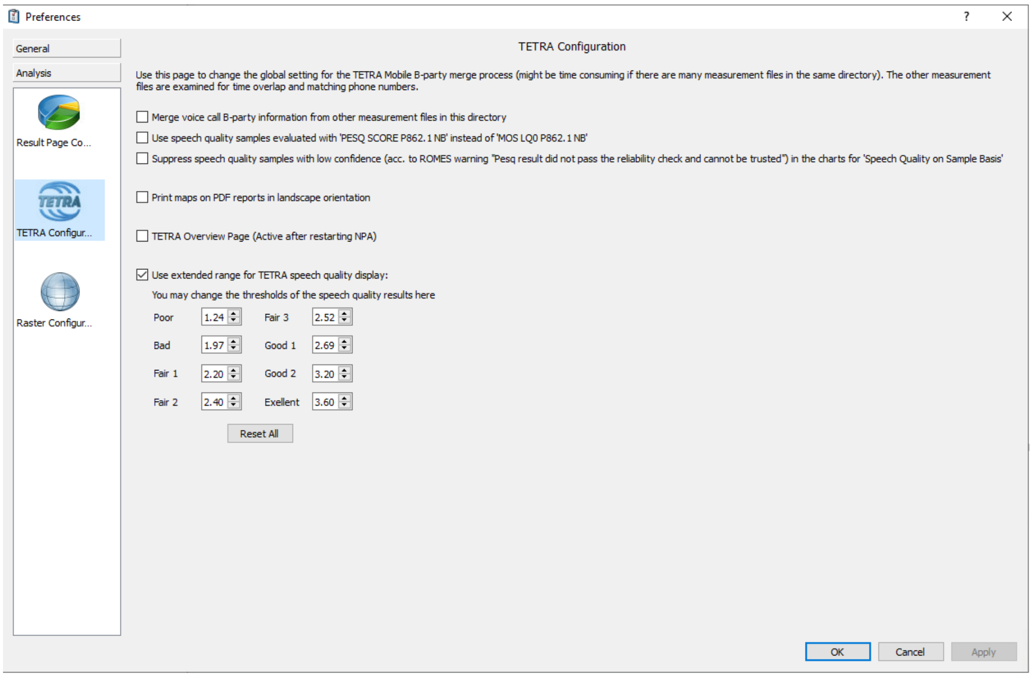


Figure 5-7: TETRA configuration analysis setting

It includes the following options:

- Option that solves the problem of long processing time of a TETRA mobile measurement file.
  The R&S ROMES4 NPA function to start searching for other TETRA mobile measurements at the 41% of a loaded file, which is causing the problem, can be activated or deactivated. By default, searching for the voice call B-party information and merging it is not active. You can activate the function by selecting the "Merge voice call B-party information..." option.
- Option to use PESQ SCORE P862 standard for quality evaluation of speech samples.
- Option not to show the low confidence samples in SQA statistics.
  By default the option is not active. To activate it, tick "Suppress speech quality samples...". The measurement files need to be processed again afterwards. The activation affects the statistics for SQA samples, but not for SQA calls.
  If active, the number of affected (low confidence) samples is reported in a processing warning, as shown in the following figure.

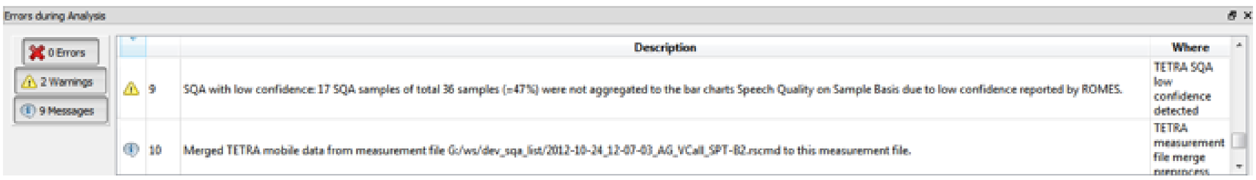


Figure 5-8: SQA processing result

- Suppressing the low confidence samples in SQA statistic affects several TETRA objects in the R&S ROMES4 NPA, see "Suppressing SQA samples effects" on page 246.

- Option to print maps on PDF reports in landscape orientation.
  The option allows direct creation of PDF reports without viewing the results in the R&S ROMES4 NPA GUI. The option helps to create overview on TETRA measurement reports on larger areas that is of up to 40 km.
- Option to customize the overview page for TETRA results.
  You can choose whether to use general overview result page or overview page customized for TETRA results.
- Option to extend the range for TETRA speech quality report
  If the "Use extended range for TETRA speech qualty display" is checked, you can adjust the threshold values of the extended number of MOS categories.

5.2.2.1 Customizing the TETRA overview page

How to do:

1. Check the "TETRA Overview Page" box.
2. Select a TETRA measurement.
3. Click the "Open Analysis Result" > "Analysis Result Overview TETRA" entry.

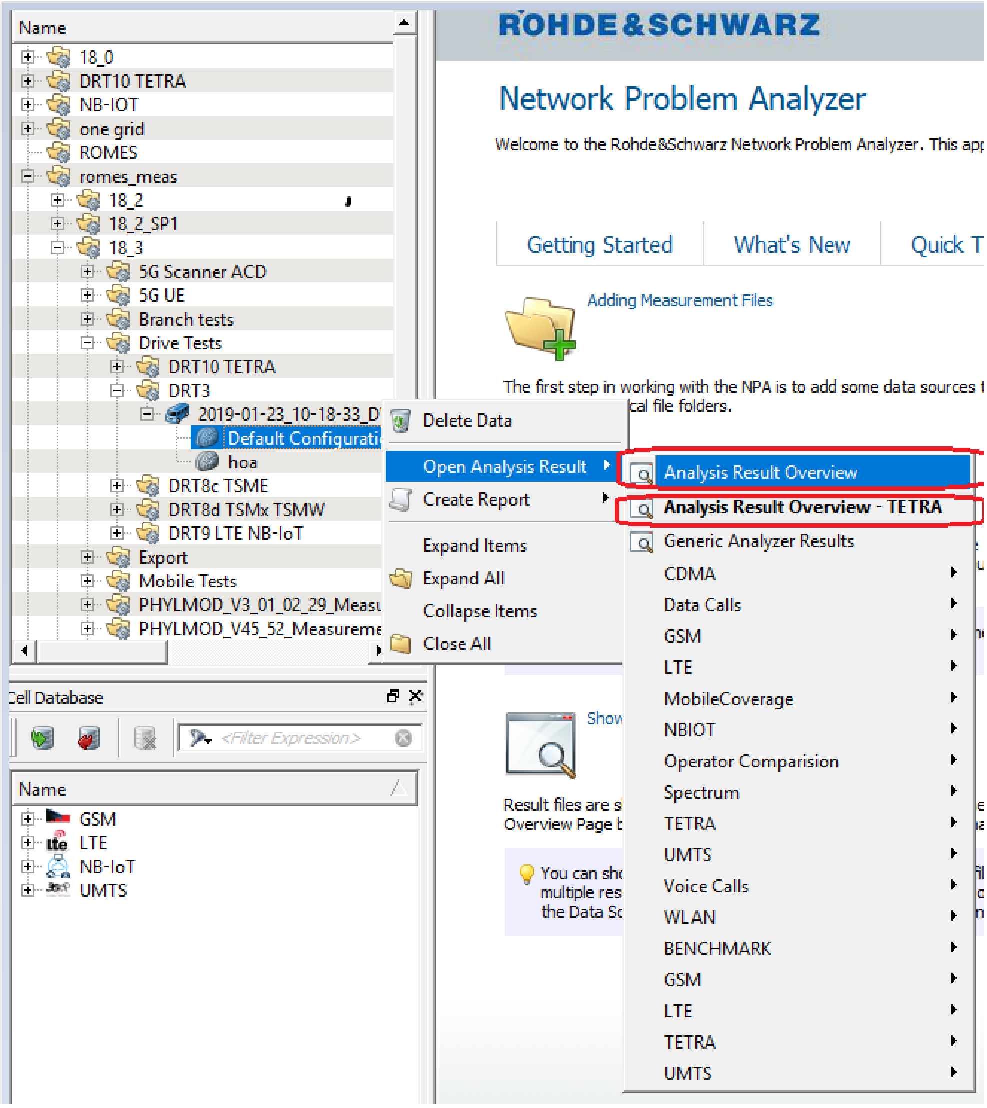


Figure 5-9: Configuration of customized TETRA overview page

You are still able to open the general overview page if you select the "Analysis Result Overview" entry instead.

The customized TETRA overview page is shown in the following figure.

It is possible to move and to resize the map and results windows.

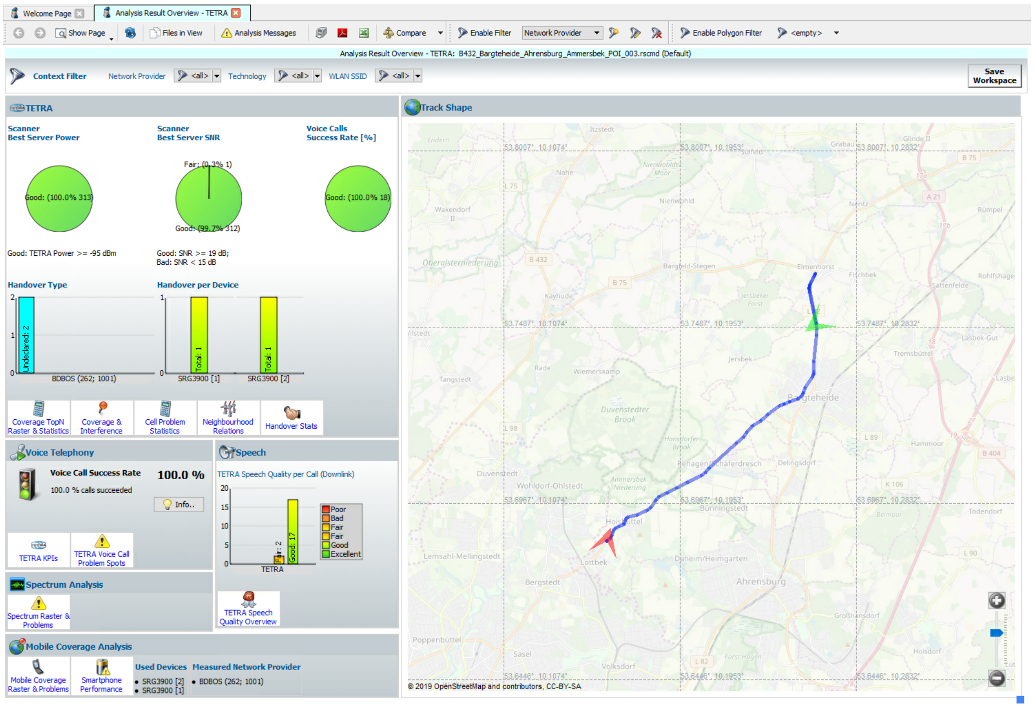


Figure 5-10: Customized TETRA overview page

- To move a window, click the header of that window and drag it to the desired location.
- To resize a window, use the dark blue rectangle at bottom right of the window.

Only the map can be resized. Meanwhile, other windows can only be moved.

After editing the workspace, it is possible to save the configuration. For that purpose, click the "Save Workspace" button located at the top right.

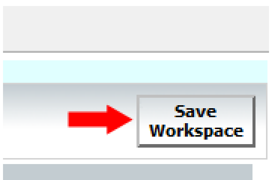


Figure 5-11: Saving the workspace

5.2.2.2 Overview report on larger areas

Create reduced processing results, according to the statement given in Chapter 4.8, "NPA usage for larger measurement files", on page 114.

- For scanner measurements, activate only the coverage analysis data processing.

- For mobile measurements, activate the handover analysis processing, mobile coverage analysis processing and TETRA data processing.

Now process the measurement files with a suitable bin size (500m … 100m), the larger the better.

1. Activate the "Print maps on PDF..." landscape orientation option.

   Note: The option to print maps on PDF reports in landscape orientation must be activated.

2. Select multiple TETRA measurement results from the data source tree.

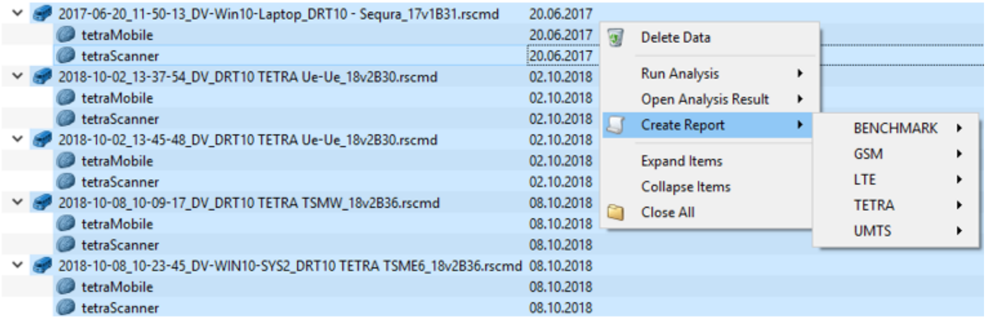


Figure 5-12: Selection of multiple measurements

3. Select the TETRA report to be created as PDF.
   There are five different TETRA overview reports available for printing. They are shown in the following figure.

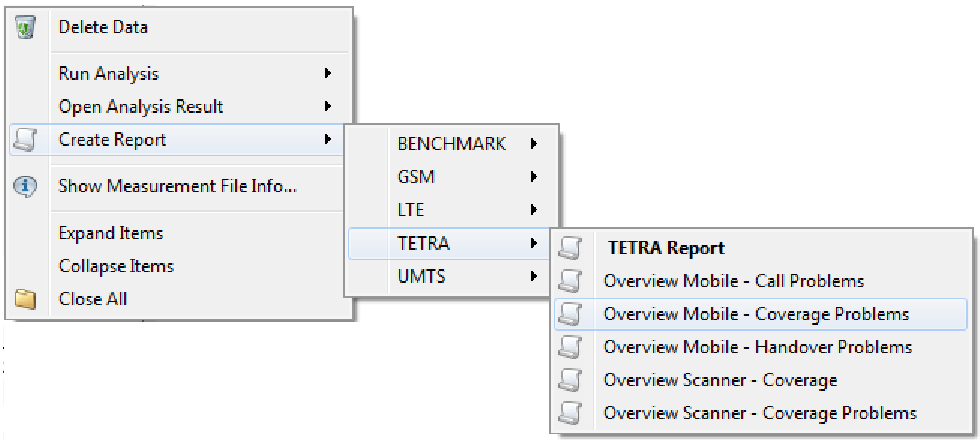


Figure 5-13: Context menus for TETRA report selection

4. Specify a new filename for the PDF report to be created.

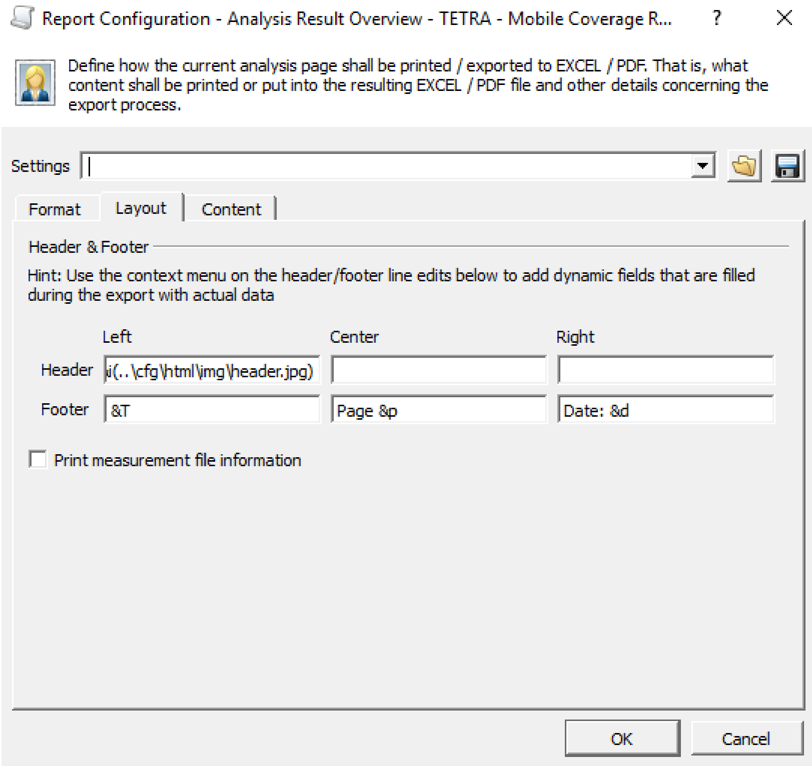


Figure 5-14: Configuration of report Coverage

5. Select the analysis configuration related to your report (scanner or mobile, depending on the selected report).

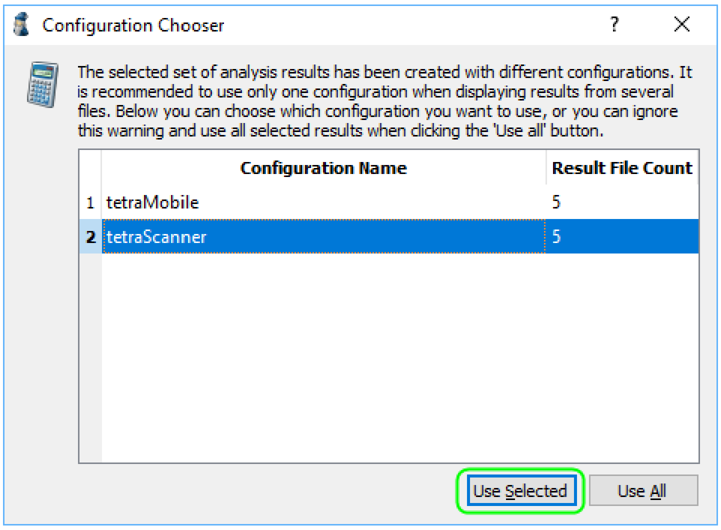


Figure 5-15: Analysis selection

After creation by R&S ROMES4 NPA, the report is opened in the default PDF viewer. The map is maximized and uses the full page width.

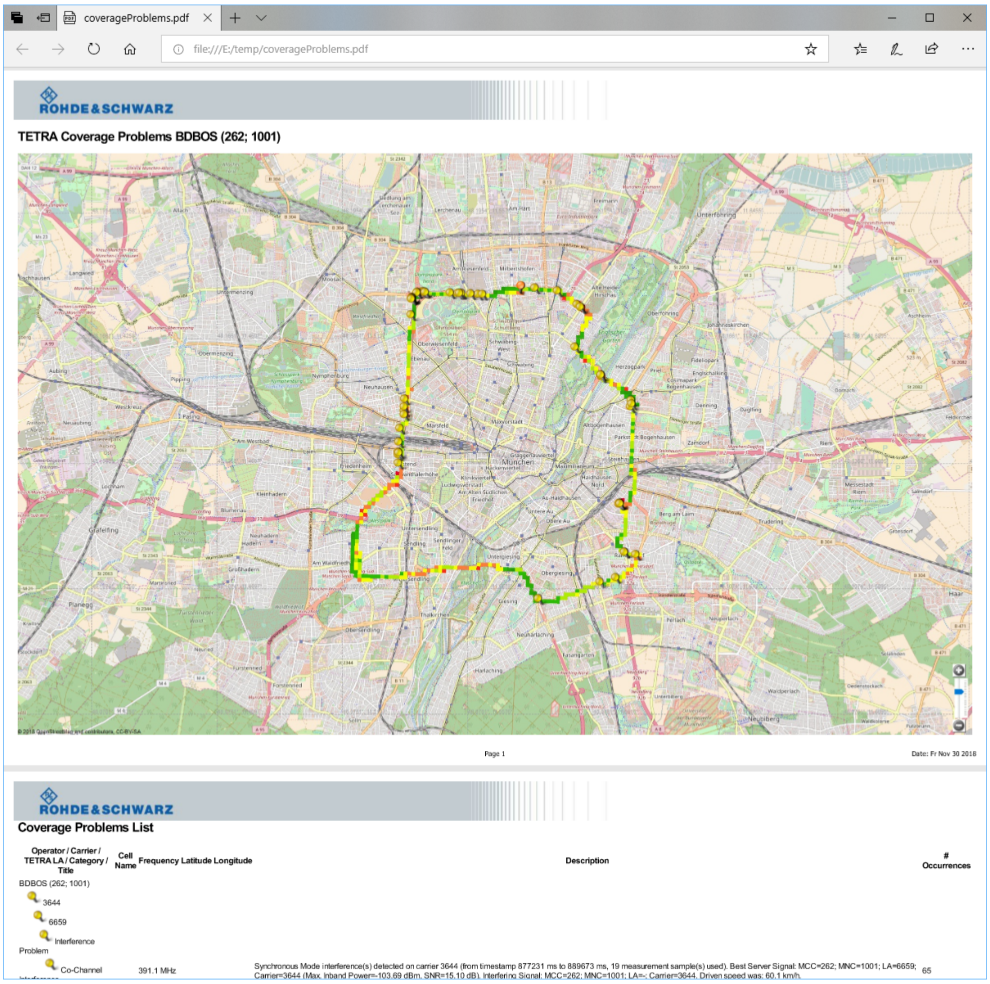


Figure 5-16: PDF report - full page width

The "Report Configuration" dialog shown in Figure 5-14 lets you activate or deactivate the File Meta Data section in the PDF report. The feature related to these options is called in the "Layout" > Print measurement file information check box of the dialog.

If the map on the PDF report shows large question marks, open the results on the "TETRA Coverage TopN Raster & Statistics" page and download the OpenStreetMap tiles with the download tool, see Chapter 6.2, "Map operations", on page 158.

5.2.3 Raster configuration

Some of the data processing modules produce geographically rasterized output, like the coverage or mobile analysis modules.

Each geographic position is described using a WGS84 coordinate from the GPS device, which consists of a longitude, latitude and altitude value.

The former two are given in degrees and cover a range of -180° to +180° (west to east) resp. -90° to +90° (south to north).

The altitude is the height above sea-level in meters.

Using these coordinates, it is possible to aggregate data from different positions into a grid, and derive a characteristic value to each covered grid element. It reduces the amount of data and also helps to gain some statistical certainty about the analyzed data. It also allows combining data from different measurement results into one meaningful visualization.

See also the description of the Raster Layer in the map view for a visualization of the resulting data.

The process how that rasterization actually happens can be controlled using the settings shown in the "Raster Configuration" dialog.

There are basically two different possible ways of doing that rasterization offered in the context of the NPA:

- Direct coordinate-based rasterization, "Use WGS84 coordinates (Specify grid size in arcseconds)"
- More complex way that allows for metric parameter definition, but introduces projection issues, "Reproject into UTM coordinate system (Specify grid size in meters)"

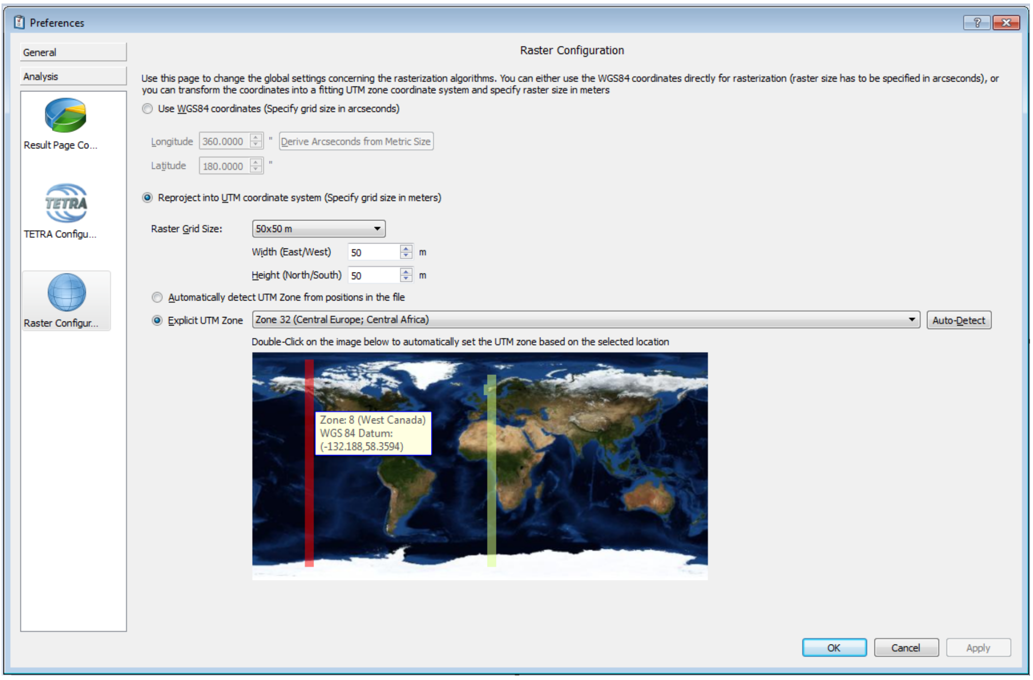


Figure 5-17: Analysis settings - raster configuration

WGS84 based rasterization

Rasterizing data in the WGS84 coordinate system requires a grid specification in arc-degrees or more conveniently in arcseconds. This specification is usually cumbersome.

Also a bin width given in arcseconds varies in the covered distance according to the latitude value.

I.e. 1" cover approximately 31 meters at the equator, but only 5 meters at 80° (north or south). The error made with this rasterization becomes more visible when doing long drive tests in north/south direction.

The NPA supports rasterization in this way, although it is not the preferred way of doing it. The related values can be entered in the rasterization dialog when the WGS84 rasterization radio box is checked.

To simplify the process of specifying appropriate arcsecond values for longitude and latitude width and height, the NPA offers the possibility to derive that values from a metrical representation.

Clicking "Derive Arcseconds from Metric Size" opens a dialog that takes the metrical raster and a reference latitude specified through a city in the neighborhood, and calculated the approximated arcseconds from those values.

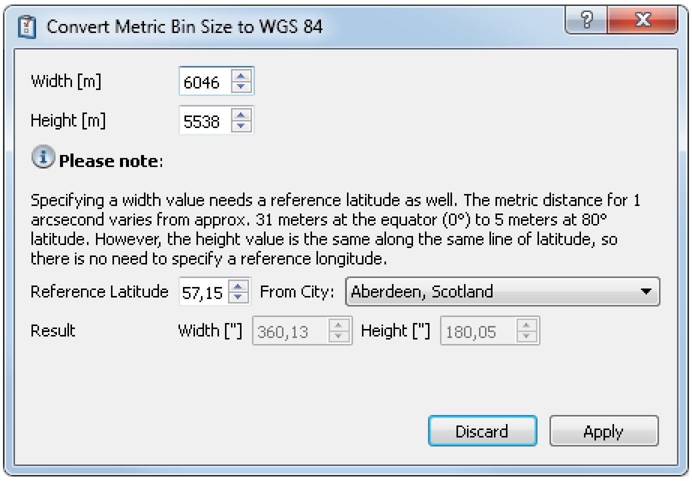


Figure 5-18: Convert metric bin size to WGS84

UTM-based rasterization

The main problem with the WGS84 rasterization is that it cannot provide a consistent meaning for the metric width of a raster element, as described above.

Transforming a geographic WGS84 datum into a UTM coordinate, applying the raster calculation and transform the UTM coordinate back into WGS84 can solve that problem. The UTM coordinates are a metric measure of the distance of the equator and a reference meridian (longitude).

This transforming introduces distortion of the grid elements, which are no longer depicted as squares or rectangles on the screen. It also introduces a dependency on the distance to the reference meridian.

The farther away the greater the distortion effects become. Since there are 60 different UTM zones used around the world, the grid looks different depending into which zone the coordinate was transformed.

If using the UTM rasterization, the raster grid size can be chosen from the related combo box. It can be also specified directly using the width and height edit fields. All values are provided in meters.

To define the UTM zone, different ways are offered. The zone can be defined manually for all files or it can be derived from the positions stored in a file. In the latter case, the reference longitude is calculated from the first position sample found in a measurement file.

If the UTM zone is specified manually, it can be explicitly chosen using the other combo box where some basic geographical hint about the actual location of the UTM zone is given. Instead, the world map can be used to find UTM zone by moving the mouse over the image.

Double-click a location modifies the content of the UTM zone combo box to one assigned to the point under the mouse cursor.

The automatic UTM zone detection uses the system time to calculate the offset from the current UTC time. The detection is not 100% accurate method, but can be used as first estimation.

In the screenshot "Analysis settings - raster configuration" two bars mark two different zones. The yellow bar marks the current selection of the UTM zone. The red bar shown the zone assigned to current mouse location when the mouse is dragged over the world map.

To avoid the overlapping caused by displaying simultaneously the mobile and scanner layers introduced are different symbols for rasterization bins for these two layers. The mobile’s raster bins are drawn smaller with rounded corners while the bins for scanner data are rectangular and bigger. Also in the legend, the rectangles have round corners to make the relation between the legend and the map clear.

5.2.4 Rasterization of mobile and scanner layer outputs

The mobile and coverage analysis modules produce geographically rasterized output. If there is simultaneously display of mobile and scanner layers, to avoid rasters overlapping introduced is different presentation of their raster bins.

The mobile raster bins are displayed as rectangles of smaller size and with rounded corners. The number of colors for all maps having cell layers is increased. The following screenshot shows mobile coverage map of TETRA mobile coverage cell statistics. There are up to 24 different colors for the TETRA LA/Carrier combinations of the UE measurements.

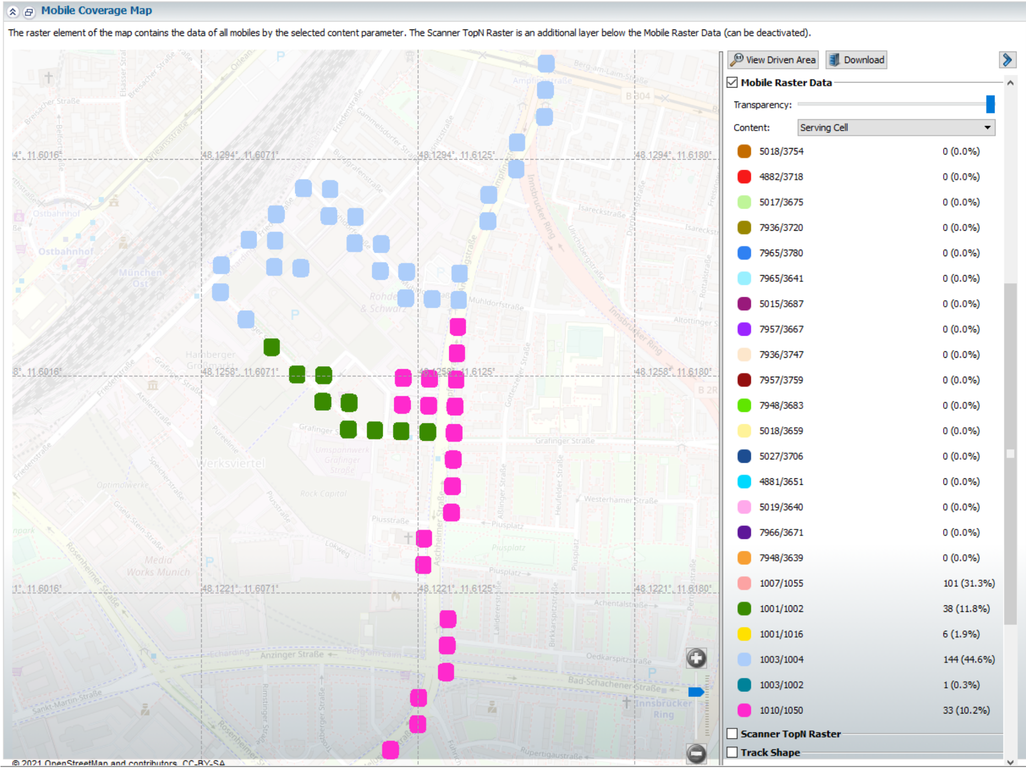


Figure 5-19: Mobile raster bins - TETRA coverage map example

The scanner raster bins are displayed as rectangles. The following screenshot shows the combined mobile and scanner Top N raster data. The legend for the mobile and scanner TopN raster data on the right indicates the bins difference.

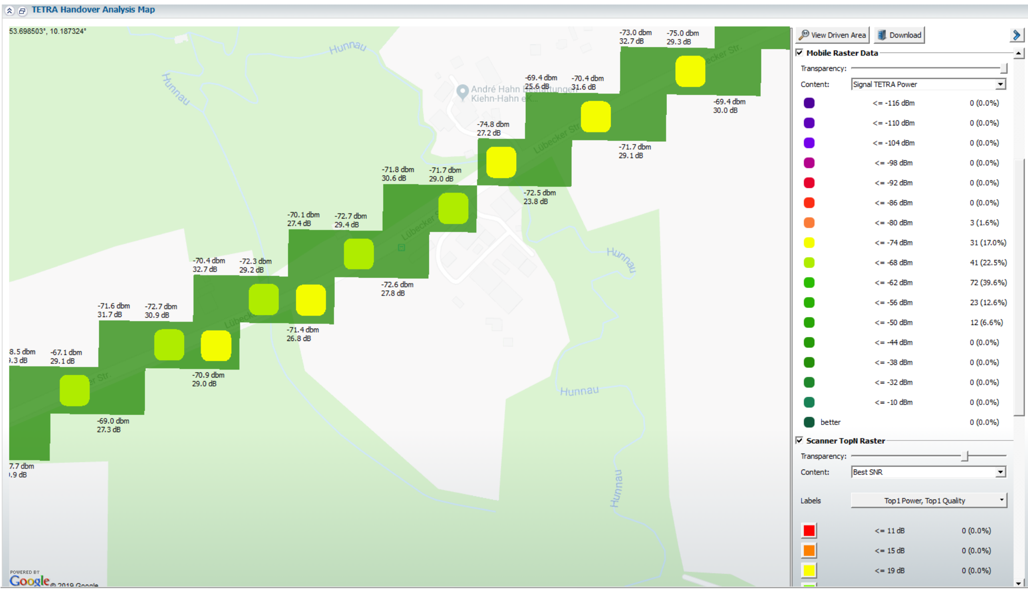


Figure 5-20: Mobile and scanner raster bins

5.3 Problem spot visualizations

5.3.1 Problem lists

The main purpose of the analysis process is to detect automatically where problems in the network exist and what the possible reason for a problem actually is. These problems are stored in the so-called Problem Lists, which are visualized as tables, as shown in the following figure.

Problem Spots

Start Time	End Time	Operator	Device	Category	Title	Description
11/5/13 7:18 AM	11/5/13 7:18 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:18 AM	11/5/13 7:18 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:18 AM	11/5/13 7:18 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:18 AM	11/5/13 7:18 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:19 AM	11/5/13 7:19 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:19 AM	11/5/13 7:19 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:19 AM	11/5/13 7:19 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:19 AM	11/5/13 7:19 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:19 AM	11/5/13 7:19 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:19 AM	11/5/13 7:19 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:20 AM	11/5/13 7:20 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:20 AM	11/5/13 7:20 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo
11/5/13 7:20 AM	11/5/13 7:20 AM	Unknown	SHV-E330S [1], DQA [1]	UE Problem	The session failed after Network Connect	No DNS Server Address for for Adapter SAMSUNG Mobile USB Remo

Figure 5-21: Problem spots table

A problem spot has some attributes which are always shown in the result table. These attributes are:

- **Category**
  Indicates which part of the network can have caused the error
- **Title**
  Short description of the actual problem
- **Description**
  More detailed explanation of the most likely problem which invokes, as a consequence, that kind of problem. It can also contain a general description of the found problem
- **Longitude/Latitude**
  Geographical coordinates specifying the position of the problem spot on the earth's surface

BSE Problems

Operator / Rat / CI	Cell Name	Latitude	Longitude	Category	Title	Description
Vodafone						
GSM						
206	MXB	48.1286	11.6297	Cross Feeder	Sector out of nominal direction	The Cell MXB020F with direction 180° is out of nominal direction. Allowed Delta in Direction +/-30°, Calculated Delta Direction 37° with Sweet Spot Direction 217°
36231	MXB	48.1163	11.6936	Cross Feeder	Sector out of nominal direction	The Cell MXB2A3A with direction 120° is out of nominal direction. Allowed Delta in Direction +/-30°, Calculated Delta Direction 49° with Sweet Spot Direction 169°
7032	MXB	48.1347	11.6942	Cross Feeder	Too high power out of sector	Found Spots for Cell MXB703B with direction 180°. 8 Spots found with a delta of direction to the larger than +/-45° and with a difference of normalized Rx power larger than -3dB (basis SweetSpot).
7301	MXB	48.1066	11.731	Cross Feeder	Too high power out of sector	Found Spots for Cell MXB730A with direction 60°. 4 Spots found with a delta of direction to the larger than +/-45° and with a difference of normalized Rx power larger than -3dB (basis SweetSpot).

Figure 5-22: Specific problem spots

Each problem spot has a list of causes that the analyzer module identifies and leading to the overall decision to mark that part of the measurement file. These causes can have the "High", "Medium" and "Low" priorities assigned to them, according to the importance that the analyzer module assigns to that spot. To show the list of causes, move the mouse cursor over a problem spot and let the Tooltip on that line appear. An example of the displayed ToolTip is shown in the following figure.

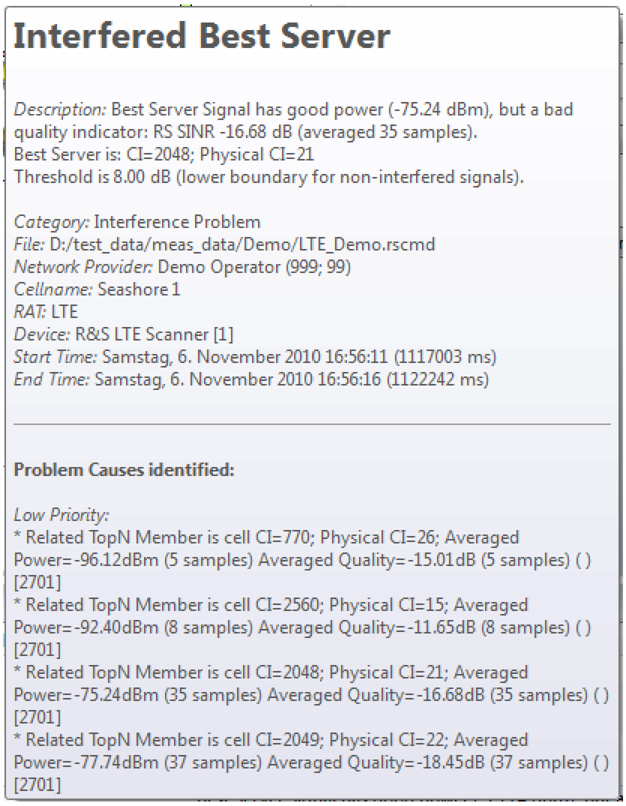


Figure 5-23: Tooltip of a specific problem spot

From a specific problem spot, it is possible to start an R&S ROMES4 instance directly. Instead, use the existing instance to show more details on this specific part of the measurement file. Details on this workflow can be found in the next section Drill-Down.

Call/Transaction lists

Besides the list of potential problems, call lists are also part of the analysis results. From these call lists, a drill-down analysis can be started in the same way as in the problem lists.

The columns in a call table depend on the kind of transaction shown in the table. Common to all are the columns "Result", "Start Time" and "End Time".

In the following sections, this type of result is referred to as "Call list".

5.3.2 Problem spot overview

Besides the table representation, problem spots are visualized in widgets where each file is depicted by a single line on a time chart.

The time chart is split into one column for each hour, and the problem spots are shown as red dots on the file lines. Using this type of view is helpful to find load-related problems.

Showing a bigger file set in such a view can show up problems occurring only in busy hours, for example.

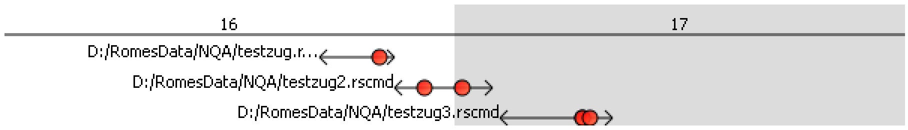


Figure 5-24: Problem spot overview - time chart

5.3.2.1 Coverage problem spot overview

The coverage problems can be seen in the TopN list of the "TopN Raster Element" view for each spot where the problem exists separately.

Double click the red highlighted square in the coverage map to open the associated list of measured TopN values for that problem spot. Each measured value is associated a colored square. Red color indicates a problem; see the following figure.

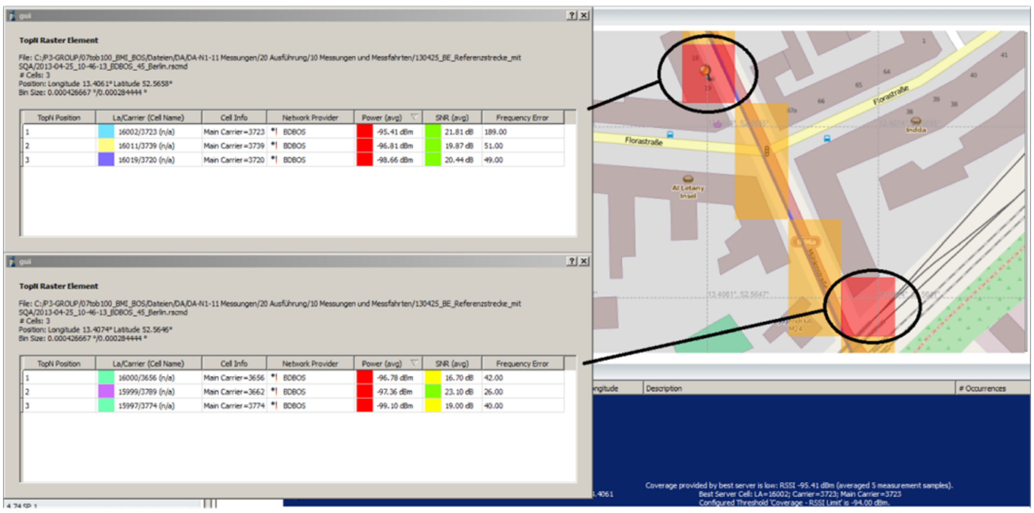


Figure 5-25: Problem spots selected for TopN

User is supposed to specify the minimum number of certain measurements exceeding the configured threshold to report the problem.

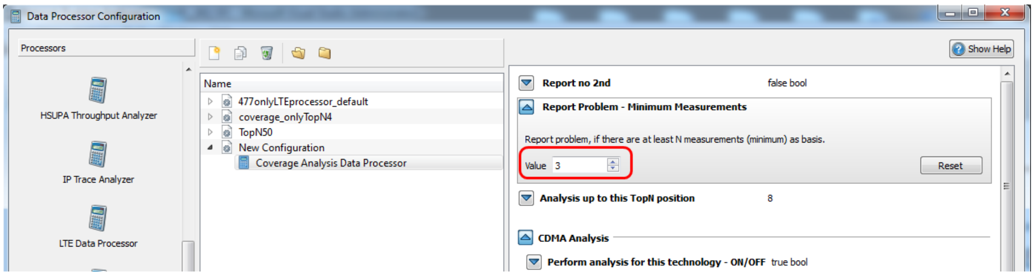
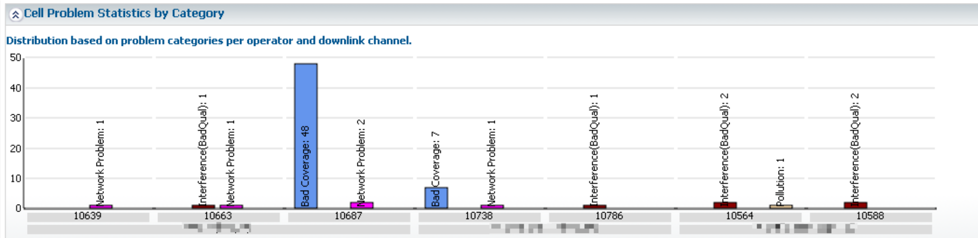


Figure 5-26: Setting for coverage problem reporting

5.3.2.2 Enhancements for coverage problem spots

There are two enhancements in the R&S ROMES4 NPA GUI to show the coverage problem spots. The enhancements are common for all technologies.

- "Cell Problem Statistics by Category"
  The statistics page improves the visualization and the workflow of scanner coverage problem spots. The total number of problem spots and the count per problem spot category is displayed per provider and channel/band in tabular form. The included bar chart shows the relation of the values.



Network Provider	Channel	Total Problems	Bad Coverage	[%]	Interference(BadQual)	[%]	Network Problem	[%]	Pollution	[%]
[redacted]	10564	3	0	0.0 %	2	66.7 %	0	0.0 %	1	33.3 %
[redacted]	10588	2	0	0.0 %	2	100.0 %	0	0.0 %	0	0.0 %
[redacted]	10738	8	7	87.5 %	0	0.0 %	1	12.5 %	0	0.0 %
[redacted]	10786	1	0	0.0 %	1	100.0 %	0	0.0 %	0	0.0 %
[redacted]	10639	1	0	0.0 %	0	0.0 %	1	100.0 %	0	0.0 %
[redacted]	10663	2	0	0.0 %	1	50.0 %	1	50.0 %	0	0.0 %
[redacted]	10687	50	48	96.0 %	0	0.0 %	2	4.0 %	0	0.0 %

Figure 5-27: Cell problem statistics

- "<TEC> Problem Spot Map"
  The map shows a problem with its geographical information. Here you can see the same number of problem spot icons like in the statistic table.
  There is no problem spots merging. The "Provider Filter" and the "Quick Filter" can be used for further investigations of a problem spot category.

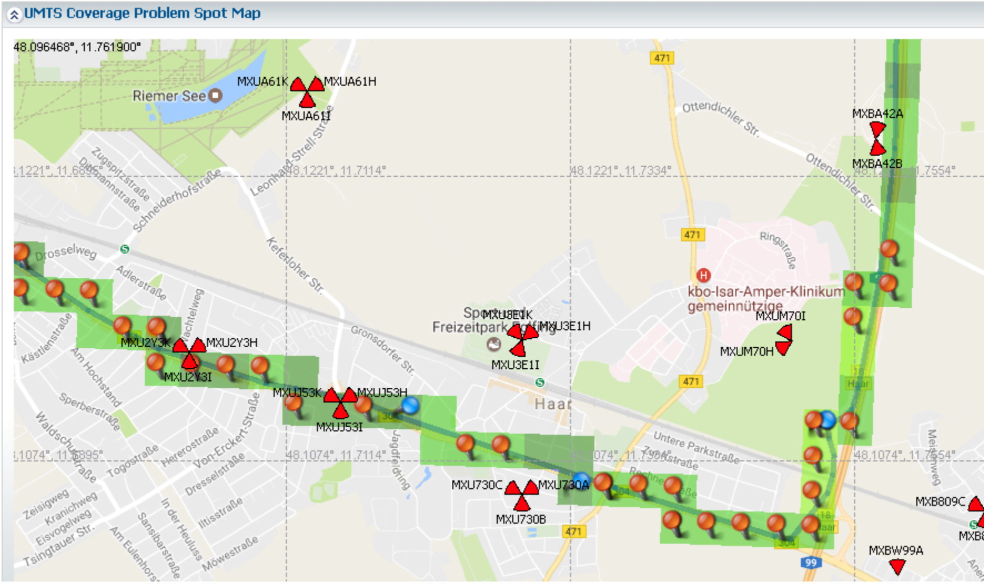
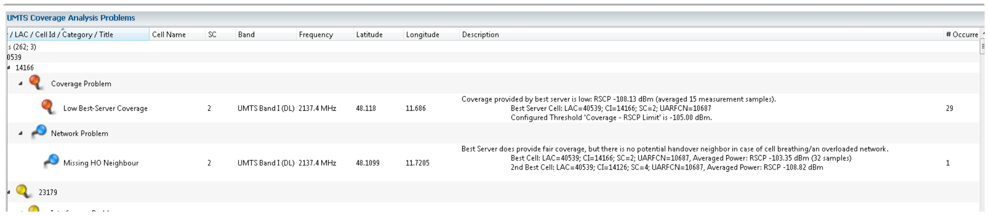


Figure 5-28: Coverage problem spot map - example

In the problem table in the following figure you can see the problems per operator, LAC and cell.

For each problem title, exists one row in the table describing the strongest problem. In the "Occurrences" column, the count of problems for a cell and problem title is available. With this information, your can find the cells with highest number of problems. With the "Context Filter" on the top, user can filter for single problem spot categories, see Chapter 4.5, "Filtering analysis results", on page 86. Click an element to synchronize the map and the table.



UMTS Coverage Analysis Problems

/ LAC / Cell Id / Category / Title	Cell Name	SC	Band	Frequency	Latitude	Longitude	Description	# Occurre
s (262; 3)								
0539								
14166								
Coverage Problem								
Low Best-Server Coverage		2	UMTS Band I (DL)	2137.4 MHz	48.118	11.686	Coverage provided by best server is low: RSCP -108.13 dBm (averaged 15 measurement samples). Best Server Cell: LAC=40539; CI=14166; SC=2; UARFCN=10687 Configured Threshold 'Coverage - RSCP Limit' is -105.00 dBm.	29
Network Problem								
Missing HO Neighbour		2	UMTS Band I (DL)	2137.4 MHz	48.1099	11.7205	Best Server does provide fair coverage, but there is no potential handover neighbor in case of cell breathing/an overloaded network. Best Cell: LAC=40539; CI=14166; SC=2; UARFCN=10687, Averaged Power: RSCP -103.35 dBm (32 samples) 2nd Best Cell: LAC=40539; CI=14126; SC=4; UARFCN=10687, Averaged Power: RSCP -108.82 dBm	1
23179								

Figure 5-29: Coverage problem spot map and table

5.3.3 Comparison mode

The problem spot tables do not support the "Delta" and the "Compare" mode of the data set comparison tool set. The problem here is that problems are detected on a per-file base and there is normally no meaningful way to compare single spots with each other.

6 Geographic view

Many drive test analysis procedures require a geographical display of the data. The R&S ROMES4 NPA can detect if a GPS device was a part of the measurement and shows the data in a map if such a device is detected. Problem spots, raster elements and cells are shown in the different configurations of the map, depending on the currently viewed analysis page.

Background data for the maps is requested from different raster image APIs, which provide, for example, the OpenStreetMap servers. Therefore, an internet-connection is necessary to get those map tiles for the first item in the "Background" pane. Once cached on the local file system, the "OpenStreeMap Street" map view can be used offline.

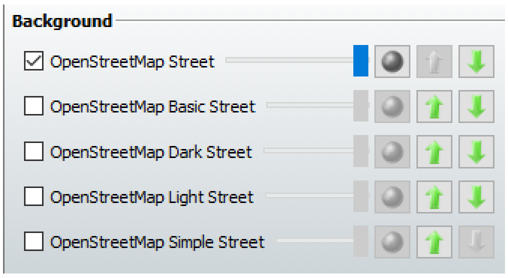


Figure 6-1: Supported OpenStreetMap maps

The four other offered OpenStreetMaps background data for maps come from the R&S MapsServer Studio, which is locally installed, so the upper condition is not needed. These four OpenStreetMap maps are Basic, Dark, Light and Simple.

Alternatively, it is possible to use MapInfo raster data files (`*.tab` or `*.gst`) as background layers. The usage of these files is especially useful to compare data from network planning tools with drive-test data or to avoid the need for an online connection. It is also required to show Indoor maps.

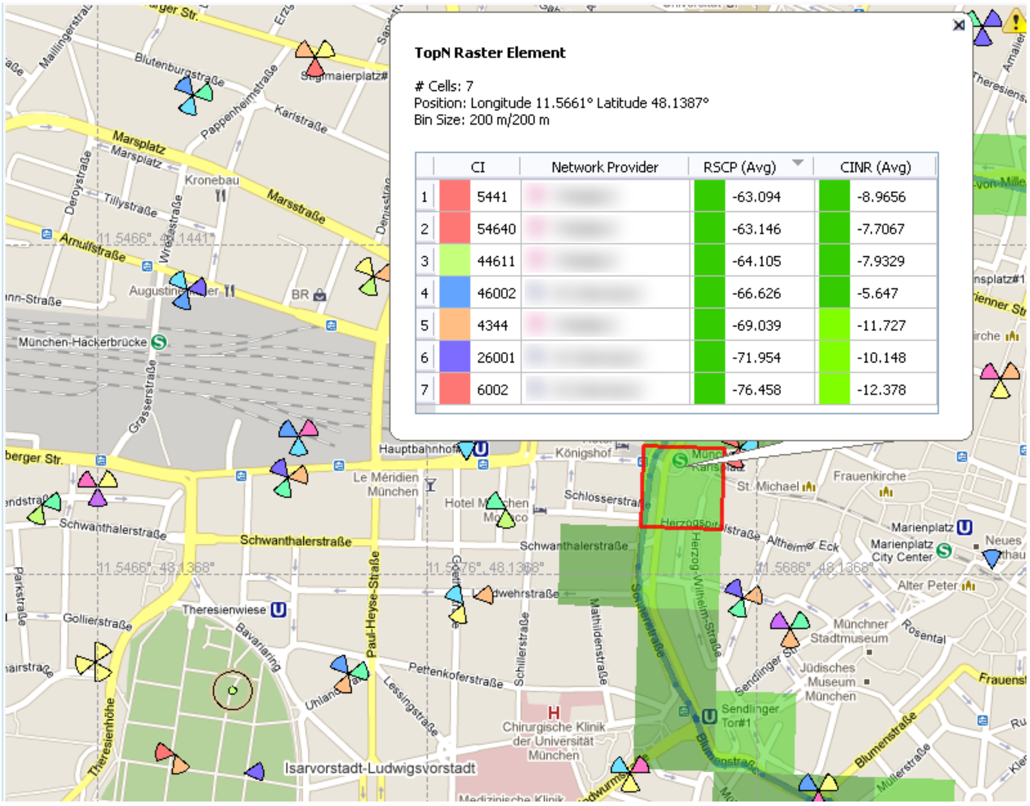


Figure 6-2: Geographic view

6.1 Simulated GPS with fixed position

The fixed position GPS simulator is an extension of the R&S ROMES4 NPA. It makes the analysis of measurements made with devices without connected GPS device (for example, mobile device test measurements) possible.

The simulator adds a fixed position to the analysis in case that during measurement no GPS position was recorded.

In this way, the R&S ROMES4 NPA can better analyze measurement files from test center measurements, for example, the mobile device performance measurements.

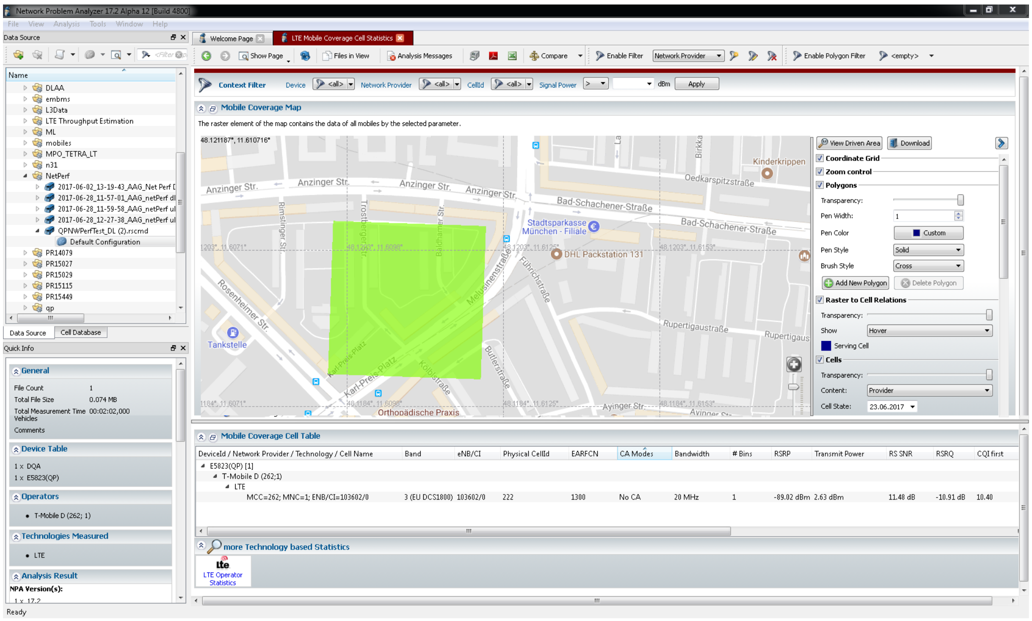


Figure 6-3: Mobile coverage analysis with GPS simulator

The R&S MCA plugin supports the bin-based data processing for such measurement files. This support includes MIMO and CA measurements with mobile devices. The hard-coded position simulator is like the GPS one the R&S ROMES4 uses (longitude: 11.611° / latitude: 48.12°).

Only the map is visible in the overview as the blue track-shape is not available with one position.

6.2 Map operations

When first displayed, the map view fits its content to the driven route track and displays a set of layers associated with the current analysis page. That initial content can be modified in various ways: The displayed area can be zoomed and moved, and the displayed data can be altered resp. the way it is visualized can be changed.

Operations on the map can only be performed with the mouse, there is no key control available for changing the position or the zoom level. The control resembles the way map data is handled in other popular tools like Google Earth™.

6.2.1 Zoom

There are three possible ways to change the zoom level.

- Double-click the map view with the left or right mouse button; the action causes the view to zoom-in (left button) or -out (right mouse button).

- Zoom control, if visible, can be used to zoom-in or zoom-out the R&S ROMES4 NPA analysis view map. Zoom check box marked in the following figure is used to hide or show the zoom control.

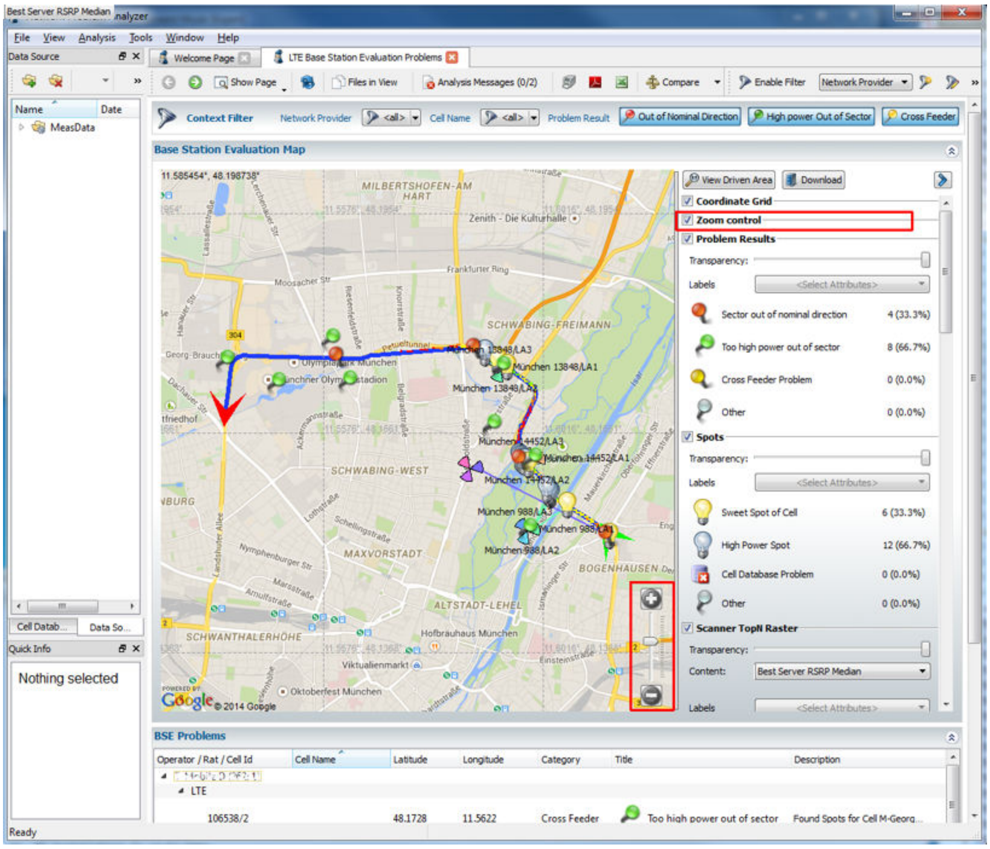


Figure 6-4: Zoom control

If "Zoom control" is checked, the zoom control is visible in a view map, as marked in the Zoom control. Otherwise it is invisible.

- Optionally the mouse wheel can be used to change the zoom level while hovering over a view map.

6.2.1.1 Navigate to selection and zoom-in

In the R&S ROMES4 NPA analysis view map an area can be selected to navigate it directly and zoom-in.

To mark an area, use the left mouse-button together with the SHIFT key. When the mouse-button is released, the R&S ROMES4 NPA automatically navigates to the selected area and the current zoom level is increased.

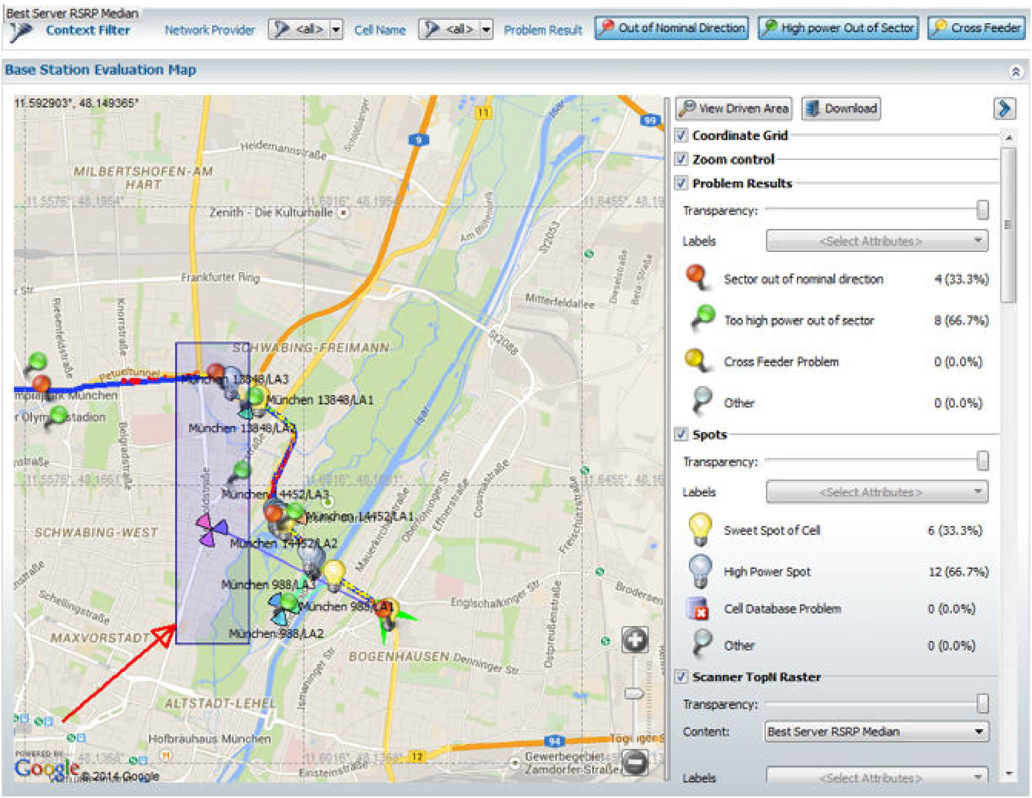


Figure 6-5: Selected area within NPA Analysis View Map

- To mark an area and select/deselect any bin/cell inside the area avoiding zoom-in, use left mouse-button + CTRL key
- To mark an area and zoom-in to the selected area, use left mouse-button + SHIFT key

6.2.2 Pan

By pressing and holding the left mouse button, the area displayed can be moved around.

6.2.3 Item details

Besides background map data and the track shape, the map view shows different items like cell sectors, raster elements and problem spots. Most of these items offer more information than their geographical position.

This information can be made visible by either moving the mouse cursor over the item and let the tool tip window pop-up, or by double-clicking on the item. The latter opens a bubble containing the same information as the tool tip, but formatted in a more convenient way. Such a bubble must be closed using the x-button in the upper-right corner to remove it from the view again.

6.2.4 Item selection

Cell items and problem spots support single and multi-selection to synchronize those elements in other widgets, like problem spot or call tables. Items are selecting simply by clicking them with the left mouse-button.

To add a single item to a selection, hold the CTRL key and select the additional item. A rectangular set of items can be selected by holding the SHIFT key, pressing the left mouse button at one corner and dragging the mouse to the opposite corner before releasing the button again.

Selected items are highlighted with a glow effect.

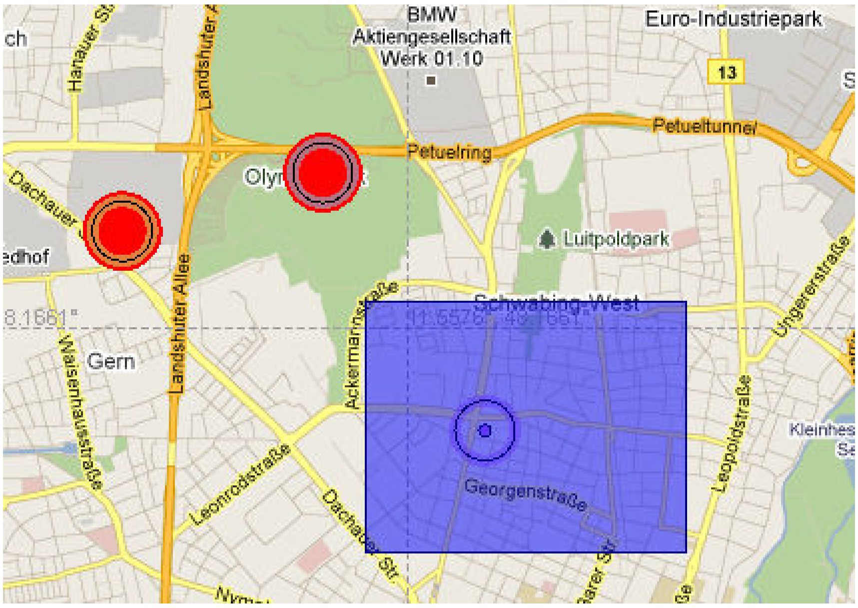


Figure 6-6: Item selection

In the screenshot above the currently selected cells are marked with the red fill state and the red border. A new selection is sized represented by the blue rectangle.

6.2.5 Explode effect

When multiple items are located at one position, those items "explode" to allow a unique selection then. For example, clicking in the middle of a tower explodes the three sectors so that each can be selected easily on its own.

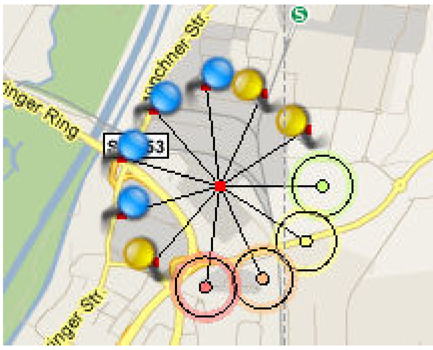


Figure 6-7: Explode effect

6.2.6 Legend

The map views legend is displayed at the right corner and hosts controls to modify the visualization of the layers in the map view. Also it offers some basic operators like resetting the view to the driven area, caching contents for offline operation and hiding or showing layers.

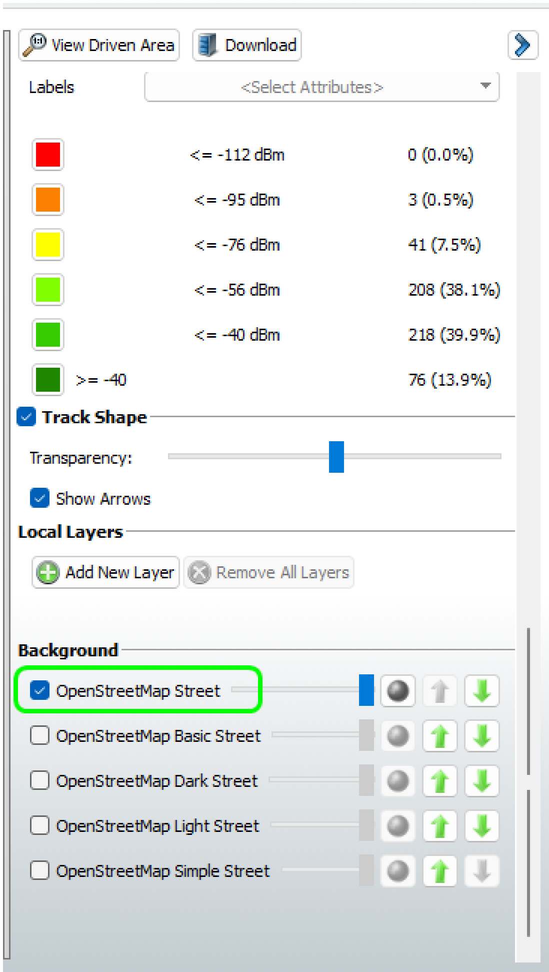


Figure 6-8: Map legend - overview

The possible modifications supported by a layer are described in the following section. Only operations not related to a specific layer are described, which also covers operations shared among all layers.

Hiding the legend

It is possible to hide the legend by dragging the line between the map view and the legend to the right-most boundary.

A hidden legend can be made visible by doing the opposite, i.e. dragging the line displayed at the right side back to the original position.

Alternatively, there is a button next to the "Download" button which can be used to hide the legend. Only the show legend button is visible on the top-left side of a map then. This button can be used to restore the legend after it has been hidden.

6.2.7 View driven area

The button "View Driven Area" resets the position and zoom level of the map view to show all track shapes in a box as small as possible.

6.2.8 Download

The map view caches the displayed map tiles on the hard-disk to reduce download capacities and to have them available when the computer has no internet connection. Since only those tiles are cached that have been displayed, it can be the case that there are many tiles missing when the NPA is used offline. To circumvent that behavior, it is possible to download all tiles in a given geographic area when online connection is available, storing them one the hard-disk for later usage.

That operation starts if selecting the "Download" button located at the top of the legend, see the following figure.

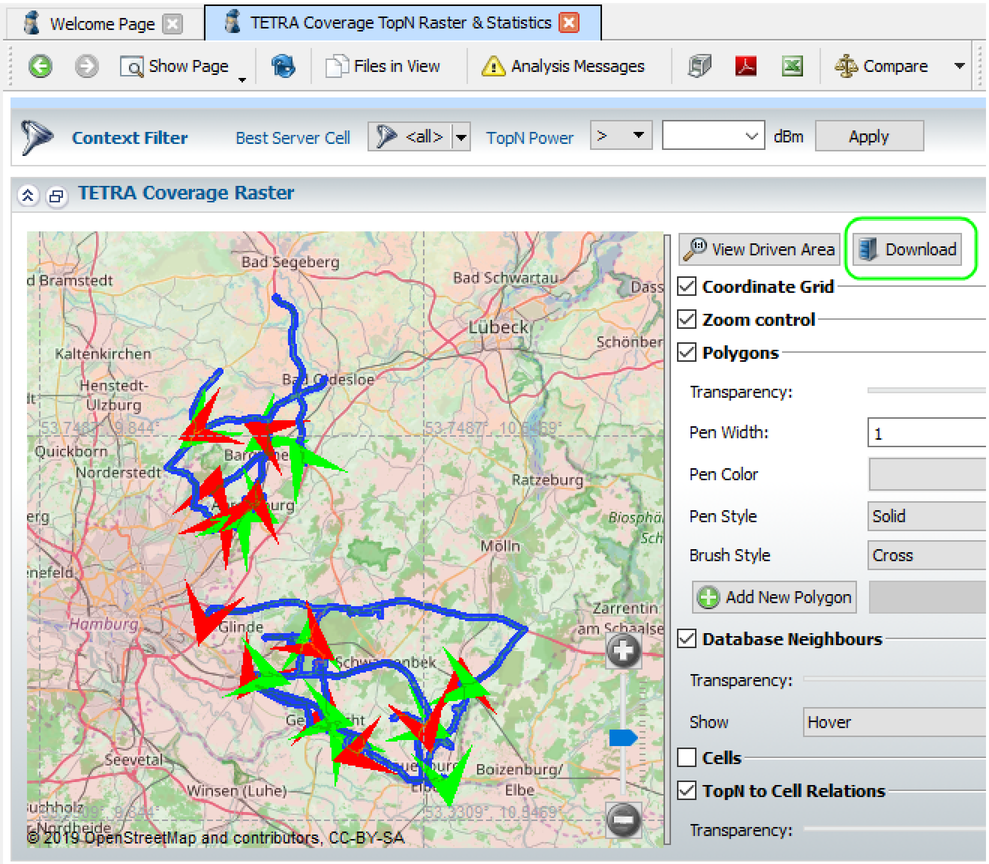


Figure 6-9: OpenStreetMap download button

As a result, a dialog is displayed providing means to define up to which zoom level data is to be downloaded. The higher the zoom level is set, the more space is required on the hard disk to store the tiles, and the longer the download.

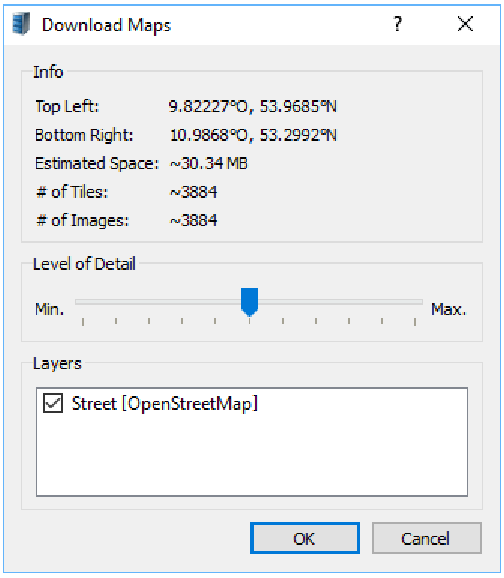


Figure 6-10: Download maps

Only the OpenStreetMap background layer is supported.

The download is limited to the maximum of 100 000 tiles.

6.3 Layers

Data is organized in layers in the geographic view. I.e. there can be different types of data displayed in one view at one time, for example, raster data and problem spots can be visualized simultaneously. The layers currently supported are explained below.

6.3.1 Visual configuration

The single layers offer different levels of influence on the visual appearance of the data. Some layers allow changing the palette used to color the contained objects, other provide different strategies of coloring or offer some kind of filter on the data. Details are described in the related layer section.

However, several layers use some kind of color table to visualize the data. There are different strategies to assign a color to an object, some of them supporting manipulation of the used thresholds, where the R&S ROMES4 NPA currently knows the following set:

- Interval to Color - used, for example, to color raster elements based on the received level or quality indicator. The intervals are defined by their upper threshold, and the lower boundary is defined by the upper boundary of the nearest smaller interval. These upper boundary thresholds can be edited.
- Network Operator to Color - Simply maps elements associated with a network operator to a color. The colors are extracted from the R&S ROMES Network Provider Database and can be edited in R&S ROMES4.

- Round-robin color tables - These tables contain a fixed set of colors, and each entry is dynamically assigned to a color. The first requested value is assigned to the first color, the second to the second and so on. When there are no more colors to be assigned, the first color is re-used again etc. This scheme is used to color data based on cell ids, for example.
- Icon Table - some tables do not map elements to colors, but to icons (small pictures). These icons are predefined and their configuration cannot be changed.

The translation table from a value to color is shown in the legend as well. The color associated with an entry can be modified by clicking the specific color button in the legend. The actual threshold can be entered only sometimes, in which the entry is highlighted when the mouse hovers over that entry.

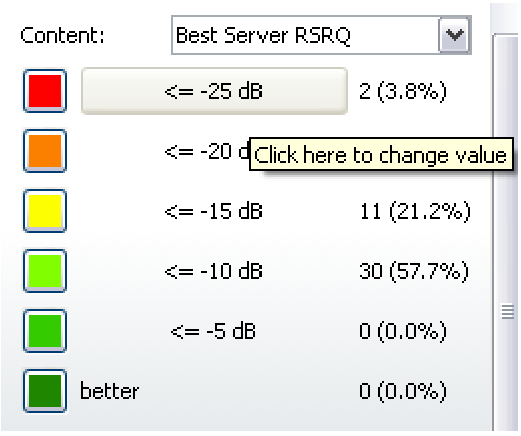


Figure 6-11: Translation table - value to color

Besides the actual mapping of colors/icons to legend entries, the distribution is also visualized in relative and absolute numbers.

The median values for the best server RxLev (GSM), RSCP (UMTS and CDMA), RSRP (LTE) and Power (TETRA) can be displayed on the geographical raster, if selected in the "Content" list box of the activated "Scanner TopN Raster". The following figure is an example for median value selection.

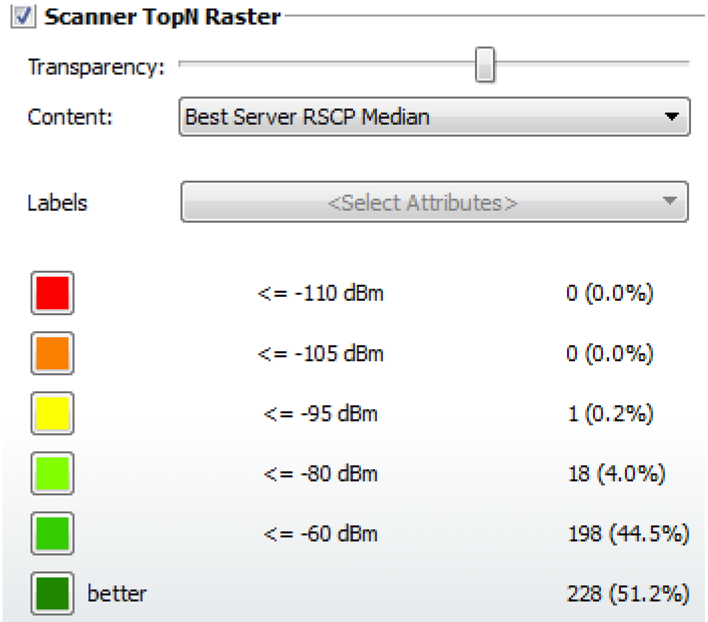


Figure 6-12: Selection of best server median value

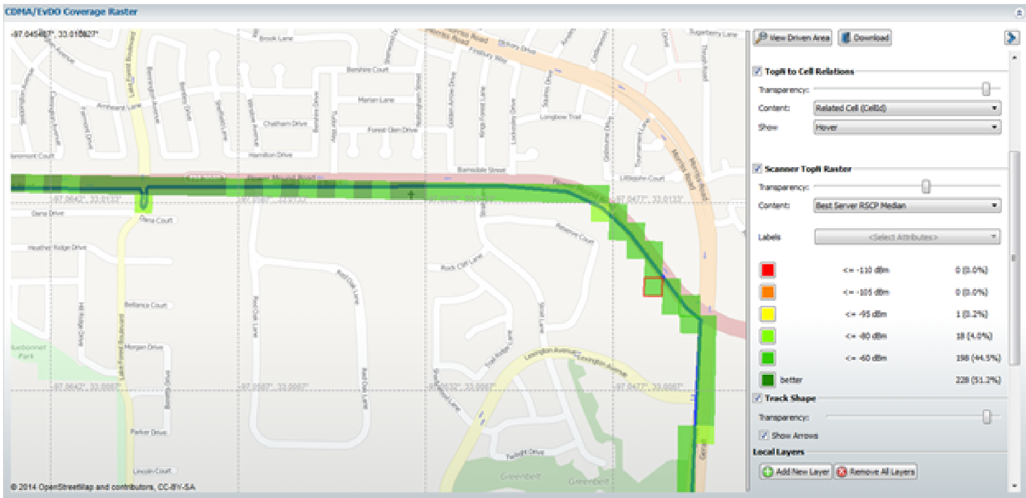


Figure 6-13: Coverage raster - median value

6.3.1.1 Calculation of average values in R&S ROMES4 NPA coverage raster

To make the calculation method clearer, the explanation is extended to a flexible series of values, for example RxLev.

The aggregation RxLevels takes place in the power domain, where the unit is Watt, not dBm.

If you want to calculate the average of two RxLevels values (Value_1 and Value_2) in dBm, you need first to linearize them, like shown in the following for n RxLev values:

W_1 = 10^(0.1*Value_1)

W_2 = 10^(0.1*Value_2)

W_3 = 10^(0.1*Value_3)

… W_n = 10^(0.1*Value_n)

Then you can build the average:

W_avg = (W_1+ W_2 + W_3 + … + W_n) / n

Finally, you can calculate the dBm value of the aggregation:

Value_avg = 10 * log10 (W_avg) [dBm]

6.3.2 Points of interest

The "Points of Interest" option lets you load your own points of interest (POI) into the R&S ROMES4 NPA map and check if the area was measured or not.

You can verify that important points or areas are covered by the drive test or not. The number of POI is limited to 1000. If in a `*.kml` file more than 1000 points are stored, only the first 1000 are displayed.

In the map legend there is the "Points of Interest" option. If checked, the transparency slider, the "Open a kml file" button and the green and red icons with the statistic in numbers and percentage are shown.

Click the "Open a kml file" button to load a `*.kml` file with user-specific POI in the map. The POI is visualized in the map layer.

Only the KML format files could be selected in the open file dialog. It is possible to store the name and a description of each POI in such a file together with the coordinates.

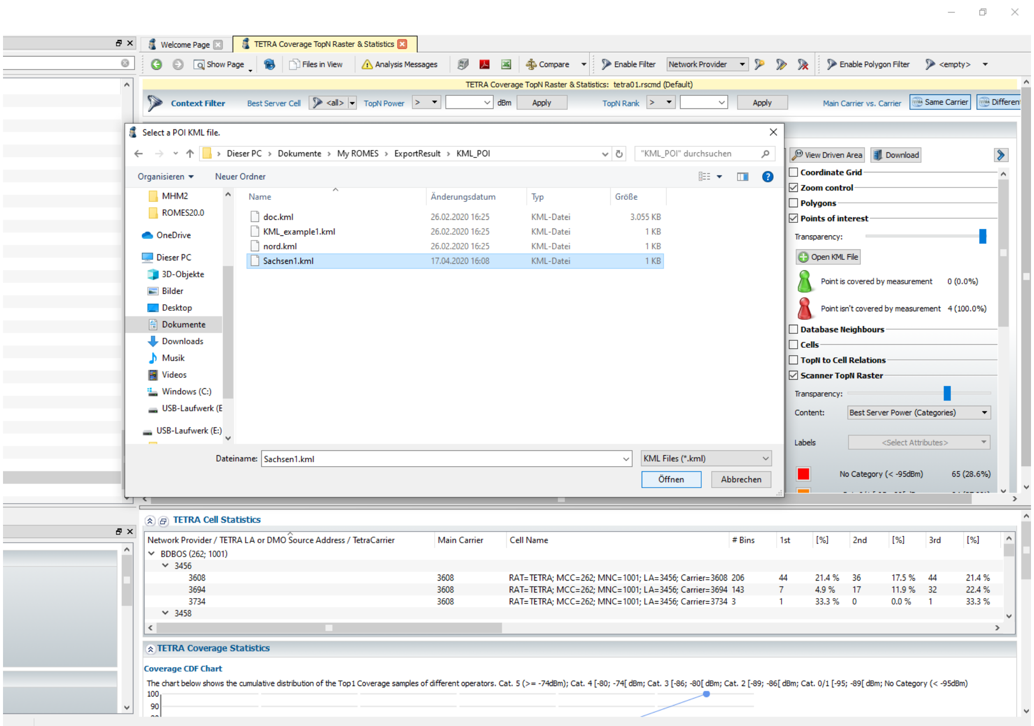


Figure 6-14: Loading kml file in the TETRA map view

The points from the imported file are visualized in the map as a green or red icon. The icon is green if the track shape of the measurement file is close to the POI. Otherwise, it stays red.

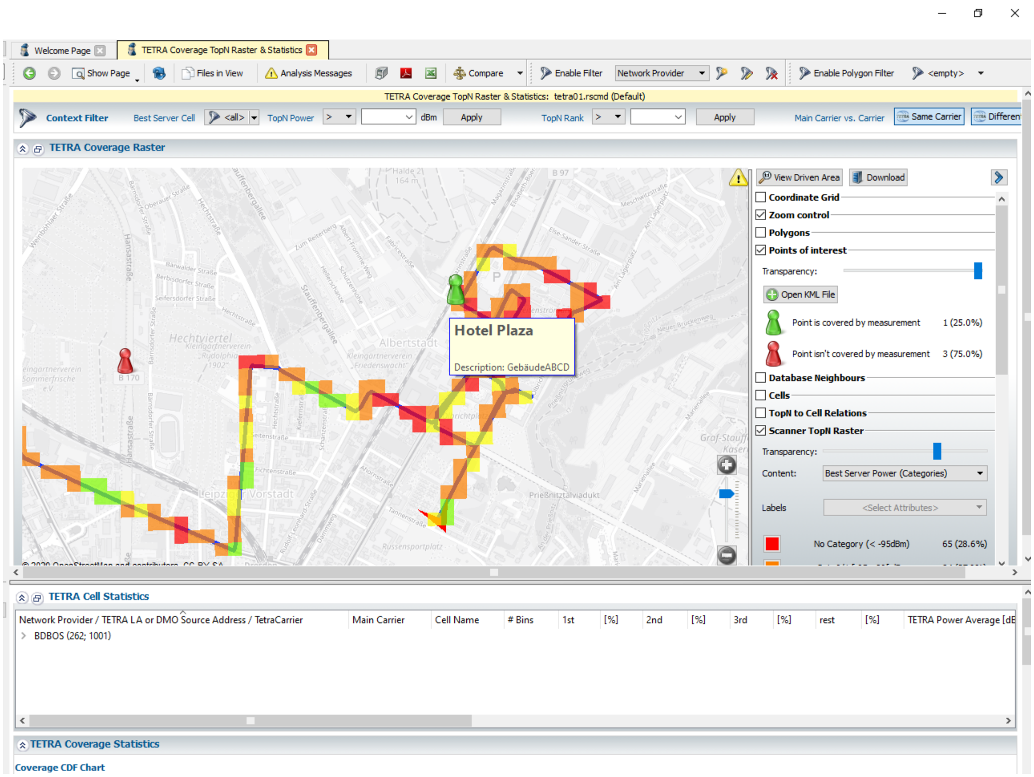


Figure 6-15: Track shape close to POI case

The name and description of a point are shown if hovering the mouse over POI icon.

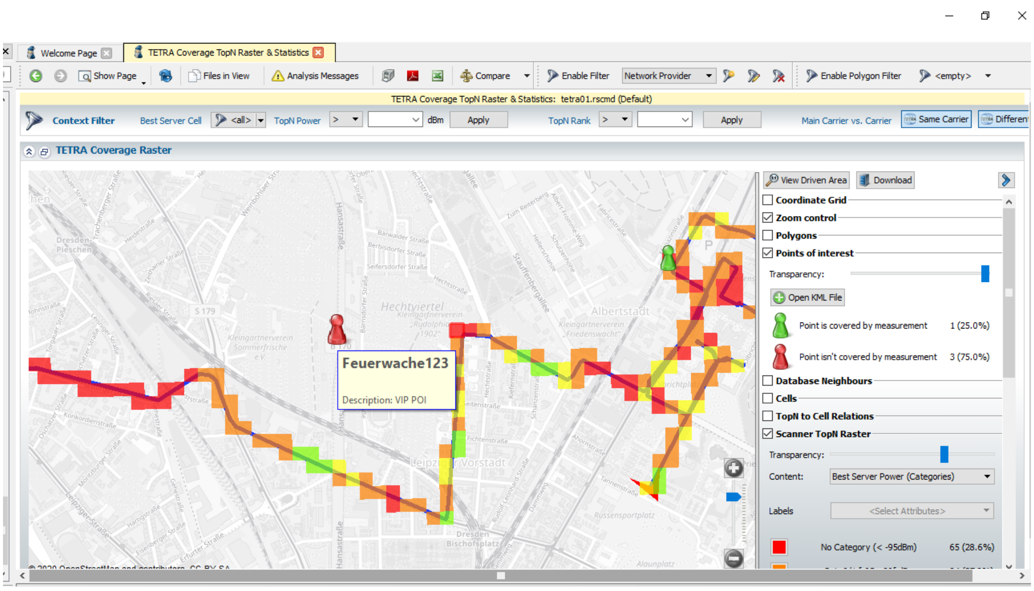


Figure 6-16: Track shape away from POI case

The default distance between the track shape and the POI for a green icon (means point is covered by measurement) is 300 m. In the "Tools" > "Preferences" > "Analysis" section you can setup the distance value between 1 m and 5000 m.

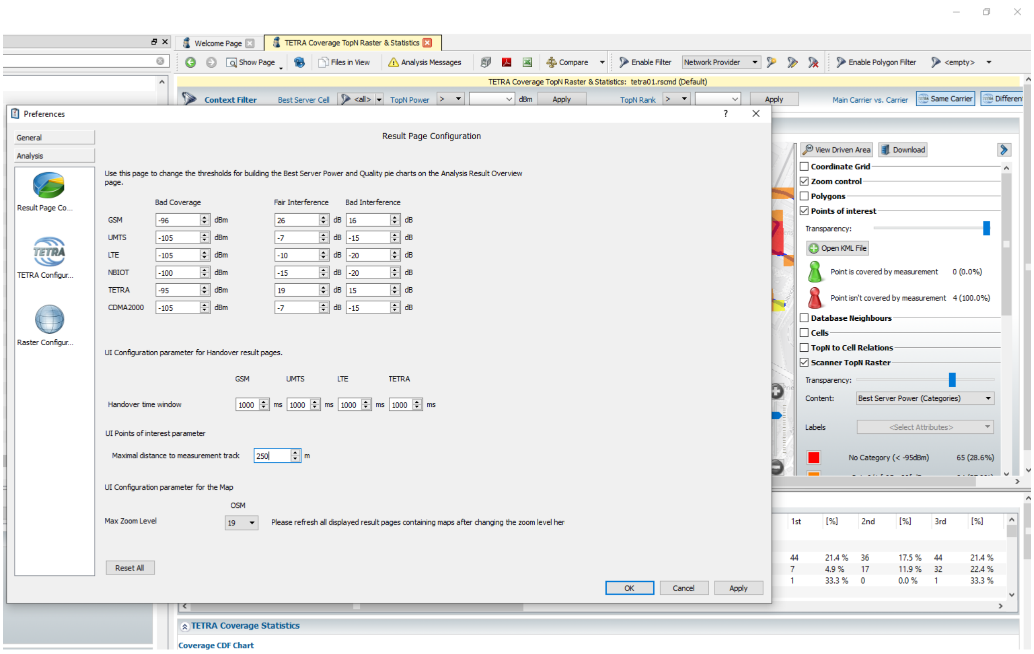


Figure 6-17: Result page settings

6.3.3 Background layer

The background of the map view always consists of some raster image data. This data can be requested from the company's OpenStreetMap developed servers named RSMapsStudio that provide access to a raster image data in a specific format. Several different default layers are preconfigured in the NPA, for example, the topographical layers.

Each of the available background rasters can be enabled or disabled by using the related check box in the map views legend. The order in which the layers are listed determines which layer is shown when more than one image is available at a specific tile. In that case, the top-most layer is painted. The order of the layers can be changed using the up and down arrows on the right-hand side of the related layer entry.

Besides the position in the list of background layers, each layer can be set to show its images in grey scale using the push button. The slider of a layer allows the transparency of that image layer to define in the same way as the foreground layers do.

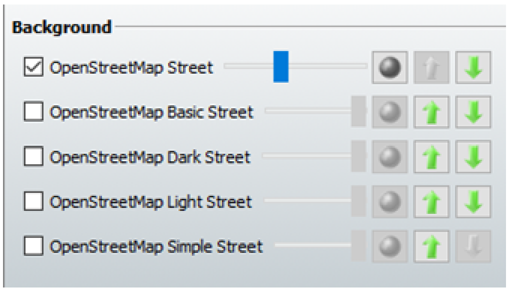


Figure 6-18: Background layer

6.3.4 Local raster image layer

Raster data from MapInfo `TAB` and `GST` files can be added to and removed from the geographic view at any time. To do so, the "Local Layer" section in the map legend offers control to add, remove and manage up to five background layers from raster image files.

`TAB` files must be referenced correctly to match exactly the other background layers. Referencing `TAB` files can either be done with MapInfo™ itself, or with the map referencing tool that accompanies the R&S ROMES installation.

Adding a new layer is done by first clicking the "Add New Layer" button in the "Local Layers" section of the map view legend.

In the file selection dialog shown afterwards, the `.tab` or `.gst` file that is to be added can be selected.

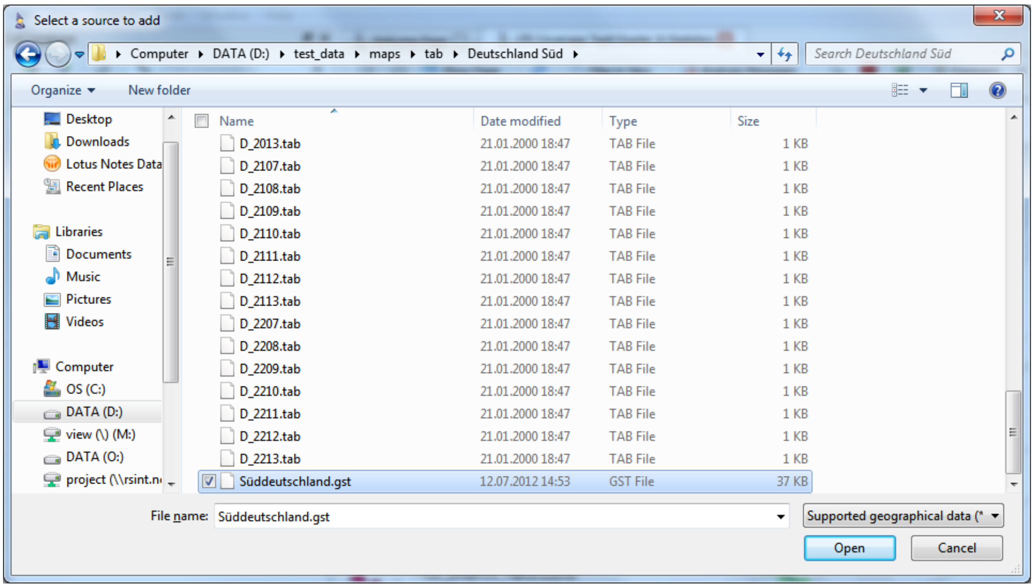


Figure 6-19: File selection dialog

Once selected, clicking "OK" starts a background import process into the local mapping servers cache of the selected file. That is done to improve the overall performance of large maps.

The first import step, which is indicated using a progress bar, is followed by a second preparation step. The second preparation step starts each time data is requested from the map view display. This processing can take some time. However, since the results are cached on the local hard disk, the processing is done only once per underlying raster map. It speeds-up after the first time a tile has been shown.

The temporary images are stored in the `%TEMP%\Geo.Map.Processing` folder. If there are large GST data sets, this directory contains lot of data over time. In that case, the whole folder can simply be deleted. The R&S ROMES4 NPA recreates the required temporary images if necessary.

After adding one or more layers, the data becomes visible in the map view as all other data. The order of local layers can be controlled using the up- and down arrows, as it is done in the background layers section.

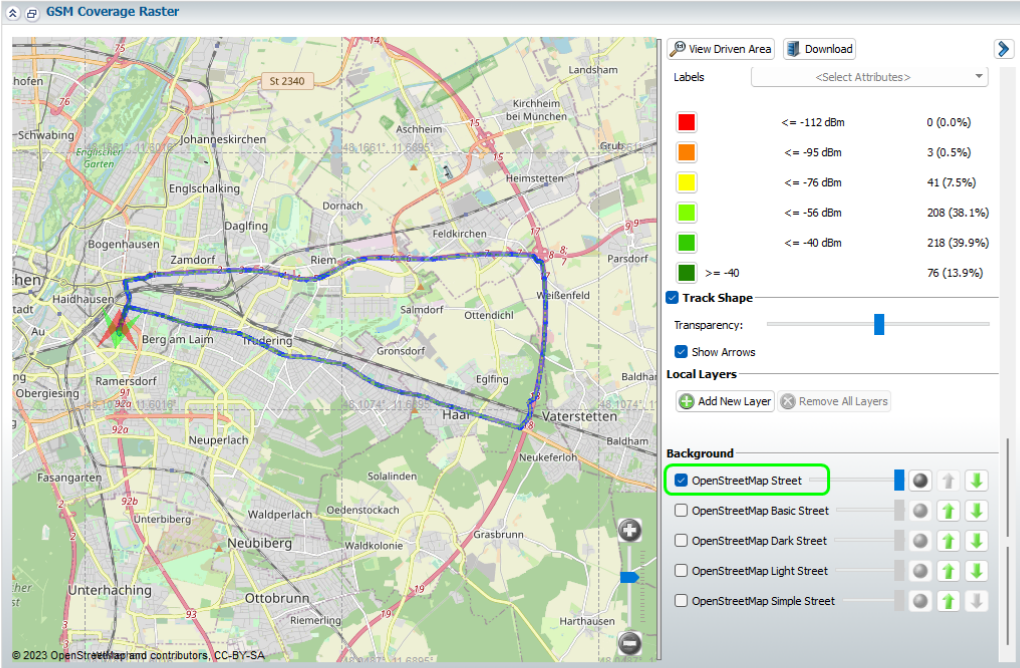
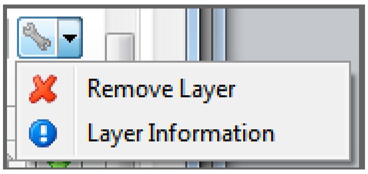


Figure 6-20: Local raster image layer

Some operations on the local layers are available using the drop-down menu available in the right-most button of a local layer.

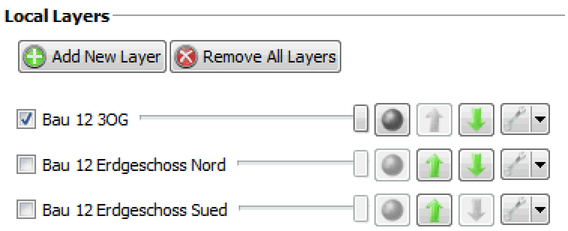


The context menu which is displayed offers the following functionalities:

- Layers can be removed using the button again.
- Layer information can be displayed using the button again.

The layers are deleted using the "Remove all Layers" button.

The additional map layers using the local maps in GeoTiff format (the TAB and GST) can be removed all together in one step by pressing the "Remove All Layers" button. The action is executed immediately, no dialog box for confirmation appears.



6.3.5 Track shape layer

One type of layer is dedicated to show a poly-line that approximates one or more driven routes of the currently displayed measurement files. The track shape is calculated on the GPS positions found, where only those positions are kept that are significant to show the overall route. That means, in some parts the shown route can slightly differ from the real route.

For each single drive test, the start and the end-points of the drive test are marked with green and red arrow.

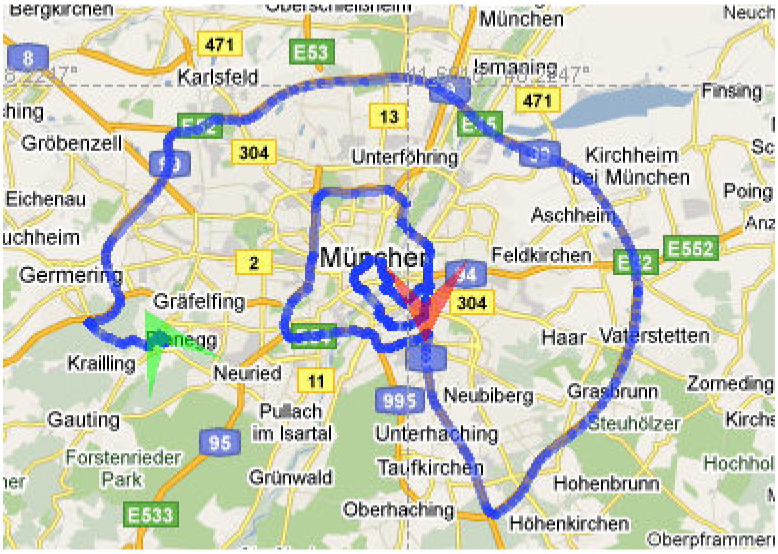


Figure 6-21: Track shape layer

6.3.6 Problem spot layer

The geographic location where a problem occurred can also be shown in the map if GPS was available in the measurement file. In that case each spot is marked with a pin of different color, where the color is normally related to the type of the problem (blocked/dropped call, for example).

Using the mouse a tool tip can be displayed that contains similar information as the one described in Problem Spot Lists. From the map view, it is also possible to open a context menu and synchronize an already active or newly started R&S ROMES4 to that problem area.

Synchronization

When a problem spot is selected, the related entry in a problem spot table in the same page is highlighted as well. In this way it possible to correlate the information of different views easily.

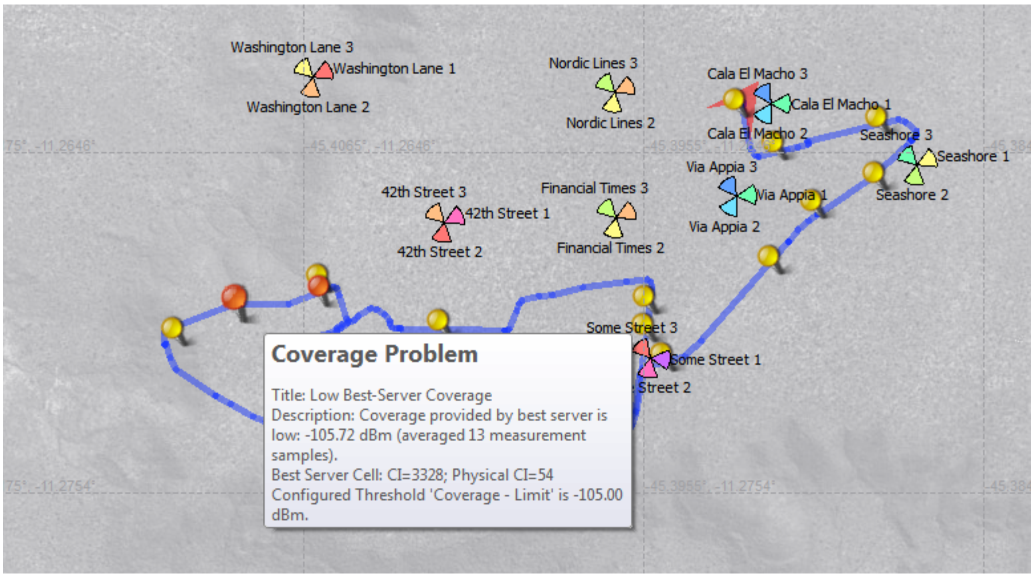


Figure 6-22: Problem spot layer

6.3.7 Raster data layer

The raster data layer shows geographically binned data. Often, the legend offers means to change the way the color of the elements is chosen. In the coverage analysis pages, for example, it is possible to paint the raster elements according to the best servers averaged power or quality value for that bin. Also it is possible to use the best servers cell id to choose a color from a round-robin color table.

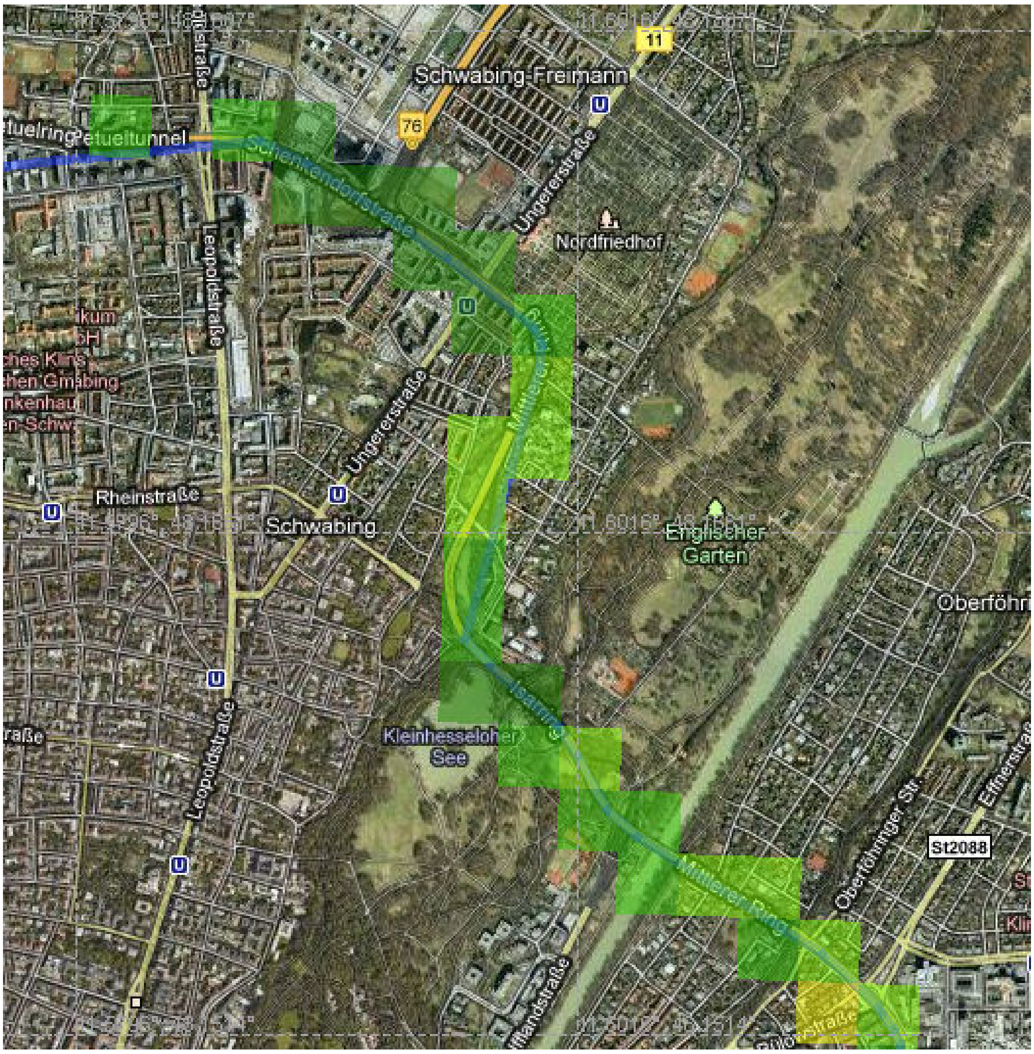
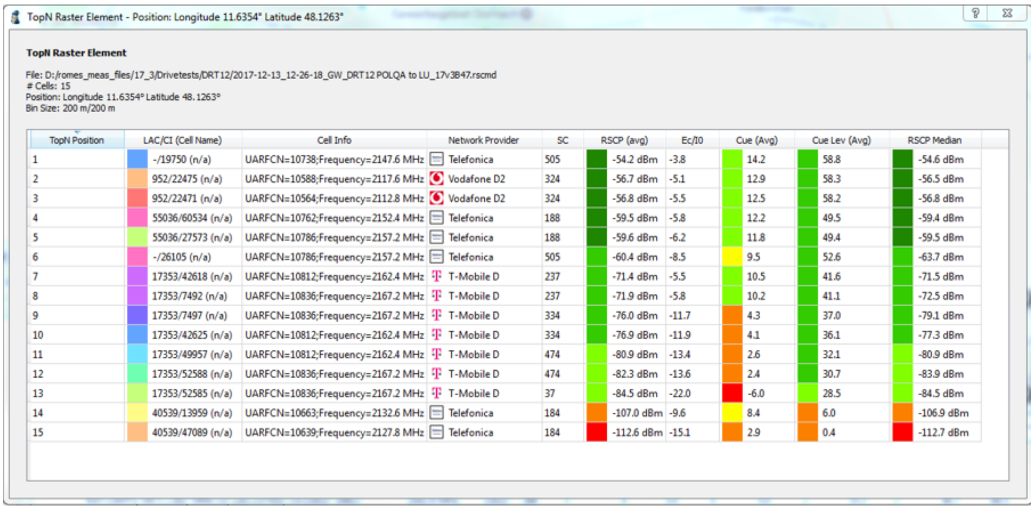


Figure 6-23: Raster data layer

Calculation details concerning the rasterization process are described in Raster configuration.

It is possible to paint both the raster data layer and cell data layer (see below) using the same color table. Choosing the cell id related color algorithm then leads to a simplified cell footprint analysis.

Double-clicking a raster element shows the enhanced information of the measurement data stored in that bin.


TopN Raster Element - Position: Longitude 11.6354° Latitude 48.1263°

TopN Raster Element

File: D:/romes_meas_files/17_3/Drivetests/DRT12/2017-12-13_12-26-18_GW_DRT12 POLQA to LU_17v3B47.rscmd
Cells: 15
Position: Longitude 11.6354° Latitude 48.1263°
Bin Size: 200 m/200 m

TopN Position	LAC/CI (Cell Name)	Cell Info	Network Provider	SC	RSCP (avg)	Ec/I0	Cue (Avg)	Cue Lev (Avg)	RSCP Median
1	-/19750 (n/a)	UARFCN=10738;Frequency=2147.6 MHz	Telefonica	505	-54.2 dBm	-3.8	14.2	58.8	-54.6 dBm
2	952/22475 (n/a)	UARFCN=10588;Frequency=2117.6 MHz	Vodafone D2	324	-56.7 dBm	-5.1	12.9	58.3	-56.5 dBm
3	952/22471 (n/a)	UARFCN=10564;Frequency=2112.8 MHz	Vodafone D2	324	-56.8 dBm	-5.5	12.5	58.2	-56.8 dBm
4	55036/60534 (n/a)	UARFCN=10762;Frequency=2152.4 MHz	Telefonica	188	-59.5 dBm	-5.8	12.2	49.5	-59.4 dBm
5	55036/27573 (n/a)	UARFCN=10786;Frequency=2157.2 MHz	Telefonica	188	-59.6 dBm	-6.2	11.8	49.4	-59.5 dBm
6	-/26105 (n/a)	UARFCN=10786;Frequency=2157.2 MHz	Telefonica	505	-60.4 dBm	-8.5	9.5	52.6	-63.7 dBm
7	17353/42618 (n/a)	UARFCN=10812;Frequency=2162.4 MHz	T-Mobile D	237	-71.4 dBm	-5.5	10.5	41.6	-71.5 dBm
8	17353/7492 (n/a)	UARFCN=10836;Frequency=2167.2 MHz	T-Mobile D	237	-71.9 dBm	-5.8	10.2	41.1	-72.5 dBm
9	17353/7497 (n/a)	UARFCN=10836;Frequency=2167.2 MHz	T-Mobile D	334	-76.0 dBm	-11.7	4.3	37.0	-79.1 dBm
10	17353/42625 (n/a)	UARFCN=10812;Frequency=2162.4 MHz	T-Mobile D	334	-76.9 dBm	-11.9	4.1	36.1	-77.3 dBm
11	17353/49957 (n/a)	UARFCN=10812;Frequency=2162.4 MHz	T-Mobile D	474	-80.9 dBm	-13.4	2.6	32.1	-80.9 dBm
12	17353/52588 (n/a)	UARFCN=10836;Frequency=2167.2 MHz	T-Mobile D	474	-82.3 dBm	-13.6	2.4	30.7	-83.9 dBm
13	17353/52585 (n/a)	UARFCN=10836;Frequency=2167.2 MHz	T-Mobile D	37	-84.5 dBm	-22.0	-6.0	28.5	-84.5 dBm
14	40539/13959 (n/a)	UARFCN=10663;Frequency=2132.6 MHz	Telefonica	184	-107.0 dBm	-9.6	8.4	6.0	-106.9 dBm
15	40539/47089 (n/a)	UARFCN=10639;Frequency=2127.8 MHz	Telefonica	184	-112.6 dBm	-15.1	2.9	0.4	-112.7 dBm

Figure 6-24: UMTS TopN raster element

As for coverage raster layer, shown is the "TopN Raster Element" table containing the list of the TopN cells measured at particular location. The segment direction of the antenna during a cell measurement is aggregated in the NPA and added to the "Cell Info" column of the table using the "Panorama Measurement" feature. The feature applies to scanners of GSM, UMTS, LTE, CDMA2000 and TETRA RATs.

The "TopN Raster Element" table contains columns which provide detailed view. For LTE and UMTS, implemented is the functionality of sorting the table properties. For UMTS and LTE, added is the column SC and PCI respectively. The "Cell Info" column of the "TopN Raster Element" table shows a cell's carrier frequency in MHz for all technologies.

The power and quality scanner measurements are aggregated without direction, before the start of the Panorama Measurement or after it. An example of the measurement is shown in Figure 12-123.

6.3.8 Cell data layer

If data is loaded into the cell database, appropriate data is automatically loaded from there when measurement data is displayed. When loading the data, data is used from the technology related to the currently displayed data. Only those cells are shown that are within the extended minimum bound rectangle of the drive test (extended by approximately 30 km in each direction). Initially, the date of the newest measurement file is put into the cell state edit field.

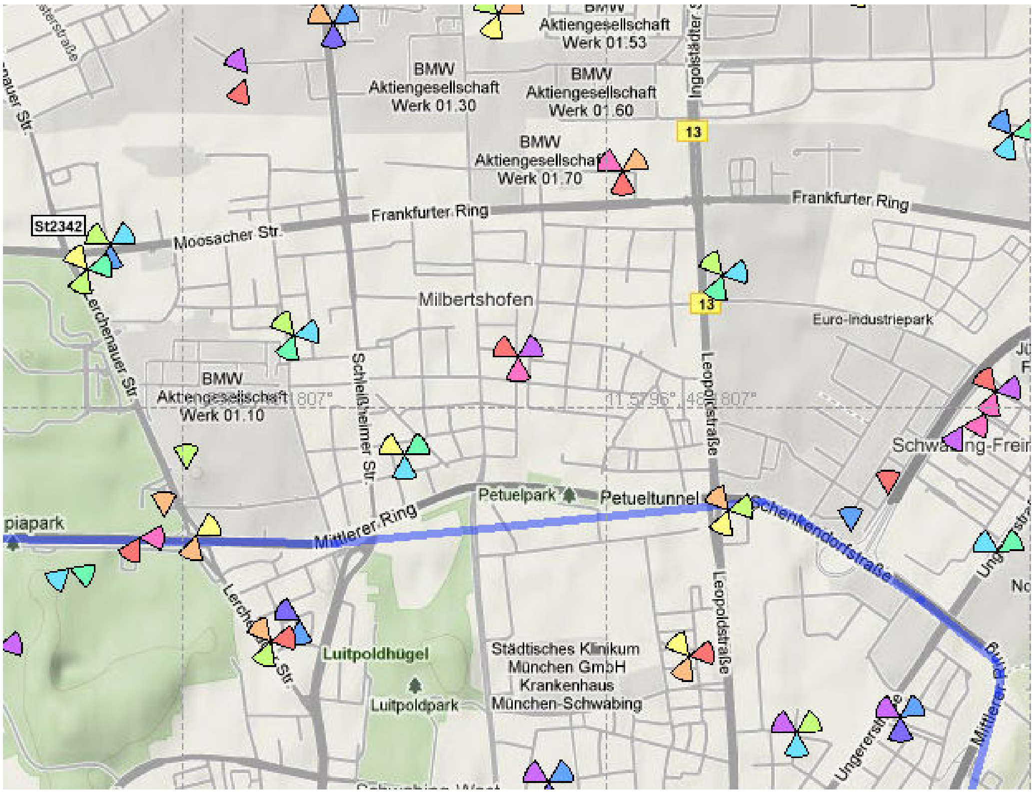


Figure 6-25: Cell data layer

Double-clicking on a sector shows a bubble containing enhanced information on the selected elements. It shows basically the same information as the tool tip displayed for the same item.

Cells are painted in two different styles, depending on whether they are directed cells or omnidirectional ones.

- Directed cells are painted as pies oriented in the main beam direction, like these ones .
- Omnidirectional cells are painted as circles, like this one .

Synchronization

Selecting cell synchronized other controls like tables and the cell database tree to the current cell selection. I.e. items that relate to the selected cells is highlighted in other widgets if possible. Note that not all other controls synchronize to the cell information. For example, pie and bar charts is not highlight related cell data.

6.3.9 Neighbor relations layer

When selecting cells, the neighbors associated with that cells are connected to the selected cell through lines. The neighbor relations are either read from the cell database, or they can be the result of the Neighborhood Analyzer and indicate potential neighbor entries or inconsistencies with the database.

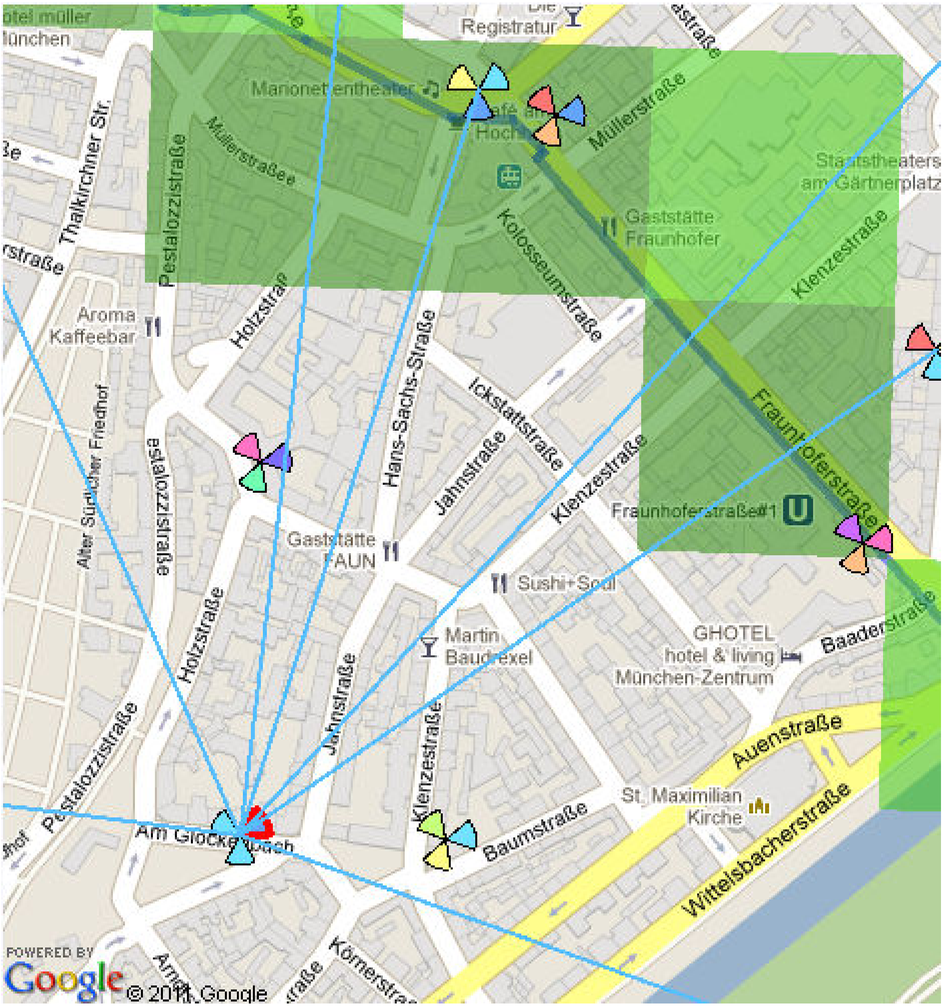


Figure 6-26: Neighbor relations layer

6.3.10 Link layer

As a more generic form of the neighbor relation layer described above, the link layers purpose is to connect entities in the map that belong together in some way. For example, handover events detected by the handover analyzer and the related cell data can be linked together with two lines, one to the source and one to the destination cell.

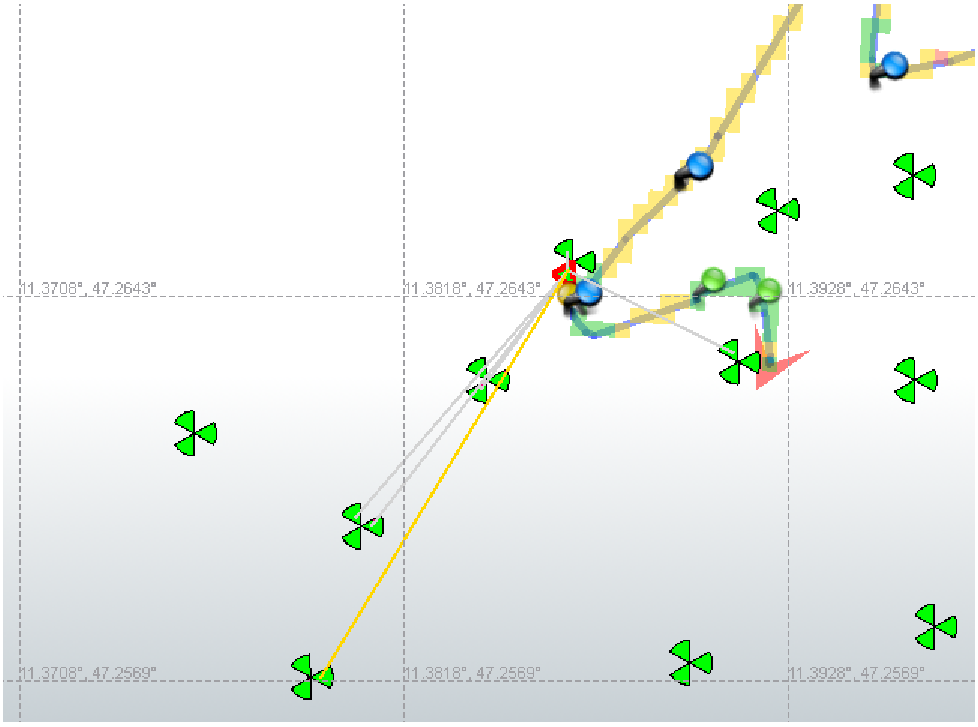


Figure 6-27: Link layer

Most of these layers offer some kind of painting option, i.e. how the lines are colored can be modified in a similar way to the raster layers. Besides that color chooser, these layers also offer the option to define when the lines are to be drawn.

For the latter option, the following list describes the offered strategies:

- Select - Lines are painted when the user selects one of the involved elements. The lines are shown until the selection is modified. In this mode a synchronization of the view has influence on the selection shown, so synchronizing the map view with a table also changes the displayed lines.
- Hover - Lines are painted for each element that is found beneath the current cursor position. The line display changes frequently when the mouse is moved.
- Always - Shows all lines at once, leading to a state where the set of displayed lines does not change.

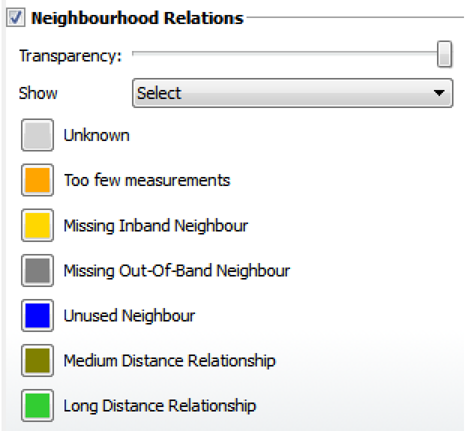


Figure 6-28: Neighborhood relations

6.4 Data set comparison

Data set comparison in the map view mainly concerns the raster layers described above, since those raster layers are the most important visualizers for measurement data. All other layers, like cell layer, do not explicitly support the comparison mode (yet), or at least do not offer specialized functionality while the comparison mode is active.

6.4.1 Delta mode

Value comparison

A delta comparison is performed on a per-bin (raster element) basis. The value compared is determined by the selected painter, which normally exists for the standard values like power, SNR, quality indicators and so on. As long as the delta comparison is active, the legend is changed. The result of the delta comparison (right value - left value) is colored as shown in the table below.

Color	Title	Description
red	Worse	The value is lower in the left data set.
gray	Unchanged	Values are similar in both data sets.
green	Improved	The value is higher in the right data set

In case where a painter not only selects the value, but also the element of a list in the bin (as it is the case in the scanner coverage views, where normally the best server is used in the painter), the element is chosen separately for each data set. In other words, the right and left data set are treated as single results, and in the case described above the best server is selected from within each list. That means that in case two operators are compared, the power of each best server of the related operator is used to get the values for the comparison.

Element comparison

Sometimes it can be of interest to compare the actual existence of an element in the one or the other data set. In some views, this comparison can be visualized using the "Change" painter entry in the legend. This entry uses a different palette for painting the color of a bin, which is described below.

Color	Title	Description
green	New	No value in the left data set
orange	Disappeared	No value in the right data set
blue	Improved	Both data sets have a value, but the right one is higher
yellow	Degraded	Both data sets have a value, but the left one is higher
gray	Unchanged	Both data sets contain the same value
purple	Changed	Both data sets contain a different value, but there is no meaningful comparison (greater/less than) possible

ToolTip

In the ToolTip window, the left and the right data set value is shown on a separate line, if the comparison mode is active. In the case where multiple items would be shown (as in the N15 Coverage Raster), the top-most entry of each list is chosen, as the painters would do.

6.4.2 Compare mode

A comparison mode is not supported by the map view, since it is hardly possible to show two visualizations on the same geographic location in a meaningful way.

7 Chart view

Key Performance Indicators (KPIs) are visualized using either Pie Charts or Bar Charts in the NPA. Most of the time, these visualizations will provide some overview to make decisions easier whether to further look into the details or not. In some cases, a more detailed version of the page adds further grouping criteria to the charts to provide a finer insight into the dataset.

7.1 Bar charts

Bar charts can be used to easily compare a small set of KPI values grouped into a few categories. The standard display for bar charts is to show an absolute amount of a counter assigned to some grouping criteria. Each series displayed is colored in the same style, for example, all good calls in the sample below are filled with a green gradient.

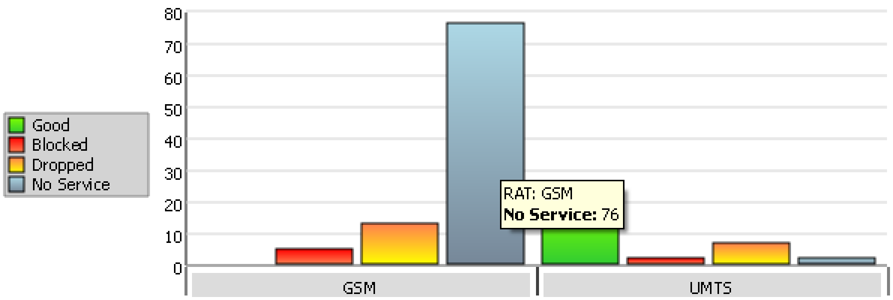


Figure 7-1: Chart View - Example: Bar Charts

Comparing data in bar charts is done depending on the mode. In most cases, this means that the y-axis is extended to show negative values as well.

7.1.1 Data set comparison - delta mode

The result of the subtraction of the values from the data sets simply enforces the y-axis to be able to show negative values as described above, and that is the main difference when bar charts are shown in the delta mode. Negative values normally mean that the related value is greater in the left data set (or missing completely in the right). When a value is missing in one of the data sets, it is interpreted as 0.

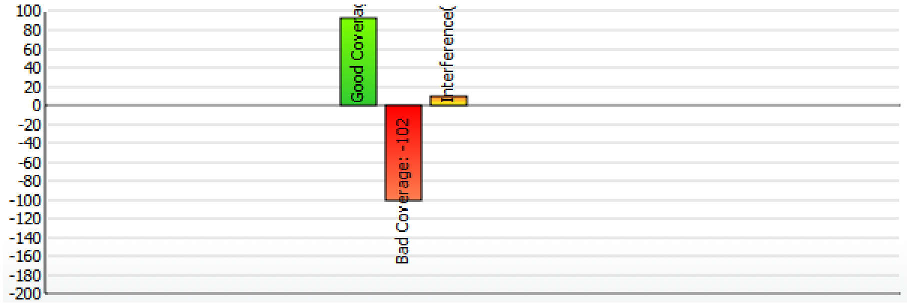


Figure 7-2: Bar Charts: Data Set Comparison - Delta Mode

7.1.2 Data set comparison - compare mode

The compare mode uses the "negative" part of a bar chart (the part below the x-axis) to display the results from the left data set, and the "positive" (=upper) part of the chart for the right data set. Those sections are then explicitly shown using appropriate background labels, as can be seen in the figure below.

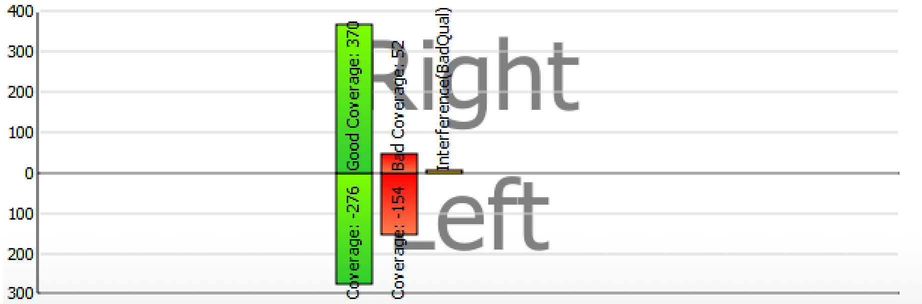


Figure 7-3: Bar Charts: Data Set comparison - Compare Mode

Bar charts can also be stacked, which normally implies that data is displayed relatively to compare the relation within one group. In the sample shown below, the same underlying data as in the figure above is used, but the display is quite different.

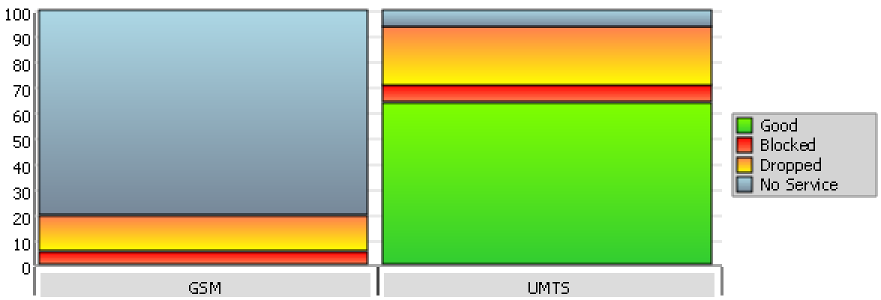


Figure 7-4: Bar Charts: Stacked

7.2 Line charts

Line charts are a way to focus the changes of values between the different categories, in comparison to the bar charts that focus more on the distribution within one category. As shown below,

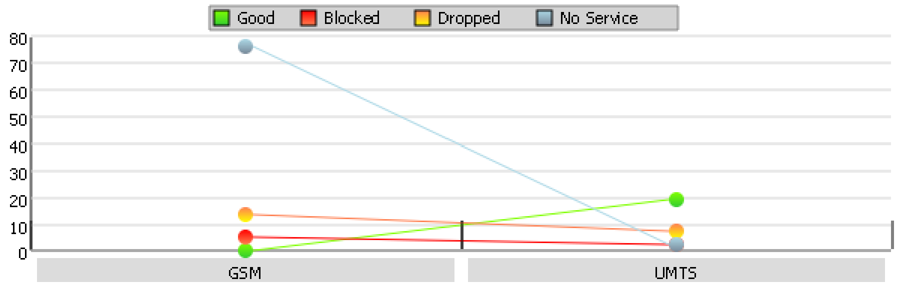


Figure 7-5: Chart View - Example: Line Charts

7.3 Pie charts

Pie Charts give a quick overview of a simple KPI relation, for example the general call result. Pie Charts do not support multiple layers (as the other chart types do), so for each different set of attributes (like GSM and UMTS results) a separate pie charts is shown.

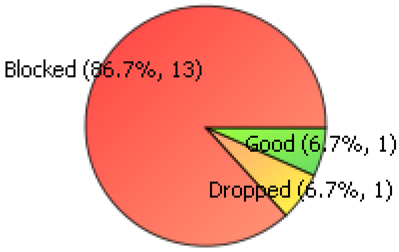


Figure 7-6: Chart View - Example: Pie Charts

Visualizing differences in a pie chart enforces a new way of depicting negative values, and even more requires some practice to understand that technique. The same also applies for the comparison mode, which is a more accessible but also different from the standard way of showing a pie chart.

7.3.1 Data set comparison - delta mode

The delta mode display is best described by an example, which is depicted below. In that example, the delta calculation resulted in a difference of -30 in the category "Bad", -5 in "Slightly Fair" and +48 in "Good". The negative values are shown with smaller segments, which are also painted above a dark gray background. The percentages are calculated over the overall sum of all absolute values, which would be 83 in that case (30+5+48), as is the angle covered by a segment.

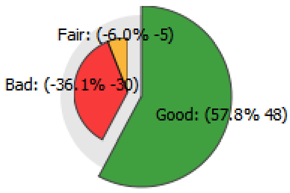


Figure 7-7: Pie Charts: Data Set Comparison - Delta Mode

The actual meaning of the chart above is that the overall number in both "Bad" and "Fair" classes decreased from left to right data set, and that the number of "Good" increased significantly. The overall charts does NOT tell about the absolute numbers of both sets, i.e. if one of the sets only contains few overall values, an overall increase or decrease might be shown, although the sets are not really comparable. Such information is better shown in the compare mode visualization explained next.

7.3.2 Data set comparison - compare mode

The two data sets are painted on the left resp. the right half of a pie chart in the compare mode. In that way it is not only possible to compare the distribution within one set, but also the number of overall values in both sets. In that way one can easily spot if two data sets are hardly comparable in the case where one set outnumbers the second by far.

The sample shown below is operates on the same data sets as the delta mode sample shown above. In this view it can be seen that the overall number of samples in each set is in the same dimension, but the distribution has completely changed. The latter has also been shown by the delta mode, whereas the former was not visible.

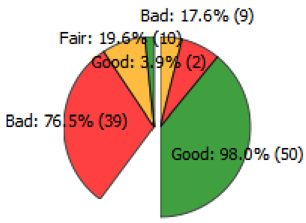


Figure 7-8: Pie Charts: Data Set Comparison - Compare Mode

7.4 Scatter plots

Scatter plots (also known as X-Y-graphs) show the correlation between two parameters. Both parameter values define the x and y coordinate in the grid used for the graph, and the actual value painted is the occurrence of that specific value pair. In the NPA, the size of the circle painted to represent a tuple is determined based on the relative amount of instances where that pair has been found, compared to both minimum and maximum occurrence. The color used to paint a value is either determined in the same way or based on the color assigned to a specific data series (if multiple series are shown).

These charts are used to derive the correlation between two parameters. By statistical terms, two values are related if there is a clear line from the lower left corner of the chart to the upper right corner. Two values are unrelated if the scatter plots looks like a random distribution of points, and two values are negatively correlated if the main occurrences form a line from the upper left corner to the lower right one.

An example of such a scatter plot is shown in the picture below, where RSRP and CINR are used for the x and y axis.

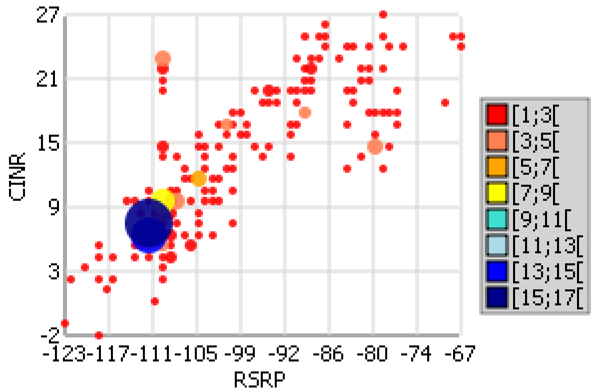


Figure 7-9: Chart View - Example: Scatter Plots

The scatter plot supports both comparison modes. However, it is recommended to use the compare mode in nearly all cases, since it is easier to understand and provides the correlation lines of both datasets, whereas the delta mode cannot show a single correlation line.

7.4.1 Data set comparison - delta mode

The delta mode shows negative values with a red border around the circles. The radius of the circle is determined by the minimum and maximum value of the delta calculation. In most cases, the result is pretty similar to the one of the compare mode - as long as the two data sets are disjunctive, the only difference are the missing correlation lines and the different colorization technique. If however two data sets share some points, the delta display can show those differences better than the compare mode. In the sample below two distinct sets are shown.

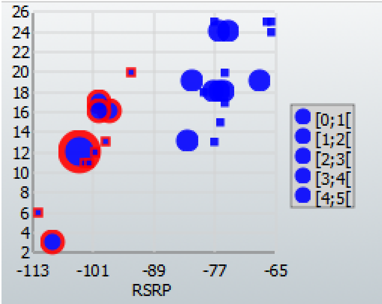


Figure 7-10: Scatter Plots: Data Set Comparison - Delta Mode

7.4.2 Data set comparison - compare mode

Comparing scatter plots on a per-value basis is a time-consuming and difficult task. In most cases the change in the correlation is of a much higher importance than the per-value comparison. Therefore, the scatter plot shows both correlation lines for the left and right data set. The scatter plots for each data set is then painted with different colors for left (gray) and right (blue).

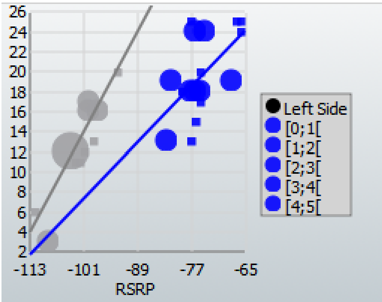


Figure 7-11: Scatter Plots: Data Set Comparison - compare mode

8 Tree view

Tree views are an alternative to tables used to represent hierarchically organized data. They present the data in a more natural way than a table. A tree view set of lines always contains the same data in the first N cells (i.e. the actual elements of the hierarchy). The neighborhood analysis result, for example, used to show the neighbor relations between a server and its neighbor and the server information, is shared between those neighbors.

LTE Cell Statistics

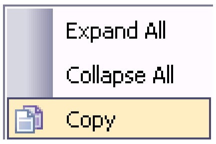
Network Provider / Cell Name	CI	PhyCI	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	RSRP Min	RSRP Avg
Demo Operator (999; 99)													
Washington Lane 3	2306		34	3	8.8 %	12	35.3 %	8	23.5 %	11	32.4 %	-127.3 dBm	-110.1 dBm
Via Appia 3	3074		16	0	0.0 %	4	25.0 %	4	25.0 %	8	50.0 %	-114.8 dBm	-83.0 dBm
Via Appia 2	3073		13	6	46.2 %	4	30.8 %	0	0.0 %	3	23.1 %	-105.5 dBm	-69.4 dBm
Some Street 3	4098		41	10	24.4 %	15	36.6 %	6	14.6 %	10	24.4 %	-124.9 dBm	-93.2 dBm
Some Street 2	4097		56	15	26.8 %	10	17.9 %	10	17.9 %	21	37.5 %	-119.3 dBm	-87.7 dBm
Some Street 1	4096		56	7	12.5 %	5	8.9 %	15	26.8 %	29	51.8 %	-126.7 dBm	-81.5 dBm
Seashore 2	2049		23	5	21.7 %	6	26.1 %	0	0.0 %	12	52.2 %	-113.8 dBm	-67.9 dBm
Seashore 1	2048		30	3	10.0 %	7	23.3 %	7	23.3 %	13	43.3 %	-117.8 dBm	-76.4 dBm
Riverside 1	2560		61	7	11.5 %	8	13.1 %	20	32.8 %	26	42.6 %	-120.8 dBm	-86.0 dBm
Financial Times 3	4610		24	0	0.0 %	1	4.2 %	3	12.5 %	20	83.3 %	-123.4 dBm	-108.1 dBm
Financial Times 1	4608		49	0	0.0 %	23	46.9 %	19	38.8 %	7	14.3 %	-127.2 dBm	-108.7 dBm
Ceasars Palace 3	3330		48	21	43.8 %	13	27.1 %	4	8.3 %	10	20.8 %	-127.3 dBm	-88.4 dBm
Ceasars Palace 2	3329		46	11	23.9 %	11	23.9 %	13	28.3 %	11	23.9 %	-123.3 dBm	-90.2 dBm
Ceasars Palace 1	3328		70	49	70.0 %	15	21.4 %	1	1.4 %	5	7.1 %	-119.5 dBm	-88.7 dBm
Cala El Macho 3	770		28	7	25.0 %	3	10.7 %	2	7.1 %	16	57.1 %	-120.4 dBm	-82.1 dBm
Cala El Macho 1	768		11	1	9.1 %	1	9.1 %	4	36.4 %	5	45.5 %	-106.6 dBm	-72.9 dBm

Figure 8-1: Example of Cell Statistics

Besides the different visualization, the remaining part of the tree view elements show the same information as the formerly used tables which they replace. They offer the same set of actions to work with the data contained in those tables. Some subtle differences are there nevertheless. For example, sorting elements in a tree does not work as in the table view.

Context menu

The tree view offers the following options in the context menu:



- Expand All - Completely expands the tree to show all elements.
- Collapse All - Completely collapses all root elements in the tree to show only elements in a list.
- Copy - Copies the content of the selected elements to the clipboard as text (tab separated)

Export to Excel

When tree views are exported to Microsoft Excel, they are exported as plain tables again. Such an export is done because there is no adequate way to represent that data in Excel and to simplify further manual processing tasks.

8.1 Data set comparison

In each tree view, rows have a unique key which identifies them in the tree. That key consists of the values in all parts of the path that leads to that specific row. Based on that unique key, two data sets can be compared in the data set comparison mode.

Ast rows are compared by their key, there can occur three different cases related to the existence of one item:

- The item is available in both data sets
- The item is available only in the left data set - it disappeared
- The item is available only in the right data set - it is a "New" item.

In the former case where an item is present in both left and right dataset, it is possible to compare the current cell values of both sets with each other. This comparison can lead to three different comparison results:

- The value is the same in both data sets
- The value in the left data set is higher - it therefore degraded in the right data set
- The value in the right data set is higher - it therefore improved compared to the left data set.

These 5 different cases are then shown in the tree view using colors and icons per row or cell, depending on the type of comparison applied. The table below summarizes those colors and icons.

Color	Icon	Title	Description
green		New	No value in the left data set
orange		Disappeared	No value in the right data set
blue		Improved	Both data sets have a value, but the right one is higher
yellow		Degraded	Both data sets have a value, but the left one is higher
gray		Unchanged	Both data sets contain the same value

Depending on the selected mode (delta or compare), the values are differently displayed in the cells. In the delta mode, the actual difference between the right and left value is shown (positive values indicate a higher value in the right set). In the compare mode both values are shown, separated by a "->" sign.

An example where most of the previously mentioned cases occur is shown in the figure below.

Network Provider / LAC / Cell Name	CI	BCCH ARFCN	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	RxLev Mi
Deutsche Bahn GSM-R (262; 10)												
7054												
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=1000	1000	973	12 (12 ->)	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	12 (12 ->)	100.0 ->	-113.8 ->
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=1006	1006	955	-21 (45 -> 24)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	1 (0 -> 1)	0.0 -> 4.2	-22 (45 -> 23)	100.0 -> 95.8	-114.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=1407	1407	963	1 (1 ->)	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	1 (1 ->)	100.0 ->	-99.9 ->
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=141	141	958	-132 (253 -> 121)	3 (2 -> 5)	0.8 -> 4.1	4 (6 -> 10)	2.4 -> 8.3	-3 (4 -> 1)	1.6 -> 0.8	-136 (241 -> 105)	95.3 -> 86.8	-111.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=143	143	968	-140 (257 -> 117)	0 (3 -> 3)	1.2 -> 2.6	-4 (5 -> 1)	1.9 -> 0.9	2 (5 -> 7)	1.9 -> 6.0	-138 (244 -> 106)	94.9 -> 90.6	-113.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=158	158	969	-40 (68 -> 28)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	-40 (68 -> 28)	100.0 -> 100.0	-115.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=346	346	960	-62 (108 -> 46)	0 (0 -> 0)	0.0 -> 0.0	2 (0 -> 2)	0.0 -> 4.3	0 (0 -> 0)	0.0 -> 0.0	-64 (108 -> 44)	100.0 -> 95.7	-114.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=4340	4340	964	-110 (204 -> 94)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	2 (0 -> 2)	0.0 -> 2.1	-112 (204 -> 92)	100.0 -> 97.9	-118.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=4518	4518	970	-132 (242 -> 110)	4 (6 -> 10)	2.5 -> 9.1	-6 (8 -> 2)	3.3 -> 1.8	-1 (4 -> 3)	1.7 -> 2.7	-129 (224 -> 95)	92.6 -> 86.4	-117.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=538	538	971	-14 (31 -> 17)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	-14 (31 -> 17)	100.0 -> 100.0	-111.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=551	551	973	-22 (59 -> 37)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	-22 (59 -> 37)	100.0 -> 100.0	-118.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=553	553	961	6 (6 ->)	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	6 (6 ->)	100.0 ->	-104.8 ->
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=554	554	955	-58 (86 -> 28)	2 (0 -> 2)	0.0 -> 7.1	1 (0 -> 1)	0.0 -> 3.6	-2 (2 -> 0)	2.3 -> 0.0	-59 (84 -> 25)	97.7 -> 89.3	-118.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=555	555	960	-89 (149 -> 60)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	-89 (149 -> 60)	100.0 -> 100.0	-118.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=855	855	956	-96 (172 -> 76)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	0 (2 -> 2)	1.2 -> 2.6	-96 (170 -> 74)	98.8 -> 97.4	-118.
RAT=GSM; MCC=262; MNC=10; LAC=7054; CI=856	856	964	-45 (60 -> 15)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	-45 (60 -> 15)	100.0 -> 100.0	-113.
7055												
RAT=GSM; MCC=262; MNC=10; LAC=7055; CI=105	105	958	2 (-> 2)	0 (-> 0)	-> 0.0	0 (-> 0)	-> 0.0	0 (-> 0)	-> 0.0	2 (-> 2)	-> 100.0	-> -104.1
RAT=GSM; MCC=262; MNC=10; LAC=7055; CI=1392	1392	969	2 (2 ->)	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	2 (2 ->)	100.0 ->	-101.4 ->
RAT=GSM; MCC=262; MNC=10; LAC=7055; CI=144	144	965	15 (15 ->)	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	0 (0 ->)	0.0 ->	15 (15 ->)	100.0 ->	-113.6 ->
RAT=GSM; MCC=262; MNC=10; LAC=7055; CI=308	308	961	-76 (126 -> 50)	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	0 (0 -> 0)	0.0 -> 0.0	-76 (126 -> 50)	100.0 -> 100.0	-118.
E-Plus (262; 3)												
32119												

9 KPI view

Displaying KPI data is done through bar and pie charts within the NPA. However, some of the most important KPIs also need some classification whether they are good or not. The classification is done within the so-called KPI Labels that show a traffic light indicator helping to grasp quickly the meaning of a certain KPI value.

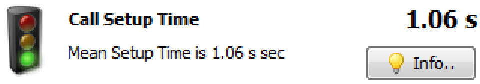


Figure 9-1: KPI Label

In nearly all cases, the KPI Label uses a traffic light to show easily the state of some KPI value. The red, yellow or green lights are shown depending on the actual value being part of one of three intervals, which are pre-defined and can be shown using "Info" in the lower right corner of the widget.

Pressing "Info" shows a dialog similar to the one below.

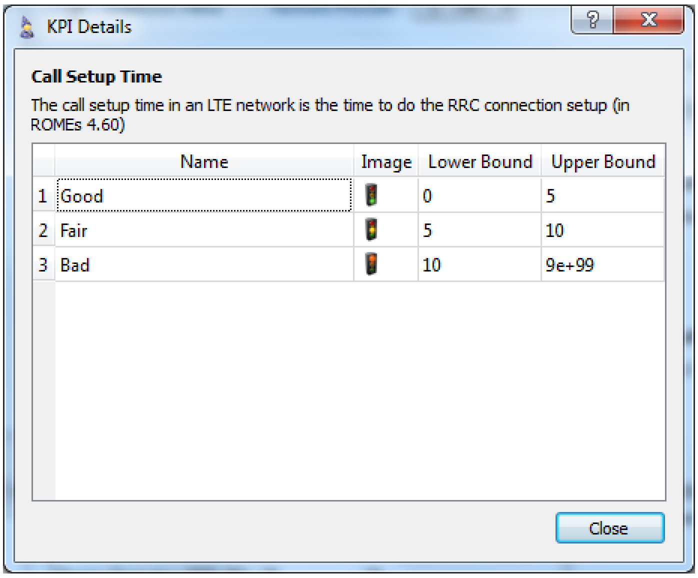


Figure 9-2: KPI Details

9.1 Data set comparison

When the data comparison mode is turned on, the visualization of the KPI view changes significantly to show the compared data properly. The main difference between the delta and comparison mode is the way that the KPI value is depicted. Most parts of the widget however are the same in both modes.

The traffic light indicator is moved to show both indicators for left and right data set separately. The overall tendency between these two values is shown as the main indicator, using an arrow. The arrow points upwards if the value of the right set is greater than the left one or downwards if vice versa. If both values are nearly the same, the arrow points to the right.

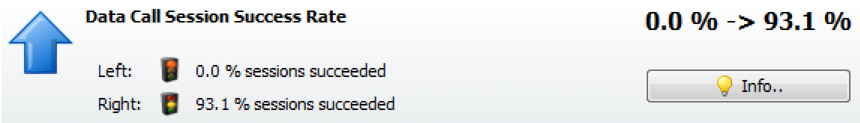


Figure 9-3: KPI - Data Set Comparison

10 R&S ROMES4 NPA filters

The following chapter describes filters available in the R&S ROMES4 NPA application.

10.1 Quick filter

Some data visualizers offer a way to filter the content they display using a "Quick Filter Edit" field, which looks as depicted below. In such a field it is possible to filter the data in the associated view to match the filter expression entered.

Figure 10-1: Quick Filter Edit Field

Each element in the view has a set of attributes, and the filter searches through that attributes to find if at least one matching the expression. According to the type of the attribute, the match is performed differently. Text elements can be filtered with so-called regular expression, where date elements and numbers can be filtered using intervals. Read below for more details.

The set of attributes used to do the actual match can be changed by opening a drop-down menu using . That menu shows the list of attributes that can be used in the filter (an example is shown below).

To remove an active filter from a view, either clear the expression field, or press on the right-hand side of the edit field.

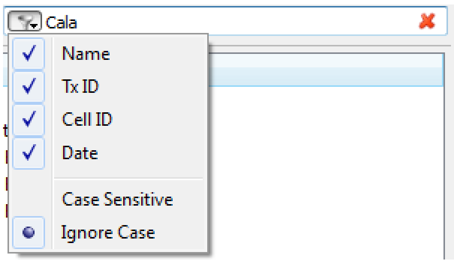


Figure 10-2: Filter Attributes

10.1.1 Tree filter

When tree structures are filtered, the decision of whether an element is visible or not is sometimes more complex and can involve filtering parents or child elements. For example, filtering a directory tree shall not hide directories where the directory name does not match the filter, but a file contained in the directory would match. So in that case the filter should hide the directory only if the filter does not match the directory name and not a single file or sub-directory. Each sub-directory itself must be checked as well.

10.1.1.1 Lazy loading and performance

For performance reasons, the data source tree and the cell database tree are not populated with all possible entries up-front. That means, the content of a directory is read the first time the file list is queried, and cells of a specific operator are loaded the first time the related operator tree item is expanded. That "lazy loading" of tree elements improves performance by order of magnitudes, but also makes filtering the content impossible unless the program would read all the children once a filter expression is set.

Since such behavior would also decrease performance of the filter to an unacceptable level, the filter handles unpopulated data differently. If for example a directory is found that has not been expanded, it is painted in a different color (grey) to indicate that the filter could not decide if that element matches the filter or not. When the directory is opened, the filter is applied immediately. Depending on the result, the item will then be painted black with the matching children or it may disappear at all (if no child element matches the criteria).

10.1.2 Matching strategies

Depending on the type of attribute that is compared to the filter, the matching is done differently. Basically three different types are distinguished:

- Text elements
- Numbers
- Data values

10.1.2.1 Text elements

In most cases, only parts of a text shall be searched. This is handled implicitly and is used as a fallback strategy if no regular expression is intered.

Example:

If the term "test" is entered as filter, the following items are matched: "This is my test", "test123", "testimonial.xy".

The case of the letters can be important for filtering, i.e. all matches are checked either case-sensitive or ignoring the case. The latter is the default behavior and will match the string "Test" also in "Mytest", "Another TEST" etc. It is possible to change that behavior so that differences in small and capital letters are not ignored by using the "Case Sensitive" toggle in the Filter menu. That means searching for "test" will not find occurrences of "Test" or "TEST".

Attributes consisting of a set of characters can also be filtered with so-called regular expressions. These regular expression enhance the concept of wildcard filtering like in a file selection (e.g. `*.jpg`).

Some examples for regular expressions are listed below. Note that the samples in the table sometimes contain a list of samples, where each entry is separated by a comma.

Regular Expression Pattern	Description	Sample Matches...	Not Matches...
Test	Tries to find the sequence of characters in the same order	Test	TestTest
(a|b)c	Checks if a or b precedes a c character	ac, bc	abc, cc
a*b	Matches an arbitrary number of a character before a b	aaaaaaaaab, b	bb, aba
.*	Matches an arbitrary number of characters	Test, 42, Some more complex test	
Test(abc)?Test	Matches optionally abc in between two Test sequences	TestTest, TestabcTest	TestaTest
[0-9]+	Matches values that contain at least one digit	123, 1	The answer is 42

Regular expressions can also be influenced by changed the case sensitivity settings described above.

10.1.2.2 Numbers

Numbers are filtered either when they exactly match the filter expression (which basically is a number too) or if they are within a range. Ranges are defined with a lower and upper interval border separated by two dot characters "..". For example "1..5" matches all numbers between 1 and 5, boundaries inclusive.

10.1.2.3 Date values

An element can have a single date attribute (like a measurement start date) or it may have a date interval assigned to it (the lifetime of a cell configuration, for example). Depending on the type of information, filtering dates is done differently.

Besides this, it is also possible to specify single dates or date ranges as filter criterion. A single date is simply specified by the date itself, whereas date ranges can be fully or partially defined. A partial interval is opened on one side, either left or right. For example, ..1.1.2010 specifies all dates before 2010, including the 1st January of 2010. On the other hand, 1.7.2010 to 31.12.2010 defines all a filter that matches all dates with the second semester of 2010. The left and right side of the date interval are always considered as valid entries.

This sums up to 4 possible cases of date/range combinations in terms of attribute values and filter criterion:

- Single Date Attribute / Single Date Filter - only matches when both are equal.
- Single Date Attribute / Date Range Filter - matches when the date attribute value is within the range.
- Date Range Attribute / Single Date Filter - matches when the date filter value is within the attributes range.
- Date Range Attribute / Date Range Filter - matches when the intersection between both dates is not empty.

10.2 Polygon filter

The Polygon Filter feature provides the possibility to filter result data depending on its geographical position.

Once a polygon filter is configured all the R&S ROMES NPA statistic views and analyses are based only on those results that are located inside the polygon filter area.

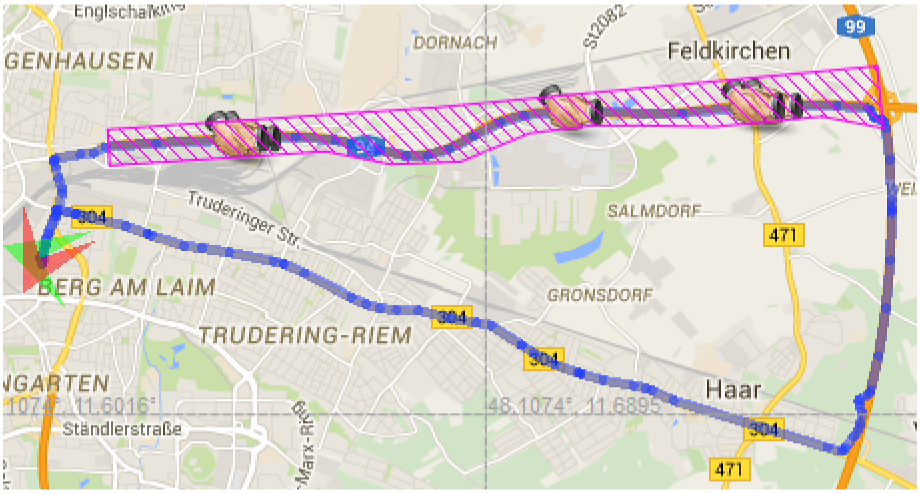


Figure 10-3: GSM Handover Analysis Map with one Polygon Filter Enabled

A polygon filter is any geographical area (closed, not open) defined by n-geo positions. Polygon areas can be of any shape and may overlap. It is also possible to configure n-polygons on the same map. Filtering results is performance sensitive. The more polygon filters are active the slower the performance is.

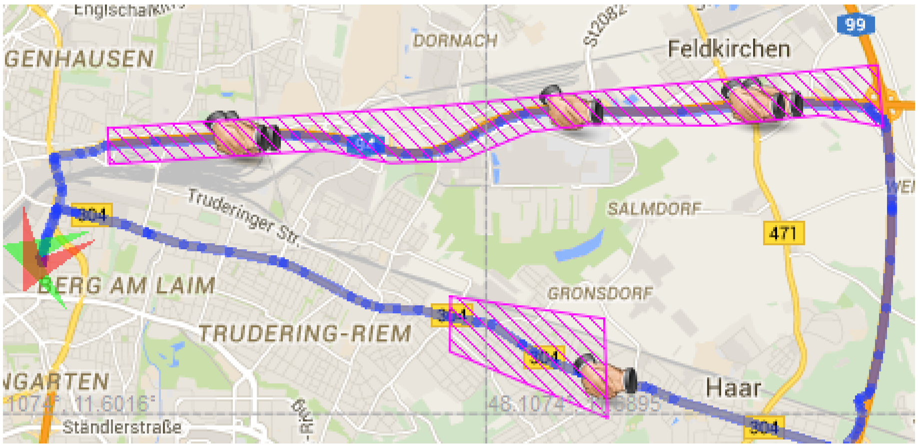


Figure 10-4: GSM Handover Analysis Map with two Polygon Filters Enabled

Once one or more polygon filters are configured only those analysis results are evaluated and shown which are inside of at-least one of the polygon areas. All other analysis results are still available but not considered while the polygon filters are activated.

Results which do not have a geographical position or have an invalid position are filtered out and neither considered nor shown.

Polygon definition files are stored within the R&S ROMES directory structure.

The two applications, that is, R&S ROMES4 and R&S ROMES4 NPA, share the polygon definition files. That means, a polygon created with R&S ROMES4 can be used with R&S ROMES4 NPA and vice versa. Therefore, changing or deleting a polygon affects both applications.

Not only the MAP but also all related statistics are affected when polygon filter gets active or inactive.

The content of the handover list depends whether a polygon filter is active or not. The difference between the handover statistics tables in these two cases is shown in the following figures. It is obvious that only those handovers are shown which are within polygon.

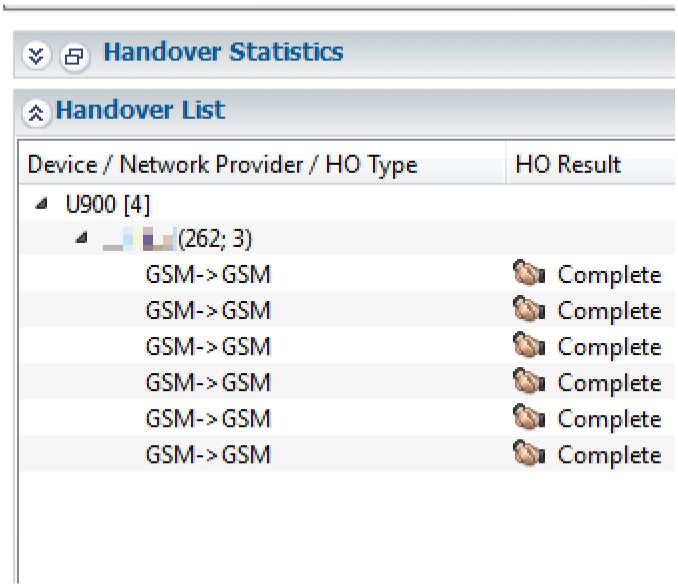


Figure 10-5: Handover Statistics with Polygon Filtering

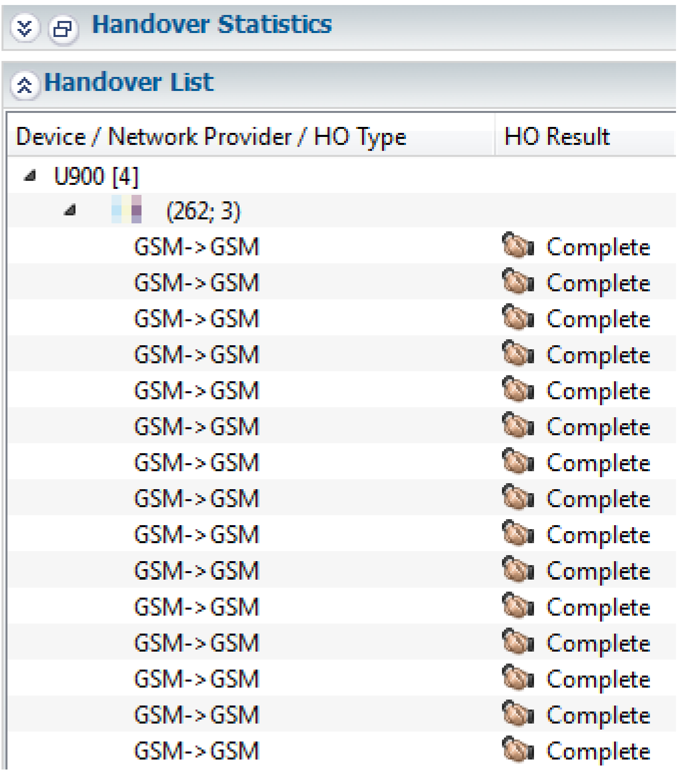


Figure 10-6: Handover Statistics without Polygon Filtering

10.2.1 Polygon filter handling

The polygon filter is handled via the "Polygon Filter" toolbar.

The toolbar is marked with 1 in the following figure. Use it to selected one or more available polygon filters and to enable or disable polygon filtering. All available polygon filters are listed in the combo box, see Available Polygon Filters.

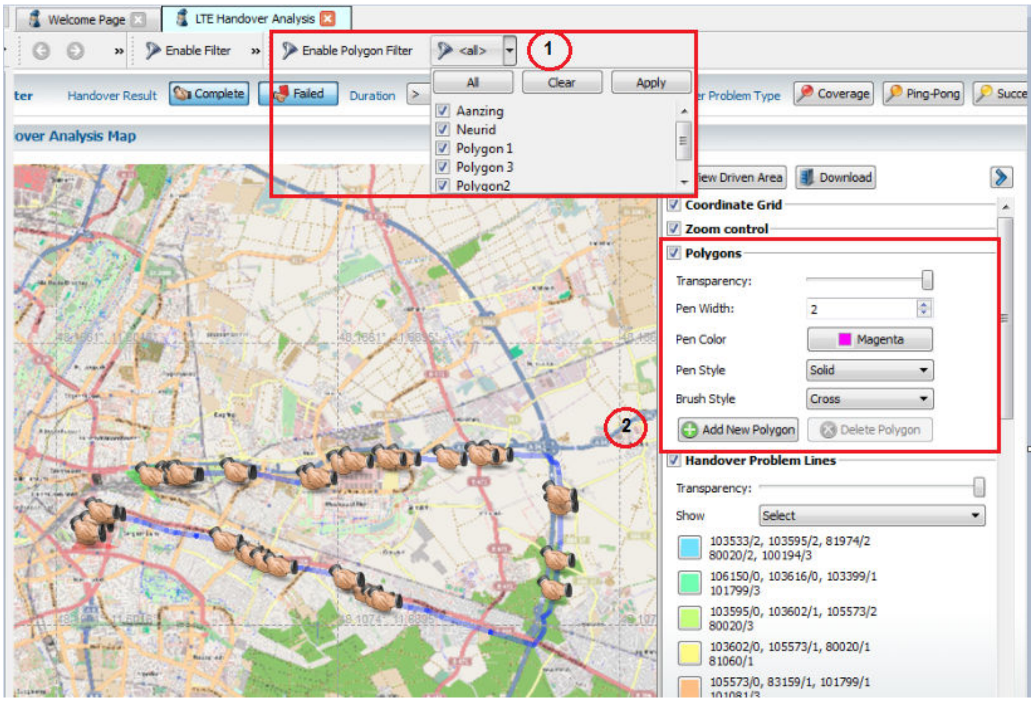


Figure 10-7: Polygon Filter Toolbar

Use the control area marked with 2 to change the style of the shown polygon areas and to hide or show the polygon areas.

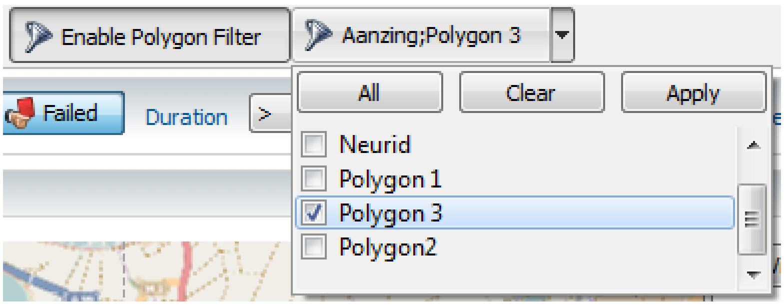


Figure 10-8: Available Polygon Filters

The combo box containing available polygon filters has three buttons to select all, to deselect all and to apply the selected polygon filters. Additional each polygon can be checked/selected individually.

10.2.1.1 Create polygon filter

To create a new polygon filter:

1. Navigate to any analysis result page (for example, LTE Handover Analysis) and press the "Add New Polygon" button in the "Legend" area of the view.

   As soon as the button is pressed the mouse cursor on the MAP changes to indicate the creation mode.

2. Every left-mouse click makes a geographical polygon position.

   To end the polygon creation left-mouse double-click.

   A dialog opens to save the created polygon under given name.

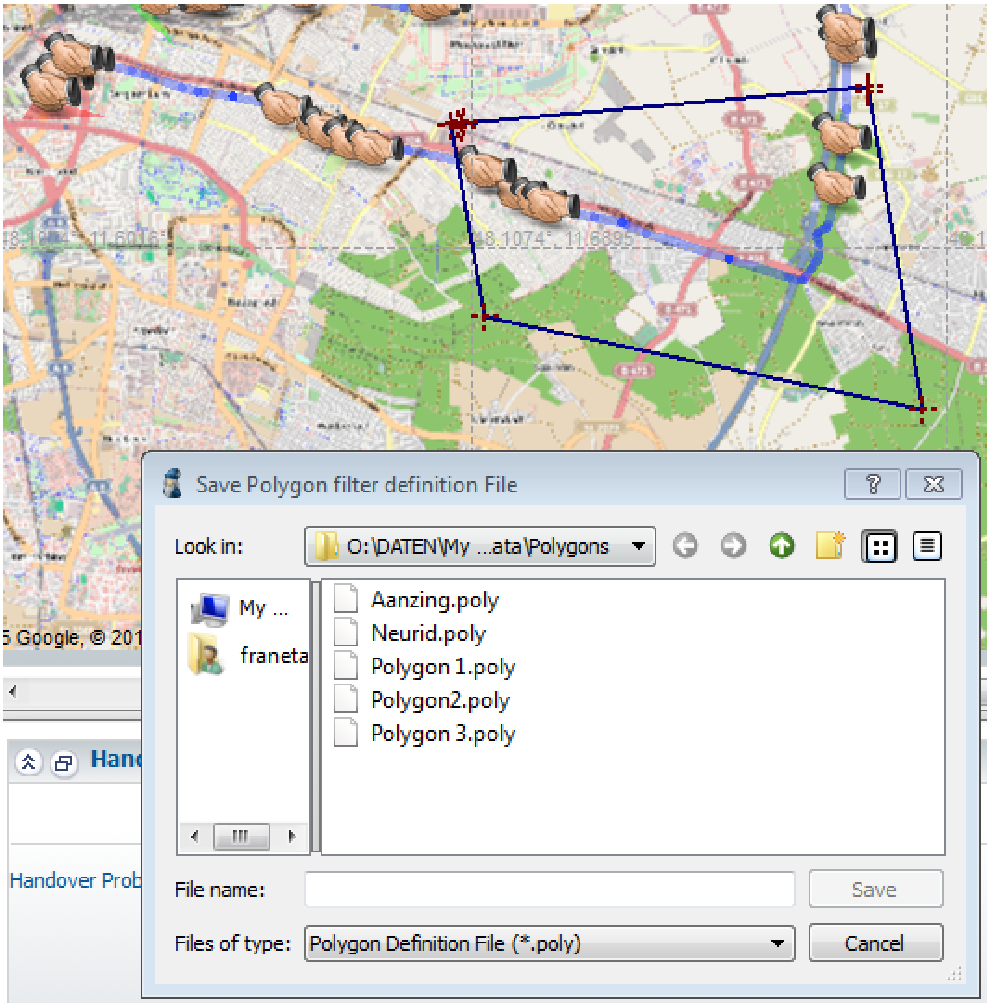


Figure 10-9: Create a New Polygon Dialog

The polygon area is automatically “closed”. That means the last position is always the start position. New created polygon filter will be activated immediately and automatically added to the list of available polygon filters.

10.2.1.2 Enable/disable polygon filter

The polygon filter toolbar provides the "Enable Polygon Filter" button, see Figure 10-8. The button can be used to enable or disable polygon filtering at all. Only when this button is checked the selected polygon are used to filter the analysis results.

In case one or more polygon filter are active and the geographical region is not contained within the result files the "Analysis Result Overview" shows an warning.

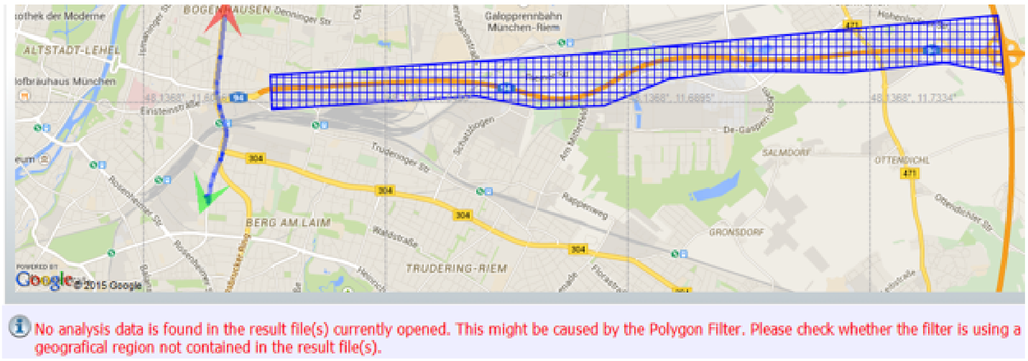


Figure 10-10: Warning Message

By default the map shows the driven area and some or all polygon filter area may not be visible.

10.2.1.3 Delete polygon filter

To delete a polygon filter it has to be marked/selected.

1. Hold the CTRL key and left-mouse click the polygon area you want to delete.

   The polygon is marked/selected. The selection is indicated by changing the color of the polygon area. The new color is opposite color of the currently used polygon color. Only one polygon can be selected.

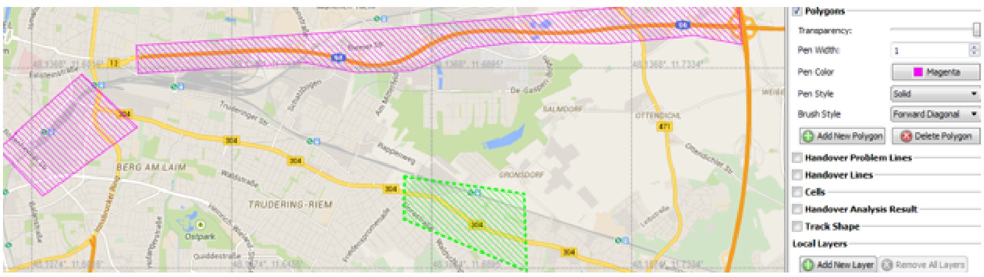


Figure 10-11: Delete Polygon Selection

2. The "Delete Polygon" button in the "Legend" area is active now.

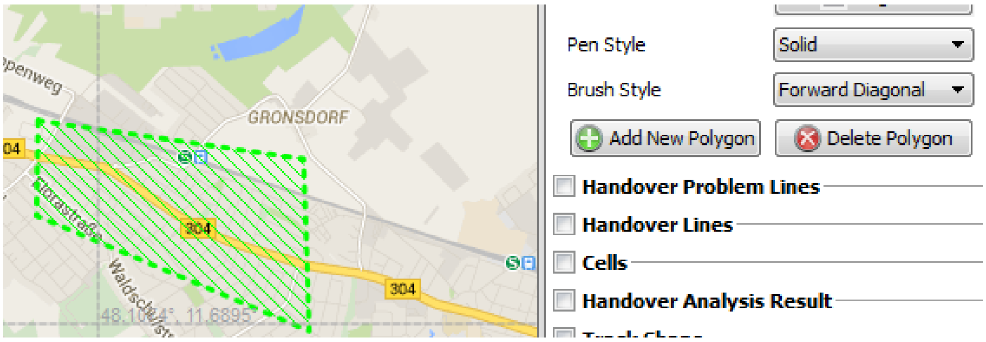


Figure 10-12: Selected polygon area with enabled delete polygon button

3. Click the "Delete Polygon" button.

   The dialog appears which asks to confirm the operation.

4. Click "Yes, delete the polygon definition file" to confirm delition.

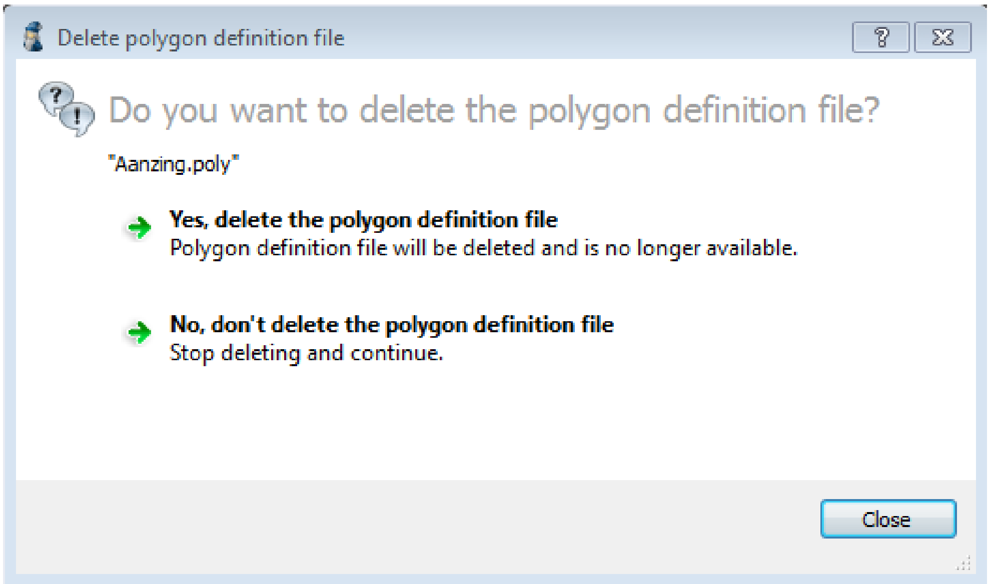


Figure 10-13: Dialog to delete the poligon definition

Once the polygon definition file is deleted it is removed from the file system and is no longer available for R&S ROMES4.

11 User interface reference

In this chapter, the user interface elements are described. Most of the important information has already been explained in Chapter 4, "Use cases", on page 38. Also the other parts of the GUI and the missing commands are contained in this reference.

Main Window	A general description of the main window's layout
Menu	Contains a description of all the commands contained in the main windows menu.
Tool bars	Similar to the Menu section, this one describes the commands available in the tool bars.

11.1 Main window

The window shown when the application starts is organized into the following sections listed below.

- Menu bar (Main Menu)
- Data Source window
- Quick Info window
- Cell Database window
- Working Area

Initially, the "Data Source" window is docked at the left side of the main window. Another two windows are docked below it, but it is possible to move each (using drag & drop) so that their listed order changes. Also, each can be moved around and place at the other edges of the main windows client area. The same applies to the tool bar that can be found inside the "Data Source window".

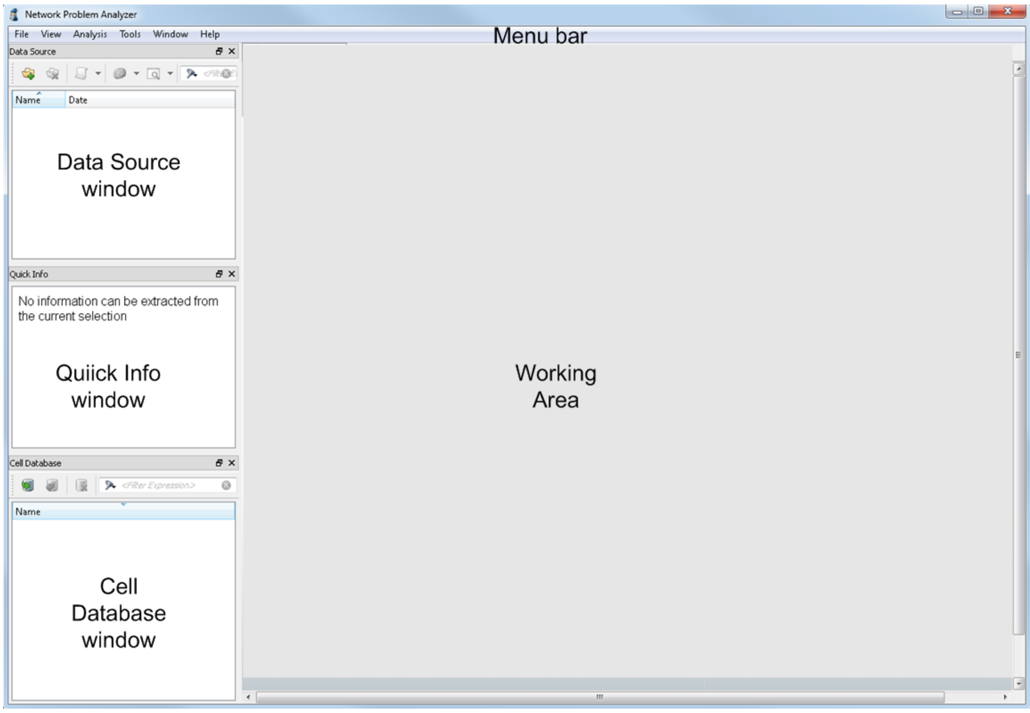


Figure 11-1: NPA GUI

11.1.1 Menu bar

In the menu bar, all the available actions can be found that control the behavior of the application. A reference documentation describing all the menu items in detail can be found in the Menu section.

11.1.2 Data source window

Insert the measurement files that have to be analyzed into the "Data Source" window first, before the analysis process can be started. All data that the application operates is displayed in this window. The analysis results are the part of it, too.

Details on how to use the "Data Source" window can be found in Managing Data Sources.

11.1.3 Quick info window

Below the "Data Source" window, a "Quick Info" window is used to display some general information about the current selection. Currently this function only displays information associated with measurement files selected. The view also aggregates the information over a set of files. To display the ROMES measurement setup description on one file which contains more details, please refer to the Chapter 4.6, "Drill-down", on page 107.

11.1.4 Cell database window

This window is used to display the lists of cells and the details of a selected one extracted from the imported cell file, see Chapter 4.2.3, "Data management", on page 44.

11.1.5 Working area

The working area consumes most of the space in the NPA window. In this area, the analysis views are displayed. Analysis views can be opened as described in the Show Analysis Results section.

If there is more than one analysis view currently visible, the actions in the Window menu.

11.2 Menu bar

11.2.1 File menu

The file menu provides functions that deal with the data handling in the application. Currently, all the data exchange is done based on files, but in future versions this approach will be changed to support database access as well.

11.2.1.1 Add data source

Add folder

Adding a folder that holds some measurement files is one of the first tasks that will be done. This action can be applied to folders stored in the file system. When this menu entry is selected, the application shows a folder selection dialog "Add File Datasource". More details can be found in Chapter 4.1.1, "How to add data source entries", on page 39.

When a folder is chosen and the selection is confirmed by clicking "Select Folder", the folder is added into the Data Source window.

11.2.1.2 Remove data sources

Removing data source entries from the "Data Source" window sometimes requires to make the tree clearly arranged again. The new arrange can be achieved using this menu entry.

However, only the root folders (top-level folders) can be removed, subfolders does not react on the remove command.

The content of the folder is not deleted. It is removed from the application data source tree.

11.2.1.3 Delete data

Data can be deleted from the underlying storage medium (i.e. file system) using this function. More details can be found in Chapter 4.1.4, "How to delete data source entries", on page 41.

11.2.1.4 Show measurement file info

Using this menu entry a dialog is shown that contains the same information as the dialog available in the File Menu in R&S ROMES4. This dialog contains a summary of the measurement setup used to create a specific `*.RSMCD` file.

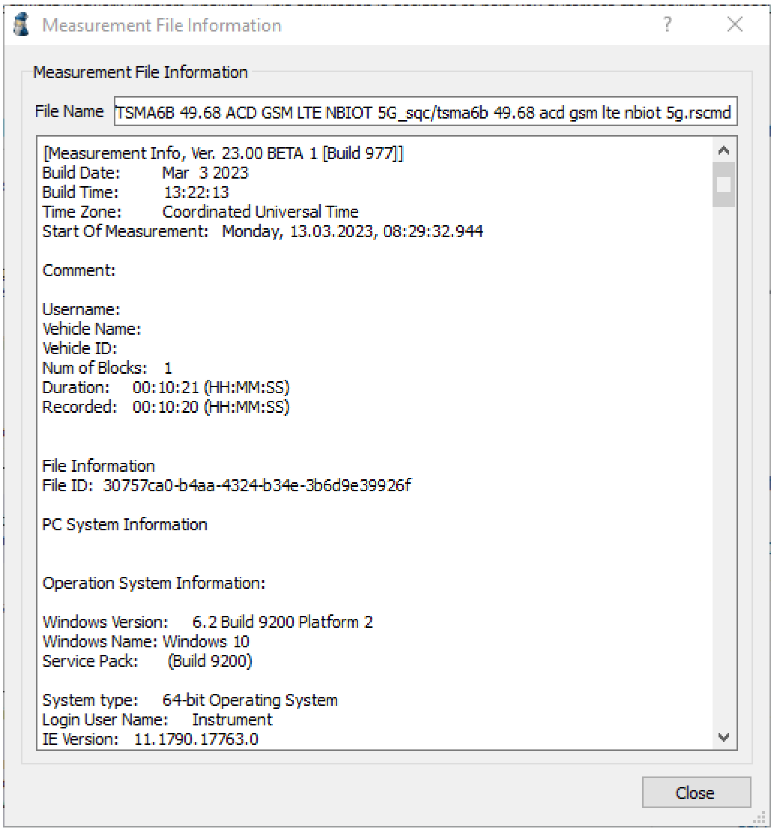


Figure 11-2: Measurement File Information

11.2.1.5 Exit

The application is closed when "File" > "Exit" is selected or via the close "X" button at the upper right corner of the R&S ROMES4 NPA application window.

11.2.2 View menu

The "View" menu contains options to control the visible representation of the application. The task of showing the analysis results belongs also to this options group.

11.2.2.1 Tabbed view

Working area can be displayed like a classic Multiple Document Interface area (the examples are the Microsoft Office applications). Also the working area can be decorated with a tab interface, as known from the popular browsers. Checking this option switches between the classic mode and the tabbed view mode.

An example of the tabbed view mode is shown in the image below.

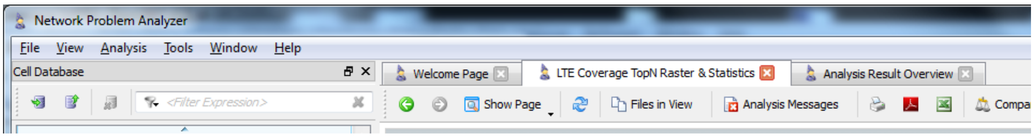


Figure 11-3: Tabbed View Mode

11.2.2.2 Tool bars

This sub-menu lists tool bars that can be shown and hidden in the application. Clicking a subentry of this menu makes the related tool bar appear or disappear.

11.2.2.3 Data source

Hiding or showing the "Data Source" window can be controlled with this option. When the view has been closed accidentally, it can be reactivated again, or it can be hidden to use the room for the analysis result windows.

11.2.2.4 Analysis views

The remaining part ofconfiguration-relatedcuts to open specific analysis views directly. These shortcuts are only available when at least one analysis result is selected in the "Data Source" window.

11.2.3 Analysis menu

In the "Analysis" menu, all actions related to the analysis process are contained. Mainly, these concern starting the analysis process, and configuring it.

11.2.3.1 Processor configuration

Configuration management of the analysis process is done in the dialog that opens when this entry is clicked. Details on this task are described in the Processor Configuration section.

11.2.3.2 Run analysis

The analysis process can be started with entries in this sub menu. For each analysis configuration, one entry is available.

The first entry is not configurable and is always a part of the menu. It starts the analysis with the default configuration, i.e. all processors are active and use their configuration defaults.

11.2.4 Tools menu

Additional tools and configuration related actions are put in the "Tools" menu.

11.2.4.1 Manage filters

Creation, modification and deletion of the filters available in the "Analysis" views can be done using the Manage Filters entry.

11.2.4.2 Preferences

General program preferences can be set in the preferences dialog. For example, proxy and cache settings used to connect to the OpenStreetMap server are placed in that dialog. More information can be found in Chapter 5.1, "General", on page 133.

11.2.5 Window menu

Inside the "Window" menu, actions can be found that control the layout of the working area.

11.2.5.1 Tile

All the windows in the working area are placed in a grid to make them all visible at one time. This placement is especially useful when it is desired to compare analysis results with each other and there are two analysis windows opened. In this case, both windows use each a half of the working area.

11.2.5.2 Cascade

All the windows in the working area are resized to a standard size and moved to the upper left corner. Each window has a different x and y coordinate offset then, so all the title bars of the sub windows are visible.

11.2.5.3 Close

Closes the currently active analysis view.

11.2.5.4 Close all

Closes all currently opened analysis views.

11.2.5.5 Next view

Switches to the next analysis window that is opened. The window list is sorted out from creation time, so the next window is the first window created after the current one.

11.2.5.6 Previous view

Opens the previous analysis window. The ordering mechanism is the same as described in "Next View". It shows the window that has been created most recently compared to the currently visible one.

11.2.5.7 Window list

The remaining part of the "Windows" menu is filled with a list of the currently visible analysis views. Clicking such an entry shows the view as the top-most window.

11.2.6 Help menu

As in other applications, the "Help" menu contains menu entries that show information about the application handling and provide other informational views, like a module version index.

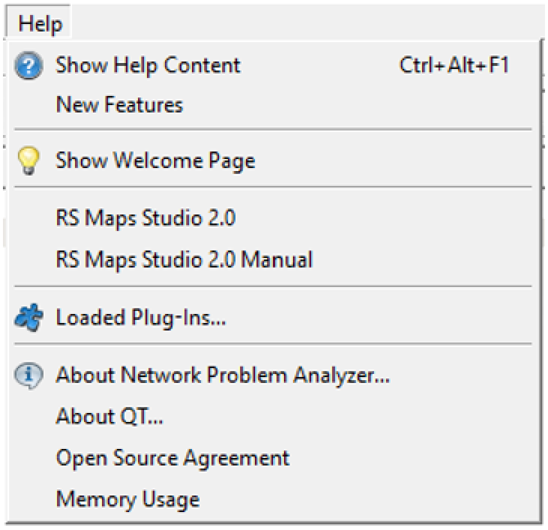


Figure 11-4: Help menu entries

11.2.6.1 Show help content

Opens the application's help window and displays the start page.

11.2.6.2 New features

Opens the "Features Overview" chapter.

11.2.6.3 Show welcome page

Displays a new instance of the welcome page in the working area. The welcome page provides a quick introduction into the application handling, and is described in Getting Started.

11.2.6.4 RS Maps Studio 2.0

The entry facilitates access to the configuration of the RS MAPS Studio 2.0 map server. The map server configuration is opened in browser.

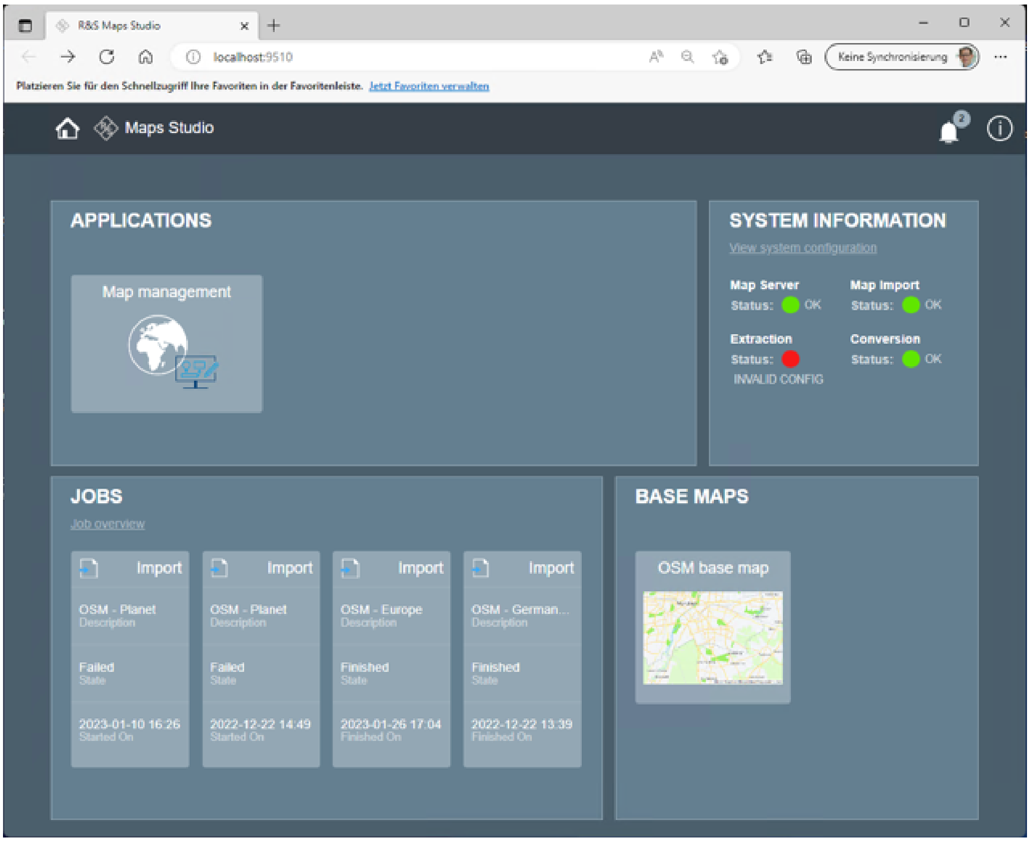


Figure 11-5: R&S Maps Studio opening page

11.2.6.5 RS Maps Studio 2.0 manual

The entry facilitates access to the manual of the RS Maps Studio 2.0 easier. The map server manual is opened in browser as well.

11.2.6.6 Load plug-ins

Opens the "Plug-In Information Dialog" which contains the list of currently loaded plug-ins.

11.2.6.7 About network problem analyzer

Displays information about the application, like version information of the GUI application and the licenses available.

11.2.6.8 About QT

"About QT" shows a dialog that provides additional information on the underlying QT library that is used to build the user interface.

11.2.6.9 Open-source agreement

Open Source Agreement (OSA) can be directly viewed in the R&S ROMES4 NPA.

11.2.6.10 Memory usage

"Memory Usage" shows the memory usage information dialog of the GUI process and some additional information regarding the occupied space.

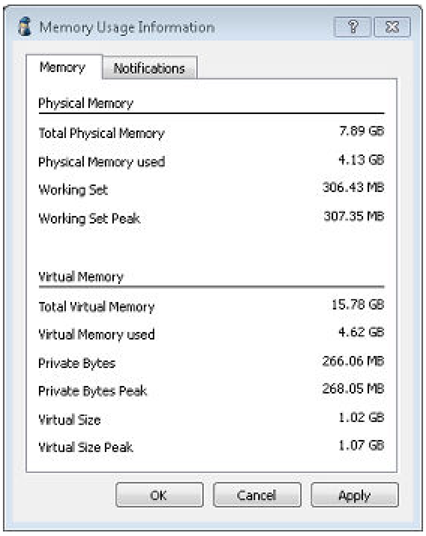


Figure 11-6: Used physical and virtual memory in GB

For more information regarding each specific metric, hover the cursor over it. A ToolTip appears showing more details.

Supported are also the customizable alarms if the user chooses the configuration option in the "Notification" tab.

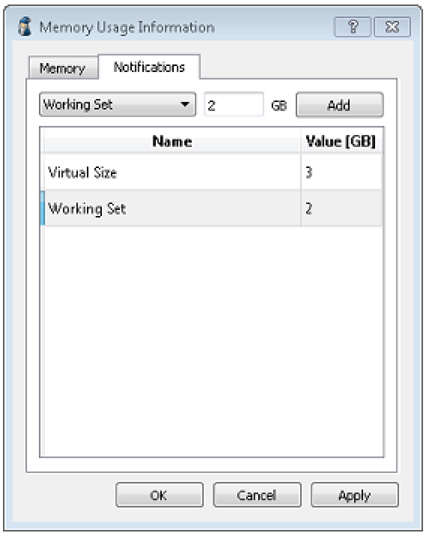


Figure 11-7: Configured values (GB) to trigger some alarms

Click the tab to get a table holding defined alarms.

By selecting an alarm in the drop-down menu and clicking "Add" or the return-key, the alarm is added to the table. If you want to delete an alarm, choose the row of the table and press the DEL-key.

The dialog can install an alarm which sends a notification once a certain threshold is reached.

The alarms are automatically set once the user presses "OK" or "Apply" and are automatically deleted once the alarm is triggered or if the user presses "Cancel".

To give the user some guidance, there is a "Help" dialog which appears after pressing the "?" button.

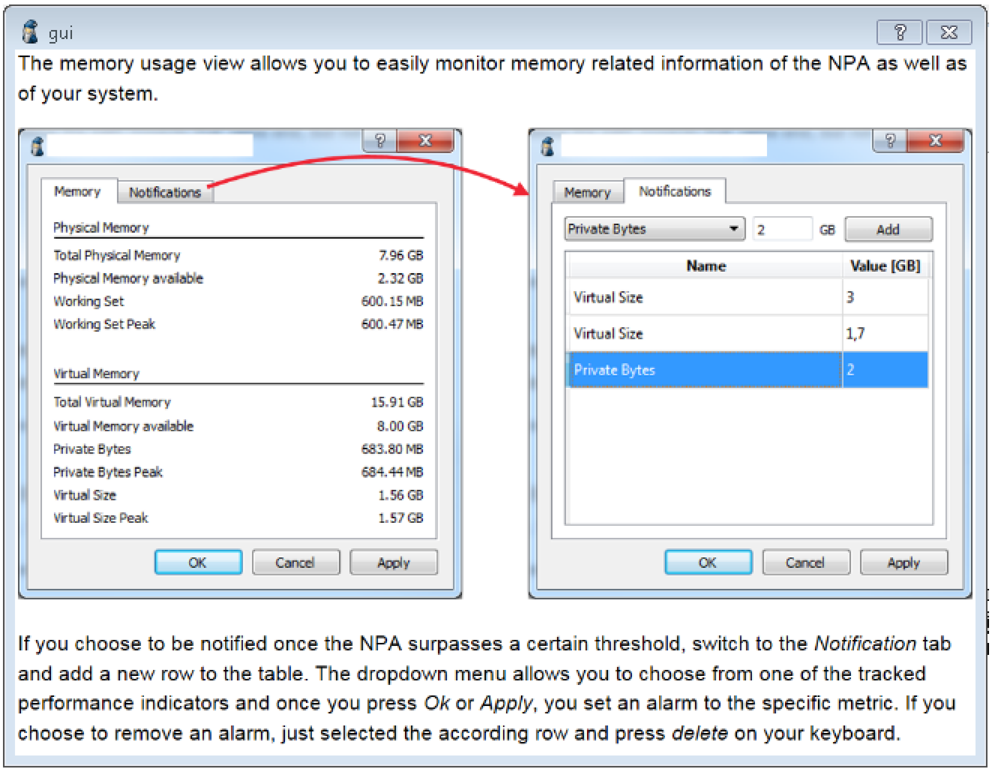
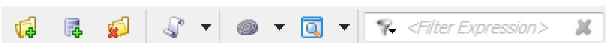


Figure 11-8: Dialog opened if "?" pressed

11.3 Tool bar

11.3.1 Tool bar - data source window

The actions available in the "Data Source" window are:



11.3.1.1 Add folder

Adds a folder to the "Data Source" window, see Managing Data Sources.

11.3.1.2 Remove folder

Removes a folder to the "Data Source" window, see Managing Data Sources.

11.3.1.3 Collapse all items

Closes all the top-level data sources so that the "Data Source" window only contains the root folders.

11.3.1.4 Run analysis (Sub-menu)

Starts the analysis process on the selected measurement files, see Run Analysis for more details.

This contains a list of sub-menu items, one for the default configuration and one for each special configuration created manually. How such configurations are created and managed is described in Configure the Analysis Process.

11.3.1.5 Show analysis result (Sub-menu)

Opens the analysis view on the set of analysis results that has been selected. For more details, refer to the tutorial Visualizing Analysis Results. This is also a sub-menu, which contains one menu item for each analysis view that is available. Most of the time, the "Overview" page might the best choice, but the more you get familiar with the system, the better you'll know which view you might want to see now.

11.3.2 Tool bar - cell database window

The actions available in the "Data Source" window are:

11.3.2.1 Import a cell data file

Used to import a cell file of different formats into the central transmitter database, see Import Cell Data.

11.3.2.2 Export cell data from the cell database

Used to export a cell data stored in the database into the ATD or CTDB format again, see Export Cell Data.

11.3.2.3 Delete cell data from the cell database

Removes selected data from the database again, see Delete Cell Data.

11.3.2.4 Filtering cell data from the cell database

Used for filtering cell data according to configured criteria: name, TxID, Cell ID or date, see Filter Attributes.

11.3.3 Tool bar - analysis view

The actions available in the Analysis Views are:

11.3.3.1 Navigate backward

Used to navigate to the previously shown page. If there is no such page, this is disabled. See Visualizing Analysis Results for details.

11.3.3.2 Navigate forward

If backward navigation was used before, then this action navigates in the opposite direction again. When opening a new view, this will be disabled again. See Visualizing Analysis Results for details.

11.3.3.3 Show page

This can be used to directly navigate to another analysis page. The menu, which is shown after clicking this entry contains all possible pages, regardless of whether they can show any meaningful data for the currently analyzed data set or not.

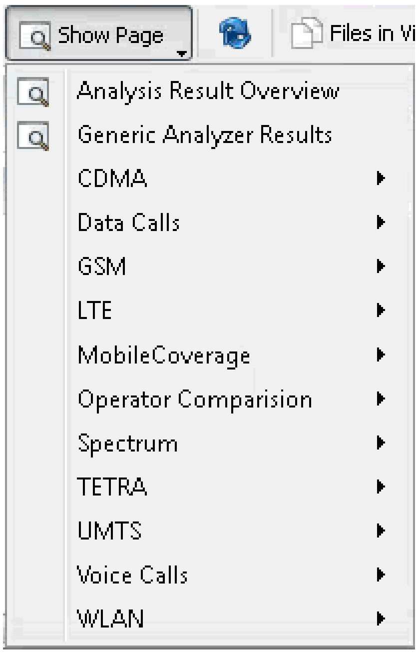


Figure 11-9: Analysis Pages Accessible via Show Page

In contrast to the "Open Analysis Result" menu entries in the Analysis Menu, this only operates on the data in the currently displayed tab and does not open a new analysis window.

11.3.3.4 Refresh

Can be used to refresh the current view.

11.3.3.5 Files in view

Opens the sidebar containing the list of files which is used to display the current view. Refer to section Show Analysis Results for more details on that topic.

11.3.3.6 Analysis messages

Opens a sidebar containing messages collected during the analysis process of the files currently displayed. These messages are error, warning or information messages.

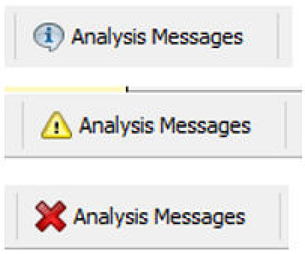


Figure 11-10: Symbols indicating the message type

Click the button to get the analysis message displayed.

For more details, see Analysis Errors and Show Analysis Results chapter.

11.3.3.7 Print

Opens a print-preview dialog of the currently displayed content of the analysis view. See Show Analysis Results for more details on that topic.

11.3.3.8 Print to PDF

Exports the current visible view, that is, the result page, as a PDF document. See Print to PDF for more details on that topic.

The function export to PDF is the creation of the PDF files.

The measurement files that the report is based on are listed in the "File Meta Data" section. A file information placed on the top of every result page is automatically parsed to the corresponding PDF file, in the "File Name" column of the section. See Figure 4-26.

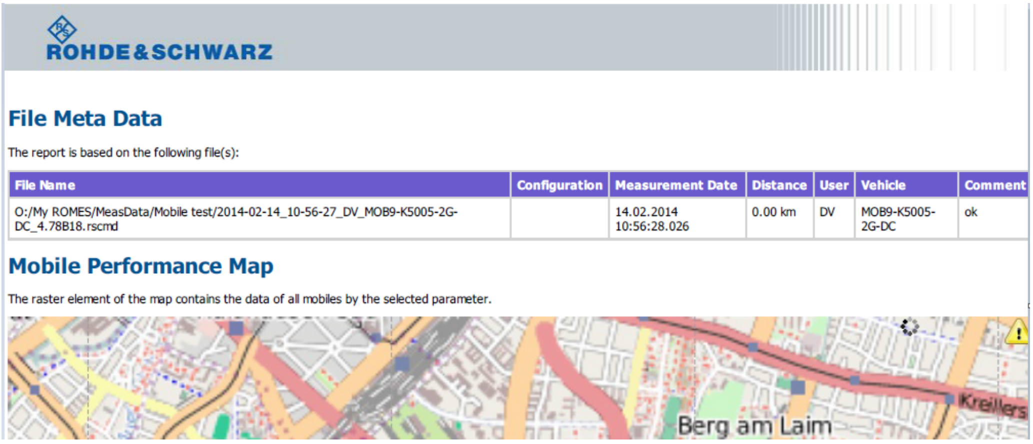


Figure 11-11: Meta data of the measurement file

The predefined reports BENCHMARK, GSM, UMTS, etc. are not a part of this implementation.

11.3.3.9 Export to excel

Exports the current visible view as Excel workbook. See Chapter 4.4.6.6, "Microsoft excel export", on page 85 for more details on that topic.

11.3.4 Tool bar - filter

The filter toolbar offers the functionality to apply a filter to the currently displayed data, to remove it again and to perform the basic filter management functions described above. It therefore offers the following actions.

11.3.4.1 Enable filter

Pressing this button enables or disables the filter currently selected in the combo box. If the filter is enabled and it contains placeholders, the placeholder definition dialog is shown.

11.3.4.2 Filter selection combobox

All available filters are listed here. Once a filter is selected, it appears automatically.

11.3.4.3 Create new filter

Create a new filter and apply it directly.

11.3.4.4 Edit current filter

The currently selected filter can be modified. After the modification has been confirmed, the filter is reapplied to the current data selection.

11.3.4.5 Delete filter

Delete the currently selected filter, removing it from the analysis view if it is applied.

12 Data processors

This chapter describes the R&S ROMES4 NPA standard analysis module packages.

Not all functionalities of the analyzers described here are available. Only a functionality that is available with your license option can be used.

For a complete list of available options, consult your Rohde & Schwarz sales contact. A list of available options is included in the License section.

Table 12-1: Analyzer modules currently available

Voice Call Analyzer GSM/WCDMA, VoLTE, TETRA	Voice Call Analyzer with sophisticated problem spot detection.
DQA KPIs	Extracts ETSI-compliant KPIs from data service tests.
IP Analysis	Check the IP traffic during a data transaction for hints on problems that occurred. As the Voice Call Analyzer, the output of this analyzer is a problem spot list.
E-GPRS Analyzer	FTP Upload/Download throughput issues are analyzed when GPRS/E-GPRS network is available for technology-related problems. It also creates additional statistics to classify problems over larger areas.
HSPA Analyzer	FTP Upload/Download throughput issues are analyzed when HSDPA/HSUPA network is available for technology-related problems.
LTE Mobile Analyzer	FTP Upload/Download throughput issues are analyzed when an LTE network is available for technology-related problems.
Coverage Analyzer	Data recorded with the R&S TSMx scanner family (it includes R&S TSME/TSME6) is analyzed with the Coverage Analyzer. This data processor creates the geographically rasterized coverage maps and statistical indicators per cell for GSM, WCDMA, LTE, EVD-O, CDMA2000 and TETRA.
Mobile Coverage Analyzer	Data recorded mobiles is analyzed with the Mobile Coverage Analyzer. This data processor creates the geographically rasterized coverage maps and statistical indicators per cell for GSM, WCDMA, LTE and TETRA.
neighborhood analyzer	Data from scanner and/or mobile is analyzed to detected potential missing neighbors and other issues concerning the neighbor relations between cells.
Handover Analyzer	Handover events from mobiles are counted in statistics and problematic scenarios are detected.

Spectrum Analyzer	RF Power Scan measurements are analyzed to find potential interferers in an otherwise empty spectrum.
Aggregation of ACD scanner measurements	Based on supported aggregation of measurements from multiple scanner devices, the ACD for different RATs is supported.
LTE mobile statistics examples	The carrier aggregation (currently for one secondary cell) is supported by the LTE mobile statistics.
NB-IoT measurements aggregation	The aggregation of the R&S ROMES4 scanner measurements for Narrowband Internet of Things is supported.
LTE-M measurements aggregation	The narrowband aggregation of the R&S ROMES4 scanner measurements for LTE-M is supported.

R&S ROMES4 NPA applies one decimal floating precision of dB and dBm values in all supported views.

12.1 Mobile coverage/interference analyzer

Many data processors available in the R&S ROMES4 NPA use a Coverage & Interference Detection algorithm when they encounter some kind of problem. The algorithm assures that this common root cause of a problem is found and reported properly.

This section describes the algorithm and the configuration of this small analysis unit.

12.1.1 Analysis approach

Each time a problem is detected, the radio conditions on the layer 1 are checked to find possible coverage or interference issues. The coverage and interference checks use freely configurable thresholds to validate the signaling parameters "RxLev","RxQual" and "QI" (GSM), "CPICH RSCP" and "Ec/No" (UMTS) resp., "TETRA Power" in TETRA networks (there is no quality criterion reported by the TETRA mobiles) and "RSRP" and "RSRQ" or"RS SINR" (LTE).

A coverage problem is assumed when the measured signal power value ("RxLev" for GSM, "RSCP" for UMTS, "TETRA Power" for TETRA and "RSRP" for LTE) is below a certain threshold (specified in dBm).

Interference problems are reported when the power value is above a certain threshold, and the related quality criterion ("RxQual" or "QI", respectively "Ec/No" and "RSRQ" or "RS SINR") measurement reports values above/below a certain threshold.

The table below shows the actual values used for the different technologies.

RAT	Power	Quality
GSM	RxLev Full	RxQual Full, QI
UMTS	RSCP	Ec/No
TETRA	TETRA Power	n/a

Evaluating only one single measurement value does not deliver meaningful results to derive useful conclusions about the network state. Therefore the measurement samples are evaluated over some time interval. If a given percentage of the raw samples is below the related threshold, the Coverage & Interference criterion is fulfilled. See the following figure for an illustration of that algorithm.

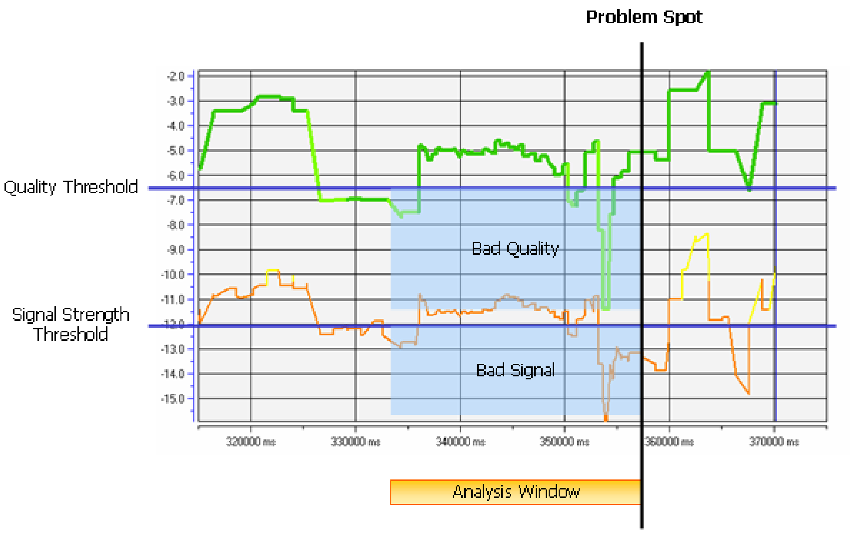


Figure 12-1: Coverage & Interference detection algorithm

Depending on the currently active RAT, this quality threshold is either an upper or lower limit.

The "RxQual" defines the minimum value and the "Ec/No" the maximum value that rates a sample as a bad quality.

The analysis time window is the part of the measurement data that is processed to find coverage and interference situations. This window definition depends on the implementation of the surrounding data processors.

Sometimes, the size of the window is configurable. In other cases, it is predefined or dynamically set according to the start and end timestamp of the problem.

All threshold parameters, the time window and the number of samples that must fulfill the criteria can be defined in the configuration of the analysis module, see Analyzer Configuration.

12.1.2 Analyzer configuration

The Coverage/Interference Analyzer extension offers a set of configuration parameters when added to a new configuration. These parameters are described in the following table.

Parameter	Value Range	Default	Description
Max. Bad Coverage Power Level	-120 dBm to 0 dBm	GSM: -80 dBm UMTS: -90 dBm TETRA: -95 dBm	Upper power level threshold for bad coverage samples. Power samples below this level are considered to indicate bad coverage.
Min. Interference Power Level	-120 dBm to 0 dBm	GSM: -80 dBm UMTS: -90 dBm TETRA: -80 dBm	Lower power level threshold for interference samples. The samples above this threshold are candidates to indicate an interference problem if the quality constraint is also fulfilled.
Min./Max Interference Quality	GSM: 0 to 7 UMTS: -50 dB to 0 dB; TETRA: -50 to 80	GSM: 5 UMTS: -15 dB TETRA: 2	Upper Ec/No, lower RxQual criterion threshold to detect interference situation. Depending on the technology, a quality sample must be below or above this threshold. If so, the sample is rated as potential interference sample when the Min. Interference Power Level criterion is fulfilled in parallel.
C/I Samples Ratio	0 % to 100 %	50 %	Number of field strength/ quality samples that must fulfill Coverage/ Interference criterion in the investigated time interval.
C/I Time Window	1 ms to 300000 ms	4000 ms	Time interval in which samples are checked on C/I criteria when a problem is detected.

12.2 Voice call analyzer

Voice calls are still the most important service in a telecommunication radio network. Guaranteeing a high service availability, good speech quality and high call success rates is a major optimizing and maintaining task of these networks' operators.

The R&S ROMES4 NPA Voice Call Analyzer module supports this task by automatically detecting the problems in a measurement file. Performing the analysis steps, like checking radio conditions, signaling issues and handover procedures the analyzer detects the problems.

The problem spot analysis requires the R&S ROMES4N11 option, named NPA Extended NQA Plug-In.

KPIs and Call List extraction are already included in the R&S ROMES4 NPA basic license which is required to start the network problem analysis.

The speech quality complexity is in details treated in the "Measuring how an ear hears - psychoacoustic in ITU-T P.863" article issued by Rohde & Schwarz, see https://cdn.rohde-schwarz.com/magazine/pdfs_1/article/219/NEWS_219__15_ITU-T_P863__DE.pdf.

12.2.1 Basic call analysis

Some basic trigger points define the normal voice call.

The user presses the dial button (the measurement application can simulate that), the mobile starts dialing, the call is established and the call terminates intentionally.

If problems arise, the call is classified according to the phase in which it terminated by the R&S ROMES4 NPA.

- Problems that arise even before the call starts due to insufficient radio conditions are rated as "No Service"
- Problems during the call setup are rated as "Blocked" or "Failed"
- Problems occurring while the call is active are rated as "Dropped"

In addition, the incoming SMS messages are reported in the R&S ROMES4 NPA if they arrive during the voice call. The reporting is based on the R&S ROMES4 ETSI QoS View capability to list the incoming SMS messages.

Currently the R&S ROMES4 NPA does not aggregate SMS messages sent or received with the DQA job SMS.

The voice call analysis with the R&S ROMES4 NPA provides the "Call Table", see the following figure.

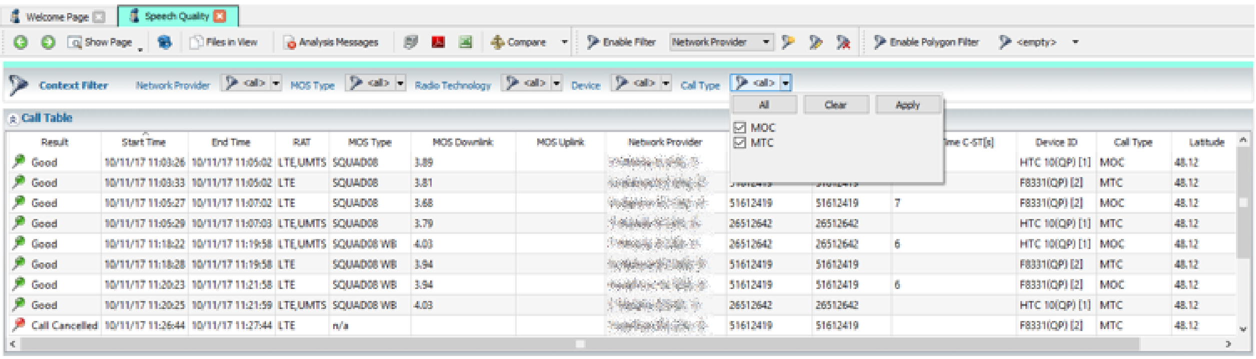


Figure 12-2: Voice Call Table

The result speech quality page has a context filter which allows to filter for a specific call type, that is, MOC and MTC. The same context filter is available on the "Voice Call Table" obtained from ETSI QoS View, see the following figure.

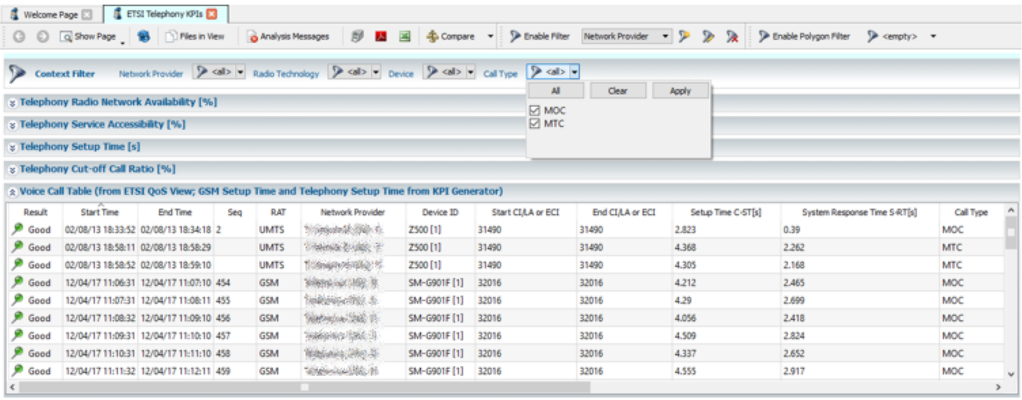


Figure 12-3: Voice Call Table from ETSI QoS View

The Voice Call Table from the "ETSI Telephony KPIs" result page does not report the last incomplete call. The call table exactly represents the calls listed in R&S ROMES4 on the "ETSI QoS View".

The "ETSI Telephony KPIs" page contains the "Call End Status" table at the bottom. The Call End Status statistics includes the statistics of the canceled calls as well. It helps you to get quicker overview of voice call success, problems and a test equipment-related results.

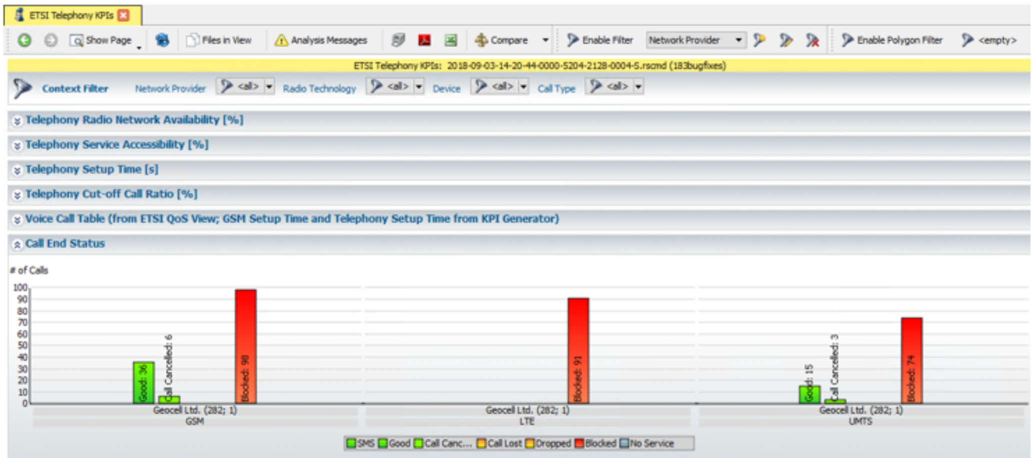


Figure 12-4: Voice call - end status

If there are multiple network operators, the results are grouped by RAT and operator.

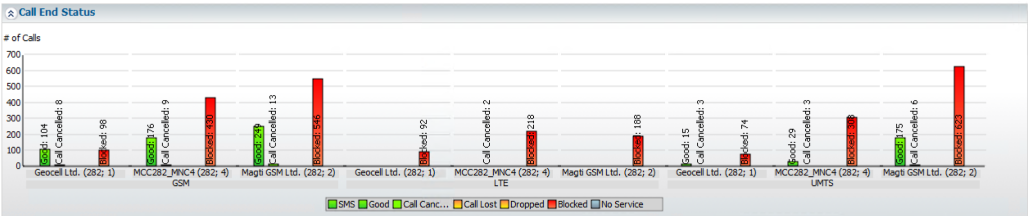


Figure 12-5: Call end status table - some calls canceled

The Voice Call Analyzer uses a different set of analyzers for each such scenario. The following figure shows which kind of analysis algorithms are run as the call fails in the phases mentioned above. Depending on the overall call situation, the analysis algorithms can deliver different results.

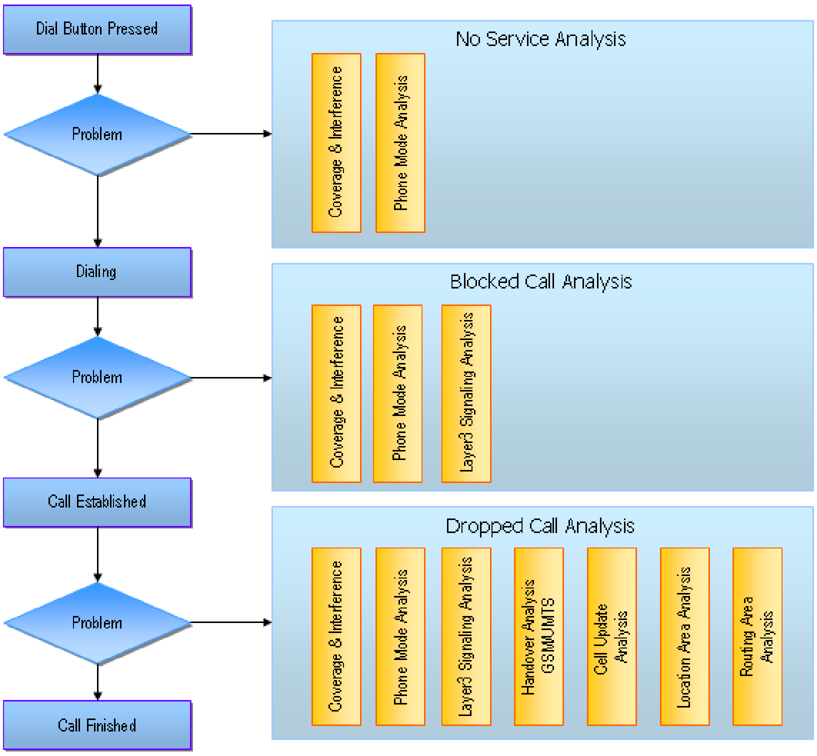


Figure 12-6: Algorithms for voice call analysis

12.2.1.1 Volte call analysis

The VoLTE call list and the aggregated VoLTE calls KPIs are supported for analysis.

If there are VoLTE calls setup with SIP INVITE messages or with 4G or CSFB, the measurement results are available for analysis via the "VoLTE KPIs" icon in the "Voice Telephony" page.

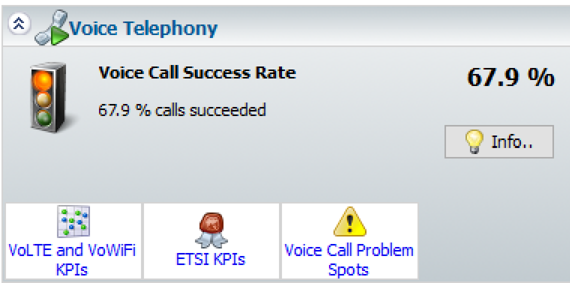


Figure 12-7: Available icons for voice telephony

The voice call table for VoLTE has additional columns for the time-related KPIs measured in the KPI Generator.

Voice Call Table with VoLTE and VoWiFi KPIs (from KPI Generator; handover results from 3GPP Handover Analyzer View)

INVITE Trying	INVITE Session Progress	INVITE Ringing	INVITE OK	Telephony Service Non-Accessibility (VoLTE) %	Telephony Setup Time (VoLTE / CSFB)
0.494	4.425	5.855	8.459	0	8.459
0.515	4.469	5.946	8.911	0	8.911
0.464	4.427	5.9	8.11	0	8.11
0.698	4.741	6.256	8.505	0	8.505
0.518	4.408	5.96	10.051	0	10.051
0.537	4.729	6.446	9.296	0	9.296
0.488	4.607	6.045	8.056	0	8.056
0.434	6.383	7.789	9.715	0	9.715
0.479	4.668	6.071	8.477	0	8.477

Voice Call Table with VoLTE and VoWiFi KPIs (from KPI Generator; handover results from 3GPP Handover Analyzer View)

rrc connection setup	rrc connection setup complete	security mode command	security mode complete	ue capability enquiry	ue capability information	esm activate dedicated eps bearer context request	esm activate dedicated eps bearer context accept
0.063	0.071	0.125	0.127	0.127	0.137	4.465	4.493
0.06	0.067	0.096	0.098	0.098	0.108	4.427	4.45
0.061	0.069	0.108	0.11	0.11	0.12	4.384	4.407
0.055	0.063	0.118	0.12	0.12	0.13	4.698	4.72
0.059	0.067	0.111	0.113	0.114	0.123	4.364	4.389
0.051	0.059	0.106	0.107	0.109	0.117	4.687	4.71
0.053	0.061	0.09	0.091	0.092	0.101	4.568	4.589
0.049	0.057	0.087	0.089	0.089	0.099	6.347	6.369
0.049	0.057	0.094	0.096	0.096	0.106	4.632	4.651

Figure 12-8: Voice Call Table with VoLTE KPIs

For more details on VoLTE call analyses, see Chapter 12.5, "Voice over LTE (VoLTE) analyzer", on page 263.

12.2.1.2 TETRA call analysis

Voice calls are also analyzed when TETRA mobiles are used.

Since there are different analysis approaches in that scenario, a different processing mode is entered. The analysis strategy of the TETRA Call Analysis module is described in the TETRA Call Analysis section.

12.2.1.3 Coverage and interference analysis

The Coverage & Interference Analysis used in the R&S ROMES4 NPA is shared among several data processors and is described in the chapter Coverage / Interference Analysis Approach.

12.2.1.4 Phone mode analysis

When a problem occurs, the history of the phone mode changes is analyzed to find potential lacks in the communication ability with the network. Such include entering area where no service is available at all, or can be due to issues with the mobile device.

12.2.1.5 Layer3 signaling analysis

The Layer3 message sequence is investigated in this part of the analysis to find missing parts or messages that contain error codes. The investigation includes the analysis of the call setup and connection setup procedures.

Call setup

The call setup is monitored from the RRC connection request to the `Connect Acknowledge` message. If the call setup is not successful (usually blocked calls), the last setup-related message is reported. It is expected that subsequent messages arrive within a certain time limit, otherwise a timeout is reported for the expected message and the coverage and interference conditions are checked.

General Layer3 message evaluation

All Layer3 messages are checked for failure and reject messages. The cause is retrieved and the classified problem (id, category, priority) is appended to the problem list. Normally only the problems that appeared within the last 30 seconds before the dropped/blocked call are reported.

Disconnect message evaluation

When a `Disconnect` message is found, it is analyzed on which channel it has been sent (uplink, downlink) and the cause stored in the message is extracted. A `Disconnect` message in the uplink can be caused by R&S ROMES4 when the mobile wants to terminate the call (dial command hangs up). This problem is classified as "Test Equipment Problem".

In the downlink, the `Disconnect` message can be caused by the B-party (answer machine in a MOC). If cause is "normal call clearing", these dropped calls are classified as "ISDN server problem".

Furthermore, the analyzer checks the "Disconnect Class" attribute if none of the above checks yield a result. From the class elements, the problem category is derived as shown in the table below.

Class	Description	Problem Category
000	normal event	Other Problem
001	normal event	Other Problem
010	resource unavailable	Network-RAN problem
011	service or option not available	Network-Core problem
100	service or option not implemented	Network-Core problem
101	invalid message (e.g. parameter out of range)	UE or Network Problem
110	protocol error (e.g. unknown message)	UE or Network Problem
111	inter-working	Network-Core problem

Reject message evaluation

Besides the `Disconnect` message, many procedures in the Layer3 protocol also support a reject message which also includes a description of the reject cause. For example, the `RRC Connection Reject` message is investigated to check for a problem description if it is found during the call setup phase.

12.2.1.6 Handover analysis

Handover procedures and the `Active Setup Update` procedure in UMTS are checked for their completeness. Problems in handovers can lead to dropped calls, if the UE, for example, reports bad radio conditions to the network. If bad condition is reported, the `Active Set Update` is not started as a consequence. Lack of this procedure, for example, is put in the Network - RAN problem category.

The handover analysis verifies the integrity of the handover process. Handovers initiated with `Handover Command`, Handover from UTRAN Command GSM or `Inter RAT Handover Info` are expected to be confirmed with `Handover Complete` message within a certain time limit. Otherwise, these handovers are reported as potential problem. Repeated `Handover Command` messages (multiple HO commands within short time frame) are also reported. For `Handover Failure` messages, the RR cause value is extracted and put into the Problem Cause description.

`Measurement Reports` in UMTS containing the events e6a, e6b, e6c, e6d and e4b are reported and analyzed for bad coverage or interference. Events e1a, e1b, e1d and e2d are tracked up to the expected `Active Set Update` and reported if a timeout occurs. Additional examinations for conditions like "DL-DCCH still active", "events e1d/e1e/e1f found" and "active set update during setup" are performed and reported.

12.2.1.7 Cell update analysis

Similar to handovers, Cell Updates can cause unintentional call releases. The Layer3 signaling protocol is analyzed for error conditions, rejects and missing elements. Problems found during this analysis phase are classified into the Network - Unknown Problem category.

12.2.1.8 Location update analysis

Another part of the dropped call analysis includes the scan for failed or incomplete Location Area Updates shortly before the call dropped. If such a failed or incomplete messaging procedure is detected, it can be an indication for a "Network - Unknown Problem".

12.2.1.9 Routing area update analysis

Basically the same checks are applied to the Routing Area Update procedure as described for the Location Area Update.

12.2.2 Analysis result

The result of analysis process is mainly a list of problem spots, each spot associated with a set of possible reasons why a problem can occur. These causes are prioritized to give an indication which reason is most likely to be the root of the problem. The priorities are set according to the chronological relevance of the cause, i.e. how long the problem indication has happened before the actual blocked/dropped call. The more recently the problem cause has been found, the more likely it is to be the root problem.

The problems are ranked as following:

- Problems in the time window defined by the Primary Analysis Time Window parameter are checked first. These problem causes are most likely related to the originating problem trigger.
- As a second check, the time interval defined by the Extended Time Window is searched for the problem indications.
- Finally, the complete call time is checked.

12.2.2.1 Problem categories

Each problem also has a category helping to assign the problem to the right department within the network optimization organizational unit. The following table shows how the problem categories are classified and which analysis type can detect that problem.

Problem Category	Possible Reasons
Coverage problem	The Coverage Problem Detection algorithm indicates a coverage issue, i.e. many RxLev/RSCP samples have been below the thresholds. See Coverage & Interference Analysis.
Interference problem	The Interference Problem Detection algorithm indicates an interference situation. Coverage seems to be good, but the quality indicator is bad nevertheless. See Coverage & Interference Analysis.
Handover problem	If a handover has been initiated shortly before a dropped call has been found and it has not been terminated within the time interval defined by the Layer3 Signaling Timeout parameter.
Network-Core problem	This category contains problems when the network does not respond to some Layer3 message sent by the mobile. However, the radio conditions are good enough to expect a stable connection to the network. This problem can be caused by specific error return codes.
Network-RAN problem	A message is not a part of the Layer3 message history, or the network directly rejects the access attempts of the mobile. This problem can also be caused by specific error return codes.
Network-Unknown problem	This category contains problems that relate to failed or incomplete Location Area/Routing Area updates. This problem can also be caused by specific error return codes in the DISCONNECT message.
ISDN Server problem	Problems expected to be caused by the answering machine are classified as ISDN Server problem.
Test Equipment problem	If the mobile does not respond to the dialing command within a time interval, the analyzer assumes that the mobile has a problem. Such situations are part of this category.

Problem Category	Possible Reasons
UE problem	If the mobile does not send answers to commands from the base station, and radio conditions are classified to be good, a problem cause in this category is entered.
Other problem	All problems that cannot be put into one of the previous categories become part of the "Other problem" category.

12.2.3 Key performance indicators

12.2.3.1 Telephony KPIs

Besides the problem spots that are identified during the analysis of voice calls, the ETSI-compliant KPIs are calculated and stored. The KPI calculation is independent of the configuration details and uses the same logic used in R&S ROMES4 for GSM and WCDMA voice calls.

The Voice Call Analyzer module supports the following KPIs:

- Telephony Radio Network Availability
- Telephony Service Accessibility
- Telephony Setup Time
- Telephony Cut off Call Ratio
- GSM Setup Time
- GSM Setup Failure Rate

The analyzer shows in addition the KPIs' trigger points and the info on their calculation.

12.2.3.2 Speech quality KPIs

The speech quality evaluation results are extracted during the analysis step from the R&S ROMES4 SQA device if such a device is found in the measurement file. The chart and table show the values of WBAMR and EVS codecs.

The following KPIs are supported:

- Speech Quality on Call Basis (Downlink and Uplink)
- Speech Quality on Sample Basis (Downlink and Uplink)

The following table explains the meaning of the PESQ P862.1 scaling. The values in the table are applicable for GSM, UMTS and LTE but not for TETRA RAT.

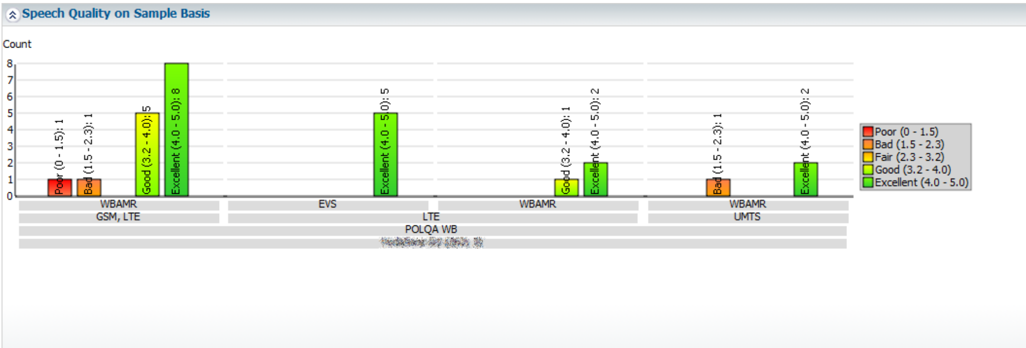
Table 12-2: PESQ P862.1

PESQ P862.1	MOS (Speech Quality)	Impairments	R&S ROMES NPA GUI view
0 to 1.5 (excluded)	Poor	Very annoying	red
1.5 to 2.3 (excluded)	Bad	Annoying	orange

PESQ P862.1	MOS (Speech Quality)	Impairments	R&S ROMES NPA GUI view
2.3 to 3.2 (excluded)	Fair	Slightly annoying	yellow
3.2 to 4 (excluded)	Good	Perceptible, but not annoying	light green
4 to 5	Excellent	Imperceptible	green

The following figure is an example of the R&S ROMES4 NPA PESQ/POLQA WB analysis.

The detailed pages for speech quality DL/UL show the WBAMR and EVS percentiles for the speech quality samples.



Network Provider	SQ Type	RAT	Codec	Count	Min	Avg	Max	5%	10%	25%	50%	75%	90%	95%	99%
[illegible]	POLQA WB	GSM, LTE	WBAMR	15	1.27	3.66	4.25	1.27	1.53	3.69	4.10	4.17	4.21	4.25	4.25
[illegible]	POLQA WB	LTE	EVS	5	4.21	4.55	4.66	4.21	4.21	4.59	4.65	4.66	4.66	4.66	4.66
[illegible]	POLQA WB	LTE	WBAMR	3	3.73	4.33	4.65	3.73	3.73	3.73	4.60	4.65	4.65	4.65	4.65
[illegible]	POLQA WB	UMTS	WBAMR	3	1.62	3.30	4.18	1.62	1.62	1.62	4.11	4.18	4.18	4.18	4.18

Figure 12-9: Speech Quality on sample basis

TETRA speech quality KPIs

As TETRA uses another MOS ranges, the separate SQA pages are created for TETRA speech quality in the R&S ROMES4 NPA.

Table 12-3: MOS categories for TETRA

SQA thresh-olds	0 to 1.3 (excluded)	1.3 to 1.8 (excluded)	1.8 to 2.5 in range 1.8 to 2.0, 2.0 to 2.2, 2.2 to 2.5 (excluded)	2.5 to 3.2 in range 2.5 to 2.8, 2.8 to 3.2 (excluded)	3.2 to 5 in range 3.2 to 3.6, 3.6 to 5 (excluded)
MOS (Speech Quality)	Poor	Bad	Fair	Good	Excellent

The TETRA KPIs result is extended to show the MOS ranges and sample counts in the chart. Click "Info" to get more KPI details on speech quality samples.

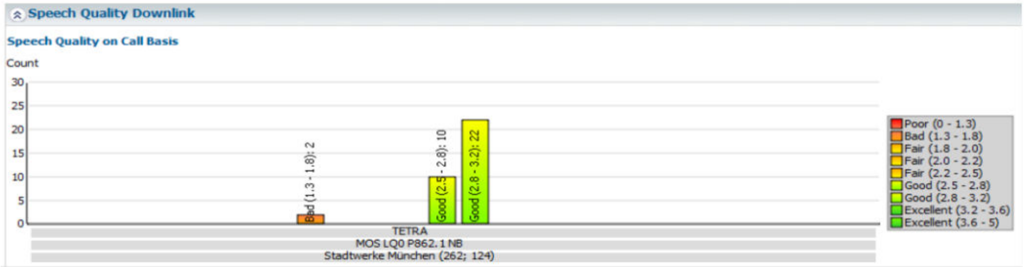


Figure 12-10: TETRA speech quality per sample distribution

Uplink results are available only if the ISDN server measurement file has been in advanced merged with the R&S ROMES4 one.

12.2.3.3 Voice codecs and data rates

The NQA analyzer aggregates the voice codecs and bit rates. The aggregated values are shown as charts for AMR, WBAMR and the EVS code with the bit rates from 2.4 kbps to 128 kbps on the result page "DL Voice codec and Rate".

The voice codecs and data rates are shown for both directions (DL/UL) as bar charts. The grouping is done by radio technology and network operator.

Figure 12-11: Voice codecs and data rates bar charts

The R&S ROMES4N22 VoLTE license is required for this page.

12.2.4 Analyzer configuration

If it is added to a new configuration, the Voice Call Analyzer module offers a set of configuration parameters. The parameters are described in the following table.

Parameter	Value Range	Default	Description
Layer3 Signaling Time-out	1..300000 ms	5000 ms	Time interval in which answers to specific Layer3 events are expected to finish. For example, handovers are assumed to complete within this interval.
Start of Call Timeout	1..300000 ms	30000 ms	If the call is not established within this time after the dialing button has been pressed, the Blocked Call analysis is started.
Primary Analysis Time Window	1..300000 ms	10000 ms	Together with the next property, ranges are defined for the ranking algorithm used to detect problem causes when an actual problem was found.
Extended Analysis Time Window	1..300000 ms	30000 ms	See description above.

12.3 Voice call analyzer (TETRA)

Fed with the data from the TETRA mobiles supported by R&S ROMES4, the Voice Call Analyzer detects several problems in TETRA networks.

Table 12-4: List of problems that the TETRA analysis can detect

Problem Category	Possible Reasons
Coverage problems	The coverage problem detection algorithm indicates a coverage issue, for example, many TETRA Power samples are below the thresholds. See section Coverage & Interference Analysis.
Network problems	Such a problem is reported, if the mobile is not registered to the network or is searching for a network to register in.
SDS problem	The SDS problem detection algorithm indicates the SDS transaction problems. See section TETRA SDS problem categories.

Problem Category	Possible Reasons
Interference problems	The interference problem detection algorithm indicates an interference situation. Coverage seems to be good, but the quality indicator is bad nevertheless. See section Coverage & Interference Analysis.
Handover problems	Several different handover issues can be detected by the TETRA Call Analyzer. Such are missing handovers to neighbors, ping-pong handovers and excessive handover sequences. See section Handover Problem Detection for more details.

Mobile raster data and scanner TopN raster layers in a view driven area

To improve the TETRA analysis and the problems investigation, the "Mobile Raster Data" layer and the "Scanner TopN Raster" layer is added to the following TETRA analyzer pages:

- TETRA Voice Call Analysis
- TETRA Handover Analysis
- TETRA Mobile Coverage Cell Statistics

As the same page shows the interference and signal power, the mobile raster data layer makes it easier to investigate the speech quality problems.

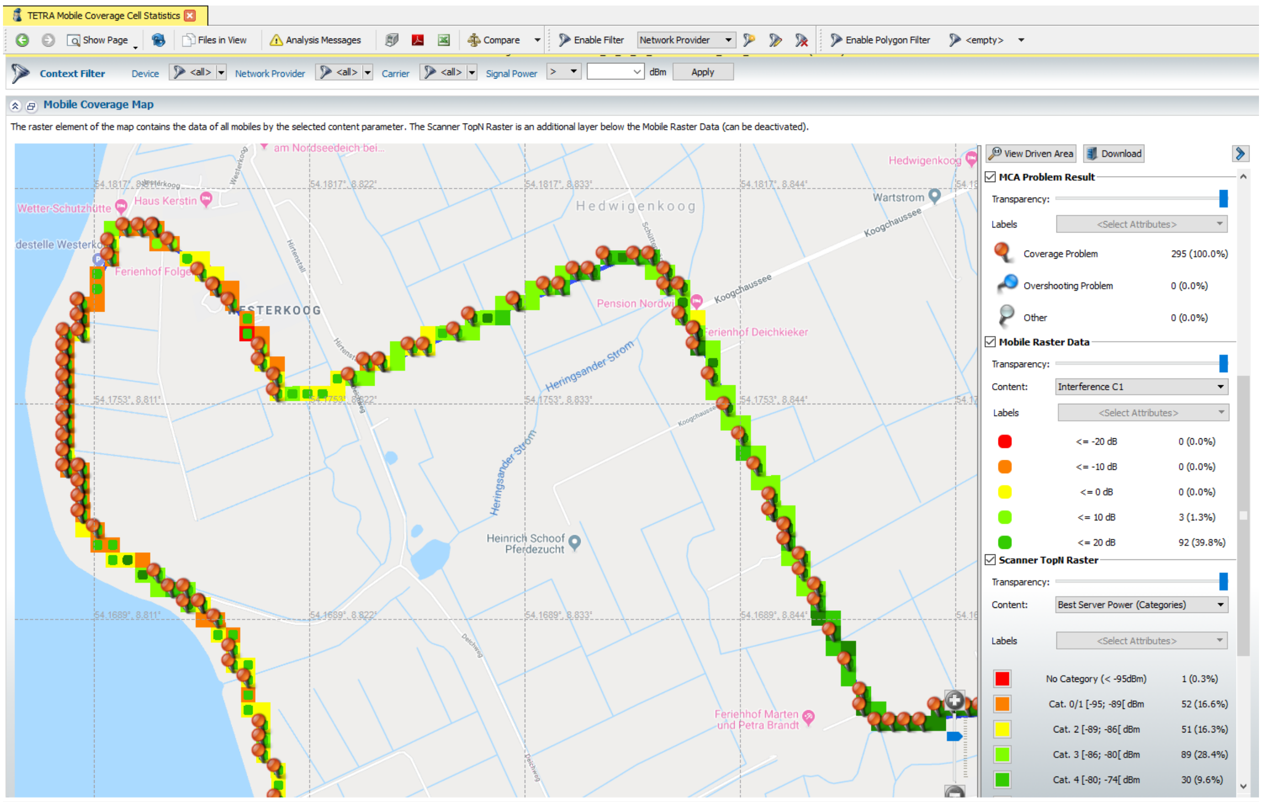


Figure 12-12: Activated layers on TETRA mobile coverage map

The "Mobile Coverage Map" page shows the labels of the mobile raster data layers that you want to be visualized if you check the labels available in the "Labels" drop-down box.

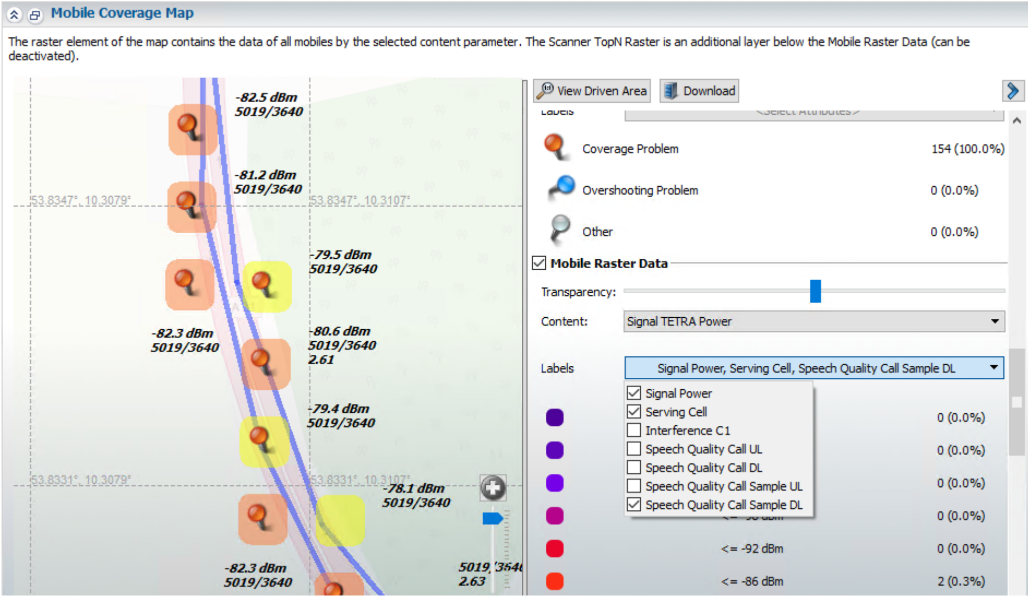


Figure 12-13: Selected mobile raster data labels

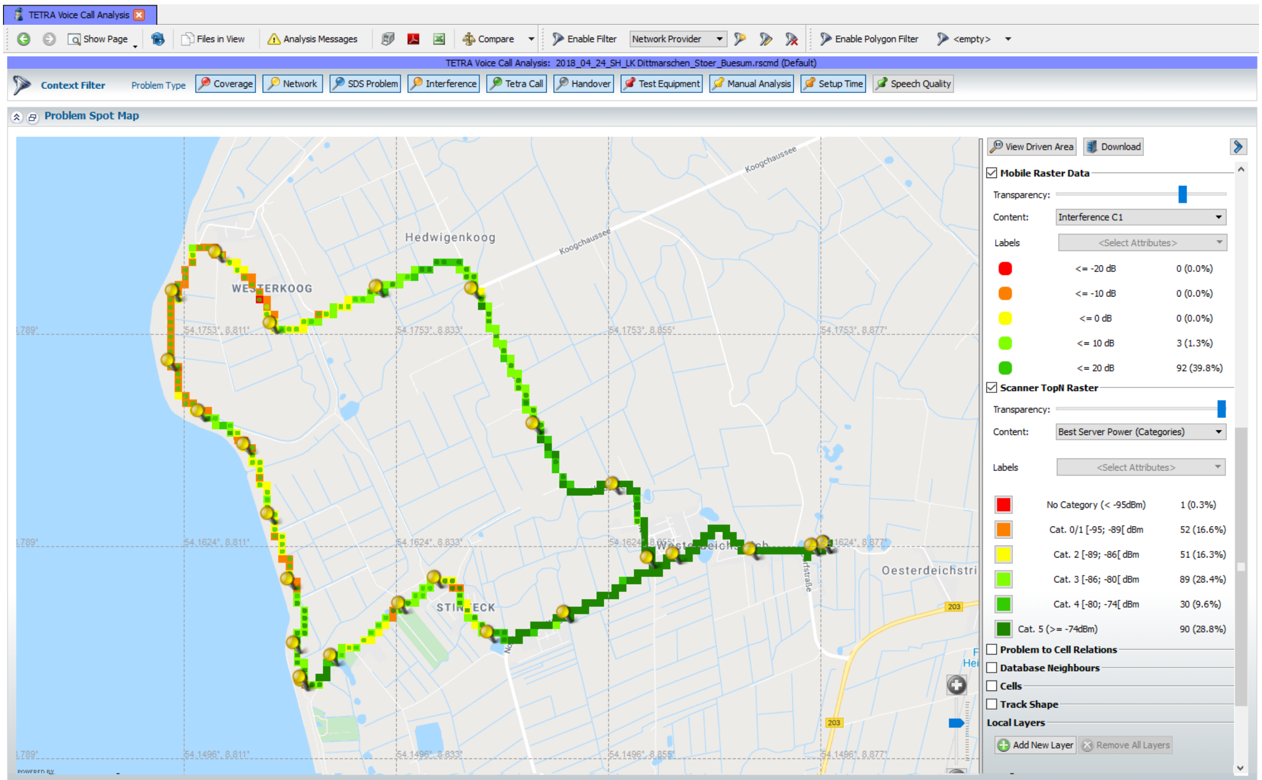


Figure 12-14: Activated layers on TETRA problem spot map

The mobile data raster layer is higher than the scanner TopN raster layer. That means, the scanner TopN raster layer is found below the mobile rater data one.

Handover problems and coverage problems are also easier to investigate. There is the mobile raster and the scanner raster data on the handover analysis map and mobile map pages.

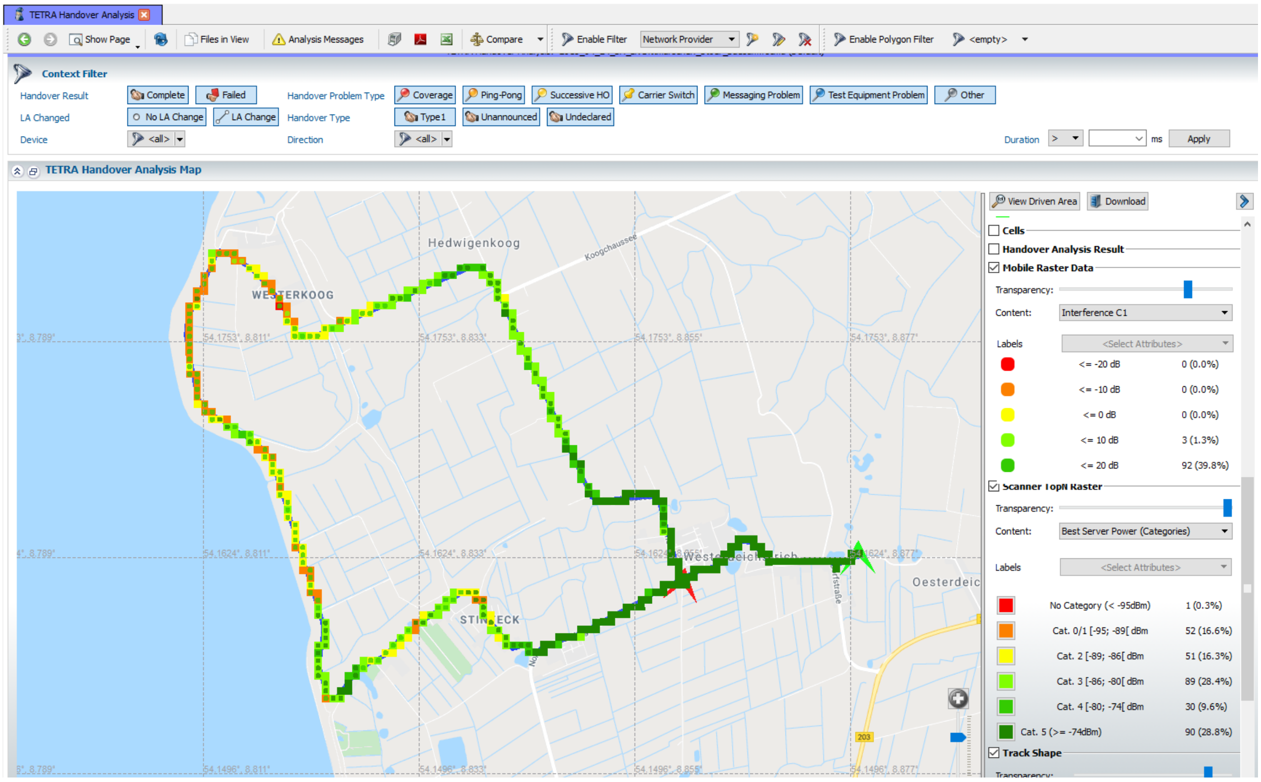
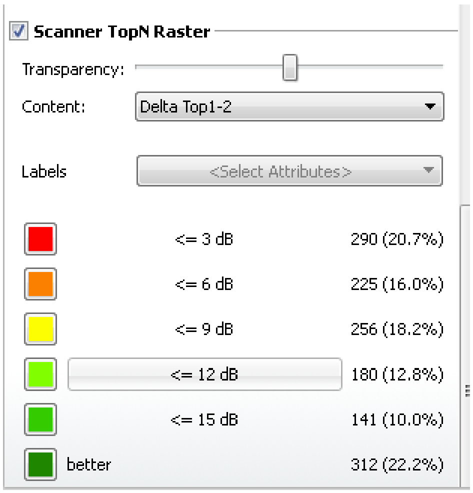


Figure 12-15: Activated layers on TETRA HO analysis map

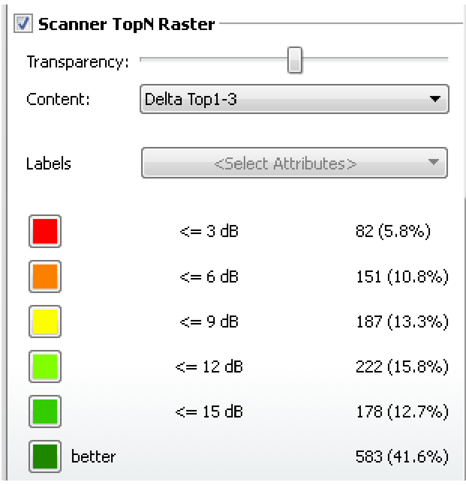
Operator can switch on or off the mentioned layers.

The "Scanner TopN Raster" layer of the "View Driven Area" has added coloring of bins for:

- Delta for Top1 cells to Top2 cell



- Delta for Top1 cells to Top3 cell



- Label for bins of both values

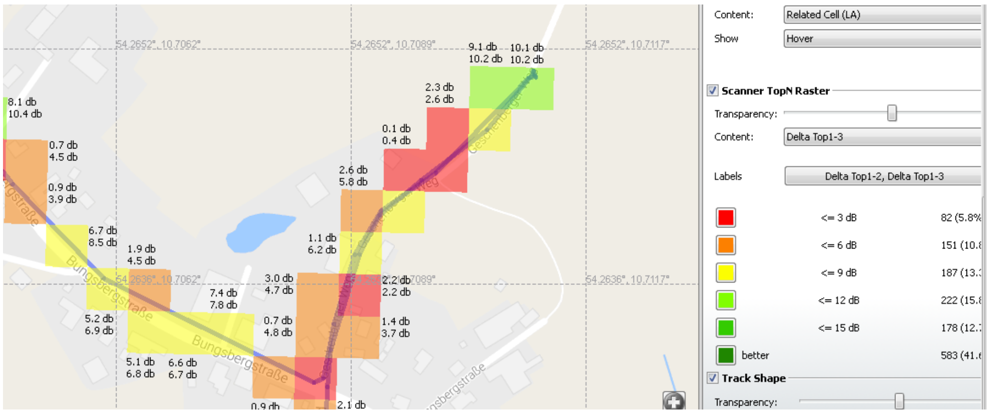


Figure 12-16: Activated labels for two Delta TopN values

Introducing these coloring bin schemes provides better interference analysis and planning possibilities regarding interference.

In combination with filtering, it is possible to analyze the data only of one provider or special carrier, where the problems can occur.

Furthermore, the Delta (dB) value can be activated as a label outside the bin.

The "Title" column in the "Problem Spot" table for TETRA speech quality per sample displays the direction of the speech sample ("Low speech quality DL" or "Low speech quality UL"). This display helps the operator to distinguish between the problems in DL and UL.

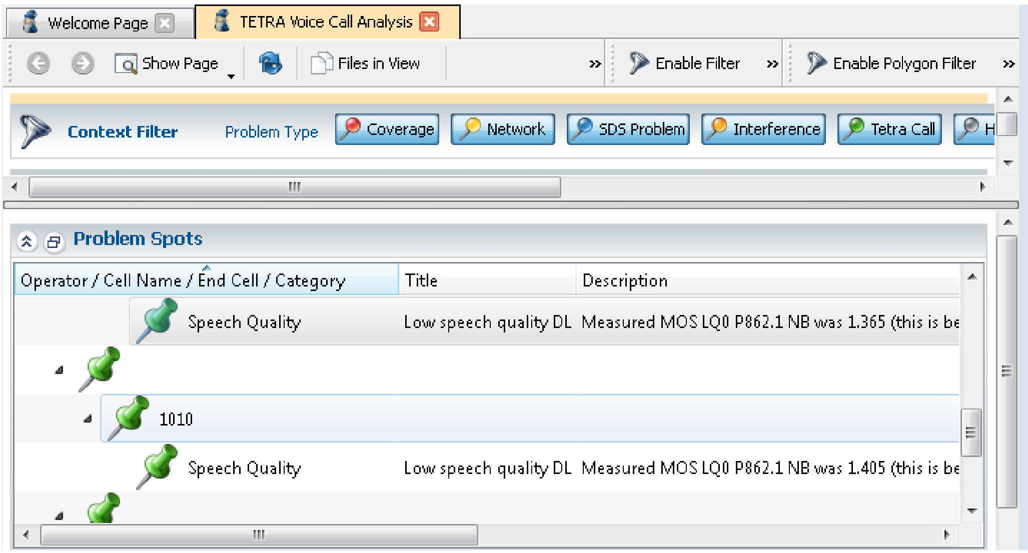


Figure 12-17: Reported low speech quality direction

12.3.1 Call setup analysis

TETRA networks have a strong limit on call setup time. It is crucial to get access to others fast in many situations. Delays of more than one second can influence acceptance within the user community. Even if a call can be established after the longer max access time in R&S ROMES4, the call has a setup problem.

A situation can be detected and a problem spot created from such scenario. The maximum setup time that is targeted in live networks is controlled using the "Max. Short Setup Time" setting. If the setup time exceeds that value, a problem spot is created at the current geographic location, even if the call is rated finally as "Good".

Such calls are shown in the "Voice Call Analyzer Problem Spot" view. They also influence the TETRA KPIs statistics for single and group calls. The normal "Call Setup Time" is accompanied by a statistic of the problems related to exceeded call setup time.

TETRA call analysis uses the modified PESQ P862.1 call quality scaling. For the values and meaning, see Table 12-3.

12.3.1.1 Speech quality list

The R&S ROMES4 NPA provides the Speech Quality Lists for TETRA calls. The list for a single call differs from the TETRA group call list.

The list for a TETRA single call contains speech quality in both directions. Speech quality is measured at both A- and B-party. The B-Party measurement results can be merged from a second measurement file located in the same directory. The "Speech

Quality List" contains the measurement samples and the call results from both parties, as shown in the following figure.

Speech Quality List

The list contains speech quality aggregated per call in ROMES and the speech quality samples for the A-party and the B-party

Result	Start Time	End Time	Call Direction	SQA Direction	Loop #	MOS Downlink	B-Party avg. MOS Downlink	Network Provider	Start CI/LA	End CI/LA	Device ID
Call	10/24/12 12:08:08	10/24/12 12:09:09	MOC	Receive		2.58		[illegible]	1027	1027	SRG3900 [1]
Call	10/24/12 12:08:08	10/24/12 12:09:09	MTC	Receive			2.304	[illegible]	1010	1027	STP8000 [1]
Sample	10/24/12 12:08:11	10/24/12 12:08:19	MTC	Receive	0		2.933	[illegible]	1010	1010	STP8000 [1]
Sample	10/24/12 12:08:20	10/24/12 12:08:28	MOC	Receive	0	2.51		[illegible]	1027	1027	SRG3900 [1]
Sample	10/24/12 12:08:21	10/24/12 12:08:40	MTC	Receive	1		2.64	[illegible]	1010	1010	STP8000 [1]
Sample	10/24/12 12:08:29	10/24/12 12:08:40	MOC	Receive	1	2.65		[illegible]	1027	1027	SRG3900 [1]
Sample	10/24/12 12:08:40	10/24/12 12:08:50	MOC	Receive	2	2.58		[illegible]	1027	1027	SRG3900 [1]
Sample	10/24/12 12:08:41	10/24/12 12:08:59	MTC	Receive	2		1.341	[illegible]	1010	1010	STP8000 [1]
Sample	10/24/12 12:08:51	10/24/12 12:09:01	MOC	Receive	3	2.58		[illegible]	1027	1027	SRG3900 [1]

Figure 12-18: TETRA Single Call Speech Quality List

The existing context filter, e.g. the device filter, can be applied to the speech quality list.

The list for a TETRA group call contains speech quality measured only at the B-party.

Speech Quality List

The list contains speech quality aggregated per call in ROMES and the speech quality samples for the A-party and the B-party

Result	Start Time	End Time	RAT	MOS Type	Direction	MOS Downlink	B-Party MOS Downlink	Network Provider	Start CI/LA	End CI/LA	Device ID
Call	10/22/13 15:55:10	10/22/13 15:55:50	TETRA	PESQ	MTC		2.245	[illegible]	6658	6658	STP8000 [1]
Sample	10/22/13 15:55:22	10/22/13 15:55:22	TETRA	PESQ	MTC		2.258	[illegible]	6658	6658	STP8000 [1]
Sample	10/22/13 15:55:34	10/22/13 15:55:34	TETRA	PESQ	MTC		2.233	[illegible]	6658	6658	STP8000 [1]
Call	10/22/13 15:56:10	10/22/13 15:56:50	TETRA	PESQ	MTC		2.229	[illegible]	6658	6658	STP8000 [1]
Sample	10/22/13 15:56:23	10/22/13 15:56:23	TETRA	PESQ	MTC		2.323	[illegible]	6658	6658	STP8000 [1]
Sample	10/22/13 15:56:34	10/22/13 15:56:34	TETRA	PESQ	MTC		2.135	[illegible]	6658	6658	STP8000 [1]
Call	10/22/13 15:57:10	10/22/13 15:57:50	TETRA	PESQ	MTC		2.132	[illegible]	6658	6658	STP8000 [1]
Sample	10/22/13 15:57:22	10/22/13 15:57:22	TETRA	PESQ	MTC		2.235	[illegible]	6658	6658	STP8000 [1]
Sample	10/22/13 15:57:34	10/22/13 15:57:34	TETRA	PESQ	MTC		2.029	[illegible]	6658	6658	STP8000 [1]
Call	10/22/13 15:58:10	10/22/13 15:58:01	TETRA	PESQ	MTC		2.178	[illegible]	6658	6658	STP8000 [1]

Figure 12-19: TETRA Group Call Speech Quality List

12.3.1.2 Speech quality charts

The R&S ROMES4 NPA GUI shows TETRA speech quality results on call and on sample basis in the following charts:

- Bar chart
- Cumulative Distribution Function chart
- Percentile chart

All bar charts, including those charts of TETRA speech quality, have an explanation for the meaning of the colors at the right-hand side of the chart.

The following figures show the charts for both kinds of speech quality basis.

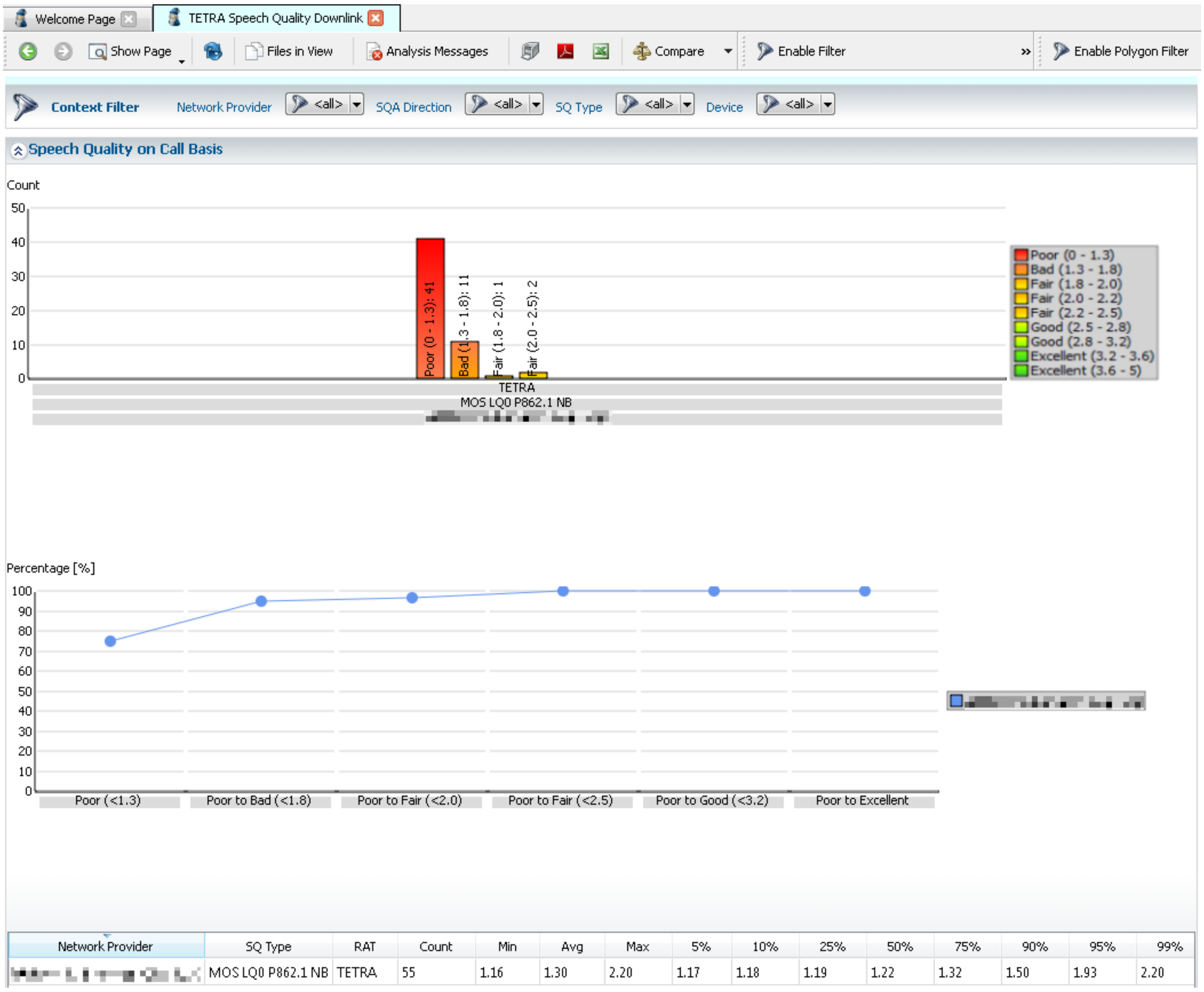


Figure 12-20: TETRA speech quality on call basis charts

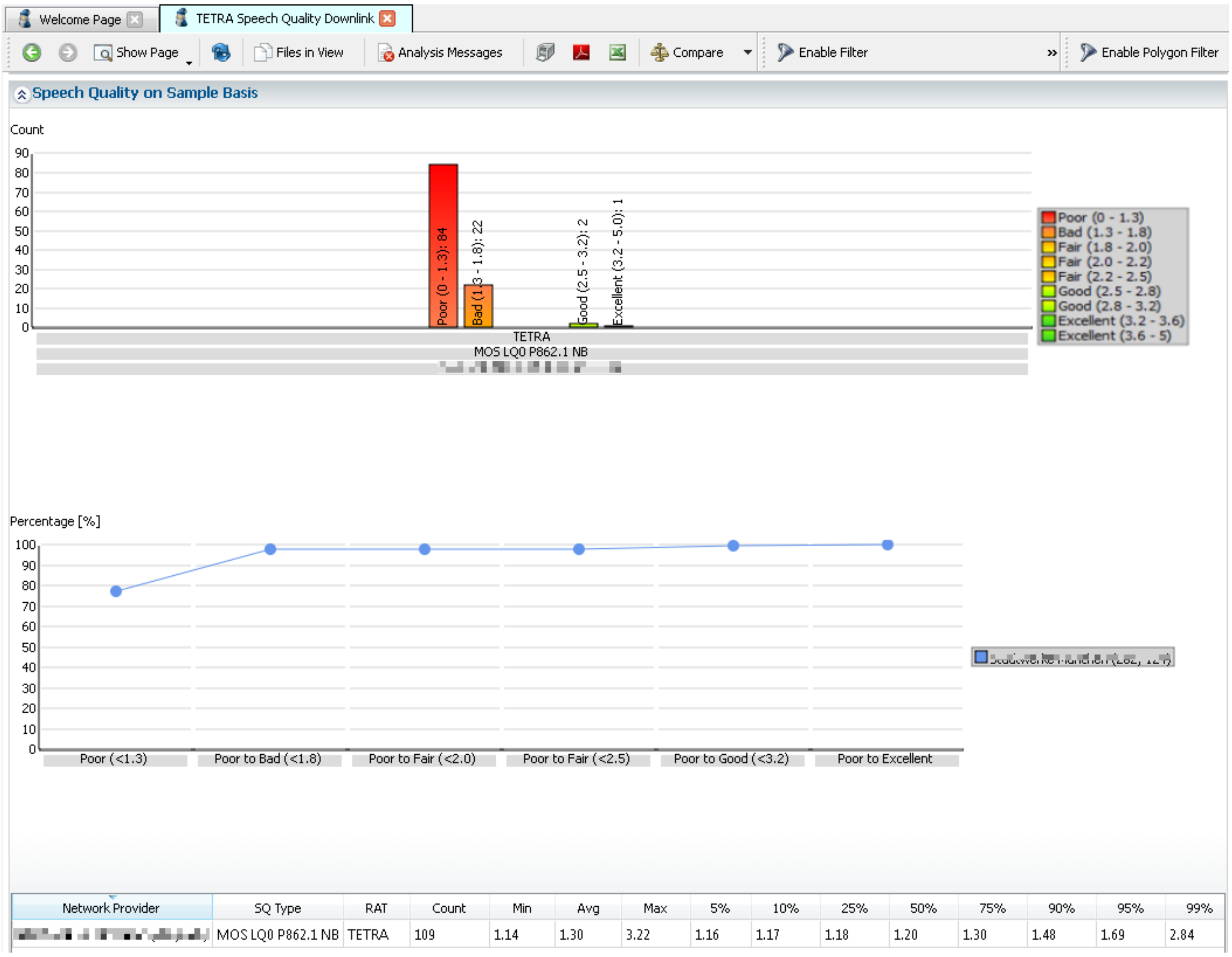


Figure 12-21: TETRA speech quality on sample basis charts

Suppressing SQA samples effects

The possibility to activate suppressing of SQA samples with low confidence has an impact on layout of several TETRA Speech Quality pages.

Affected are the following pages:

- TETRA Speech Quality Samples (Downlink)
  The bar chart does not show the low confidence samples.

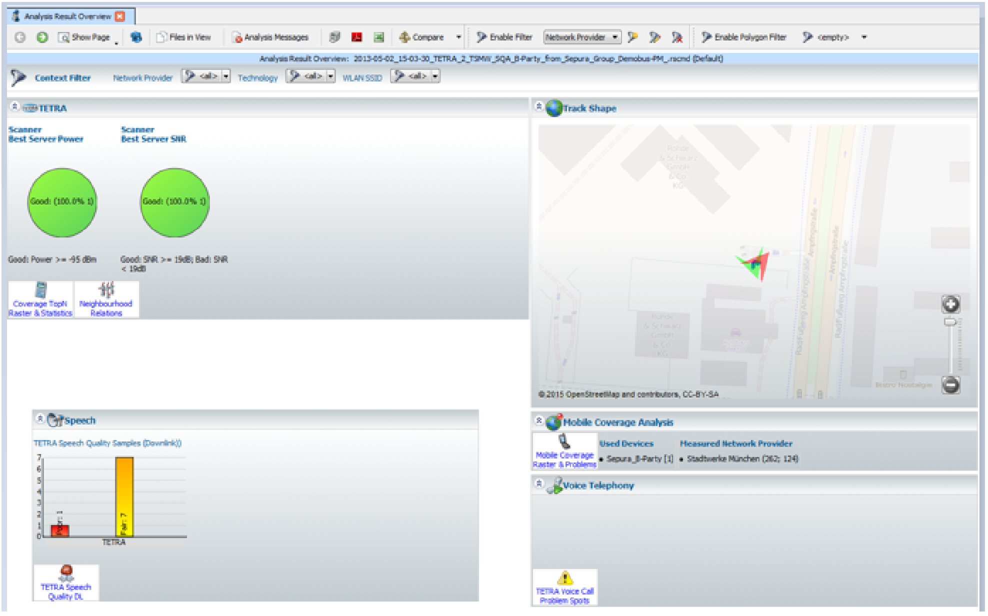


Figure 12-22: TETRA speech quality samples

- TETRA Speech Quality Overview
  The bar chart of the "TETRA Speech Quality per Call (Downlink)" shows low confidence samples.

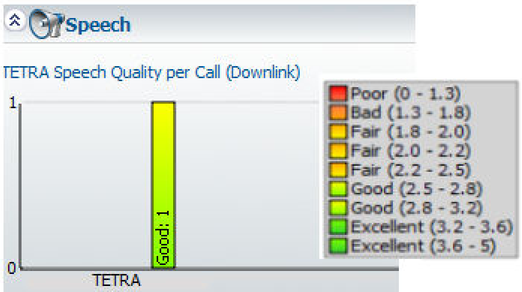


Figure 12-23: TETRA speech quality overview

- TETRA Speech Quality
  In the "TETRA Speech Quality" page the following applies regarding displaying the low confidence samples:
  – "Call Table" list shows the samples.
  – "Speech Quality on Call Basis" bar chart shows the samples.
  – "Speech Quality on Sample Basis" bar graph does not show the samples.

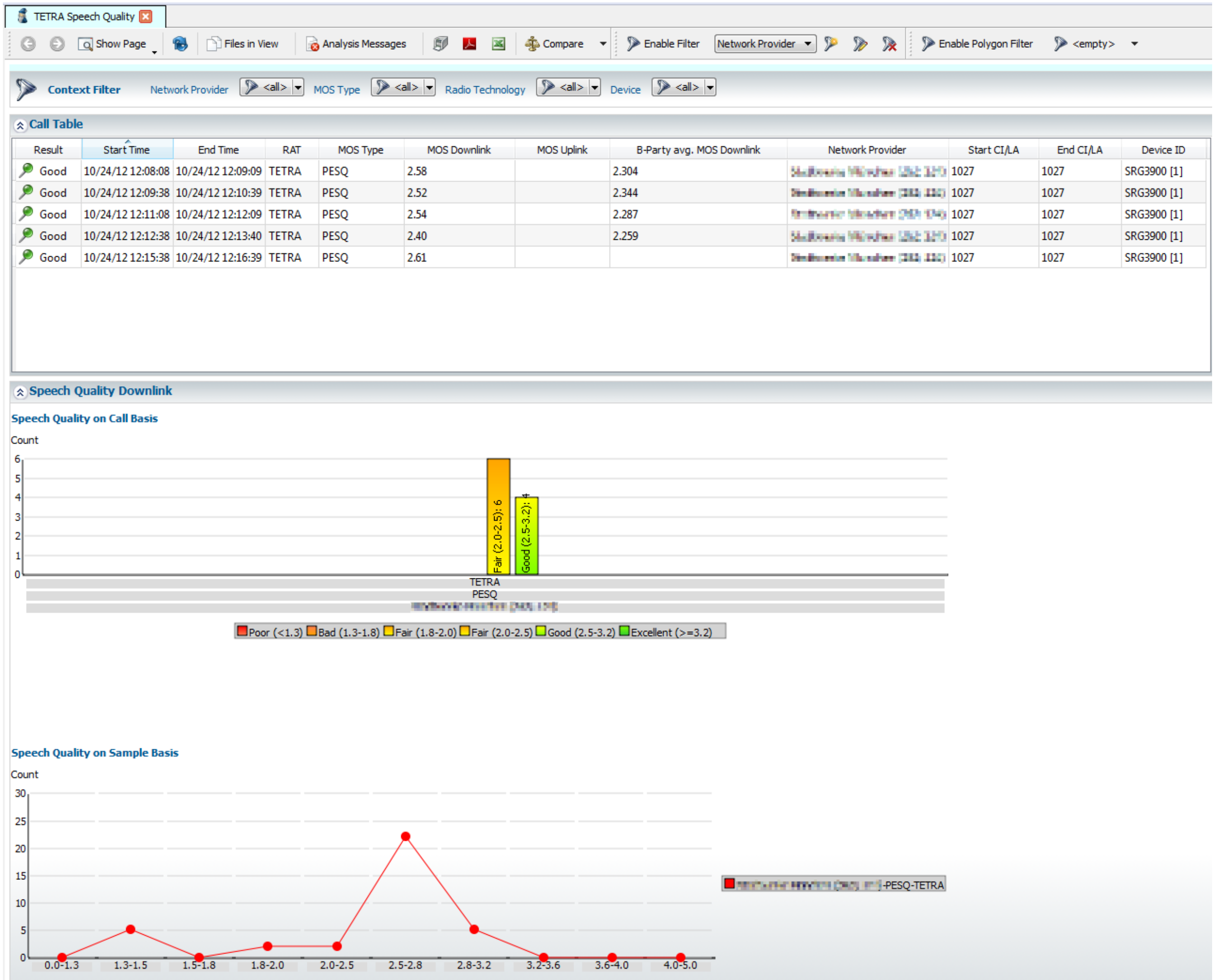
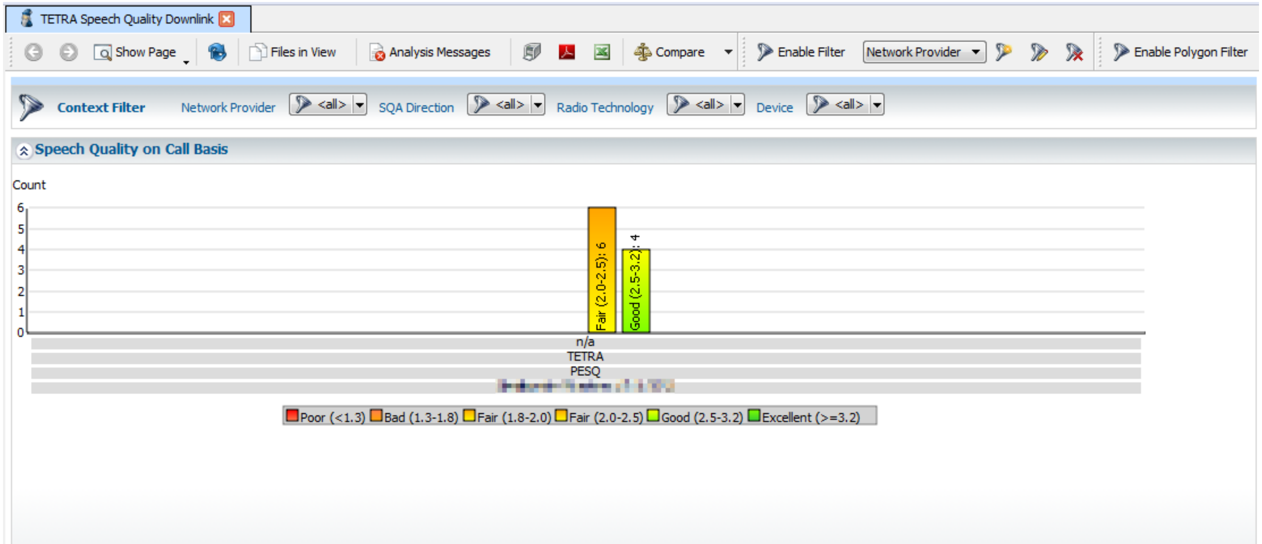


Figure 12-24: TETRA speech quality views

- TETRA Speech Quality Downlink
  – "Speech Quality on Call Basis" contains the previously mentioned samples as bar charts and percentiles.



Network Provider	MOS Type	RAT	Codec	Count	Min	Avg	Max	5%	10%	25%	50%	75%	90%	95%	99%
	PESQ	TETRA	n/a	10	2.26	2.43	2.61	2.26	2.29	2.30	2.48	2.54	2.61	2.61	2.61

Figure 12-25: TETRA speech quality downlink on call basis

– "Speech Quality on Sample Basis" does not contain the low confidence samples in bar charts and percentiles, but the "Speech Quality List" contains them.

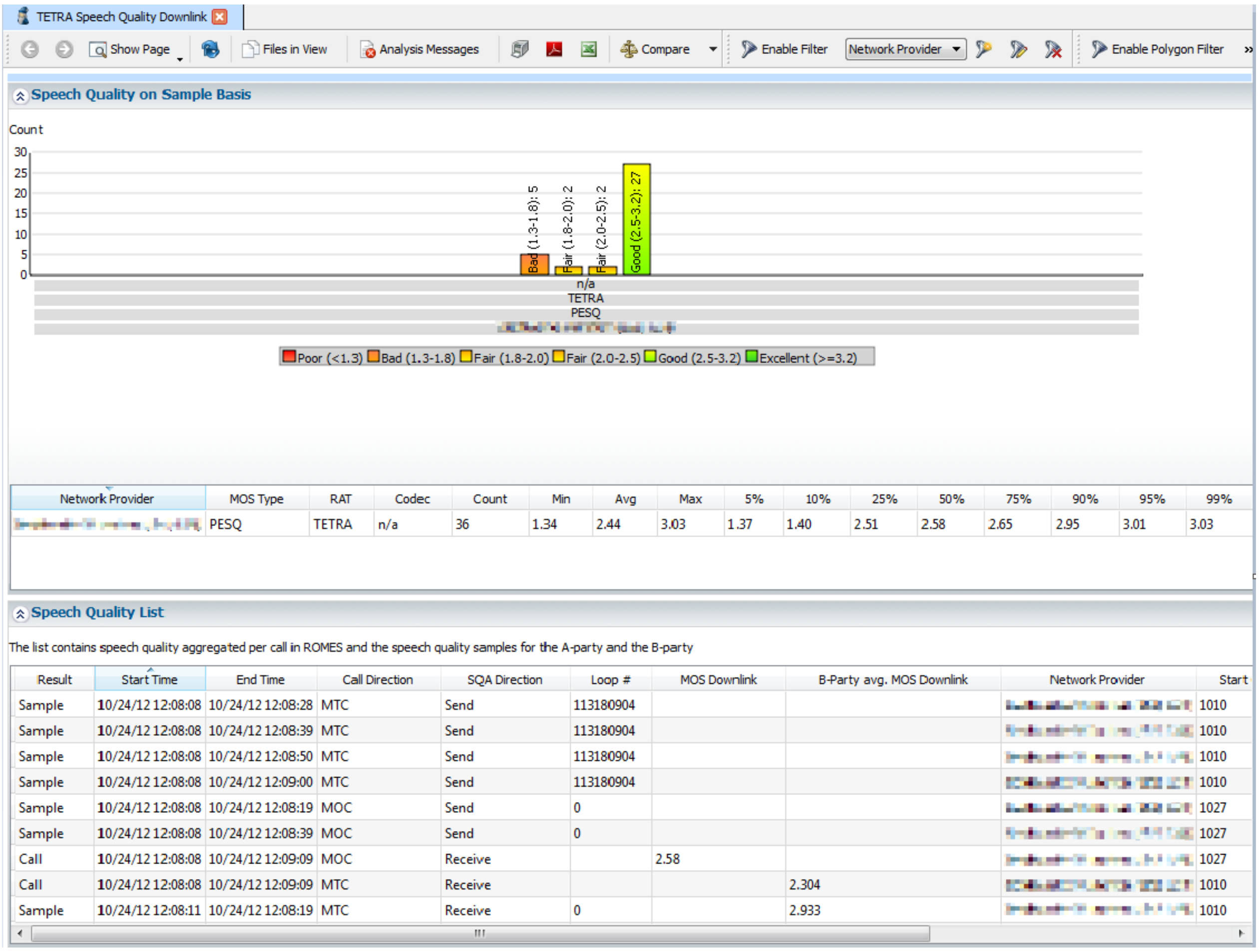


Figure 12-26: TETRA speech quality on sample basis

12.3.1.3 Mobile coverage map parameters

The "TETRA Mobile Coverage Cell Statistics" > "Mobile Coverage Map" page shows the speech quality per samples and speech quality results per call for TETRA group calls (point-to-multipoint) and voice calls (point-to-point).

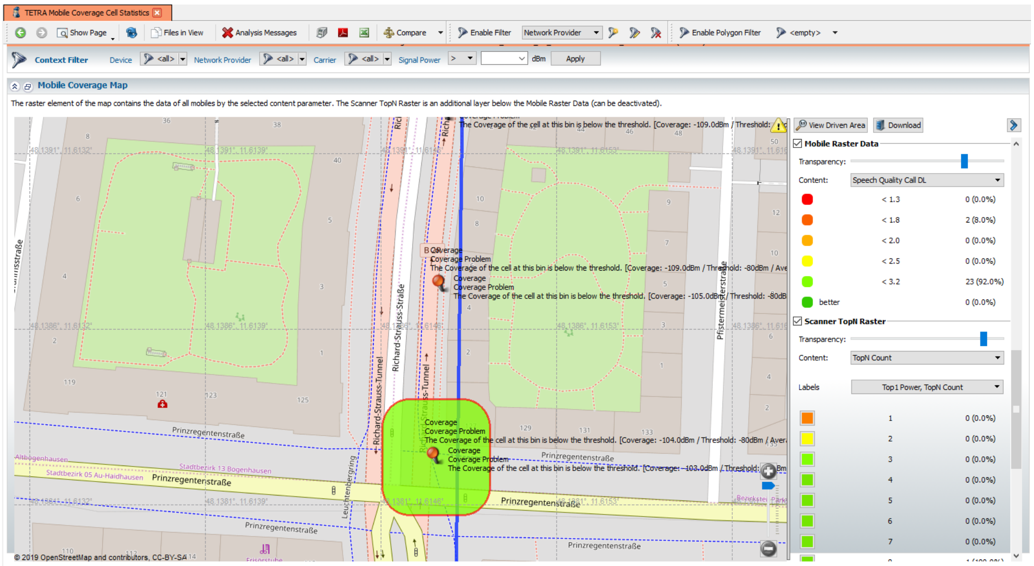
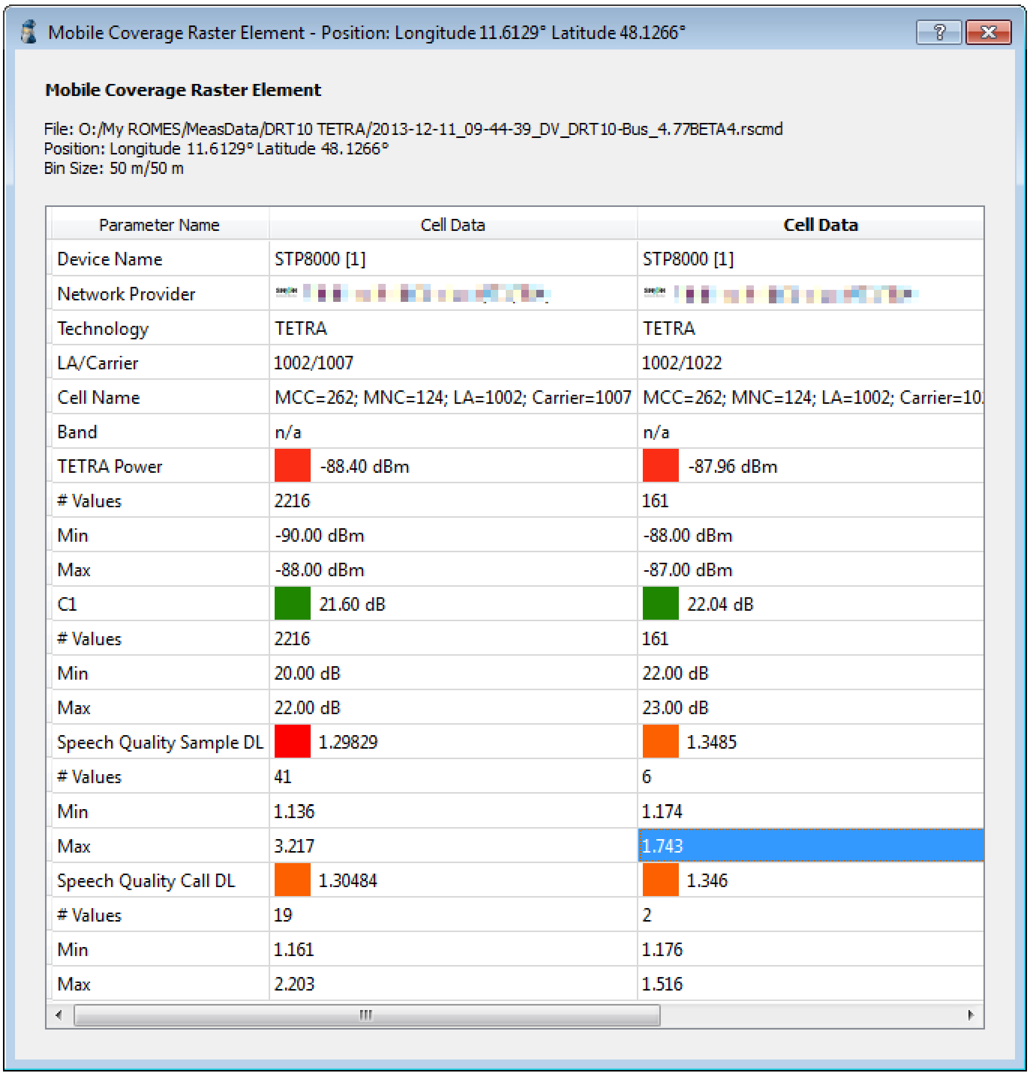


Figure 12-27: TETRA mobile coverage map

Double click the selected bin to see the details of the bin samples. The cell details, number of counts, minimum and maximum of speech samples and the MOS parameters are contained in the "Mobile Coverage Raster Element" window.


Mobile Coverage Raster Element - Position: Longitude 11.6129° Latitude 48.1266°

Mobile Coverage Raster Element

File: O:/My ROMES/MeasData/DRT10 TETRA/2013-12-11_09-44-39_DV_DRT10-Bus_4.77BETA4.rscmd
Position: Longitude 11.6129° Latitude 48.1266°
Bin Size: 50 m/50 m

Parameter Name	Cell Data	**Cell Data**
Device Name	STP8000 [1]	STP8000 [1]
Network Provider	[illegible]	[illegible]
Technology	TETRA	TETRA
LA/Carrier	1002/1007	1002/1022
Cell Name	MCC=262; MNC=124; LA=1002; Carrier=1007	MCC=262; MNC=124; LA=1002; Carrier=10
Band	n/a	n/a
TETRA Power	-88.40 dBm	-87.96 dBm
# Values	2216	161
Min	-90.00 dBm	-88.00 dBm
Max	-88.00 dBm	-87.00 dBm
C1	21.60 dB	22.04 dB
# Values	2216	161
Min	20.00 dB	22.00 dB
Max	22.00 dB	23.00 dB
Speech Quality Sample DL	1.29829	1.3485
# Values	41	6
Min	1.136	1.174
Max	3.217	1.743
Speech Quality Call DL	1.30484	1.346
# Values	19	2
Min	1.161	1.176
Max	2.203	1.516

Figure 12-28: TETRA - speech quality samples

If hovering with mouse over a bin, the Tooltip pops-up showing the cell data in "Mobile Coverage Result".

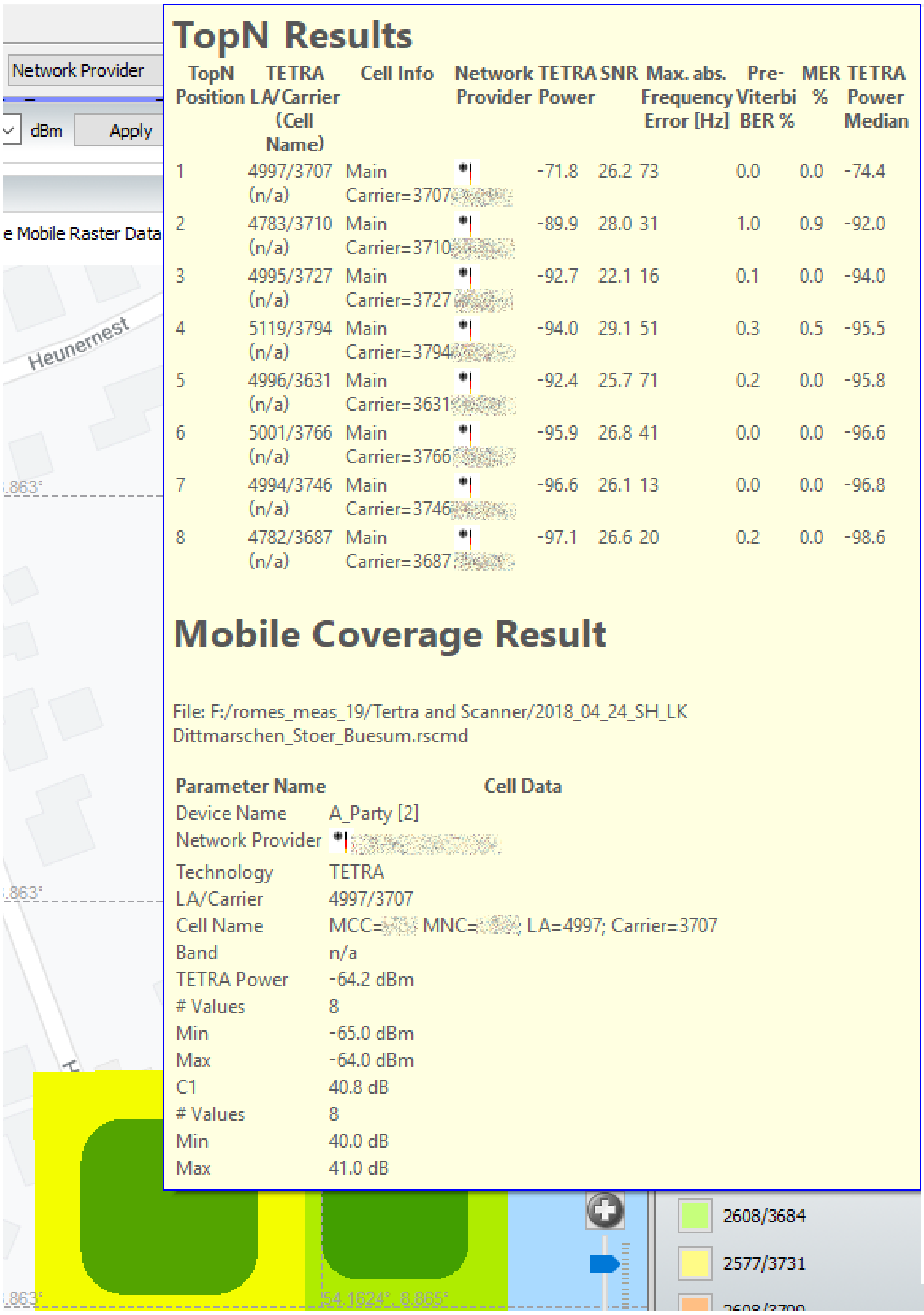


Figure 12-29: Tooltip of a bin

The map of the TETRA mobile coverage analysis offers in addition the scanner TopN raster layer below the mobile raster data layer. The layer can be activated or deactivated.

If the layer is activated, double click the bin opens the "TopN Raster Element" window. The TETRA handover results and problems are in that way added to mobile coverage map. The separate handover page is available as well.

TopN Raster Element - Position: Longitude 11.6122° Latitude 48.1257°

TopN Raster Element

File: O:/My ROMES/MeasData/DRT10 TETRA/2013-12-11_09-44-39_DV_DRT10-Bus_4.77BETA4.rscmd
Cells: 16
Position: Longitude 11.6122° Latitude 48.1257°
Bin Size: 50 m/50 m

TopN Position	TETRA LA/Carrier (Cell Name)	Cell Info	Network Provider	TETRA Power	SNR (avg)	Max. abs. Frequency Error [Hz]	Pre-Viterbi BER %	MER %	TETRA Power Median
1	6658/3629 (n/a)	Main Carrier=3744	[illegible]	-72.39 dBm	28.95 dB	54	0.00	0.00	-72.40 dBm
2	6658/3744 (n/a)	Main Carrier=3744	[illegible]	-72.67 dBm	30.80 dB	54	0.00	0.00	-72.67 dBm
3	6693/3723 (n/a)	Main Carrier=3786	[illegible]	-84.97 dBm	31.28 dB	52	0.00	0.00	-84.95 dBm
4	6693/3786 (n/a)	Main Carrier=3786	[illegible]	-87.36 dBm	26.78 dB	56	0.00	0.00	-87.37 dBm
5	1002/1007 (n/a)	Main Carrier=1007	[illegible]	-88.75 dBm	22.23 dB	36	0.00	0.00	-88.78 dBm
6	6659/3622 (n/a)	Main Carrier=3622	[illegible]	-89.13 dBm	27.49 dB	56	0.00	0.00	-89.12 dBm
7	6668/3658 (n/a)	Main Carrier=3658	[illegible]	-89.28 dBm	28.45 dB	57	0.00	0.00	-89.29 dBm
8	6657/3672 (n/a)	Main Carrier=3633	[illegible]	-89.33 dBm	28.61 dB	53	0.00	0.00	-89.35 dBm
9	6668/3617 (n/a)	Main Carrier=3658	[illegible]	-89.37 dBm	27.57 dB	54	0.00	0.00	-89.37 dBm
10	1002/1022 (n/a)	Main Carrier=1007	[illegible]	-94.57 dBm	17.50 dB	40	0.00	0.00	-94.62 dBm
11	1003/1004 (n/a)	Main Carrier=1004	[illegible]	-96.47 dBm	15.80 dB	68	0.02	0.05	-96.56 dBm
12	1/1174 (n/a)	Main Carrier=1174	[illegible]	-97.58 dBm	14.42 dB	74	0.03	0.02	-97.54 dBm
13	1010/1050 (n/a)	Main Carrier=1050	[illegible]	-99.31 dBm	11.97 dB	42	0.41	0.44	-99.34 dBm
14	1003/1019 (n/a)	Main Carrier=1004	[illegible]	-100.60 dBm	11.84 dB	85	1.07	1.08	-100.75 dBm
15	1001/1031 (n/a)	Main Carrier=1016	[illegible]	-101.75 dBm	9.56 dB	93	3.42	3.22	-101.84 dBm
16	1027/1027 (n/a)	Main Carrier=1027	[illegible]	-102.28 dBm	9.71 dB	114	3.60	3.80	-102.38 dBm

Figure 12-30: TopN raster element

The Tooltip shows also the list of TopN cells in the "TopN Results" part if the layer "Scanner TopN Raster" is activated. The "TopN Results" part shows maximum 10 cell entries. Shown are the values of a bin for scanner coverage. If more cells are available, the last line is "...". Reducing the number of cell entries improves the visibility of the first results. To see all TopN cells, use the "TopN Raster Element".

The "TETRA Mobile Coverage Cell Statistics" > "Mobile Coverage Cell Table" shows the same what "Mobile Coverage Raster Element" shows. The MOS values are between the TETRA Power and C1 values, see the following figure.

Mobile Coverage Cell Table

DeviceId / Network Provider / Technology / Cell Name	LA/Carrier	Carrier	# Bins	TETRA Power	# Values	Min Values	Max Values	C1	# Values	Min Values	Max Values	Speech Quality Samples DL	Speech Quality Samples UL	Speech Quality Call DL
STP8000 [1]														
[illegible]														
TETRA														
MCC=262; MNC=124; LA=1002; Carrier=1007	1002/1007	1007	4	-88.46 dBm	5215	-90.00 dBm	-88.00 dBm	21.54 dB	5215	20.00 dB	22.00 dB	1.30	0.00	1.30
MCC=262; MNC=124; LA=1002; Carrier=1022	1002/1022	1022	1	-87.96 dBm	161	-88.00 dBm	-87.00 dBm	22.04 dB	161	22.00 dB	23.00 dB	0.00	0.00	0.00
MCC=262; MNC=124; LA=1010; Carrier=1050	1010/1050	1050	1	-84.00 dBm	92	-84.00 dBm	-84.00 dBm	26.00 dB	91	26.00 dB	26.00 dB	0.00	0.00	0.00

Figure 12-31: Mobile Coverage Cell Table content

12.3.2 Dropped call analysis

If a call finishes improperly, i.e. is qualified as a dropped call, the following detection strategies can be applied.

Coverage & Interference Problems

Like all other modules, the TETRA Mobile Analyzer checks basic coverage and interference when a call drop occurs. Coverage and interference have a high impact on the call drop rate. The coverage check uses the TETRA Power to find out the time intervals with bad coverage. TETRA Power and C1 are used to find out interference problems. For more detailed description on how the coverage and interference checks work, see Coverage / Interference Analysis chapter.

Handover problem detection

Although the PEI interface does not report handover attempts and failures, the TETRA Voice Call Analyzer tries to find problems related to handovers.

This is done by investigating the neighbor cells reports and the state of the currently used serving cell. If specific conditions are met, these algorithms scan a specific time interval before the actual drop classification. The measurement reports containing the neighbor cells and the changes in the current serving cell are checked. The scanned time interval can be defined by changing the "Handover Analysis Time Interval" setting.

With this approach, the problems listed in the following can be found.

Missing handover

If a dropped call is detected, the monitored neighbor cell list is checked for the best neighbor which has provided a significant better radio signal for at least 2 seconds. The signal of a neighbor is considered to be better than the serving cell if the averaged TETRA Power difference between both is greater than 3.0 dB.

Normally, the network triggers then a handover, but handover trigger depends on the base station configuration (hysteresis parameters). Since the PEI interface does not report that configuration, the R&S ROMES4 NPA reports that problem in all cases.

Ping-pong handover

In some situations, a mobile repeats handovers between two cells over a short period of time. These handover repetitions normally indicate a network configuration/coverage issue and sometimes lead to dropped calls.

If such a situation is detected, it is classified as "Ping-Pong Handover" problem.

Excessive handover

Similar to the Ping Pong Handover problem, an "Excessive Handover" is detected when too many handovers between multiple cells (each LA is reported once) happen in the analyzed time interval.

Potentially missing handover

If none of the above two checks conditions are met, i.e. if there is only one LA measured in the complete analyzed interval, then probably a neighbor relation is missing. This problem can be especially the case if there is no better neighbor measured. Another problem could be that there is no other base station to be received at all. In such case, it can be useful to use the TETRA neighborhood Analysis module.

12.3.2.1 Layer3 messages for problems analysis

The analysis of problems due to dropped and blocked calls and no service cases is enhanced showing the Layer3 messages for the A-Party and the B-Parties in the "Details" page.

The high and normal priority problem causes are placed on top, followed by the Layer3 messages, which are ordered by timestamp.

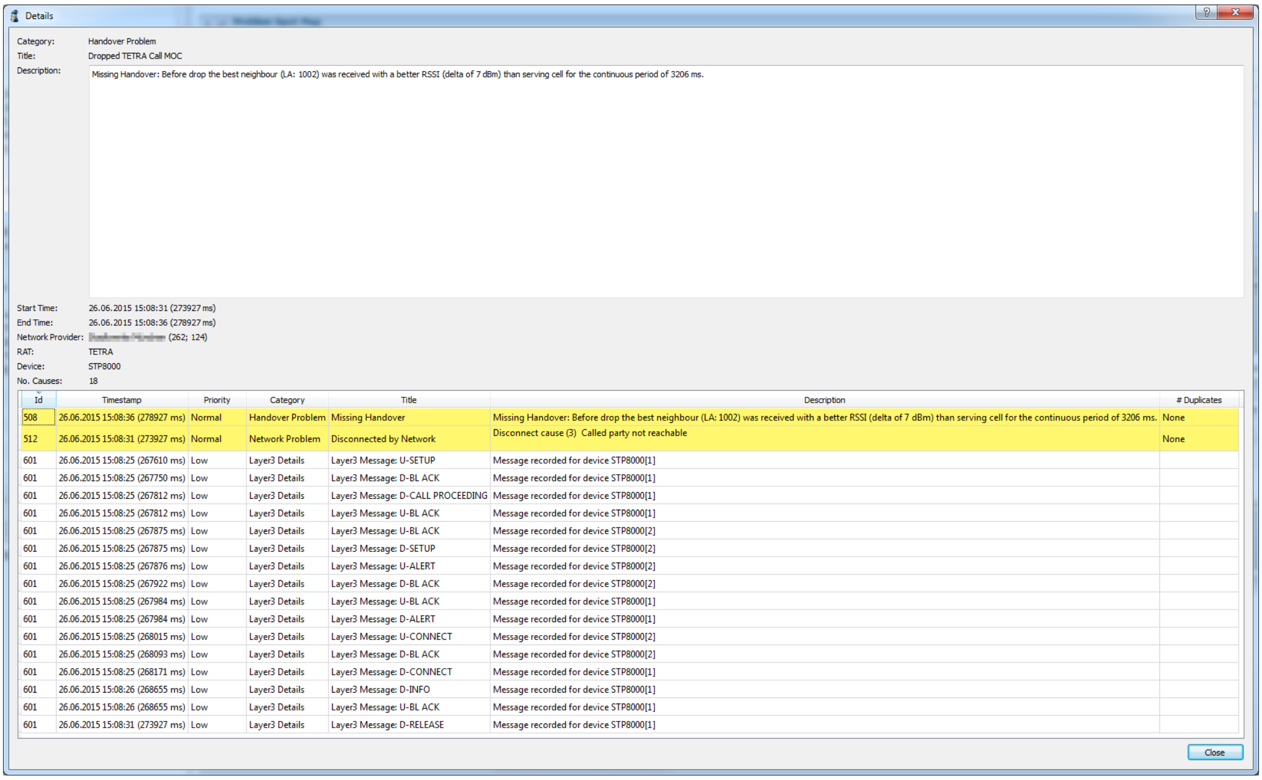


Figure 12-32: Layer3 details with reported dropped MOC call

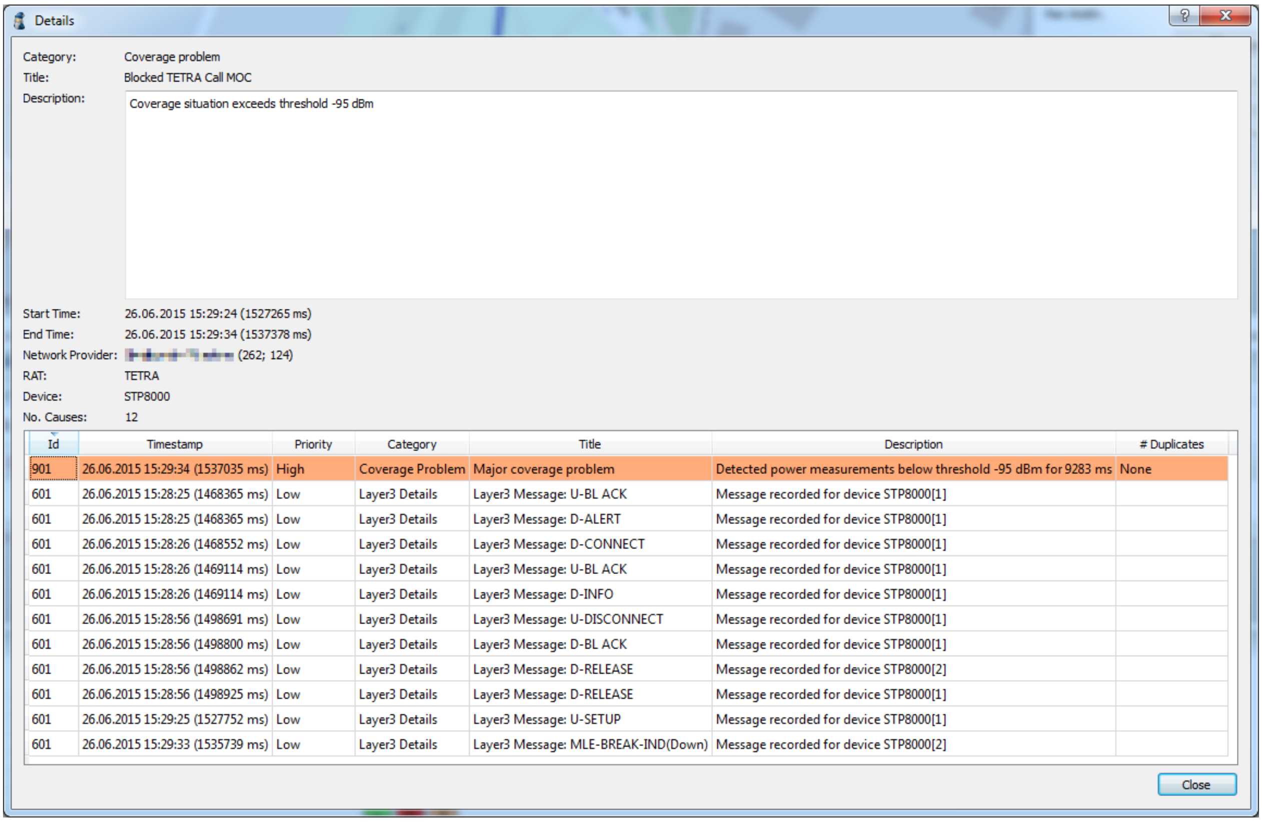


Figure 12-33: Layer 3 details with reported blocked MOC call

12.3.3 TETRA-specific KPIs

The TETRA KPIs are calculated by the R&S ROMES4 NPA since R&S ROMES4 does not provide them in the RSCMD file format based on the Layer3 signaling (if available) or the AT commands. The latter approach is deprecated. Do not use it anymore for new measurements as many KPIs cannot be calculated properly without the SAIL support in R&S ROMES4 (ROMES4TDS option).

The following table shows which trigger points are used when the SAIL interface is available to calculate the KPIs for TETRA measurements.

KPI	Type	Calculation Method	Comment
Network Availability	[%]	1 - # No Service # Call Attempts	
Attach Success Rate	[%]	# D-LOCATION UPDATE ACCEPT # U-LOCATION UPDATE COMMAND	

KPI	Type	Calculation Method	Comment
Attach Delay	[msec]	t D-LOCATION UPDATE ACCEPT - t U-LOCATION UPDATE COMMAND	
Handover Success Rate	[%]	# U-RESTORE # D-NEW-CELL	Currently R&S ROMES4 does not provide trigger points originating from the Mobile messages MLE-BREAK, MLE-LINK, MLE-UPDATE and MLE-RESTORE/ RESUME. Once the U-RESTORE or D-NEW-CELL message is available, the handover success rate and duration detection use it as trigger point instead.
Handover Duration	[%]	t U-RESTORE - t D-NEW-CELL	See previous comment
Call Setup Success Rate	[%]	# D-CONNECT (within Max Setup Time) # U-SETUP	The calculation is basically the number of blocked calls over the total number of call attempts. "Max Setup Time" is read from the Autodialer settings configured in R&S ROMES4.
Call Setup Time	[msec]	t D-CONNECT - t U-SETUP	
Call Success Rate / Single Call	[%]	# U-DISCONNECT (after Min Call Duration) # D-CONNECT	The Min Call Duration threshold is read from the configuration of the Autodialer in R&S ROMES4.
Call Duration / Single Call	[msec]	t U-DISCONNECT - t D-CONNECT	

KPI	Type	Calculation Method	Comment
Call Success Rate / Group Call	[%]	# U-TX-CEASED (after Min Call Duration) # D-CONNECT	The Min Call Duration threshold is read from the configuration of the Autodialer in R&S ROMES4.
Call Duration / Group Call	[msec]	t U-TX-CEASED - t D-CONNECT	
Speech Quality per Call	[%]	# min(SQ-Sample PESQ) >= 2.0 # Successful calls	
Speech Quality per Sample	MOS	Speech Sample PESQ-value	Calculated within the SQA driver of R&S ROMES4

R&S ROMES4 and R&S ROMES4 NPA use different trigger points to calculate the call setup for single and group calls. The R&S ROMES4 NPA uses the time difference between the ATD command and the AT+CTCC answer.

12.3.3.1 Configuration

Parameter	Value Range	Default	Description
Min. Coverage TETRA Power	-120 dBm to -40 dBm	-95 dBm	If coverage is below this threshold, a coverage problem is detected.
Max. Interference TETRA Power	-120 dBm to -40 dBm	-80 dBm	Interference problems are detected if TETRA Power is above that threshold and C1 is below Min. C1 criterion.
Max. Interference C1	0 to ...	2	Interference problems are detected if TETRA Power is above the Max. Interference TETRA Power threshold and C1 is below this threshold.

Parameter	Value Range	Default	Description
Max. Short Setup Time	0 msec to ...	500 msec	If the call setup time exceeds this threshold, a problem spot "Call Setup Time Exceeded" is created.
Handover Analysis Time Interval	0 s to ...	10 s	This parameter defines the time interval before a dropped call. It is scanned for possible missing handovers and handover ping-pong effects.

12.4 Voice call analyzer (GSM)

R&S ROMES4 supports measuring a set of timing information for GSM mobile devices and displays it in the R&S ROMES4 basic views, as shown in the following figure.

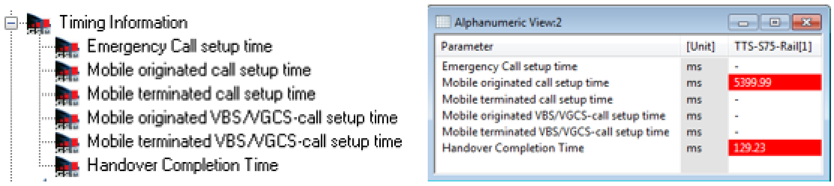


Figure 12-34: R&S ROMES GSM timing information signals

R&S ROMES4 NPA aggregates these signals and displays them on the "GSM UE Timing" result page.

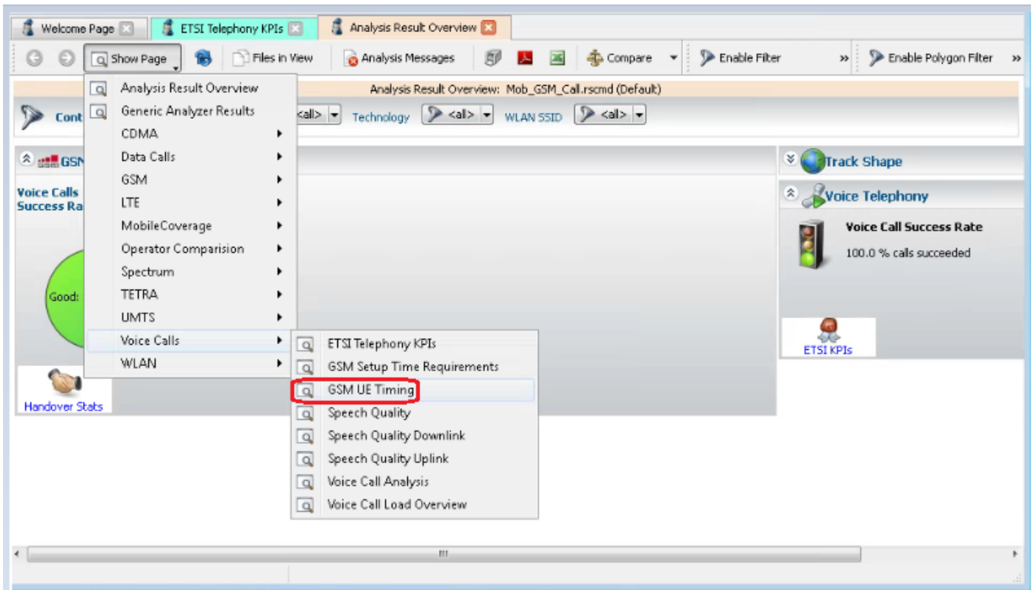


Figure 12-35: Command to open GSM UE timing page

The "GSM UE Timing" result page is also available via the "ETSI Telephony KPIs" result page as shown in the following figure.

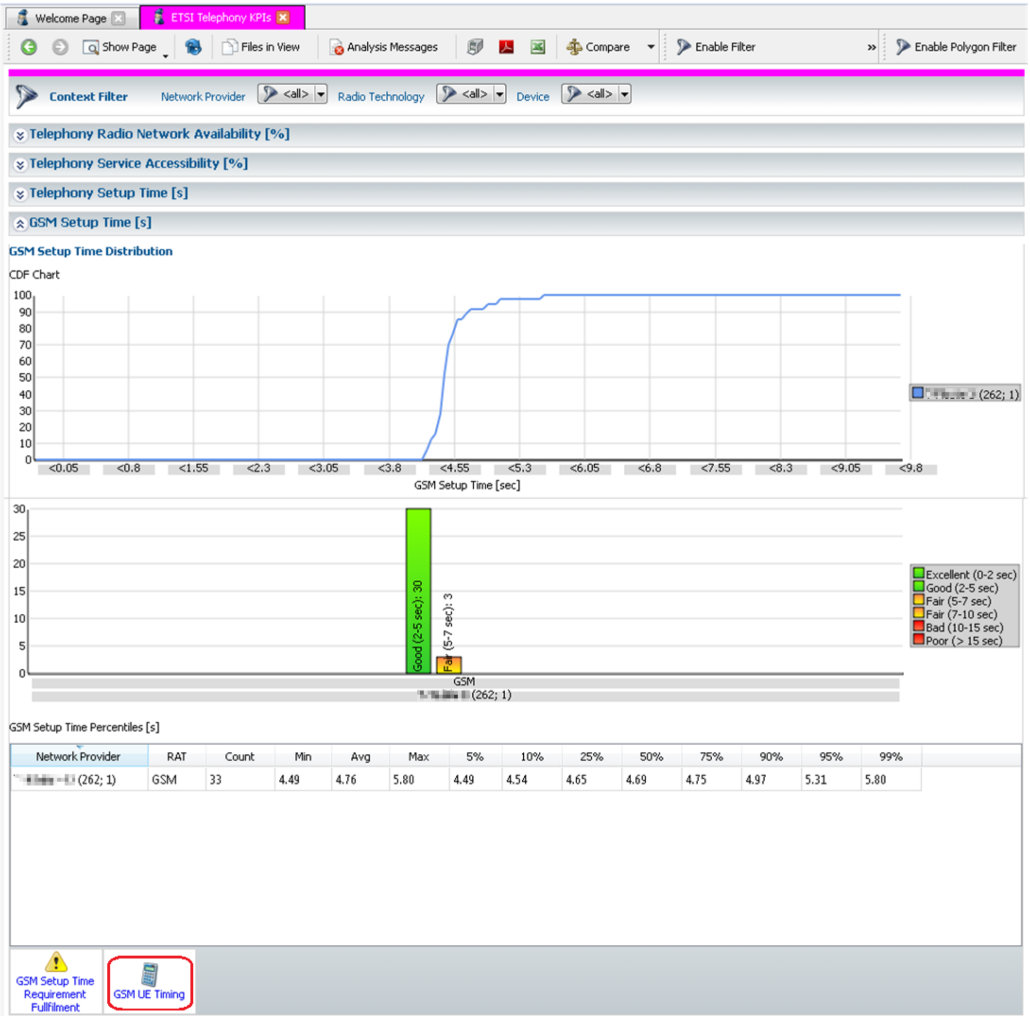


Figure 12-36: GSM UE Timing button in the ETSI telephony KPIs page

A mobile originated (MOC) call setup time is displayed in CDF chart, bar chart and percentiles within, for example, the "GSM UE Timing" page, see the following figure.

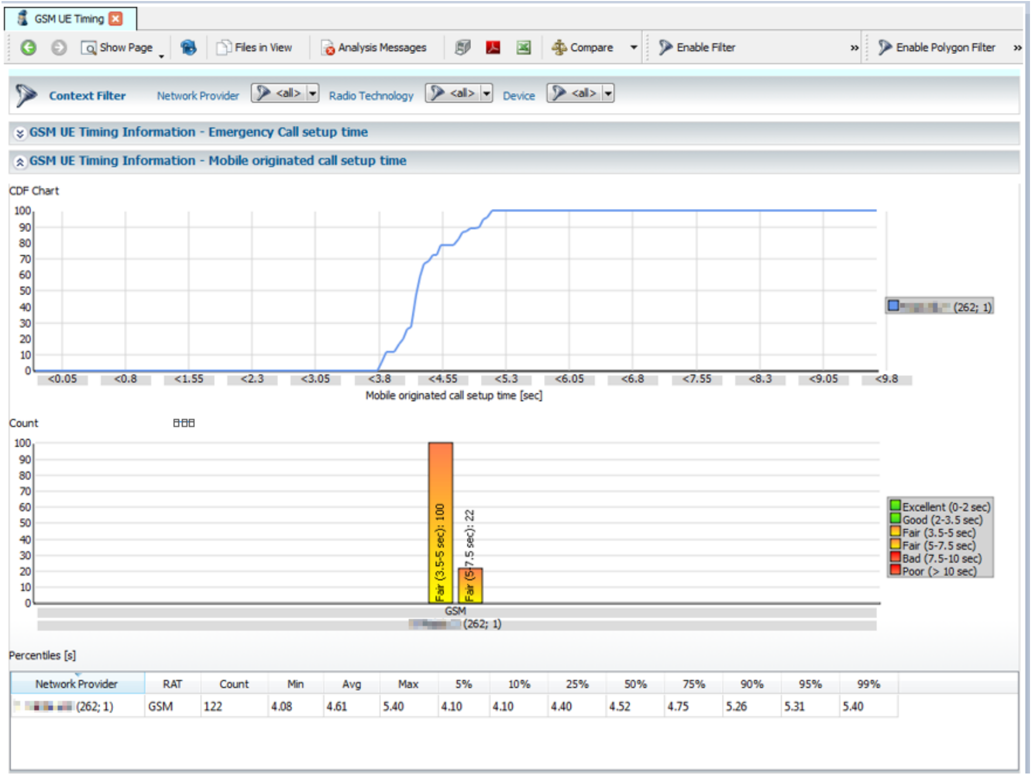


Figure 12-37: GSM UE Timing Information - MOC setup time

Other GSM KPIs, like emergency call, mobile terminated call, mobile originated/terminated VBS/VGC call performances are shown in the similar way. There is a slight difference in the coloring of good and bad slots.

The handover completion time is placed into the range of up to 2 seconds, see the CDF chart and the legend of the "Count" diagram in the following figure.

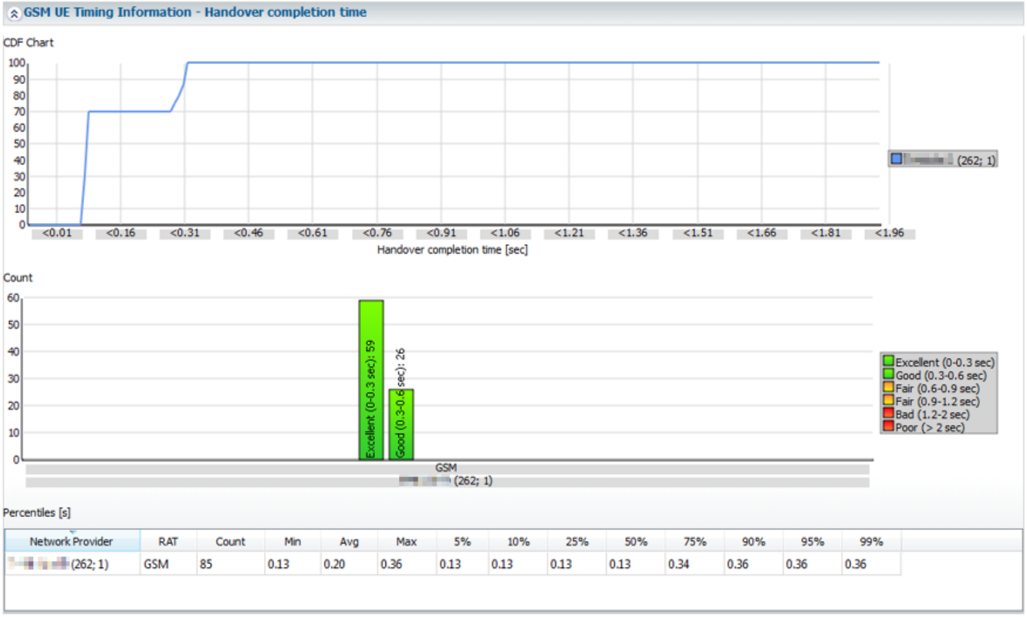


Figure 12-38: GSM UE Timing Information - HO completion time

12.5 Voice over LTE (VoLTE) analyzer

R&S ROMES4 NPA aggregates the LTE voice measurement files for deriving the VoLTE KPIs. The voLTe KPIs are shown in the "VoLTE and VoWiFi Telephony KPIs" page.

The R&S ROMES4N22 license is needed to run this analysis.

12.5.1 Volte KPIs

If VoLTE calls are set up with SIP INVITE message or within 4G or CSFB call setup, the "Voice Telephony" overview page contains in addition the "VoLTE KPIs" icon, see Figure 12-7.

The Call Setup Type, Call Result and Telephony Service Non-Accessibility (VoLTE) VoLTE KPIs are aggregated to pie charts.

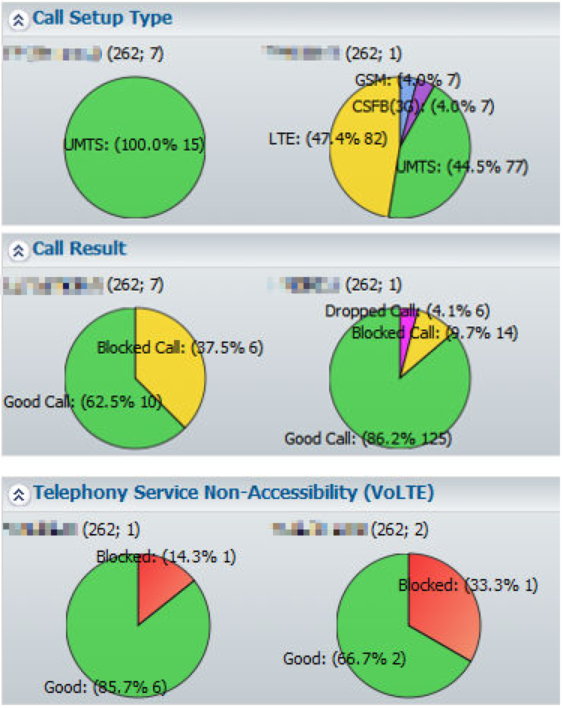


Figure 12-39: Pie charts of some VoLTE KPIs

The voice codecs and data rates are shown as bar charts and grouped by radio technology and network operator, see Figure 12-11.

For SIP messages, the response codes are aggregated to three bar charts, grouped per operator.

Figure 12-40: SIP response codes

The "Voice Call Table with VoLTE and VoWiFi KPIs" has columns which contain the timing KPIs measured in R&S ROMES4 KPI Generator.

The table has columns for the following time-related VoLTE and VoWiFi KPIs. See Figure 12-8).

The VoLTE related KPIs created by R&S ROMES4 KPI Generator are shown in R&S ROMES4 NPA as:

- Continuous Distribution Function (CDF) chart
- Bar chart
- Percentiles

The VoLTE KPIs are displayed in predefined order. The SIP messages are displayed first. They are followed by Telephony Setup KPIs and the detailed Layer3 messages come at the end.

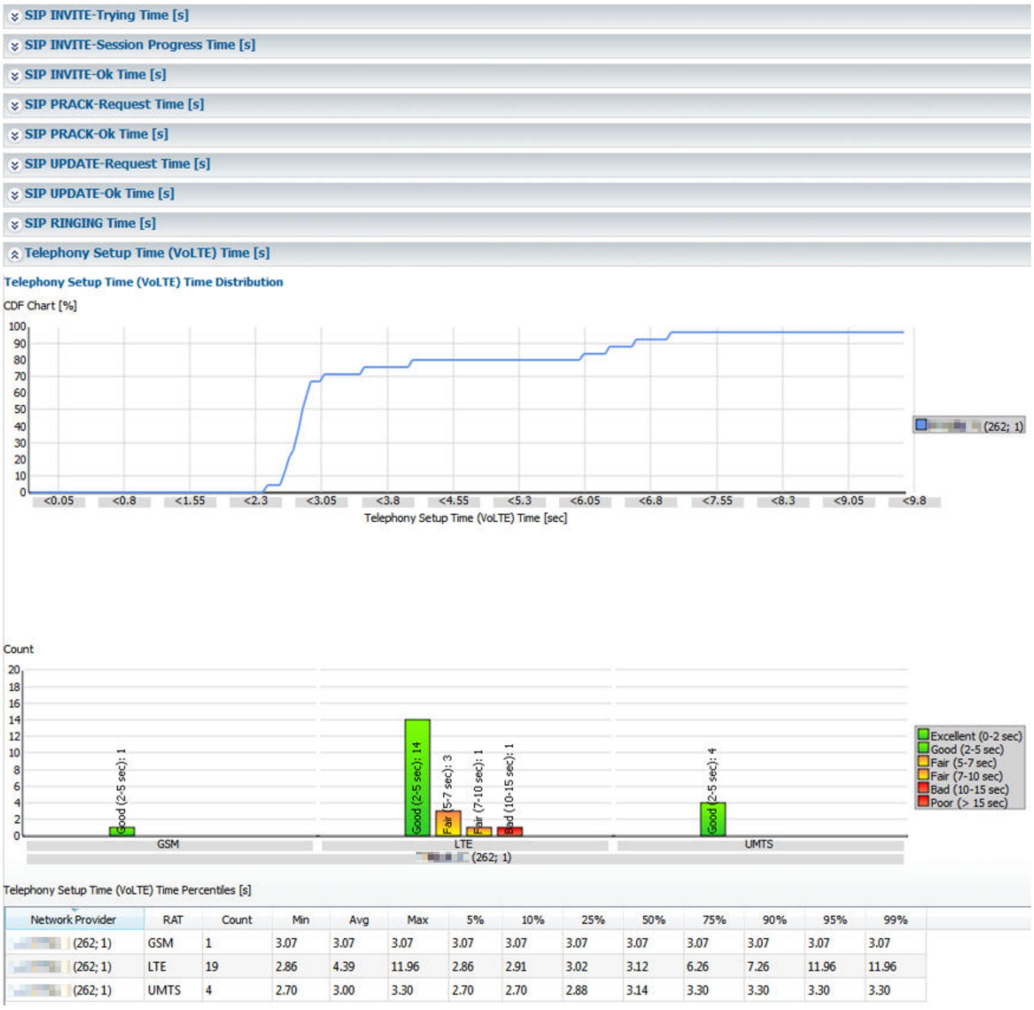
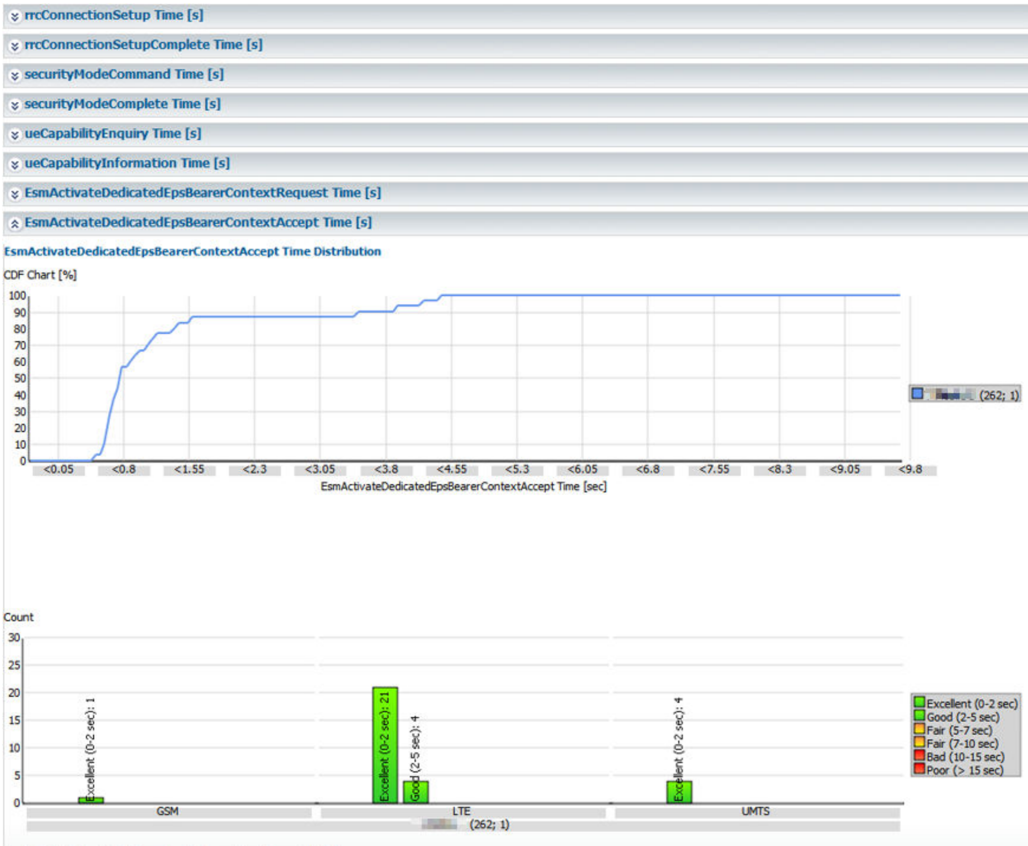


Figure 12-41: SIP KPIs and telephony setup time

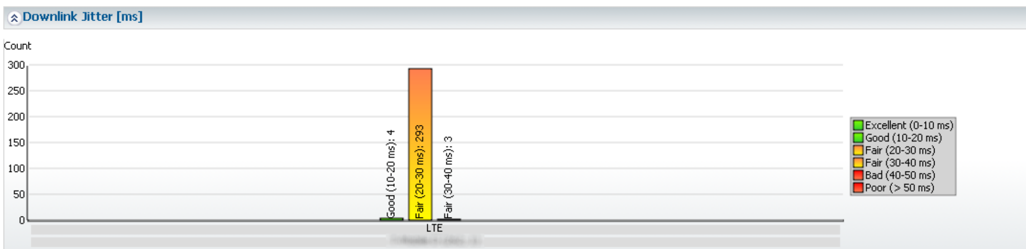


EsmActivateDedicatedEpsBearerContextAccept Time Percentiles [s]

Network Provider	RAT	Count	Min	Avg	Max	5%	10%	25%	50%	75%	90%	95%	99%
(262; 1)	GSM	1	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
(262; 1)	LTE	25	0.73	1.62	4.67	0.82	0.86	0.92	1.04	1.61	4.20	4.47	4.67
(262; 1)	UMTS	4	0.84	0.98	1.21	0.84	0.84	0.86	1.03	1.21	1.21	1.21	1.21

Figure 12-42: Results of voice call analysis - VoLTE KPIs

The "VoLTE and VoWiFi Telephony KPIs" page also contains a chart which displays the aggregated DL jitter values for VoLTE calls.



Downlink Jitter Percentiles [ms]

Network Provider	RAT	Count	Min	Avg	Max	5%	10%	25%	50%	75%	90%	95%	99%
	LTE	300	17.00	26.03	31.00	26.00	26.00	26.00	26.00	26.00	26.00	27.00	30.00

Figure 12-43: DL VoLTE jitter

12.5.1.1 VoLTE problem spots

The VoLTE analyzer extends the problem spots reporting to additional KPIs of SIP messages. These KPIs are related to the events of exceeding the limits for the (configurable) timing thresholds.

The timing thresholds, which trigger a problem spot reporting when exceeded in addition to thresholds for SIP INVITE message, are associated to the following messages:

- SIP PRACK Request
- SIP PRACK OK
- SIP UPDATE Request
- SIP UPDATE OK

These timing thresholds are by default inactive, on the contrary to the timing thresholds for the SIP INVITE message. The following figure shows the "Data Processor Configuration" > "Voice Call Analyzer" default page.

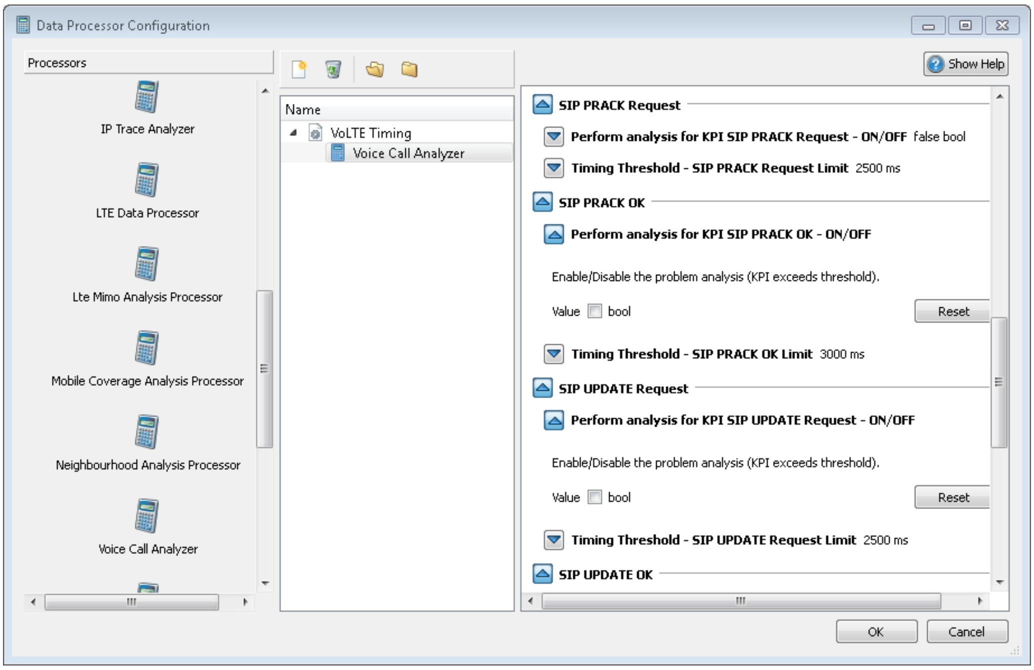


Figure 12-44: Timing threshold limits configuration

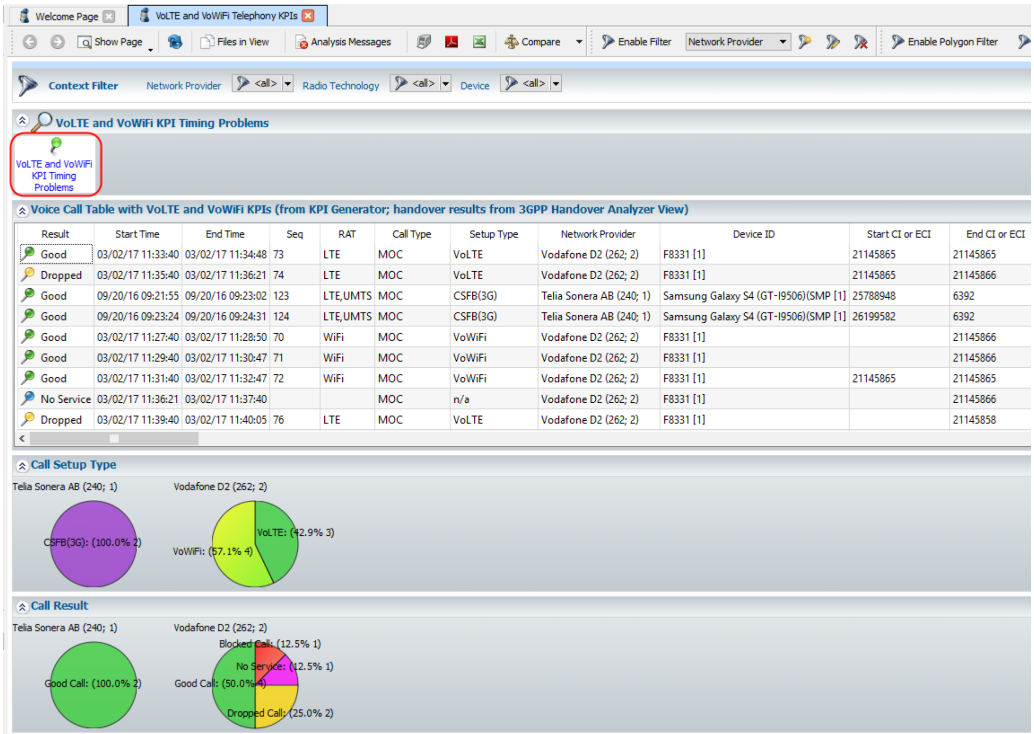


Figure 12-45: VoLTE and VoWiFI KPI timing problems button

The problem spots are show as a map and a list on the "Voice Call Analysis" page.

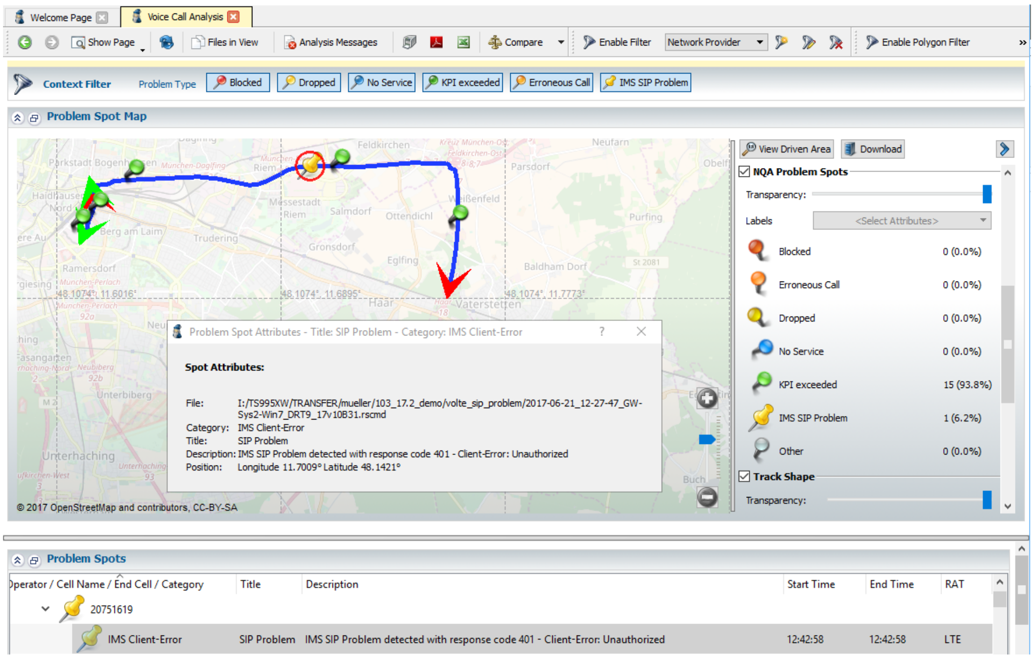
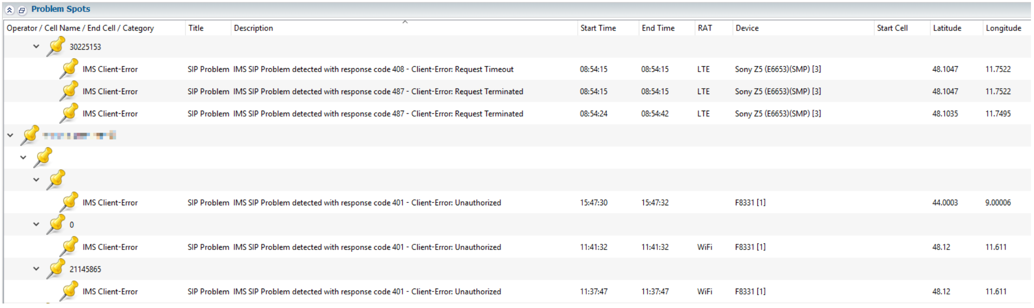


Figure 12-46: Voice call analysis - map and list of problem spots

The Voice Call Analyzer reports on the "Voice Call Problem Spots" page the IMS SIP message response codes. These codes show problems in the call setup or transaction (codes from 300 onwards) as the problem spots.



Problem Spots

Operator / Cell Name / End Cell / Category	Title	Description	Start Time	End Time	RAT	Device	Start Cell	Latitude	Longitude
30225153									
IMS Client-Error	SIP Problem	IMS SIP Problem detected with response code 408 - Client-Error: Request Timeout	08:54:15	08:54:15	LTE	Sony Z5 (E6653)(SMP) [3]		48.1047	11.7522
IMS Client-Error	SIP Problem	IMS SIP Problem detected with response code 487 - Client-Error: Request Terminated	08:54:15	08:54:15	LTE	Sony Z5 (E6653)(SMP) [3]		48.1047	11.7522
IMS Client-Error	SIP Problem	IMS SIP Problem detected with response code 487 - Client-Error: Request Terminated	08:54:24	08:54:42	LTE	Sony Z5 (E6653)(SMP) [3]		48.1035	11.7495
[redacted]									
IMS Client-Error	SIP Problem	IMS SIP Problem detected with response code 401 - Client-Error: Unauthorized	15:47:30	15:47:32		F8331 [1]		44.0003	9.00006
0									
IMS Client-Error	SIP Problem	IMS SIP Problem detected with response code 401 - Client-Error: Unauthorized	11:41:32	11:41:32	WiFi	F8331 [1]		48.12	11.611
21145865									
IMS Client-Error	SIP Problem	IMS SIP Problem detected with response code 401 - Client-Error: Unauthorized	11:37:47	11:37:47	WiFi	F8331 [1]		48.12	11.611

Figure 12-47: Undocked list of problem spots related to SIP registration

The often occurred SIP registration problem (401 client error unauthorized) can be configured to be reported or not, according to the following settings.

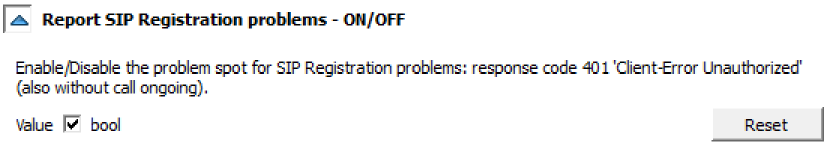
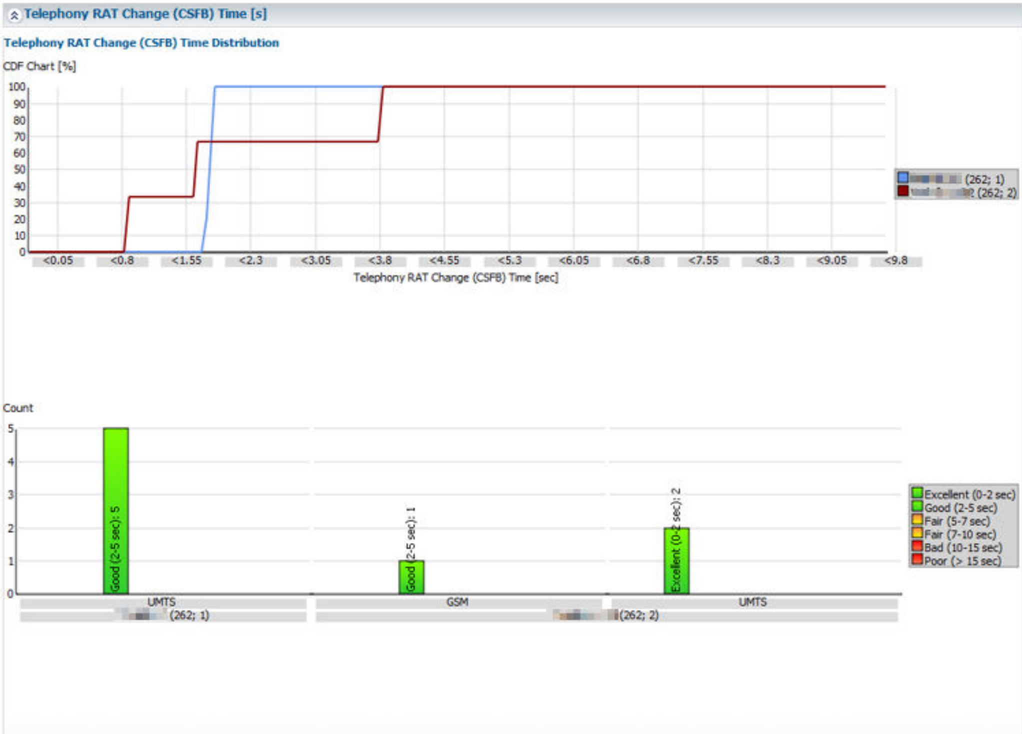


Figure 12-48: Enabling/disabling the problem spot for SIP registration

To dock/undock the Problem Spot list, click the button on the left-hand side of the "Problem Spots" title bar.

12.5.2 CSFB and HO statistics

The following figures show the KPIs for CSFB procedure as graphs, bar charts and lists.



Telephony RAT Change (CSFB) Time Percentiles [s]

Network Provider	RAT	Count	Min	Avg	Max	5%	10%	25%	50%	75%	90%	95%	99%
(262; 2)	GSM	1	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09
(262; 2)	UMTS	2	1.13	1.52	1.91	1.13	1.13	1.13	1.91	1.91	1.91	1.91	1.91
(262; 1)	UMTS	5	2.04	2.08	2.12	2.04	2.04	2.07	2.08	2.11	2.12	2.12	2.12

Figure 12-49: Telephony RAT change (CSFB) time

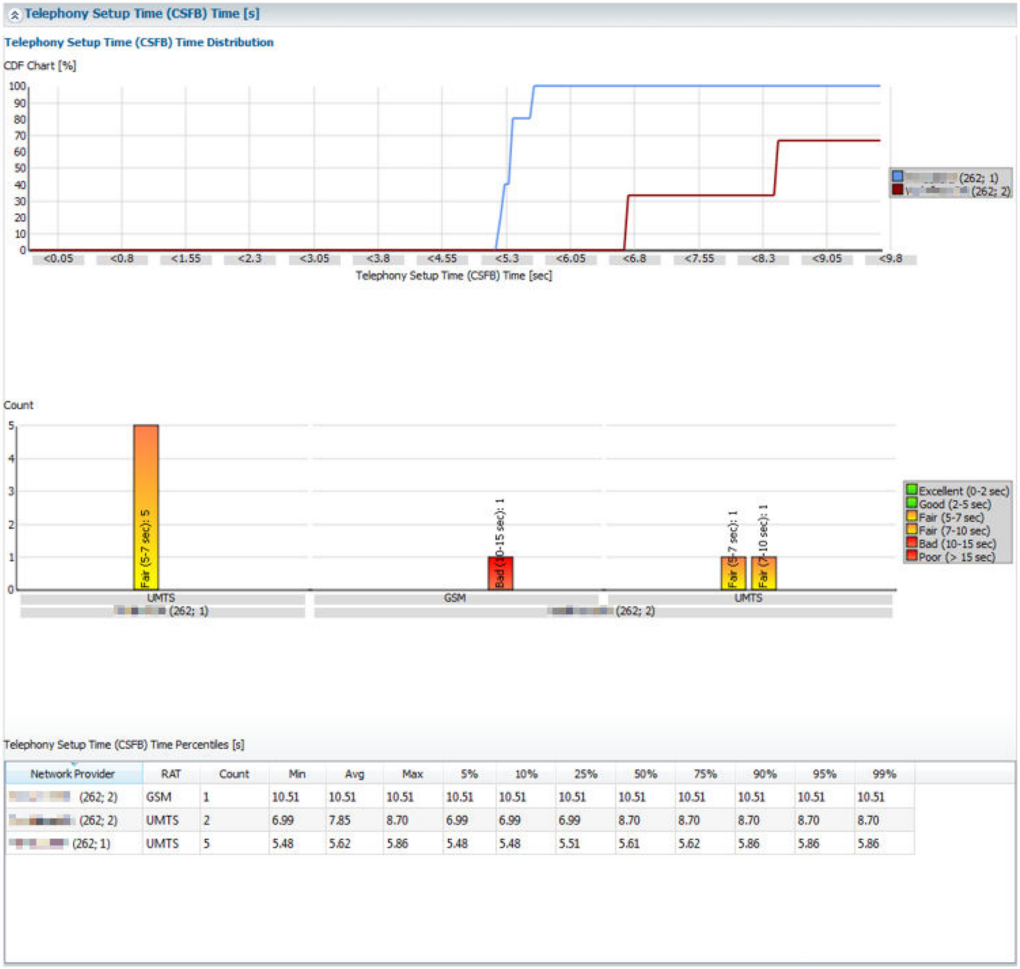


Figure 12-50: Telephony setup time (CSFB) KPI

The following figure shows the HO statistics for each HO type as a bar chart named "HO Results".

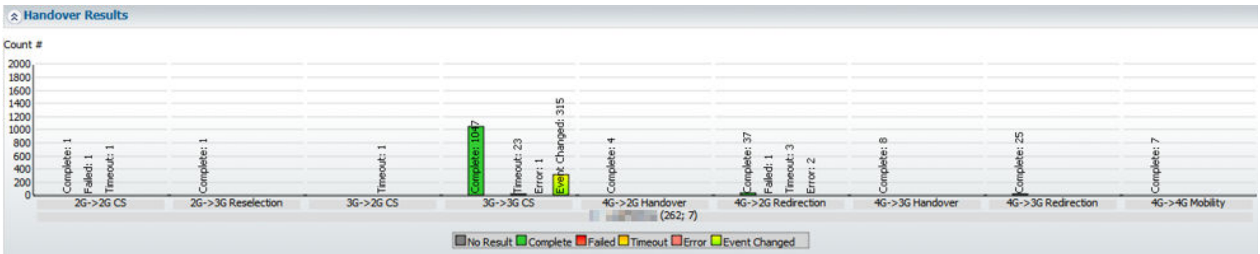


Figure 12-51: Handover statistics

12.5.3 Aggregation of voice calls over WiFi

R&S ROMES4 NPA includes the aggregation of voice calls over WiFi (VoWiFi). These calls can be in WiFi only or partially in the mobile network. R&S ROMES4 NPA reports the setup type and all RATs of the call.

The voice call table also contains the IMS KPIs from the R&S ROMES4 KPI Generator. The benefit is a quick overview of call types contained in the measurement, that is, RAT and setup type.

Several voice calls in the following figure are aggregated over WiFi.

Voice Call Table with VoLTE and VoWiFi KPIs (from KPI Generator; handover results from 3GPP Handover Analyzer View)

Result	Start Time	End Time	Seq	RAT	Call Type	Setup Type	Network Provider	Device ID	Start CI or ECI	End CI or ECI
Good	03/02/17 11:27:40	03/02/17 11:28:50	70	WiFi	MOC	VoWiFi	Vodafone D2 (262; 2)	F8331 [1]		21145866
Good	03/02/17 11:29:40	03/02/17 11:30:47	71	WiFi	MOC	VoWiFi	Vodafone D2 (262; 2)	F8331 [1]		21145866
Good	03/02/17 11:31:40	03/02/17 11:32:47	72	WiFi	MOC	VoWiFi	Vodafone D2 (262; 2)	F8331 [1]	21145865	21145865
Good	03/02/17 11:33:40	03/02/17 11:34:48	73	LTE	MOC	VoLTE	Vodafone D2 (262; 2)	F8331 [1]	21145865	21145865
Dropped	03/02/17 11:35:40	03/02/17 11:36:21	74	LTE	MOC	VoLTE	Vodafone D2 (262; 2)	F8331 [1]	21145865	21145866
No Service	03/02/17 11:36:21	03/02/17 11:37:40			MOC	n/a	Vodafone D2 (262; 2)	F8331 [1]		21145866
Dropped	03/02/17 11:39:40	03/02/17 11:40:05	76	LTE	MOC	VoLTE	Vodafone D2 (262; 2)	F8331 [1]		21145858
Blocked	03/02/17 11:41:40	03/02/17 11:41:55	77	WiFi	MOC	VoWiFi	Vodafone D2 (262; 2)	F8331 [1]		21145858

Figure 12-52: Voice call table - voice aggregation over WiFi

The upper part of the following figure shows the further parameters of the voice call included in the "Voice Call Table with VoLTE KPIa (from KPI Generator, handover...)". The lower part shows the KPI Call Setup Type. Mainly, a voice call is set up as VoWiFi.

Voice Call Table with VoLTE and VoWiFi KPIs (from KPI Generator; handover results from 3GPP Handover Analyzer View)

IMS INVITE Trying	IMS INVITE Session Progress	IMS INVITE Ringing	IMS INVITE OK	Telephony Service Non-Accessibility (IMS) %	Telephony Setup Time (IMS)
0.699	1.219			100	
0.185	1.05	2.924	5.767	0	5.767
0.191	0.919	4.01	7.559	0	7.559
0.247	0.996	7.132	8.11	0	8.11
0.439	0.92	4.761	5.844	0	5.844
0.217	0.94	3.192	5.312	0	5.312
0.247	1.08	5.187	6.411	0	6.411

Figure 12-53: Voice call table - voice aggregation over WiFi with associated KPI

IMS KPIs of aggregated VoWiFi calls

R&S ROMES4 NPA shows the IMS KPIs in a detail in the tables, graphs and charts.

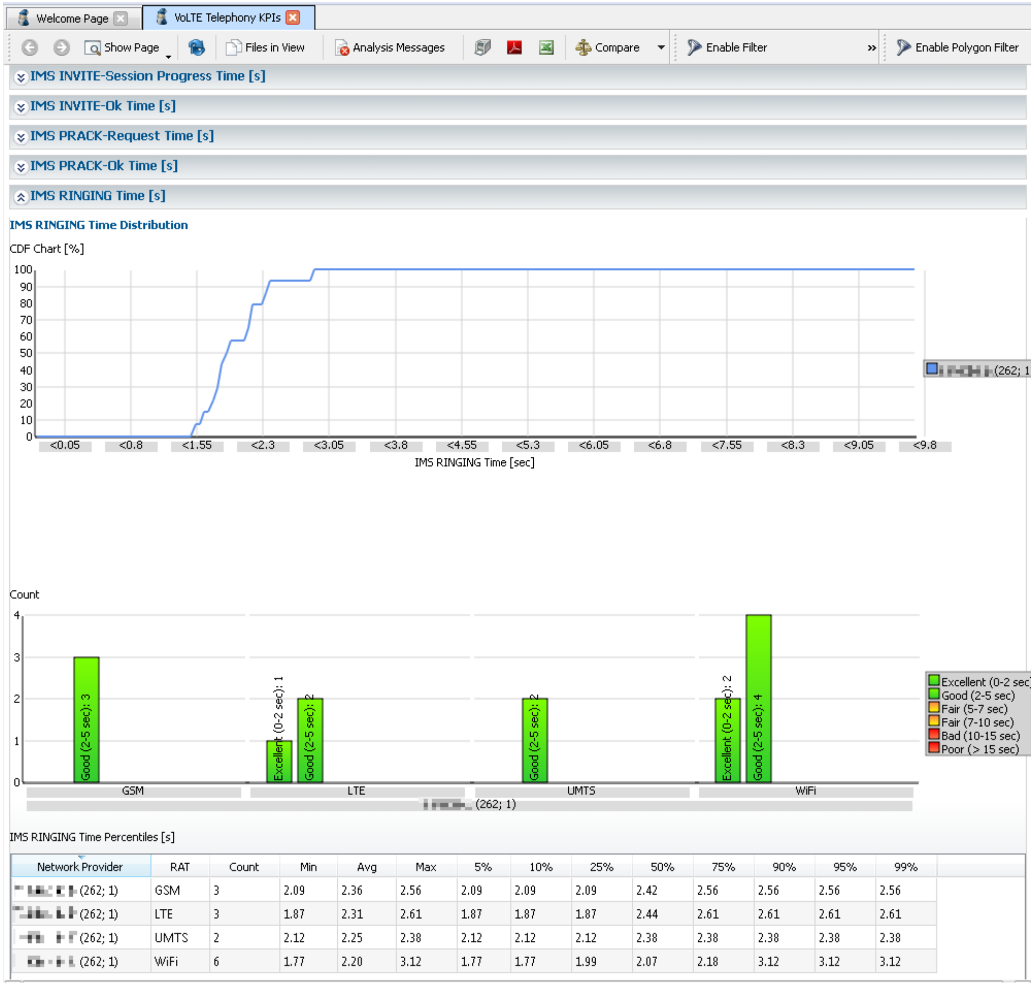


Figure 12-54: IMS KPIs available for aggregated VoWiFi calls

Aggregation for SIP registration

The SIP register response messages are aggregated continuously (independent from active calls or idle state). The aggregation can be turned off in the analyzer configuration.

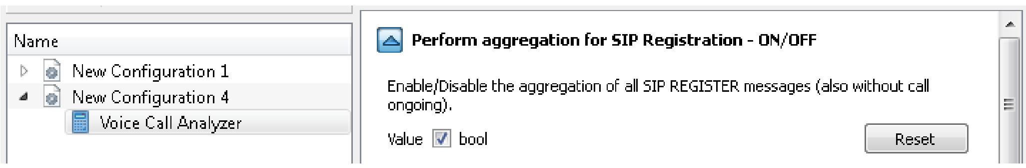


Figure 12-55: Setting of aggregation for SIP registration

If the registration activated, the R&S ROMES4 NPA shows SIP register response codes in a bar chart. The codes can be "accepted", "OK", "unauthorized" and so on.

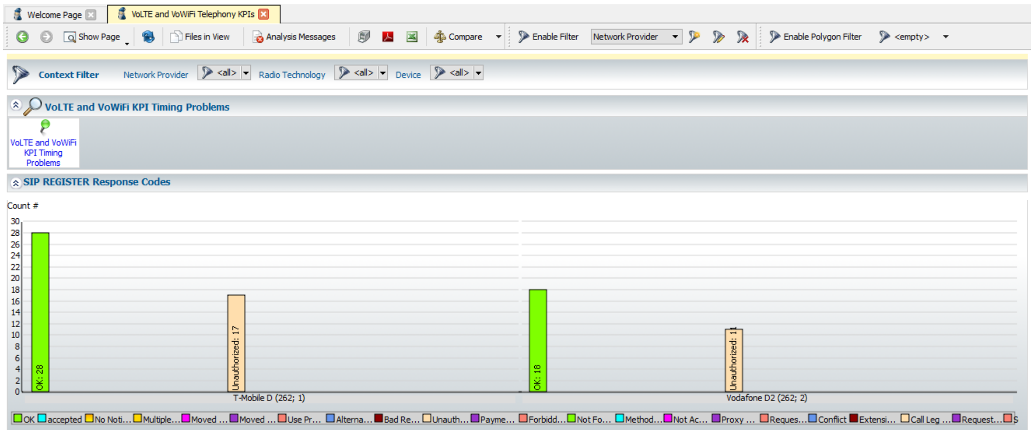


Figure 12-56: Response codes

12.6 TETRA SDS analyzer

The R&S ROMES4 NPA can analyze the messages flow in a TETRA network when SDS are sent and received. The analysis of these procedures combines the statistics created for the transfer with a basic problem detection.

The TETRA section of the overview page contains the following tabs:

- "Coverage TopN Raster&Statistics"
- "Coverage&Interference"
- "Call Problem Statistics"
- "Handover Statistics", see Chapter 12.19.8, "TETRA handover", on page 407

SDS transfer procedures can be analyzed with the R&S ROMES4 NPA over multiple mobiles, as long as they are recorded in the same file. If both A- and B-party are available within a single file, the maximum number of KPIs can be calculated (see table below). If not, only a rough overview of the SDS procedure is provided. To produce the proper R&S ROMES4 NPA results, use a measurement setup where the sending and receiving unit are placed in the same car and connected to the same R&S ROMES4 instance.

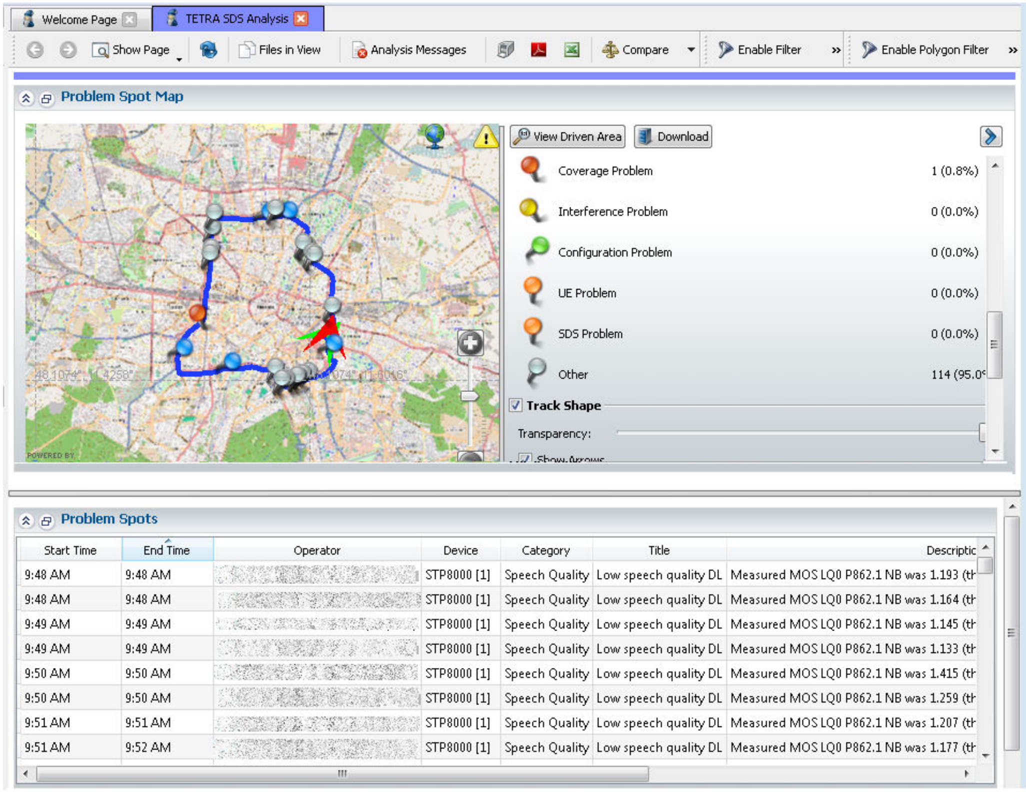


Figure 12-57: TETRA SDS analysis - driven area view and problem spots

12.6.1 TETRA SDS problem categories

The TETRA SDS analysis can detect the following problems:

Problem Category	Possible Reasons
Incomplete SDS transaction	No acknowledgment message D_STATUS received from the network.
Send Time too long	Time to send a SDS took more than "Max. Send Time for Success" seconds.
Delivery time too long	Time to send and confirm that the delivery of an SDS exceeds the "Max. Delivery Time for Success" threshold.
Missing messages	If no B-party messages are found in the trace, this problem spot is created.
Other Problem	Remaining issues that could not be related to one of the above problems is rated as "Other Problem" at the end of the file analysis stage.

12.6.2 TETRA SDS KPIs

The following KPIs are created based on the data from the TETRA mobiles. Note that most of these KPIs require A- and B-party data (data from both the sending and receiving unit).

Many KPIs cannot be calculated properly without the SAIL support in R&S ROMES (the R&S ROMES4TDS option).

The following table shows which trigger points are used when the SAIL interface is available to calculate the KPIs for TETRA measurements.

KPI	Type	Calculation Method	Comment
Send Rate	[%]	# Successfully confirmed send attempts within "Max. Send Time for Success" # Send Attempts	
Delivery Success Rate	[%]	# Delivered SDS within "Max. Delivery Time for Success" # Send Attempts	
Service Level	[%]	# Delivered SDS within "Max. Delivery Time for Service Level" # Send Attempts	The same as Delivery Success Rate, but with a tighter constraint. This KPI is used as the primary KPI when optimizing a TETRA network. The Delivery Success Rate generally states if an SDS could be sent, even if it took too long to be classified as Good SDS.
Send Time	[sec]	$t_{A(D\_STATUS)} - t_{A(U\_SDS\_DATA)}$	
Delivery Time	[sec]	$t_{B(D\_SDS\_DATA)} - t_{A(U\_SDS\_DATA)}$	

12.6.2.1 Analyzer configuration

The time values used to classify SDS sending and transmission times as good or bad can be configured in the TETRA analysis plug-in.

Parameter	Value Range	Default	Description
Max. Send Time for Success	0..300 sec	5 sec	Sending of SDS is counted successful, if the receipt is received within this time frame.
Max. Send Duration	0..300 sec	1 sec	If the time frame for sending SDS is above this threshold, a problem spot is created.
Max. Delivery Duration	0..300 sec	6 sec	If the time frame for receiving SDS is above this threshold, a problem spot is created.
Max. Delivery Time for Success	0..300 sec	120 sec	Receiving of SDS is counted successful, if it is received within this time frame.
Max. Delivery Time for Service Level	0..300 sec	20 sec	Receiving of SDS is counted successful for the KPI service level, if received within this time frame

12.7 TETRA scanner results based UE comparison

The R&S ROMES4 NPA TETRA scanner comparison analyzer evaluates the performance of a TETRA UE based on scanner results.

This feature offers possibility to track the TopN position of the cells used by the TETRA UE. To perform the UE tracking, set a TopN position threshold and a power threshold.

A problem spot is highlighted if the following two conditions are met:

1. The UE uses a cell with a TopN position below the position threshold.

2. The power difference between the best server (Top1) and the used cell is bigger than the power threshold.

12.7.1 Enable/disable TETRA UE scanner comparison analyzer

To enable the analyzer:

1. Select "Analysis" > "Processor Configration" menu from the R&S ROMES4 NPA menu bar.
2. On the upper tool-box of the opened window, click the button to create configuration file.

3. Be sure to include the TETRA Scanner, the Mobile Combined Analysis analyzer, the "Coverage Analysis Data Processor" and the "Mobile Coverage Analysis Processor". You need the last two mentioned analyzers for the correct function of the TETRA scanner and the mobile analysis.

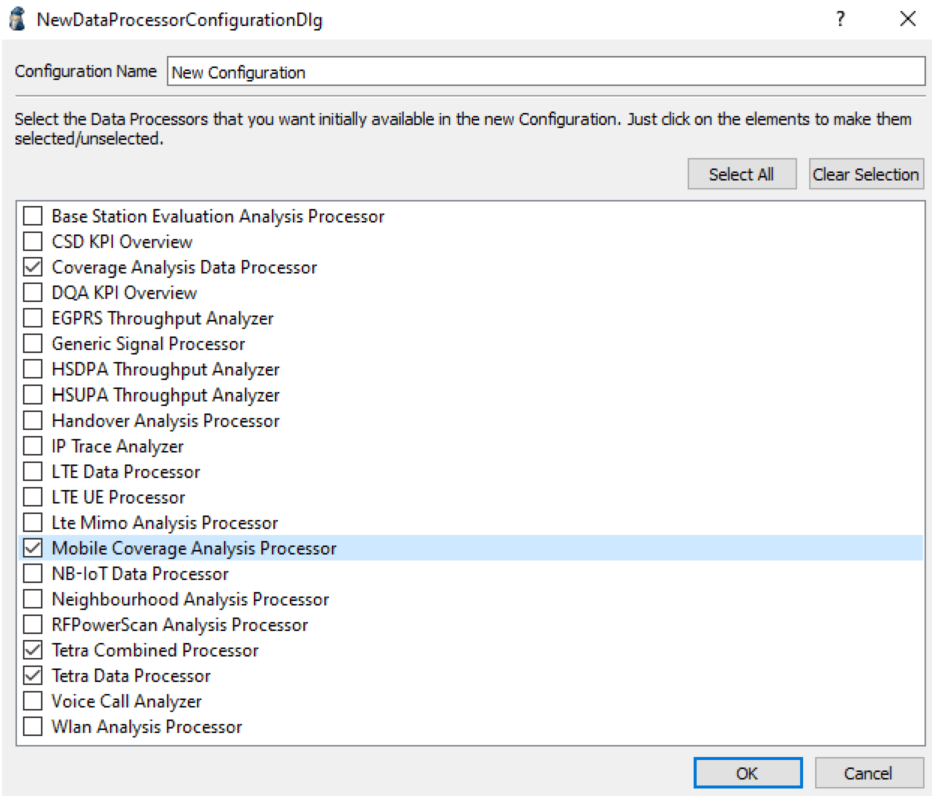


Figure 12-58: Processors needed to be activated

4. Click "OK" to confirm the selection.

   The configuration file is created.

In the created configuration file, within the analyzer parameters, you can edit the thresholds of TopN position and power.

After activating the analyzer, you have to process the measurement file once again to obtain the results.

It is strictly recommended to change the "Min Raster Sample" parameter value from (default) value 3 to 1 in the "Mobile Coverage Analysis Processor" configuration page. This change archives all results and makes it possible to track all UE cell changes and detect all possible problems.

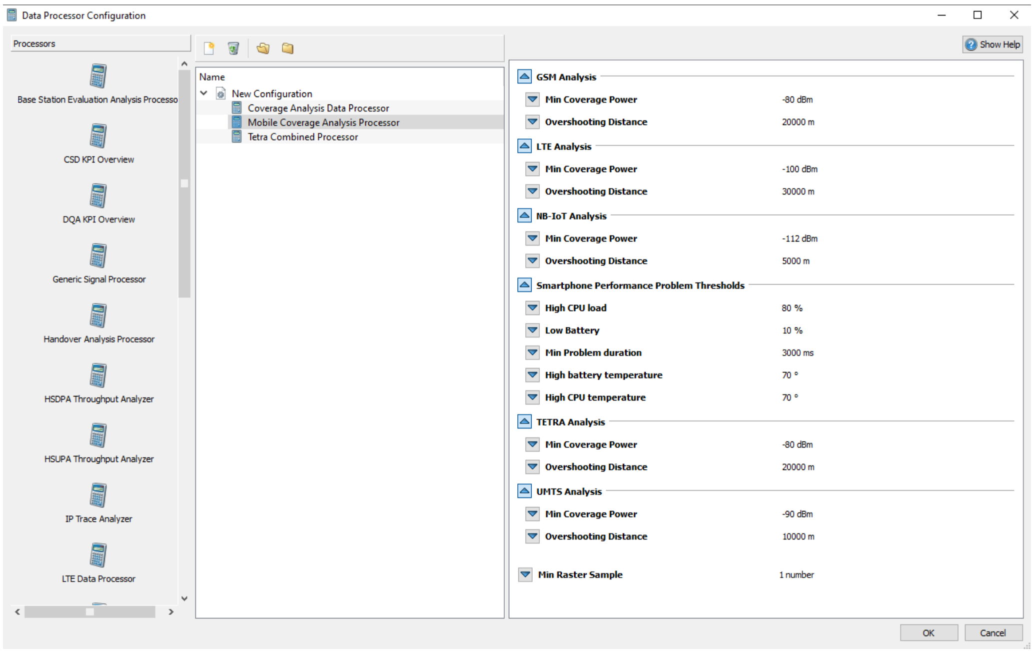


Figure 12-59: Changing the raster sample value

12.7.2 Examples of TETRA UE comparison results

The following screenshots are examples showing the results of analysis cases in which the TETRA UE used a cell with a TopN position below the threshold defined by the user.

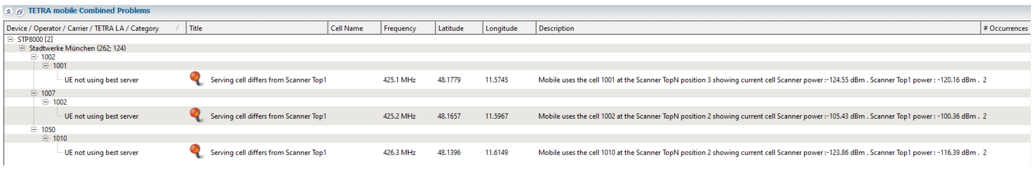


Figure 12-60: Indication that the threshold is below the defined

If the UE changes the current cell in the same bin, only the position of the last used cell is evaluated.

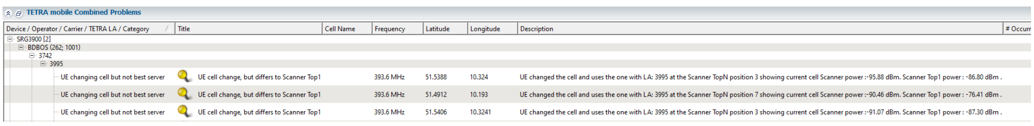


Figure 12-61: Indication that UE changed the cell

You can keep a track of the cell changes using the problem spot "Details" page.

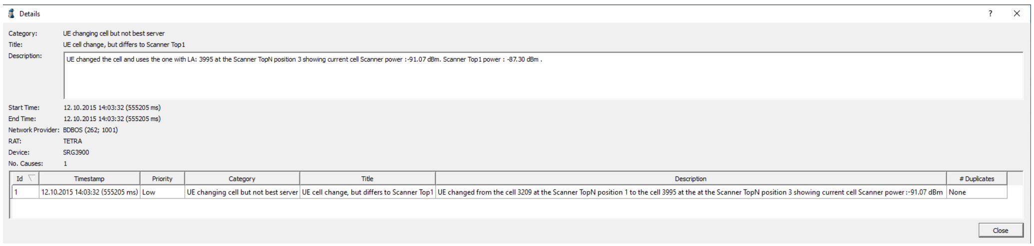


Figure 12-62: Reported problems

12.8 Circuit switched data analyzer

The R&S ROMES4 NPA circuit switched data (CSD) analysis plugin unit aggregates the specific KPIs proposed by the European Railway Networks (i.e. the ETCS).

Aggregated are the following CSD KPIs:

- Network Registration Delay
- Total Number CS Dialups
- Total Connection Loss
- Total Frames Sent
- Total Connection Duration
- Connection Establishment Error Ratio
- Connection Loss Rate
- Connection Establishment Delay
- Transmission Delay
- Transmission Total Frames
- Intervals REC / Interfered
- Transmission REC Intervals
- Transferred Interfered Intervals

Way of displaying KPIs

The R&S ROMES NPA collects and displays these KPIs in two ways:

- On a geographical raster
- As "traffic lights", pies, bar and/or CDF charts, and percentiles.

The KPIs for a raster element selected in the geographical raster are shown as a Tool-tip when hovering with mouse arrow above the raster element.

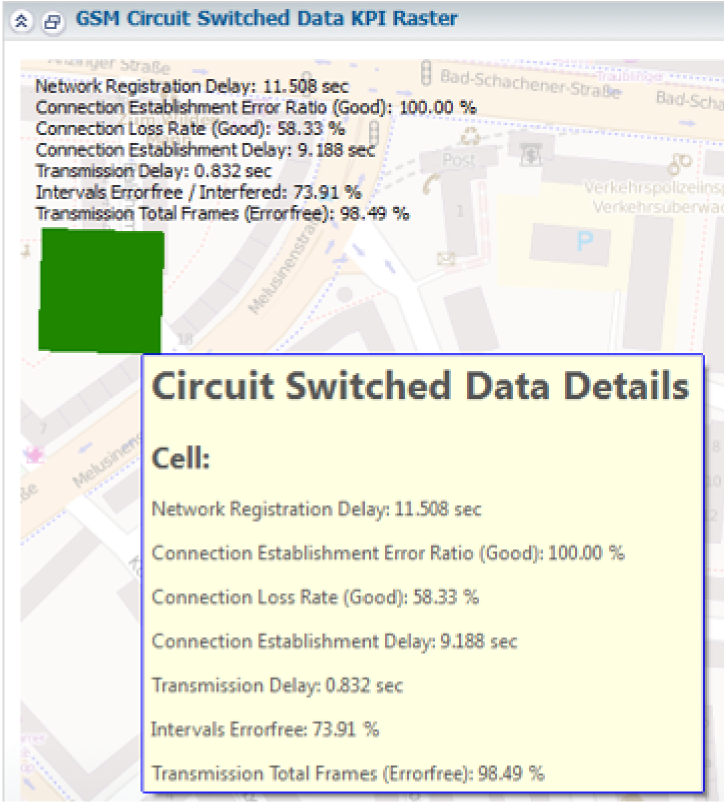
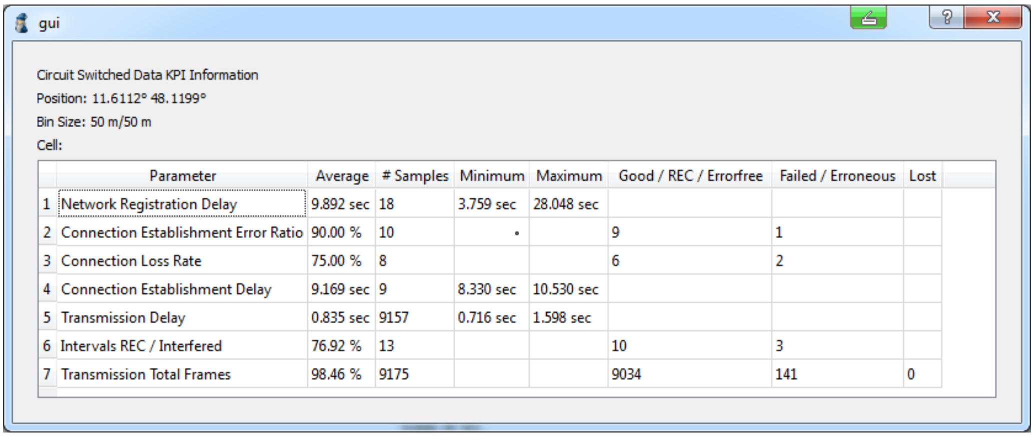


Figure 12-63: Tooltip for CSD KPIs of raster element

Instead, double click a raster element. The "gui" table shows the same content, i.e. KPIs.



	Parameter	Average	# Samples	Minimum	Maximum	Good / REC / Errorfree	Failed / Erroneous	Lost
1	Network Registration Delay	9.892 sec	18	3.759 sec	28.048 sec			
2	Connection Establishment Error Ratio	90.00 %	10			9	1	
3	Connection Loss Rate	75.00 %	8			6	2	
4	Connection Establishment Delay	9.169 sec	9	8.330 sec	10.530 sec			
5	Transmission Delay	0.835 sec	9157	0.716 sec	1.598 sec			
6	Intervals REC / Interfered	76.92 %	13			10	3	
7	Transmission Total Frames	98.46 %	9175			9034	141	0

Figure 12-64: GUI CSD KPIs details of a raster element

If an "Erroneous" is detected, the complete BIN becomes the status Interfered.

If the "CSD Raster" > "Content" field is set to "Intervals Errorfree/Interfered", this status is marked with a red quad in the "qui" table.

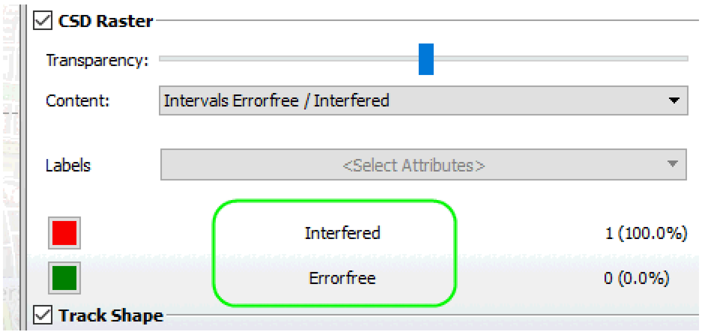
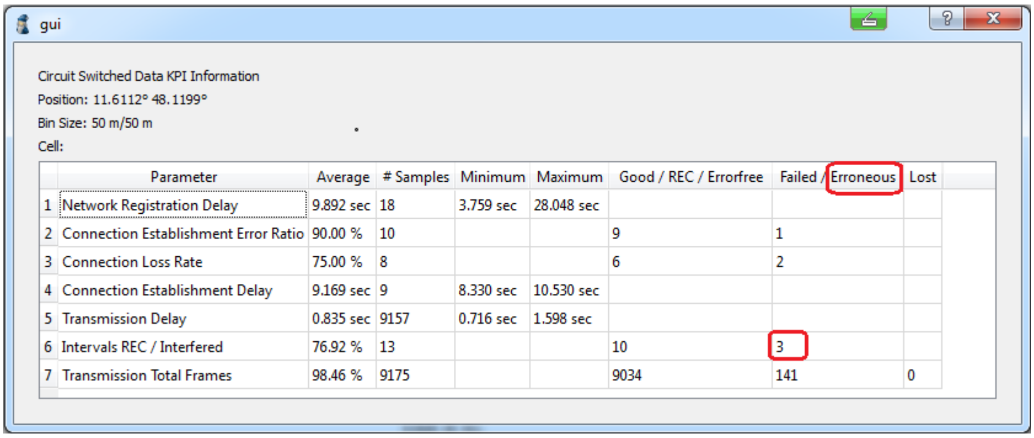


Figure 12-65: CSD raster setting

The legend shows the sum number of red/green BIN and the distribution in percentage.



	Parameter	Average	# Samples	Minimum	Maximum	Good / REC / Errorfree	Failed / Erroneous	Lost
1	Network Registration Delay	9.892 sec	18	3.759 sec	28.048 sec			
2	Connection Establishment Error Ratio	90.00 %	10			9	1	
3	Connection Loss Rate	75.00 %	8			6	2	
4	Connection Establishment Delay	9.169 sec	9	8.330 sec	10.530 sec			
5	Transmission Delay	0.835 sec	9157	0.716 sec	1.598 sec			
6	Intervals REC / Interfered	76.92 %	13			10	3	
7	Transmission Total Frames	98.46 %	9175			9034	141	0

Figure 12-66: Marked Erroneous in CSD KPI table

Only if the transfer is complete "Error free", the entries are marked with the green quads.

To fulfill the certain ETCS specified quality requirements, the “traffic lights” (green/red) evaluate measurement results for an immediate status overview.

The continuous CDF charts for some CSD KPIs replace the former ones. The charts provide a precise graphical display of the measurement results.

The following CSD KPIs have the continuous CDF chart presentation:

- Network Registration Delay, see Figure 12-68
- Connection Establishment Delay, see Figure 12-74
- Transmission Delay, see Figure 12-76
- GSM Setup Time Distribution, see Figure 12-85

12.8.1 Network registration delay KPI

Network Registration Delay KPI is displayed in three different ways in the R&S ROMES NPA GUI. The "traffic light", the bar chart and the continuous CDF is supported for the Network Registration Delay KPI display. The following figures are an example of the way the R&S ROMES NPA displays it.

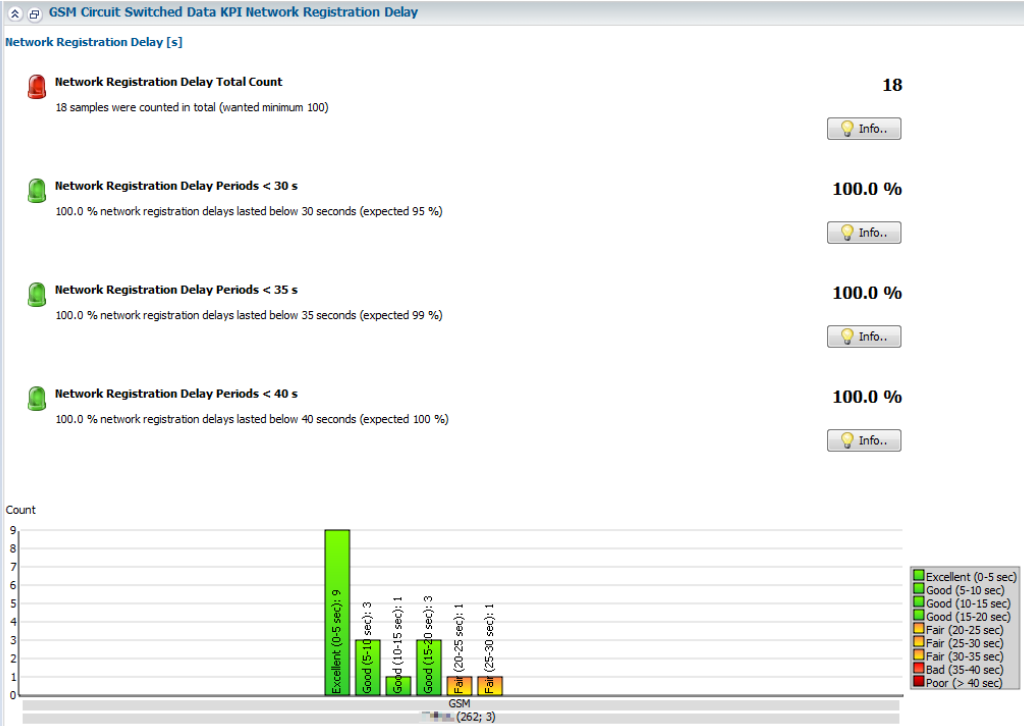


Figure 12-67: Traffic light and bar chart of Network registration delay KPI

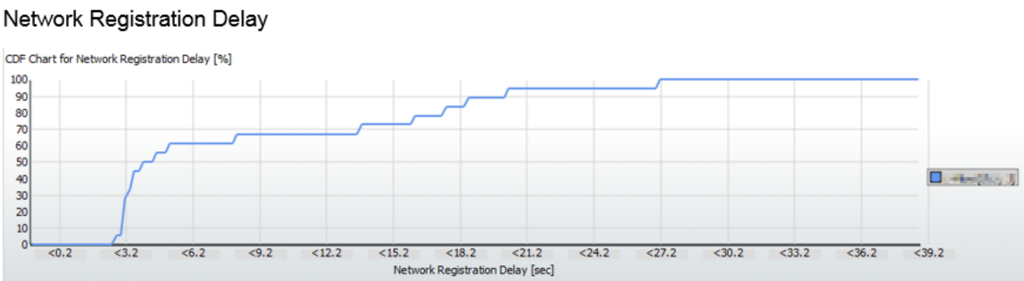


Figure 12-68: Continuous CDF chart of Network registration delay KPI

The “traffic lights” (green/red) display contains an additional info button to see KPI details, which are the criteria to claim the KPI good or bad.

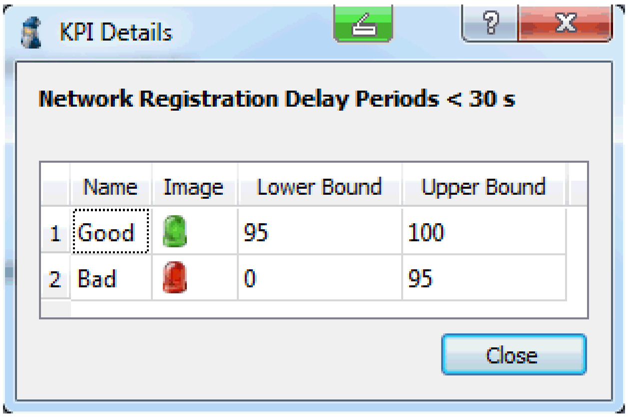


Figure 12-69: Traffic lights info of Network registration delay KPI

12.8.2 Data transfer KPIs

The R&S ROMES4 NPA GUI presentation of Data Transfer KPIs includes some GSM CSD KPIs.

The following sub-chapters display the GUI's presentation of the KPIs included in the "GSM Circuit Switched Data Transfer KPIs" window.

The order of sub-chapters is according to the appearance of the KPIs in the window.

The following "total counts" Data Transfer KPIs are displayed via bar charts:

- Total Number CS Dialups
- Total Connection Loss
- Total Frames Sent
- Total Connection Duration

The following figure displays these KPIs.

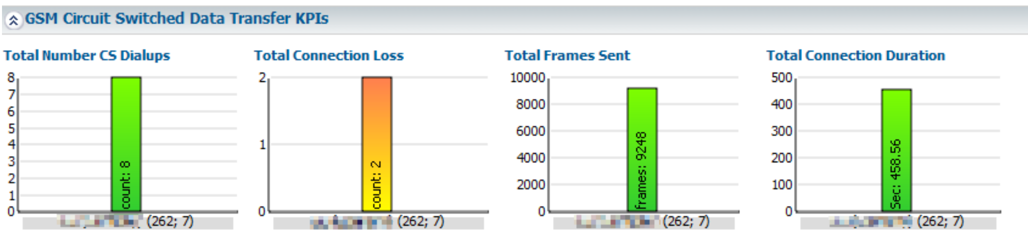


Figure 12-70: Bar chart of some CSD transfer KPIs

12.8.2.1 Connection establishment-related KPIs

As previously mentioned, the KPIs belonging to this group are displayed in the "GSM Circuit Switched Data Transfer KPIs" window of the R&S ROMES4 NPA GUI.

The CSD connection-related KPIs are:

- Connection Establishment Error Ratio

- Connection Loss Rate
- Connection Establishment Delay

Connection establishment error ratio

For the Connection Establishment Error Ratio KPI, the "traffic lights" and the pie chart are supported. An example is shown in the following figure.

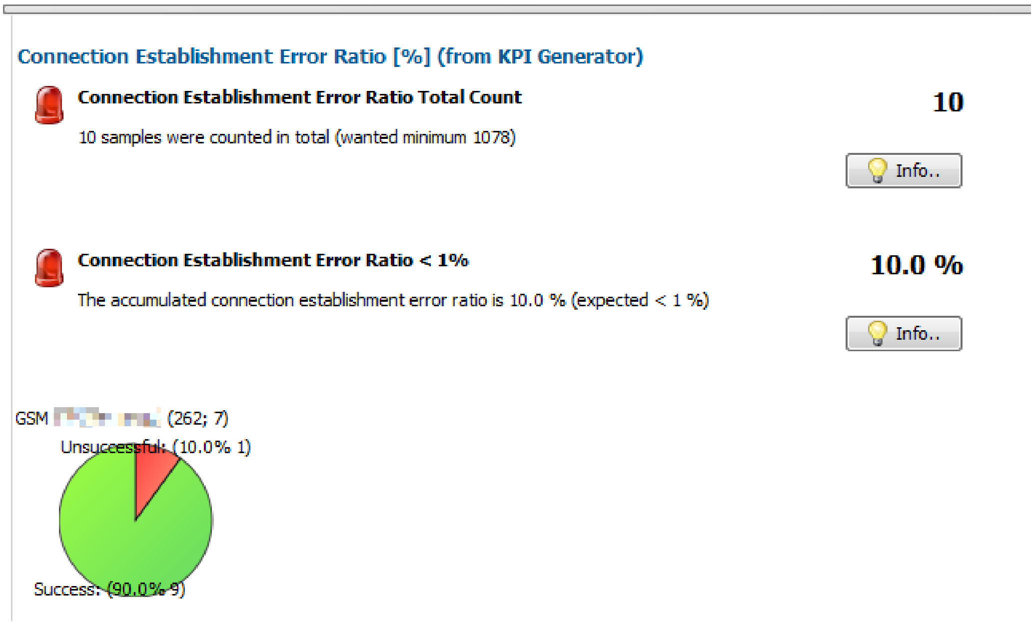


Figure 12-71: Traffic light and pie chart of Connection establishment error ratio KPI

Connection loss rate KPIs

The same type of display is supported for Connection Loss Rate KPIs.

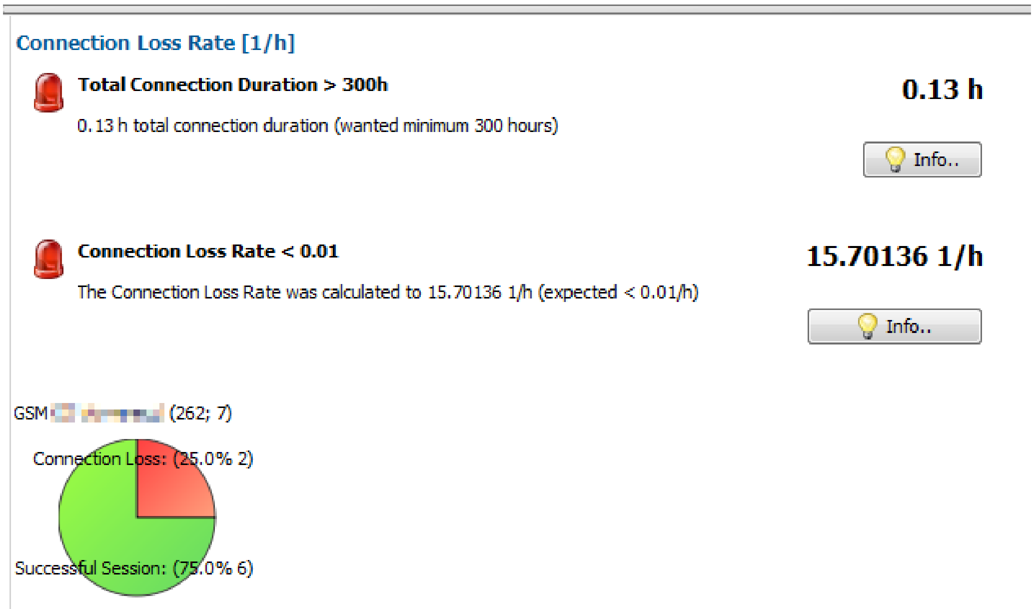


Figure 12-72: Traffic light and pie chart of Connection loss rate KPIs

Connection establishment delay KPI

The Connection Establishment Delay KPI is displayed as "traffic lights", charts and percentiles. These displays are illustrated in the following figures.

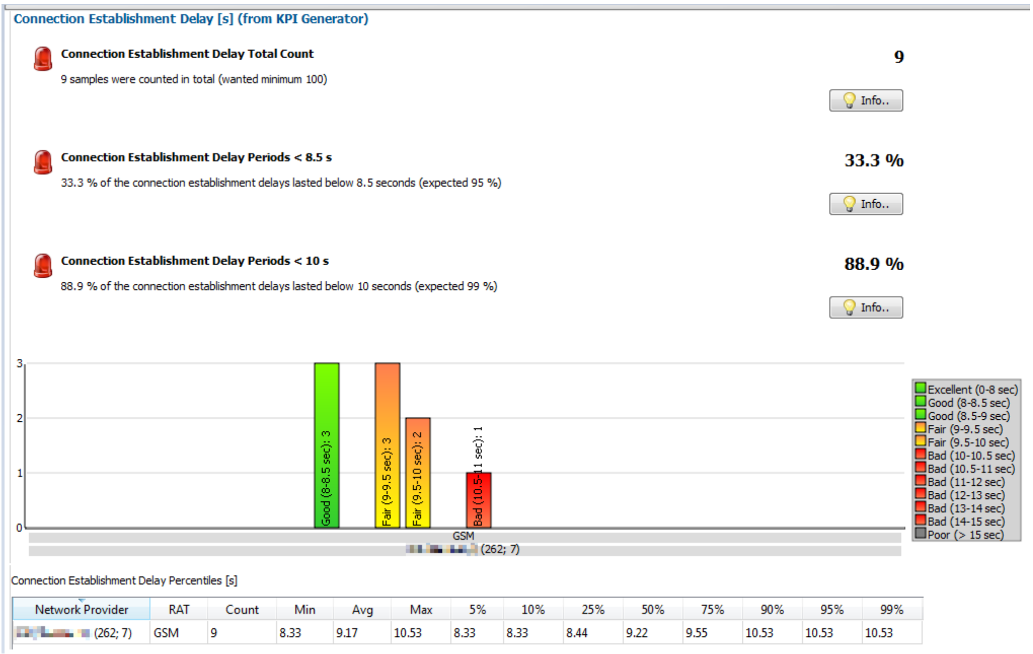


Figure 12-73: Traffic lights, bar chart and percentiles of Connection establishment delay KPI

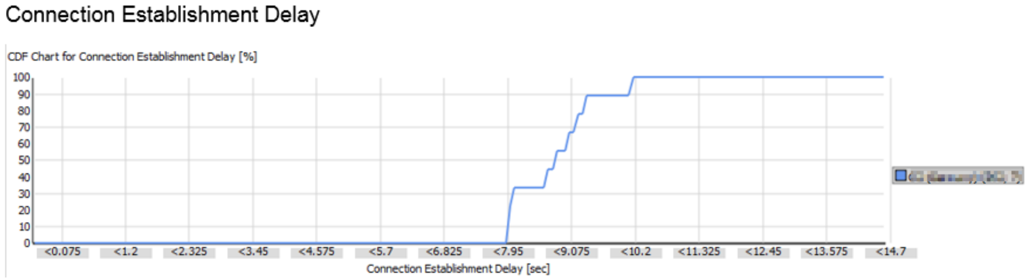


Figure 12-74: Continuous CDF chart of Connection establishment delay KPI

12.8.2.2 Transmission-related KPIs

Transmission-related KPIs are sorted in the following way in the GSM Circuit Switched Data Transfer KPIs:

- Transmission Delay
- Transmission Total Frames KPIs which include error-free, erroneous and lost frames ones
- Intervals Error-free / Interfered
- Transmission Error-free Intervals
- Transmission Interfered Intervals

Transmission delay KPI

Transmission Delay KPI is displayed with traffic lights, charts and percentiles. An example is shown in the following figures.

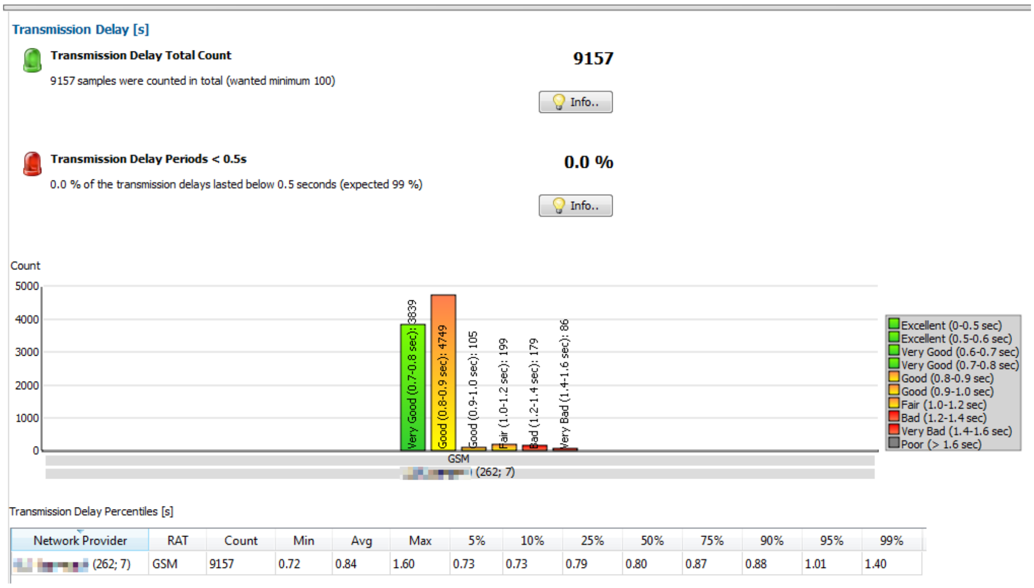


Figure 12-75: Traffic lights, bar chart and percentiles of Transmission delay KPI

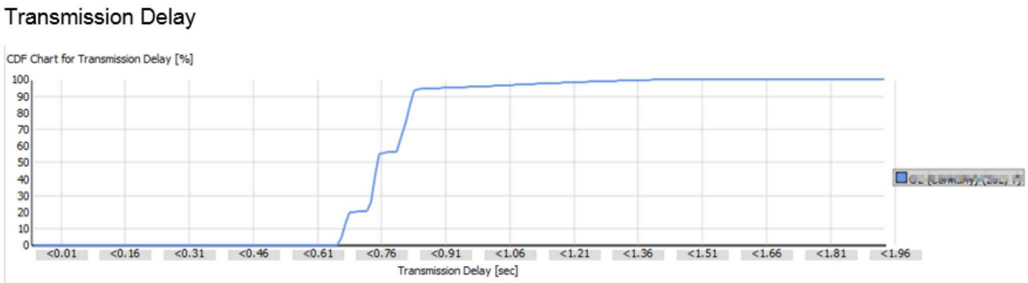


Figure 12-76: Continuous CDF chart of Transmission delay KPI

Transmission total frames KPI

The KPI is displayed in a pie chart.

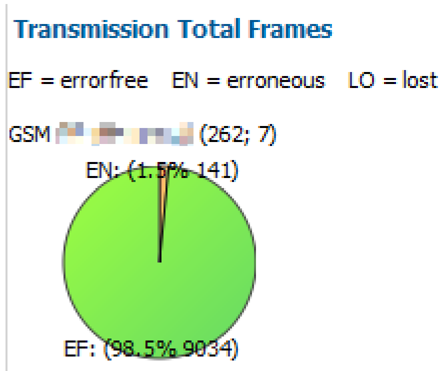


Figure 12-77: Pie chart of Transmission total frames KPI

Intervals REC / interfered KPI

The KPI is displayed in a pie chart.

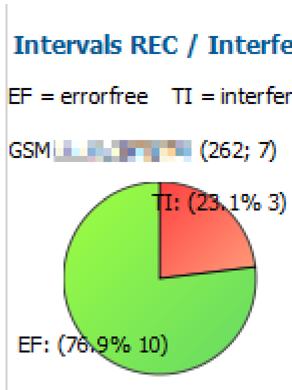


Figure 12-78: Pie chart of Intervals REC / Interfered KPI

Transmission REC intervals KPI

The KPI is displayed as "traffic lights" for counted erroneous intervals, a pie and the charts. An example for the KPI display is shown in the following figure.

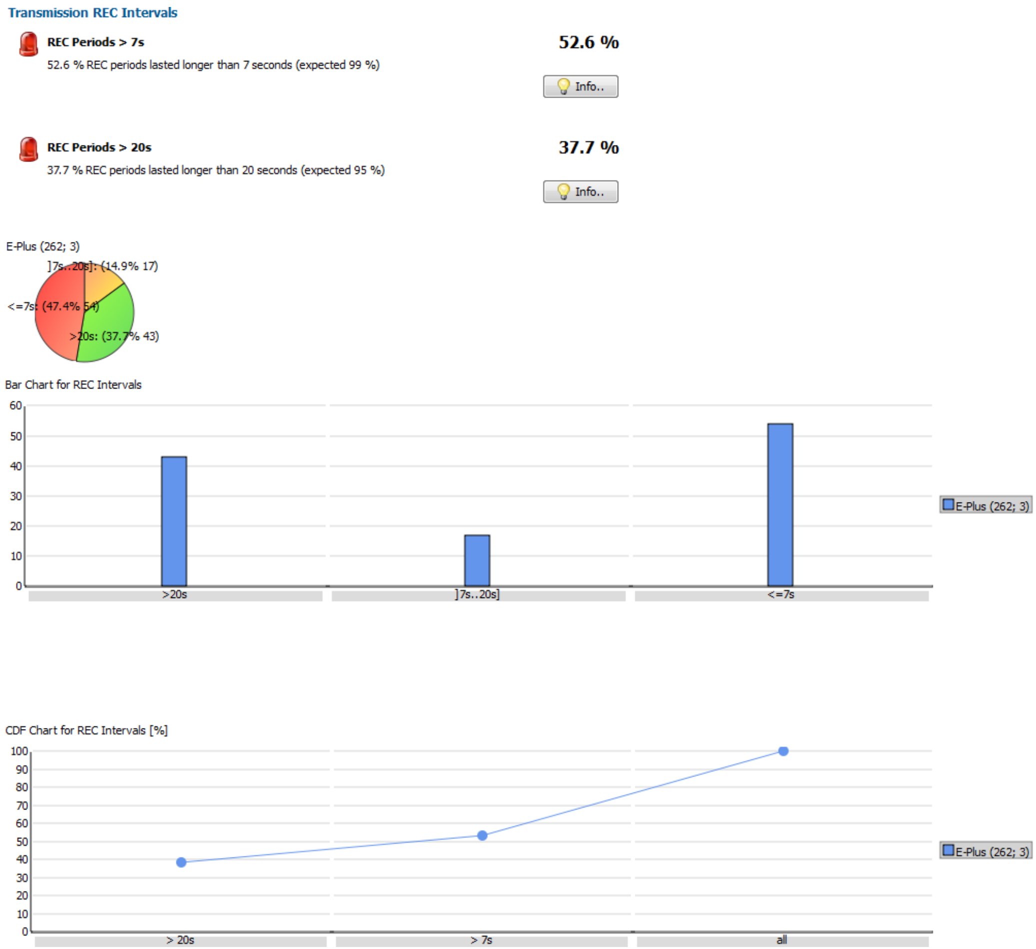


Figure 12-79: Traffic lights, pie and charts of Transmission REC intervals

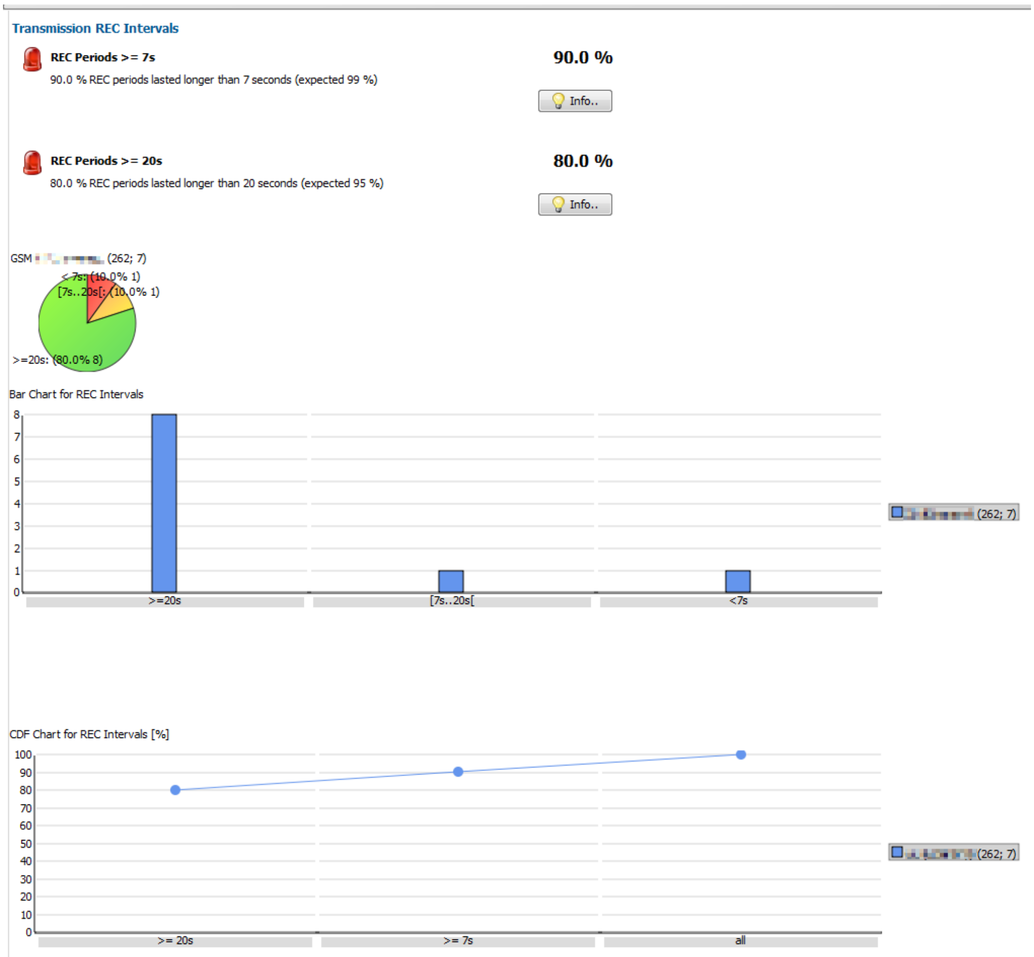


Figure 12-80: Traffic lights, pie and charts of Transmission REC intervals

Transmission interfered intervals KPI

The KPI is displayed in a same way as the previous KPI.

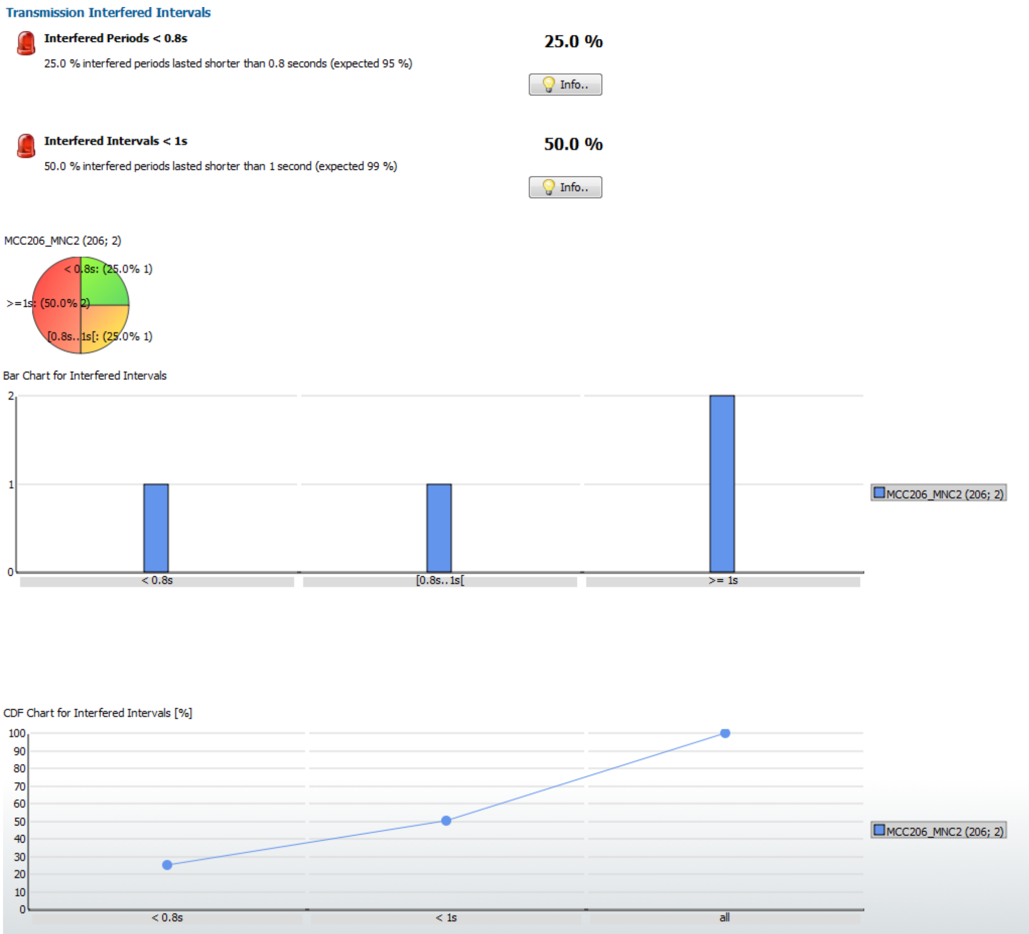


Figure 12-81: Traffic lights, pie, bar and CDF charts of Transmission interfered intervals

12.8.2.3 GSM setup time KPI

The GSM Setup Time is the elapsed time between the channel request and the indication of a successful connection. The R&S ROMES "QoS KPI Generator View" delivers this KPI.

For details, see the "R&S ROMES4 Operating Manual", chapter 9 "R&S ROMES KPI Description > R&S ROMES CS Data Call KPIs".

There are several result pages fulfilling the GSM Setup Time Phase_2 requirements in the R&S ROMES NPA. The following figures show the GSM Setup Time KPI of REC, GCC and MOC.

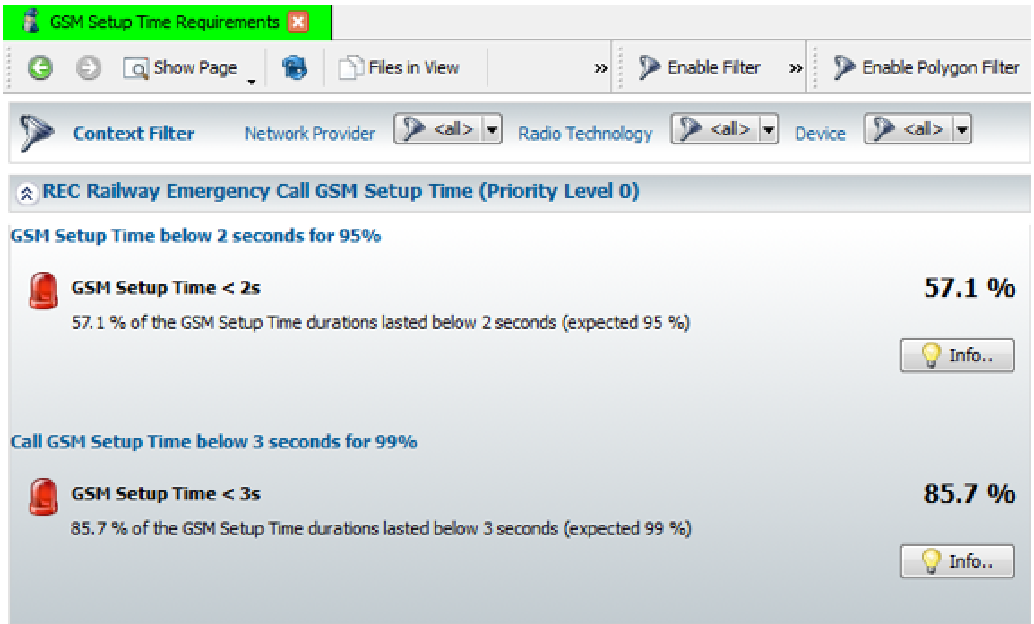


Figure 12-82: Traffic lights for REC setup time

A GCC call with the Priority Level 0 is treated as an REC.

Figure 12-83: Traffic lights for GCC setup time

Figure 12-84: Traffic lights for MOC setup time

The GSM Setup Time Distribution presentation uses the continuous CDF chart.

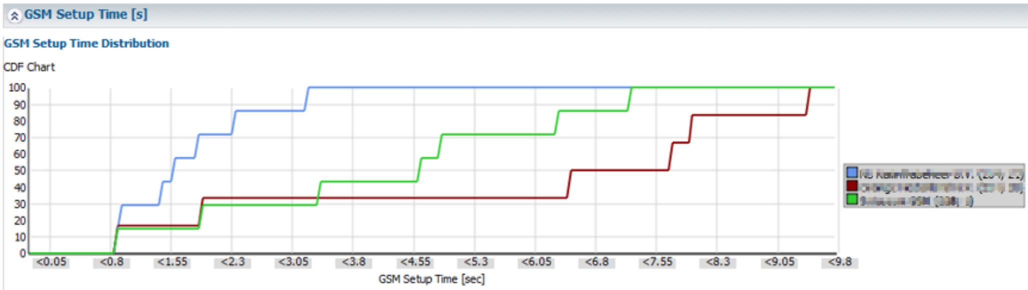


Figure 12-85: Continuous CDF of the GSM setup time distribution

The R&S ROMES4 for GSM-R networks does not deliver the Call Setup Time and System Response Time KPIs.

The absence of the mentioned KPIs is the reason for the empty corresponding columns in the Voice Call Table, see Figure 12-2.

For definition of the System Response Time and the Call Setup Time, see the "R&S ROMES4 Operating Manual", chapter 4 "ETSI QoS View > IREG IR.42 Parameters". Also, refer to ETSI TS 102 250-2.

The following figure shows the KPIs obtained with R&S ROMES4.

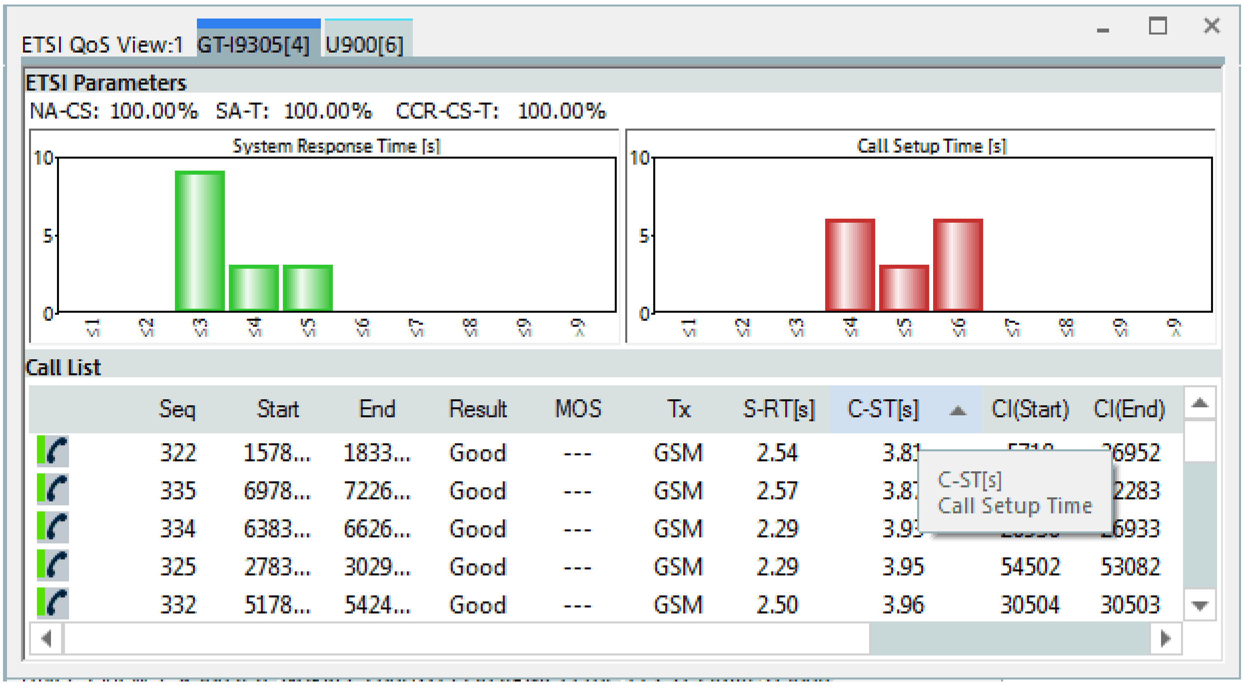


Figure 12-86: ETSI QoS view

12.8.3 CSD KPIs filtering

Filtering the CSD KPIs which are displayed in raster is possible per device type and per network provider, as shown in the following figure.

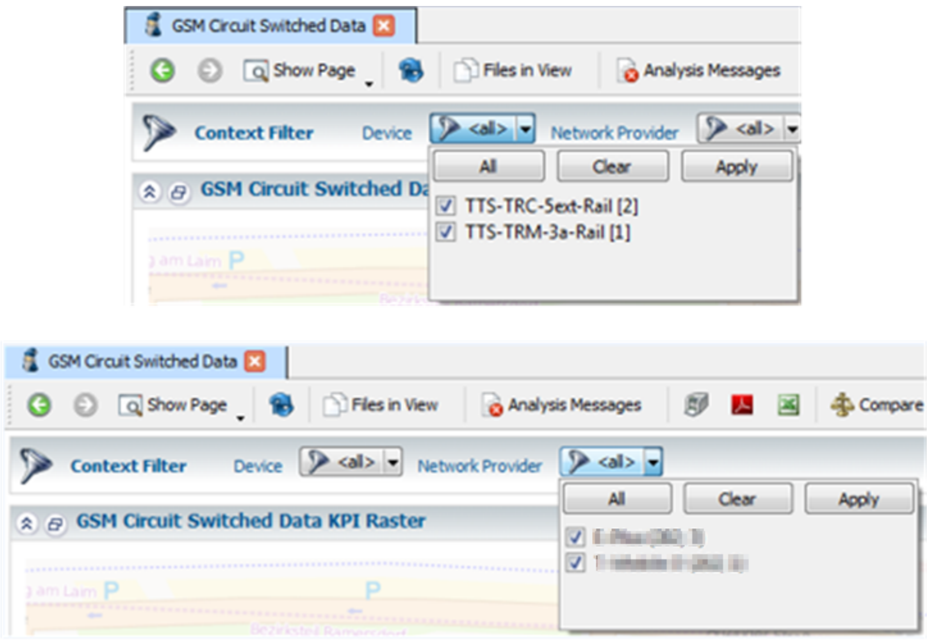


Figure 12-87: CSD KPIs filtering

12.8.4 Processing the ETCS-server measurement files

The R&S ROMES4 ETCS-Server application provides services to circuit switched data.

The ETCS-Server is treated as a DQA device. The device name is hard coded to ETCS-Server. However, the server has no a link to a mobile device. A network provider cannot be determined and is set to ISDN.

The previously mentioned device name is shown in some KPI charts. For example, the "Total Connection Duration grouped by UE" in Figure 12-90 shows the ETCS-Server name.

ETCS-Server data frames are transferred between both sides. DL and UL can be handled and tested separate.

12.8.4.1 Include ETCS-server with UL and DL separation

The ETCS-server measurement file can be processed itself or when it is merged into the main measurement file.

The R&S ROMES4 NPA displays the ETCS-server measurements as "traffic lights", pies, bar and/or CDF charts, and percentiles.

The R&S ROMES4 NPA places the server data for KPIs "Connection Loss Rate", "Intervals REC / Interfered" and "Transmission Total Frames" on the map raster.

The KPIs data is placed in the map raster at the position where the vehicle is located at the current timestamp.

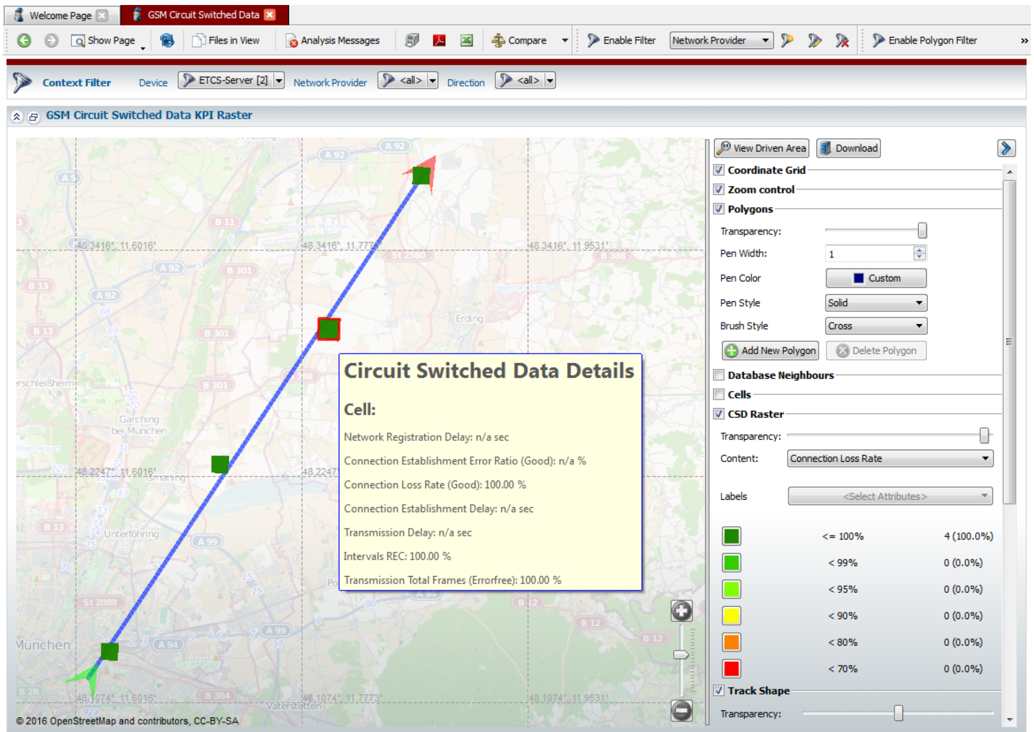
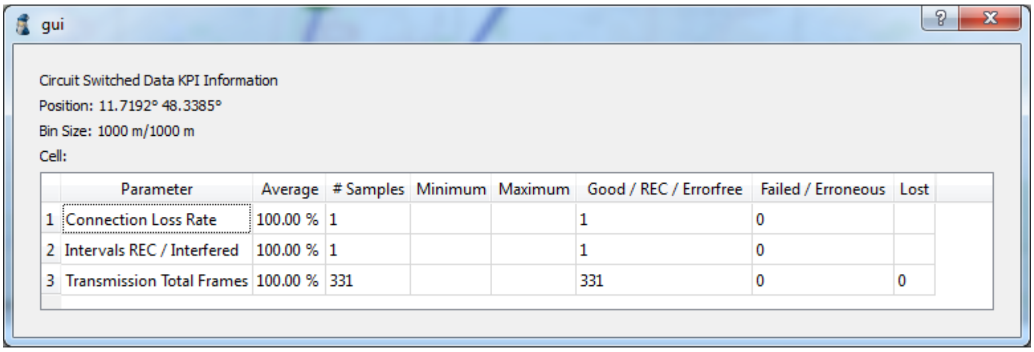


Figure 12-88: Map raster filtered for ETCS-server

Double-click a raster element to get the elements ETCS-server KPIs in tabular form.



gui

Circuit Switched Data KPI Information
Position: 11.7192° 48.3385°
Bin Size: 1000 m/1000 m
Cell:

	Parameter	Average	# Samples	Minimum	Maximum	Good / REC / Errorfree	Failed / Erroneous	Lost
1	Connection Loss Rate	100.00 %	1			1	0	
2	Intervals REC / Interfered	100.00 %	1			1	0	
3	Transmission Total Frames	100.00 %	331			331	0	0

Figure 12-89: ETCS-server KPI information

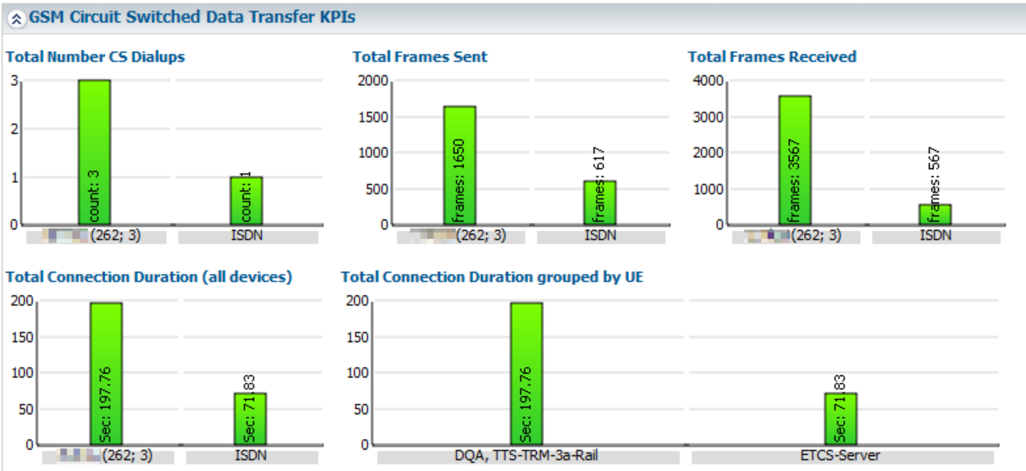


Figure 12-90: GSM CSD transfer KPIs marked with ISDN or ETCS-server

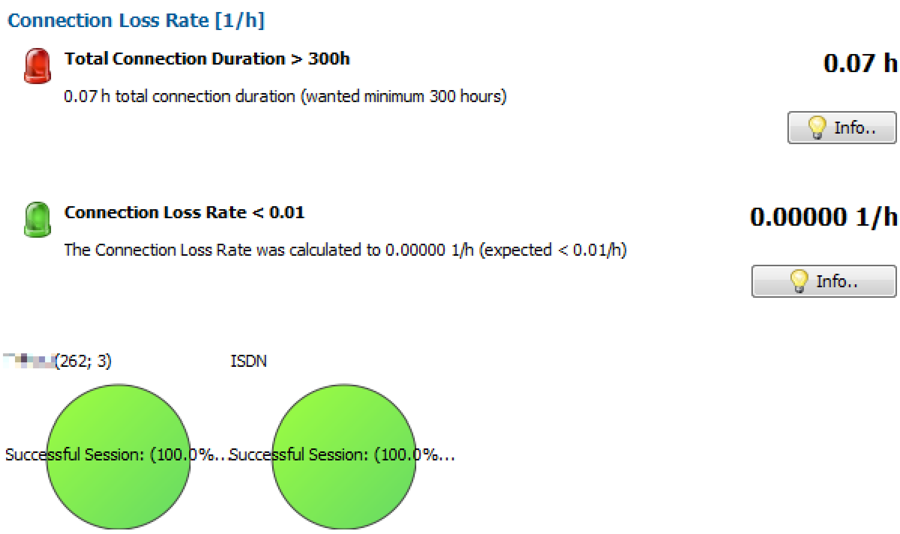


Figure 12-91: Connection loss rate KPI marked with ISDN

The previous two figures show the bars of the GSM CSD Transfer KPIs and the Connection Loss Rate pies both for ETCS-server and the mobile device.

It is possible to filter KPIs of ETCS-server or mobile device. Select the wanted direction (DL/UL) in the filter's "Direction" checkbox.

DL filtering stands for filtering the KPIs obtained in ETCS-server to mobile device direction.

UL filtering stands for filtering the KPIs obtained in ISDN (mobile device) to ETCs-server direction.

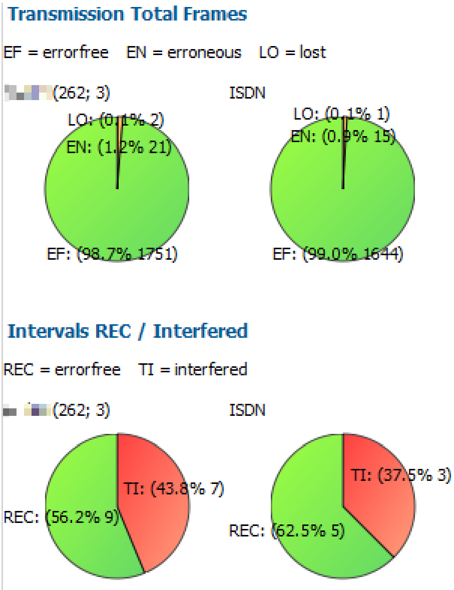


Figure 12-92: Transmission total frames marked with ISDN

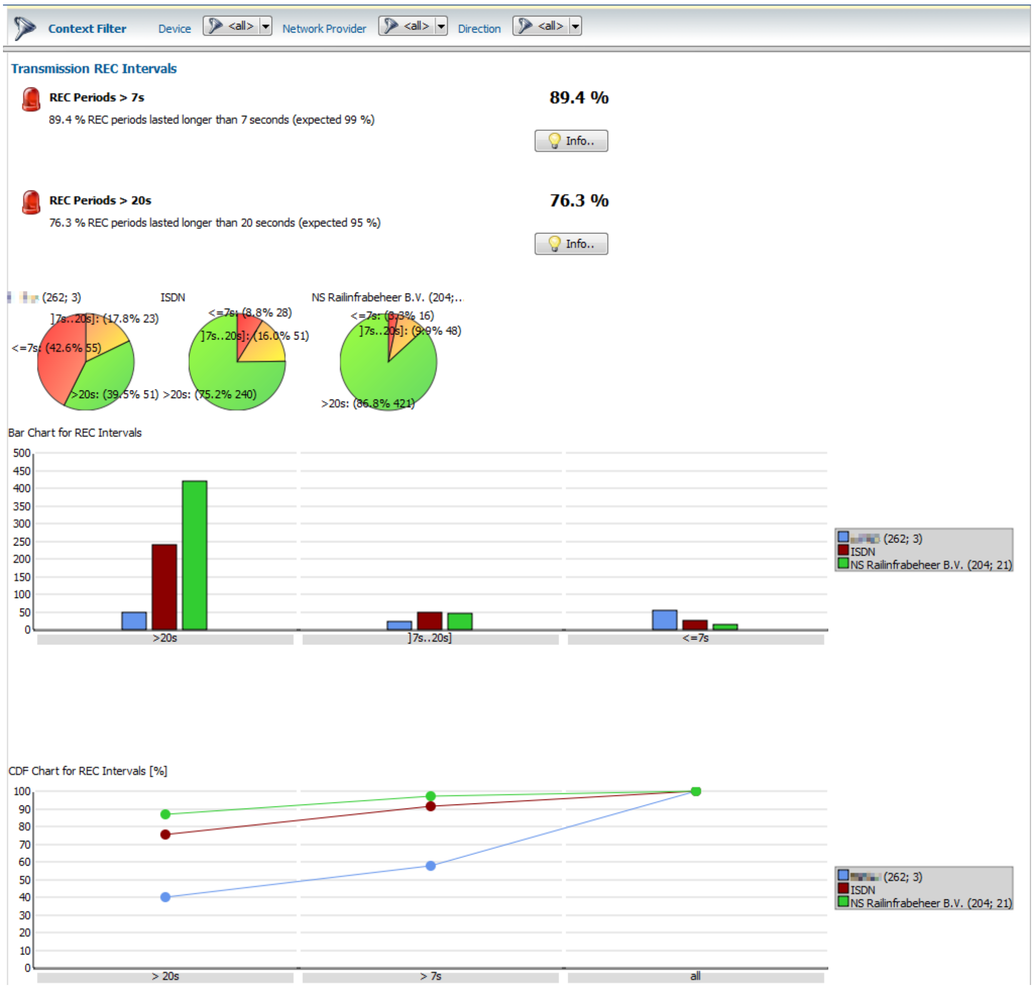


Figure 12-93: Transmission REC intervals marked with ISDN

The following figure shows the KPI Transmission Interfered Intervals for both directions, according to selection.

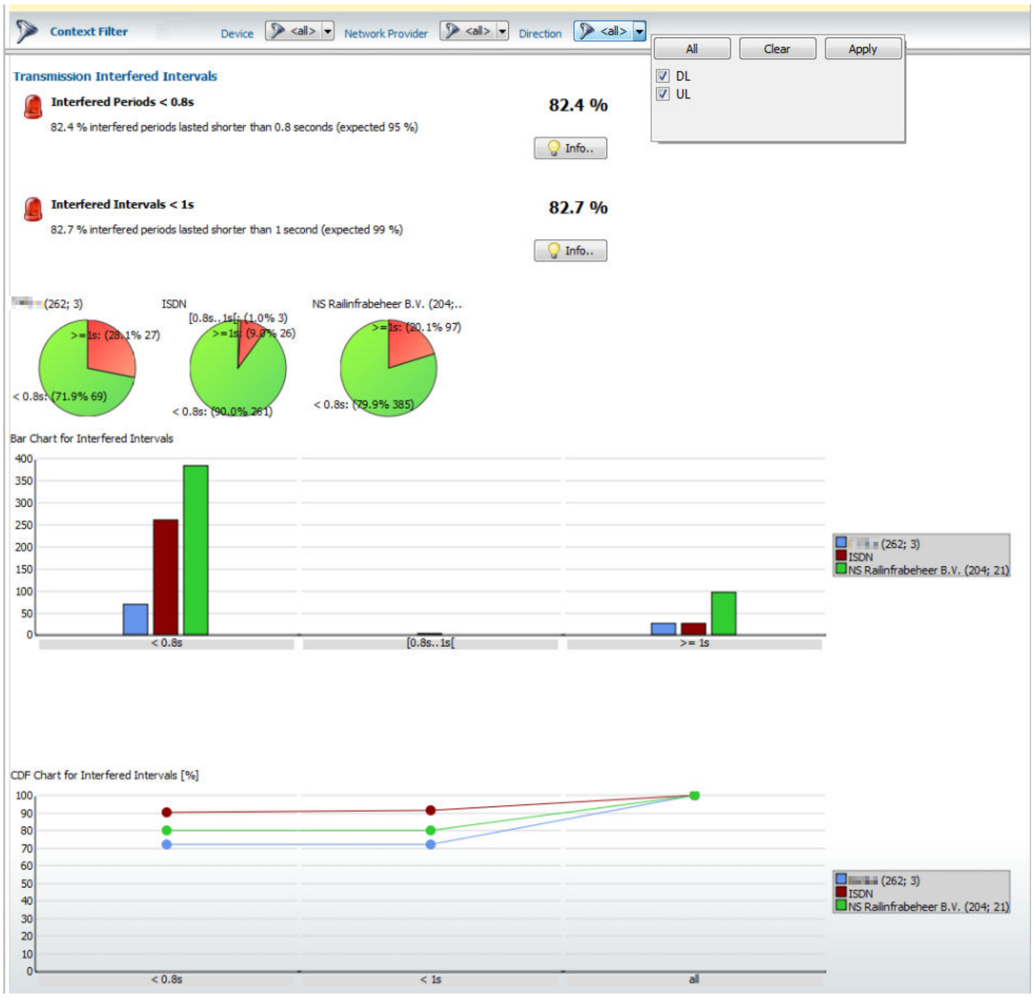


Figure 12-94: Transmission interfered intervals marked with ISDN

12.9 Data transaction analyzer

The data services testing became important with launching the LTE networks. The R&S ROMES4 NPA supports analysis of data services in different ways.

The basic analysis simply extracts the ETSI-compliant KPIs and the transaction lists from the R&S ROMES4 measurement files. In the GUI, the KPIs and lists can be aggregated over sets of measurement files and visualized in the ways described in chapter Chapter 4.4, "Visualizing analysis results", on page 70.

The R&S ROMES4 NPA Data Transaction KPIs analyzer supports the analysis of the QualiPoc measurements performed to test network performances, Streaming You-Tube, Facebook/Dropbox, What'App and SMS jobs.

The data tests for the mentioned jobs are analyzed by the NPA DQA module, see Chapter 4, "Use cases", on page 38. The "Service Page" is available with the tabs to start the analysis and visualize the results of the selected data type test. At the overview page, the icon and the statistics contain the results of the added tests.

The basic Data Transaction Analyzer does not support configuration. If the configuration is added to an analysis configuration set, the analyzer does not expose any changeable settings.

The following figure shows the output of data transaction analysis. The problem spots, the data transaction KPIs and throughput are reported.

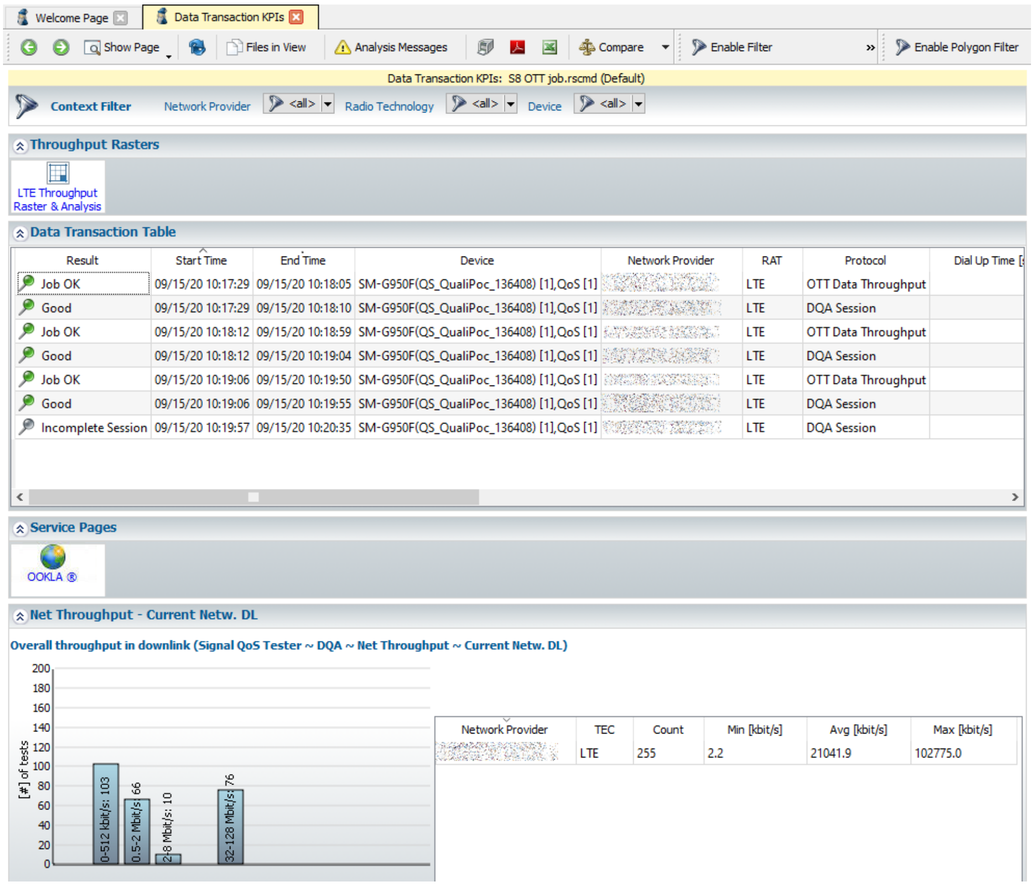


Figure 12-95: Data transaction analysis results for LTE

12.9.1 Key performance indicators

The following list contains the KPIs exported by the Data Transaction Analyzer. Though, not all KPIs are visualized in the R&S ROMES4 NPA. They are listed here for completeness.

The ETSI document TS 102 250-2 is referred to as the ETSI QoS specification in the following sections.

Measurement files from version 4.71 onwards are evaluated using the R&S ROMES4 KPI_Generator. Parameters not shown in the KPI_Generator view are evaluated from the DQA results in the same way as before.

12.9.1.1 Service-independent KPIs

Table 12-5: Service-Independent KPI

KPI	Description
Radio Network Unavailability	Probability that the mobile services are not offered to a user.
Network Non Availability	Probability that the user cannot perform a successful registration on the PLMN.
Attach Failure Ratio	Probability that a subscriber cannot attach to the PS network.
Attach Setup Time	Attach setup time describes the time period needed to attach to the PS network.
PDP Context Activation Failure Ratio	The PDP context activation failure ratio denotes the probability that the PDP context cannot be activated. It is the proportion of unsuccessful PDP context activation attempts and the total number of PDP context activation attempts. (Not existing for LTE)
PDP Context Activation Time	This parameter describes the time period needed for activating the PDP context. (Not existing for LTE)
PDP Context Cut Off Ratio	The PDP context cut-off ratio denotes the probability that a PDP context is deactivated without being initiated intentionally by the user. (Not existing for LTE)
DNS Host Name Resolution Failure Ratio	The DNS host name resolution failure ratio is the probability that a host name to host address translation of a DNS resolver was not successful.
DNS Host Name Resolution Time	The DNS host name resolution time is the time that takes to perform a host name to host address translation.

12.9.1.2 FTP upload/download

Table 12-6: FTP upload/download KPIs

KPI	Description
Service Non-Accessibility	The service non-accessibility ratio denotes the probability that a subscriber cannot establish a PDP context and access the service successfully.
Setup Time	The setup time describes the time period needed to access the service successfully, from starting the dial-up connection to the point of time when the content is sent or received. For parallel jobs, the first successful job 'catches' the setup time.

KPI	Description
IP Service Access Failure Ratio	The IP-service access ratio denotes the probability that a subscriber cannot establish an TCP/IP connection to the server of a service successfully.
IP Service Setup Time	The IP-service setup time is the time period needed to establish an TCP/IP connection to the server of a service. It is the time from sending the initial query to a server to the point of time when the content is sent or received.
Session Failure Ratio	The completed session ratio is the proportion of incompleted sessions and sessions that were started successfully.
Session Time	The session time is the time period needed to complete successfully a PS data session.
Mean Data Rate	Based on the per Call KPI in R&S ROMES. After a data link has been successfully established, this parameter describes the average data transfer rate measured throughout the entire connect time to the service. The data transfer is successfully terminated. The prerequisite for this parameter is network and service access.
Data Transfer Cut-Off Ratio	The data transfer cut-off ratio is the proportion of incomplete data transfers and data transfers that were started successfully.

12.9.1.3 HTTP download/web browsing

The same as listed in the FTP section. Also, see the chapter 6.8 in ETSI QoS specifications.

12.9.1.4 E-Mail upload/download

The same as listed in the FTP section. Also, see the chapter 7.2 in ETSI QoS specifications.

Currently R&S ROMES4 NPA supports only the ETSI Method B and the KPI trigger points definition (`kpi.xml`) delivered with R&S ROMES4.

12.9.1.5 Ping

The KPIs and results from the ping test are analyzed and collected for each mobile device separately. The device columns in test table show the same device identification as the R&S ROMES4 does. The results of the Ping job test are presented as tables, pie and bar charts in R&S ROMES4 NPA.

Data Transaction Table

Result	Start Time	End Time	Device	Network Provider	RAT	Protocol	Dial Up Time	PDP Context Activation Time	DNS Hostname Resolution Time	Setup Time	Latitude	Longitude
Good	11/30/12 14:42:39	11/30/12 14:43:16	E398 [2],DQA [2]		LTE	DQA Session					48.1259	11.6122
Good	11/30/12 14:42:39	11/30/12 14:43:48	E398 [1],DQA [1]		LTE	DQA Session	0.901 s				48.1267	11.6124
Job OK	11/30/12 14:42:41	11/30/12 14:42:51	E398 [1],DQA [1]		LTE	PING			0.149 s	1.372 s	48.1252	11.612
Job OK	11/30/12 14:42:43	11/30/12 14:42:53	E398 [2],DQA [2]		LTE	PING			0.140 s	1.370 s	48.1253	11.612

Figure 12-96: Ping test results in data transaction table

The table with all jobs at the "Ping" page has the "Device" column intended for better distinguishing between the jobs.

PING

Result	Start Time	End Time	Device	Network Provider	RAT	Protocol	Start CI	End CI	Min RTT	Avg RTT	Max RTT	Latitude	Longitude
Job OK	11/30/12 14:42:41	11/30/12 14:42:51	E398 [1],DQA [1]		LTE	PING	26522112	26522112	36.00 ms	39.00 ms	43.00 ms	48.1252	11.612
Job OK	11/30/12 14:42:43	11/30/12 14:42:53	E398 [2],DQA [2]		LTE	PING	26522112	26522112	36.00 ms	45.00 ms	85.00 ms	48.1253	11.612
Job OK	11/30/12 14:43:20	11/30/12 14:43:30	E398 [2],DQA [2]		LTE	PING	26522112	26522112	39.00 ms	240.00 ms	1476.00 ms	48.1265	11.6124

Figure 12-97: Dedicated table for ping test analysis

The "Ping Series Problems" table shows the detected Ping job problem spots and the problems description.

Ping Series Problems

Start Time	End Time	Operator	Device	Category	Title	Description	Latitude	Longitude
11:01:50.329	11:03:52.104		ME910C1-E1 [1], DQA [1]	Ping series problem	Failed Pings	The Ping series contains to much failed Pings (failed count or failure ratio is to high) Failed Count:1, Threshold:1, FailureRation:10 %, Threshold:20 %	59.3775	18.0128
11:09:31.345	11:13:36.930		ME910C1-E1 [1], DQA [1]	Ping series problem	Failed Pings	The Ping series contains to much failed Pings (failed count or failure ratio is to high) Failed Count:10, Threshold:1, FailureRation:100 %, Threshold:20 %	59.3703	18.01
11:22:09.125	11:26:14.600		ME910C1-E1 [1], DQA [1]	Ping series problem	Failed Pings	The Ping series contains to much failed Pings (failed count or failure ratio is to high) Failed Count:10, Threshold:1, FailureRation:100 %, Threshold:20 %	59.3704	18.017
11:27:23.097	11:29:25.309		ME910C1-E1 [1], DQA [1]	Ping series problem	Failed Pings	The Ping series contains to much failed Pings (failed count or failure ratio is to high) Failed Count:2, Threshold:1, FailureRation:20 %, Threshold:20 %	59.3757	18.013

Figure 12-98: Ping series problems table

A problem is created for each Ping job test series if a defined number of failed pings or the failure ratio of the series exceeds the configurable threshold. The failure ratio is calculated as the count of all ping in relation to failed pings of a single Ping job test. The thresholds setting is a part of the "Analysis" > "Processor Configuration" > "DQA KPI Overview" dialog.

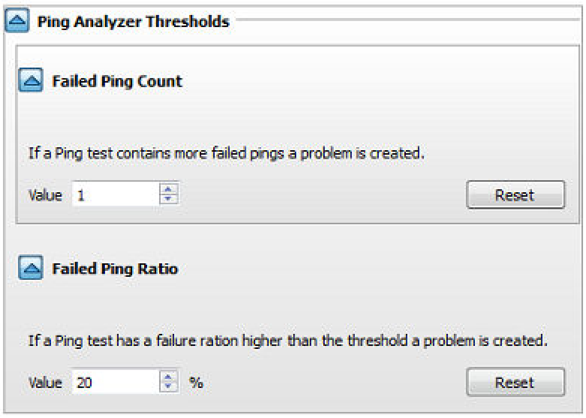


Figure 12-99: Configuration of ping thresholds

There are the following pie charts supporting the Ping job tests grouped per RAT or network provider.

- "Job Results per RAT"
- "Job Results per Network Provider"

- "Ping Series Success Ratio per Network Provider"

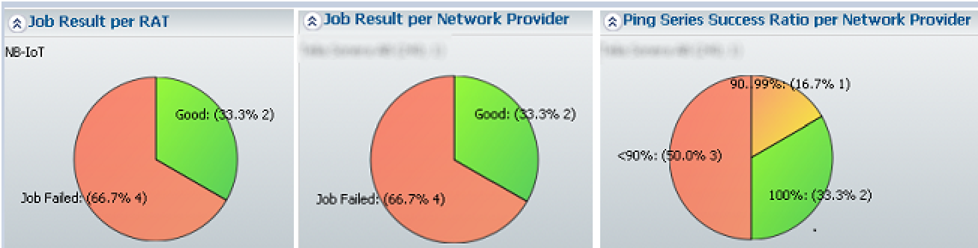


Figure 12-100: Available pie charts for ping

Furthermore, the bar chart and the table with RTT values get the device as new identification. The results at the bar chart are grouped by device, provider and RAT.

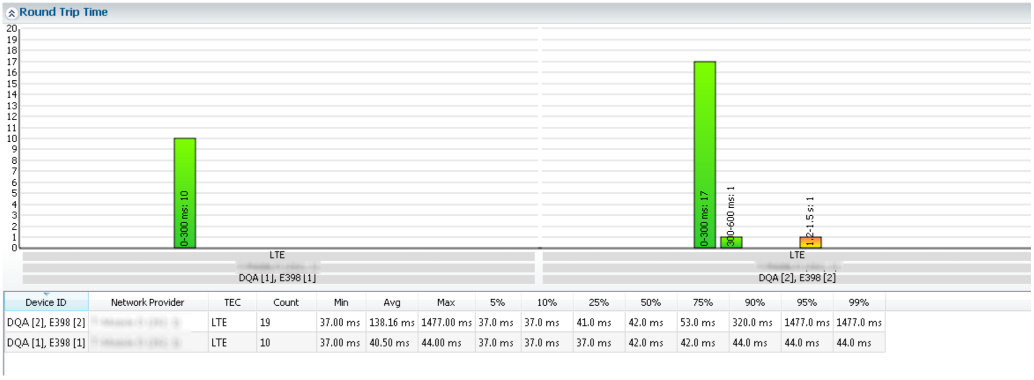


Figure 12-101: Details on RTT of ping

KPI	Description
PING ROUND TRIP TIME	The round trip time is the time required for a packet to travel from a source to a destination and back. It is used to measure the delay on a network at a given time. For this measurement, the service must already be established.

For details on Ping, see the chapter 6.3 in ETSI QoS specifications.

12.9.1.6 Extension for smartphone use

Smartphones show only KPIs related to the IP Setup Time ETSI B TSP/IP. Other setup time KPI is not shown.

For the FTP DL/UL, HTTP DL/UL and E-mail jobs the setup time KPI is aggregated into the IP Service Setup Time statistics.

12.10 IP analyzer

The IP Tracer plug-in is able to detect network problems on layer 4 to layer 7 in the OSI model, LTE, UMTS and GSM transmission problems. The IP analyzer also detects the problems caused by erroneous measurement configuration.

To start the analysis of the R&S ROMES4 measurement files, click the "Data Transaction" > "IP Tracer Problems" button, see Figure 4-70. As a result, the problem spots of various application protocols are reported, for example:

- TCP Handshake
- UDP
- HTTP
- FTP
- POP3
- SMTP
- DNS

A problem can be, for example, an error code returned from the server for a recently invoked operation or a timeout while waiting for requested data. Once a problem is detected, the plug-in searches for possible causes. To find the problem causes, a more detailed analysis of a specified time frame surrounding the problem spot time is run.

Once finished analyzing, the plug-in option tries to match the found problem spots to specific jobs and reports the problem spots that happened during a job's time frame. All abnormalities related to the problem spots are reported. In that way you get an overview over the measurement.

Example:

A DNS request was not answered after 20 seconds. The plug-in first checks within this time frame for coverage, interference and UE connection causes. If there is none, it checks within the time frame of the current job (from start to end) for the same problems. If it still cannot detect any, the cause is unknown.

In addition to the IP tracing function, there is the possibility to get the geographic presentation of failed data sessions and jobs. For this presentation, click the "Data Transaction" > "Data Job Problems" button.

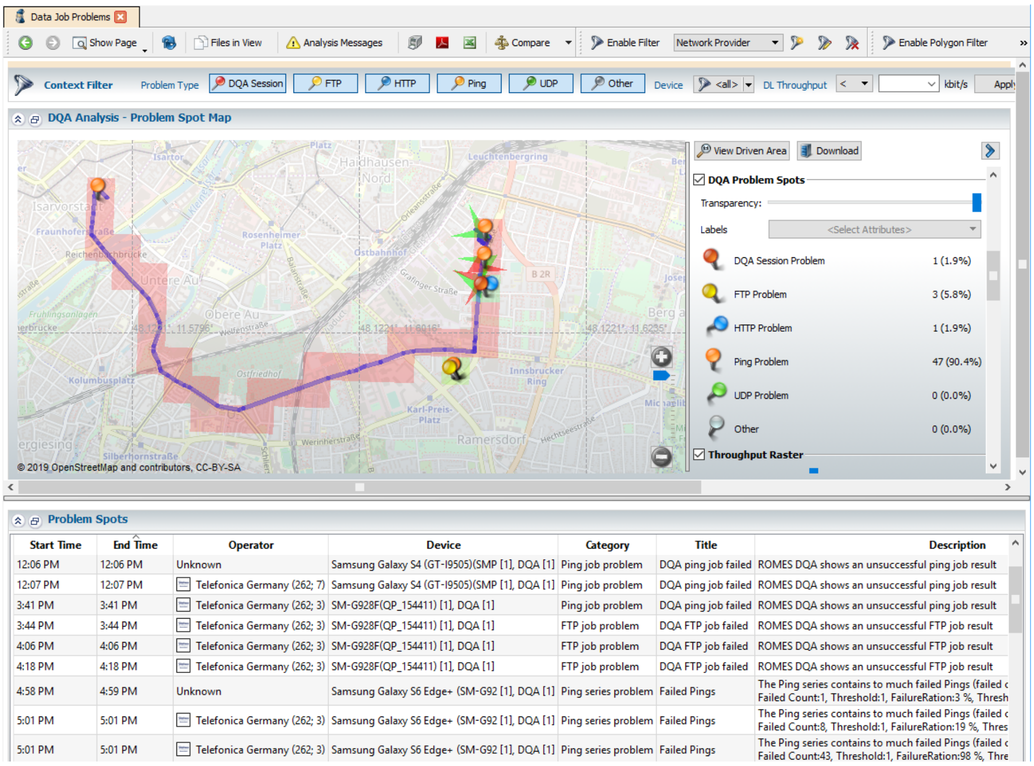


Figure 12-102: DQA problem spots marked on the map

The result page shows on the map the locations of the failed data sessions and jobs. The DQA problem spots are grouped by the most important categories: session, FTP, HTTP, PING and UDP.

The throughput raster showing the data rates and ping times is included in the result page.

The problem spot list shows the failed sessions and jobs with more details in some specific cases. The context filters provide for devices and problem types fast filtering.

IP analysis requires the R&S ROMES4N20 option, named Plug-In 2G-/3G-/4G-Data.

12.10.1 Analysis steps

The analysis process of each single job is split in several phases, which are executed in the same order every time. A job normally consists of a connection setup, a data transfer and the connection disconnect. A job is configured differently in R&S ROMES4. For example, multiple data transfer types can be performed, but the detection routines are slightly changed.

12.10.1.1 Connection setup

The first thing to do when a data transfer has to be performed is to set up the connection to the network. To establish that connection, several stages have to run through successfully. The stages differ slightly between the different used technologies. In GSM (and the enhancements), the mobile first must perform an ATTACH procedure, following the PDP Context Activation. In UMTS, RRC Connection must be set up first, before the PDP context can be activated.

These steps are verified to be executed successfully when a data transfer job fails. Errors, for example, can be bad radio conditions like Coverage or Interference issues. See Coverage & Interference Analysis for details on how the Coverage/Interference situation is detected. The error can be a timeout occurred while waiting for a response (on the UE). The C/I analysis is always performed using the data from the start to the end time of the problem spot found.

12.10.1.2 Transfer setup

Once the connection is available, a DNS request is performed to resolve the destination address of the operation. The destination address is also checked for errors reported within the protocol, timeouts and radio conditions if such a request fails.

Within the complete transaction, the state of the TCP/IP communication is monitored as well.

12.10.1.3 Data transfer

The data transaction jobs communicate through some application-specific protocol, like FTP or HTTP. While the data transfer is set up and processed, the communication on these layers is analyzed and checked for error codes and erroneous conditions.

12.10.1.4 Setup time for smartphone use

There is an extension in the R&S ROMES4 NPA for smartphone use. It concerns the smartphone IP services analysis.

Smartphones show only the IP Setup Time ETSI B TSC/IP KPIs. Other setup times are not shown separately.

However the IP Service Setup Time KPIs are aggregated for smartphone services FTP, HTTP and E-mail. The results of the measurement processing are shown as a bar chart and data table, which shows minimal, maximal and averaged service setup time of the smartphone used services.

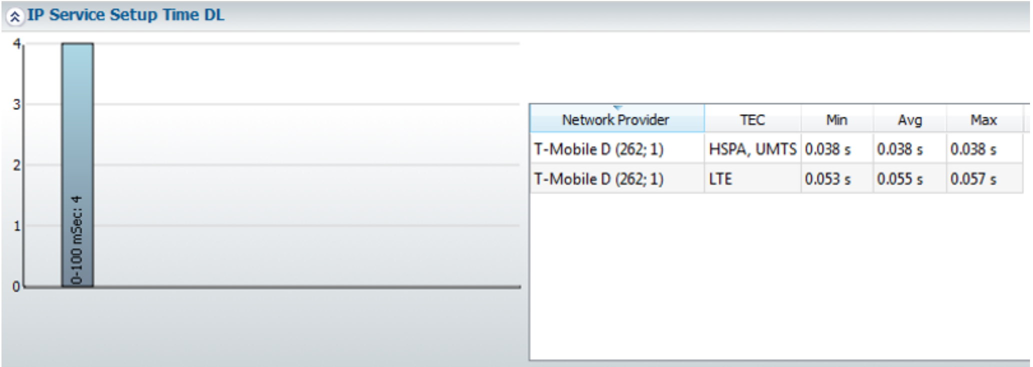


Figure 12-103: IP analysis extension for smartphones

The bar chart can be exported to Excel or printed to PDF format.

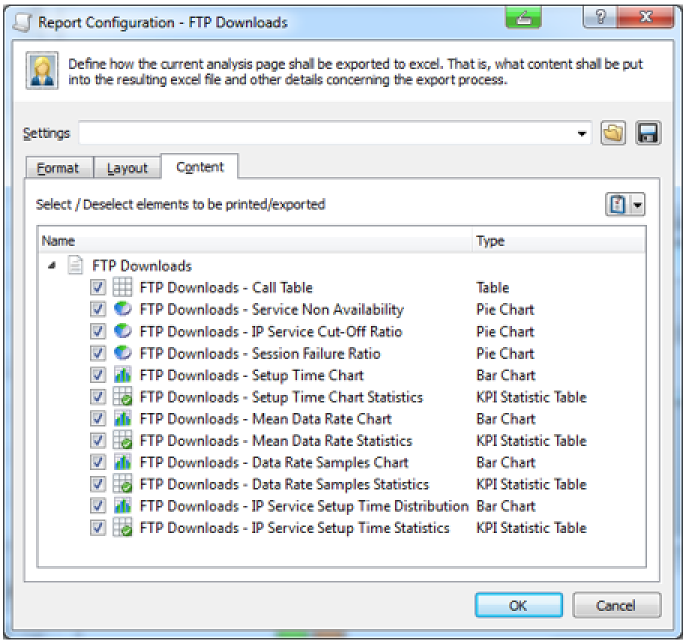


Figure 12-104: Exporting FTP downloads

12.10.2 Problem categories

The IP Analysis Processor is able to detect problems from the following list of categories:

Problem Category	Problem Description
Coverage Problem	The RSCP/RxLev samples dropped below a certain threshold in the time interval defined by the problem spot.
Interference Problem	The Ec/No/RxQual samples dropped below a certain threshold for a specific amount of time

Problem Category	Problem Description
Configuration Problem	The cause is most likely a configuration error. I.E. wrong username and/or password, wrong filename, etc.
Server Problem	The cause has identified to be a server error: The server responded that it aborted the current request/ command
Client Problem	The cause is most likely an error in the client-side implementation of the specific job: The server responded that it could not interpret the request/ command
Network Problem	The cause for the problem is somewhere in the Network. An example would be an 'Attach Reject' sent by the BTS.
Unknown Network Problem	The cause is none of the above: It is unknown

12.10.2.1 Combination of problem causes

If the transfer cannot be completed or connection drops due to some other reason, the analyzer checks all possible problems found in the steps above. These problems check always includes a check of coverage and interference situations. These checks are enhanced by prioritizing the problem causes found so far, adding them to the identified problem spot.

12.10.3 Analyzer configuration

The configuration of the IP analysis module is split in a few subcategories. The Connection Setup Timeouts listed below, the Protocol Timeouts and the Coverage and Interference settings.

12.10.3.1 Connection setup timeouts

Parameter	Value Range	Default	Description
RRC Connection Setup Timeout	0..60000 msec	5000 ms	This timeout defines which time interval is considered to be valid for a response to be sent after a request during RRC Connection Setup.
Attach Procedure Timeout	0..60000 msec	5000 ms	This timeout defines which time interval is considered to be valid for a response to be sent after a request during Attach Procedure.

Parameter	Value Range	Default	Description
PDP Context Activation Timeout	0..60000 msec	5000 ms	This timeout defines which time interval is considered to be valid for a response to be sent after a request during PDP Context Activation.
RRC Connection Setup Timeout	0..60000 msec	5000 ms	This timeout defines which time interval is considered to be valid for a successful handover message after a hand-over procedure has been started.

12.10.3.2 Protocol settings

Parameter	Value Range	Default	Description
TCP/IP Timeout	0..120000 msec	20000 ms	Timeout for TCP/IP com-munication, like packet acknowledgment.
DNS Timeout	0..120000 msec	20000 ms	Timeout for DNS requests.
HTTP Timeout	0..120000 msec	20000 ms	Timeout for HTTP down-loads.
FTP Timeout	0..120000 msec	20000 ms	Timeout for FTP down-load/upload.
POP3 Timeout	0..120000 msec	20000 ms	Timeout for E-Mail down-load using POP3 proto-col.
SMTP Timeout	0..120000 msec	20000 ms	Timeout for E-Mail send-ing using SMTP protocol.

12.10.3.3 Coverage analysis settings

The Coverage and Interference Analysis Settings are described in Chapter 12.16.4, "General configuration for a problem detection", on page 353.

12.11 Throughput analyzer - general

Specific analysis of data throughput in existing networks can be done using the E-GPRS, HSPA and LTE analysis modules.

There are four analyzer modules, for LTE, HSDPA, HSUPA and for E-GPRS. All them analyze FTP DL/UL transactions. Using this protocol, a large amount of data can be transferred without much protocol overhead, leading to a relatively stable user data transfer rate. The measurement files that are analyzed with the throughput analyses modules must contain a DQA job as it performs FTP DL/UL.

The following figure shows an analysis result of an LTE data call.

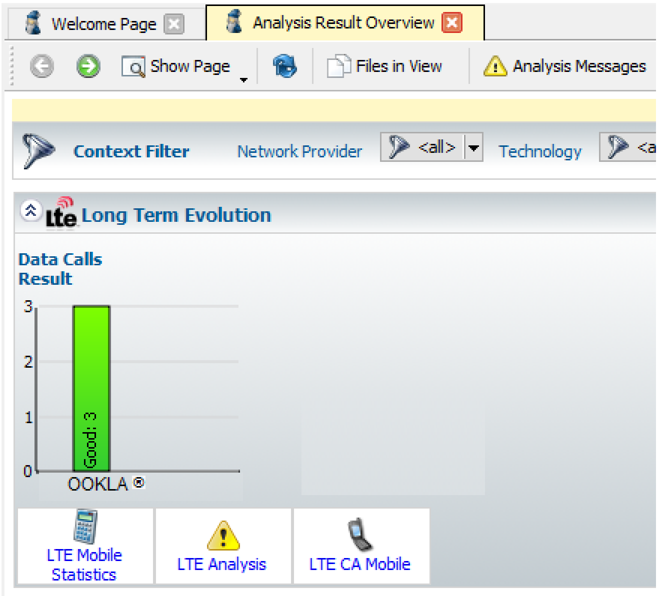


Figure 12-105: LTE data call result

The scaling of data rates for DQA histograms is adjusted to the actual LTE ones. The scaling of the LTE throughput is shown in the following table.

Table 12-7: LTE scaling of data rates for DQA histogram

Throughput										
0-512 kbps	0.5-2 Mbps	2-4 Mbps	4-16 Mbps	16-32 Mbps	32-64 Mbps	64-128 Mbps	128-256 Mbps	256-384 Mbps	384-512 Mbps	>512 Mbps

The data rates for downlink and uplink are collected from the R&S ROMES4 signals "QoS Tester ~ DQA Current State ~ DQA Curr. DL/UL Data Rate" and "QoS Tester ~ Net Throughput ~ Current Netw. DL / UL".

Some examples are shown in the following figures.

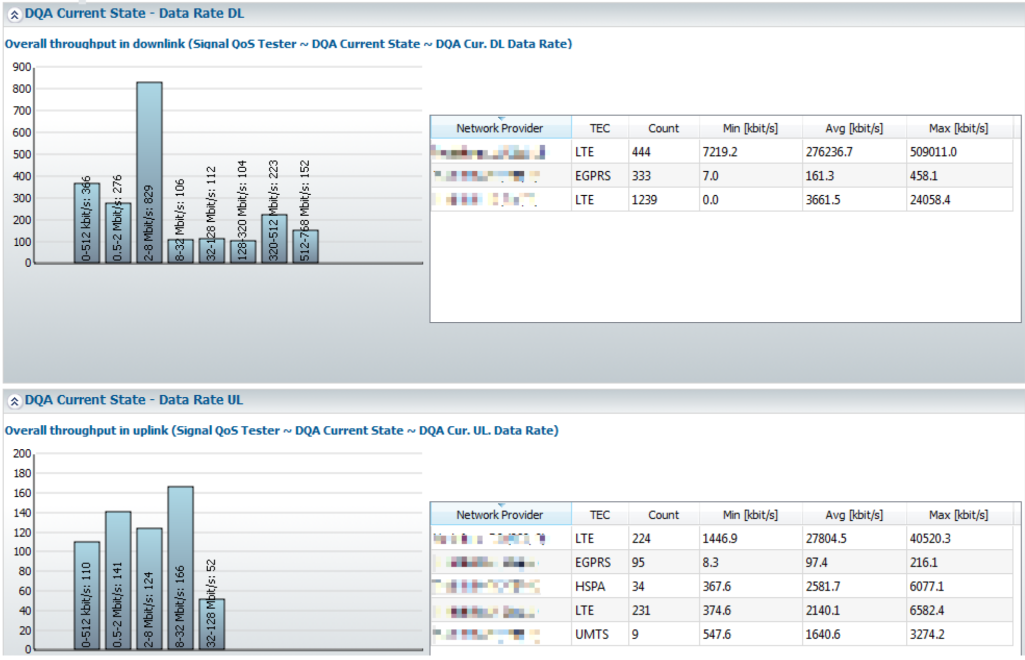


Figure 12-106: Scaling of data rates

The network throughput data rate is also aggregated when YouTube job is performed.

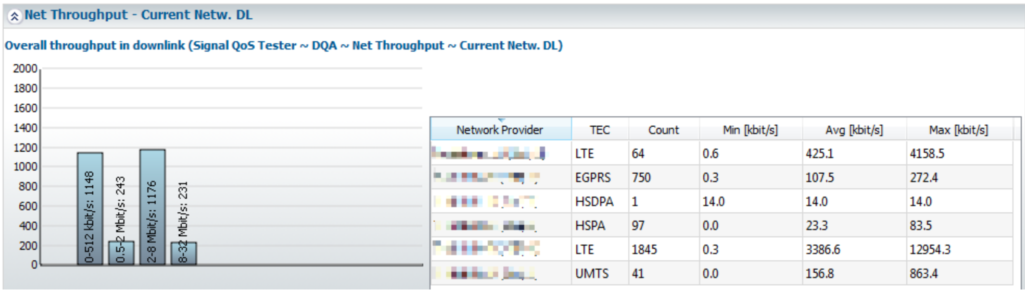


Figure 12-107: Current net throughput DL

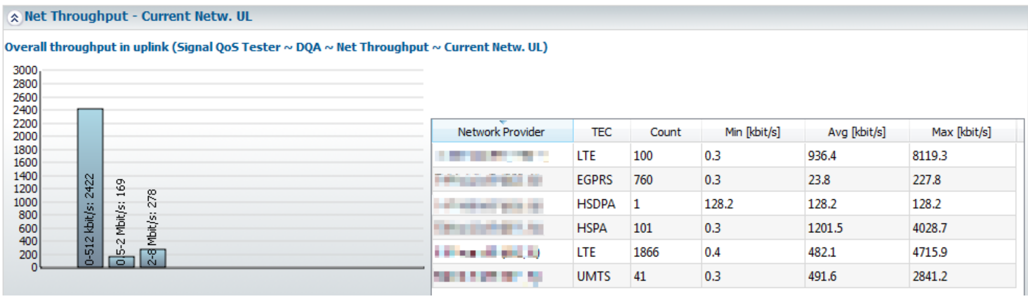


Figure 12-108: Current net throughput UL

Some UEs show throughput data rates only in one of signals. R&S ROMES4 NPA aggregates throughput data rates to the throughput rasters for GSM, UMTS and LTE.

Three buttons on the "Data Transaction KPIs" page lead the user directly to the throughput raster result pages.

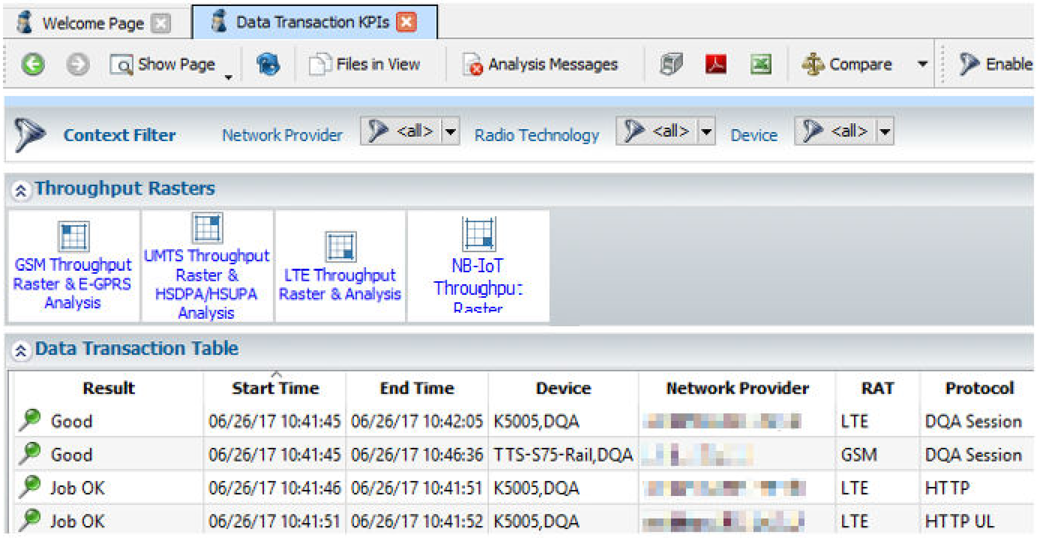


Figure 12-109: GSM / UMTS / LTE/ NB-IoT throughput raster buttons

For the faster comparison of data rates and session results for multiple network operators, the R&S ROMES4 NPA provides more charts and statistics of the data rates and session results.

Supported is the analysis results for total average mean data rates as a sum of the data rates of all jobs of all technologies grouped by network operator.

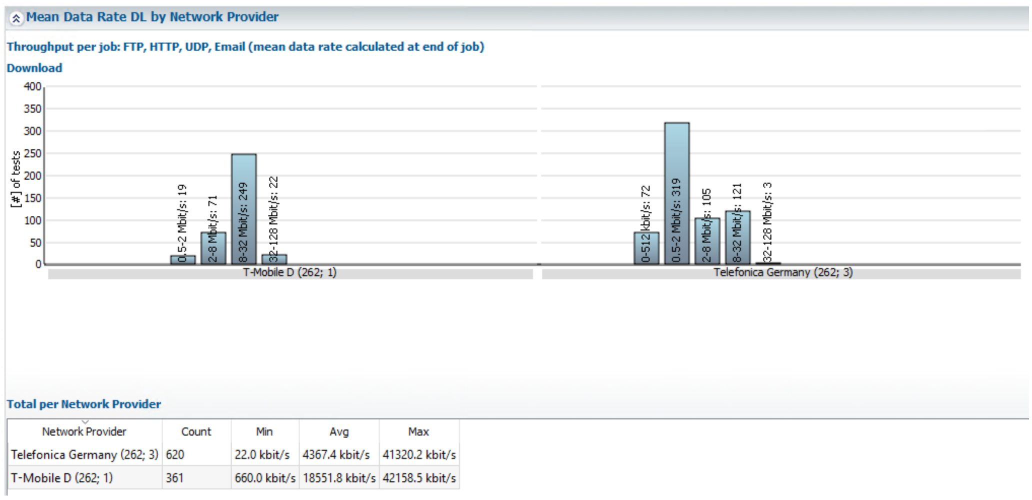
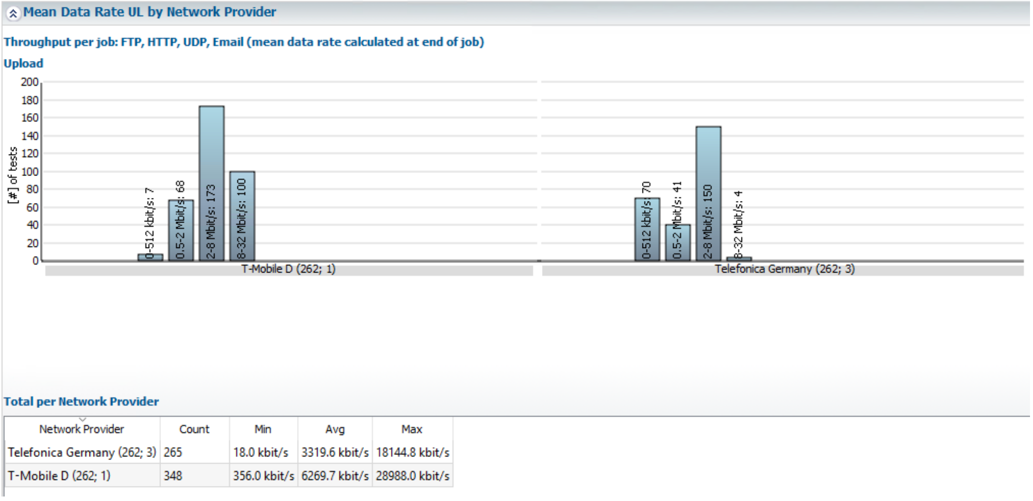


Figure 12-110: Mean data rate DL



Network Provider	Count	Min	Avg	Max
Telefonica Germany (262; 3)	265	18.0 kbit/s	3319.6 kbit/s	18144.8 kbit/s
T-Mobile D (262; 1)	348	356.0 kbit/s	6269.7 kbit/s	28988.0 kbit/s

Figure 12-111: Mean data rate UL

The session result (Good, Blocked, Dropped, No Service, Application Error) is shown in a bar chart grouped by network operator.

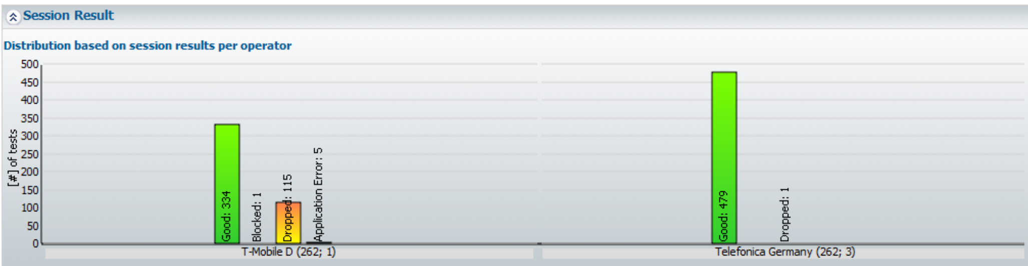


Figure 12-112: Session results bar chart

Data throughput analysis of HTTP and UDP jobs of the 3GPP technologies is triggered if the low throughput is detected.

To find out more on the technology-specific analysis details, refer to the related sections:

- E-GPRS Analysis for FTP Up- and Downloads in 2.5G networks
- HSDPA Analysis for FTP Downloads in 3G networks
- HSUPA Analysis for FTP Uploads in 3G networks
- LTE Mobile Analysis for FTP Down- and Uploads in LTE networks

Throughput analysis for each RAT requires the R&S ROMES4N20 option.

12.11.1 Problem area detection and analysis

Basically the analysis uses the following approach to find areas of low throughput: The data throughput is monitored during the complete transaction. Each time the throughput drops below a certain threshold and remains low for a specific time, the detailed analysis phase starts. Other measurement data is then analyzed as long as the transaction lasts and remains in the low data rate state.

Normally there is a ramp-up phase at the start of the FTP transactions, where throughput is usually low. To avoid reporting technically inherent problems in this phase, the analyzer modules ignore the first N seconds of a transaction. The same applies to the end of a transaction. The attribute TCP Slow Start Delay defines this pause.

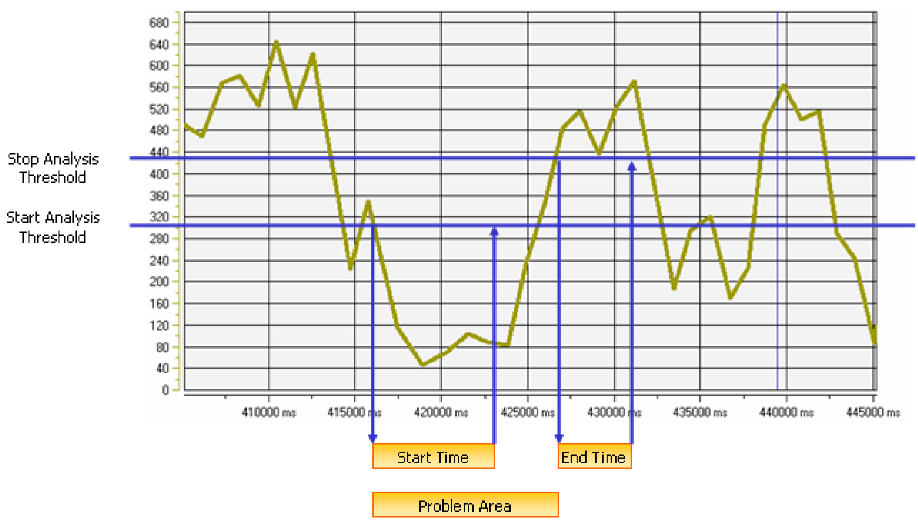


Figure 12-113: Highlighted problem areas

As depicted in the picture above, the start of the problematic area is placed at that point where the throughput rate drops below the "Start Analysis Threshold". It is important that the throughput rate stays below that threshold for the amount of time specified in Start Analysis Time. If not, the short drop is not analyzed further.

The end point of the problem area is determined by the first timestamp where the rate exceeds the "Stop Analysis Threshold" and stays above that threshold for the amount of time specified in Stop Time. If the rate drops again within that time interval, the area is continued.

If the total duration of a problem area is only a short time interval, the area can be ignored. The decision whether an area is too short to be worth analyzing is also done based on a configurable threshold called Minimum Problem Area Duration. The default is 5 seconds.

All the threshold values that are used to detect low throughput rates depend on the mobile category found in the Layer3 signaling. Using the mobile category, an expected maximum throughput rate is calculated. In the configuration, these thresholds and the time limits can be modified.

12.11.2 Detail analysis

When the download/upload transaction is finished, a still unfinished problem area is closed and analyzed. The detailed analysis is done in the same way for HSUPA and HSDPA. In both cases, the time interval defined by the start and stop time found as described above is scanned according to detailed analysis algorithms.

Detail analysis algorithms basically work in the same way for both technologies: For a specific parameter, the number of samples in the range of the problem area are counted that are below/above a threshold associated with that parameter. If a predefined number of samples fulfills the criterion, a problem cause is generated to create a hint on that specific problem.

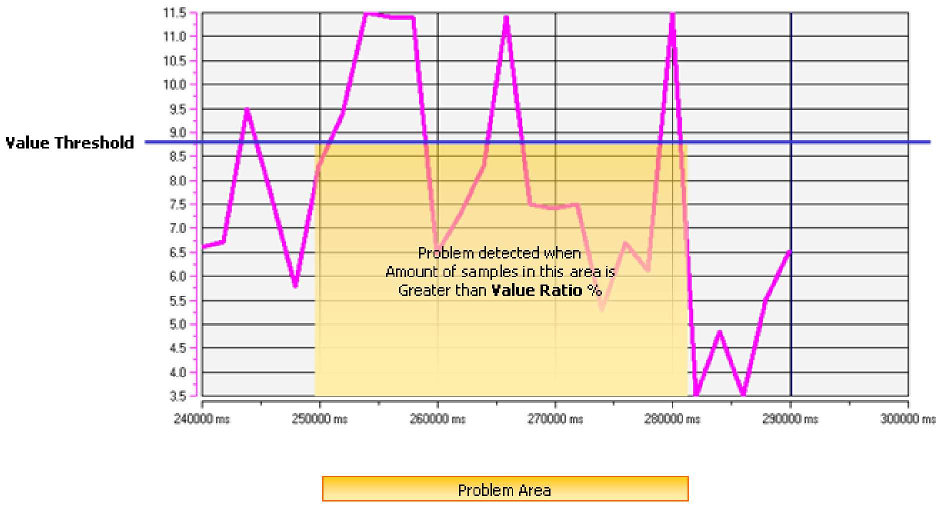


Figure 12-114: Problem area details

More details on the detailed analysis algorithms can be found in the sections explaining HSDPA and HSUPA analysis.

12.11.3 General configuration

Due to the same underlying basic problem area detection strategies, both HSDPA and HSUPA modules share the basic configuration properties.

Table 12-8: Configuration properties of HSDPA and HSUPA

Parameter	Value Range	Default	Description
TCP Slow Start Delay	1..60000 ms	5000 ms	After FTP login and start of transfer, there is no throughput analysis started within this interval. In this way, avoided is analysis in the TCP rump-up phase, where low throughput is system inherent.
Start Analysis Time	1..60000 ms	2000 ms	Time interval that the FTP DL/UL current data rate must be below the "Start Analysis Throughput" threshold to detect a problem area start.
Stop Analysis Time	1..60000 ms	2000 ms	Time that the FTP DL/UL current data rate must exceed the "Stop Analysis Throughput" threshold to detect a problem area end.
Minimum Problem Area Duration	1..60000 ms	5000 ms	Problems up to this length are discarded (considered too short).

12.12 Throughput analyzer - E-GPRS analysis details

12.12.1 Packet switching data

Packet data capabilities were added in the 3GPP Release '97 version of the GSM standard as GPRS. GPRS is a data service that is available to users of GSM and IS-136 handsets. GPRS can be used for all data services such as Internet browsing, WAP access, SMS, and MMS. In comparison to GSM, GPRS is packet-switched. In terms of multiple users, it shares the transmission channel only when data must be sent. The achievable data rates in GPRS depend on the supported multislot class. The max. data rate per time slot is 21.4 kbit/s with a max. possible number of 8 slots in either the downlink or uplink direction. A mobile device of multi-slot class 10, for example, supports max. 4 Rx slots in the downlink and max. 2 Tx slots in the uplink. However, the sum of both Rx and Tx slots is max. 5.

To increase the data transmission rate and to improve network capacity, EDGE was introduced in Release '98. With EDGE (also named E-GPRS), a new modulation scheme is applied, 8-PSK (phase shift keying). Applied are three bits per RF modulated symbol as opposed to the original one bit per symbol in GPRS. This technology change triples the effective data rate for EDGE resulting in a peak date rate of 59.2 kbit/s per time slot. The maximum achievable data rate depends on the supported multislot class of the mobile device similar to GPRS. The average downlink data rate in commercially operated networks is in the range of 300 kbit/s. E-GPRS is a superset expression comprising EDGE and GPRS.

The multi-slot class supported by mobile and network site determine the maximum throughput in EDGE. The following table shows the relationship between a mobile multi-slot class and maximum throughput.

Multi-Slot Class	max. DL Channels	max. UL Channels	max Nr. Of Channels
1	1 (59.2 kbit/sec)	1 (59.2 kbit/sec)	2
2	2 (118.4 kbit/sec)	1 (59.2 kbit/sec)	3
3	2 (118.4 kbit/sec)	2 (118.4 kbit/sec)	3
4	3 (177.6 kbit/sec)	1 (59.2 kbit/sec)	4
5	2 (118.4 kbit/sec)	2 (118.4 kbit/sec)	4
6	3 (177.6 kbit/sec)	2 (118.4 kbit/sec)	4
7	3 (177.6 kbit/sec)	3 (177.6 kbit/sec)	4
8	4 (236.8 kbit/sec)	1 (59.2 kbit/sec)	5
9	3 (177.6 kbit/sec)	2 (118.4 kbit/sec)	5
10	4 (236.8 kbit/sec)	2 (118.4 kbit/sec)	5
11	4 (236.8 kbit/sec)	3 (177.6 kbit/sec)	5
12	4 (236.8 kbit/sec)	4 (236.8 kbit/sec)	5

12.12.2 Analysis plug-in

Using the E-GPRS analysis plug-In, the R&S ROMES4 NPA can detect technology-related issues and creates specific statistics to evaluate the overall network performance. The analysis mainly considers the general radio conditions and GPRS-specific parameters, like the modulation scheme used and the number of time slots allocated.

The basic approach for problem analysis is the same as used in the HSDPA/HSUPA modules. A complete description of the analysis algorithm is found in the Throughput Analysis chapter. In few words, FTP transactions (uploads and downloads) are investigated to find intervals with bad throughput. The analysis checks several different parameters and their interrelation, and derives conclusion about what problems can lead to the low throughput. Such parameters are the used coding schemes and the retransmission rates, for example, besides other technology-specific data.

The following sections describe how the single parameter analysis procedures work, which kind of problems they detect and what solutions can help to resolve the situation. The way the analyzer do their job can be controlled using the standard way of configuring data processor in the software, as described in the Processor Configuration chapter. The configuration parameters specific to E-GPRS are explained below.

12.12.3 GPRS parameter analysis

When a throughput problem is detected, the analyzer investigates the situation of the parameters listed below for abnormalities and specific constellations. From the set of potential issues found, the most likely cause of a problem is chosen and displayed in the result pages.

GPRS/E-GPRS parameter analysis includes the following specific analyses:

- Coverage analysis
- Interference analysis
- Timeslot analysis
- Coding scheme analysis
- Retransmission rate analysis
- Packet cell change analysis

12.12.3.1 Coverage analysis

The coverage situation is checked using the RxLev parameter to detect such problems fast and reliable. A low coverage leads to low data rates in nearly every case. Therefore, the number of RxLev measurements that fall below the Coverage Threshold threshold are counted. If the countings make up more than 50% of the measured samples, the coverage is considered bad.

12.12.3.2 Interference analysis

The SNR or I_LEVEL values are investigated in good coverage situations.

Note that not every mobile reports these values and potential interference situations cannot be discovered with certain mobile types.

12.12.3.3 Timeslot analysis

The number of time slots allocated to a user varies during data transmission and changes happen frequently. It is expected, that related to the maximum number of time slots for the current coding scheme, some minimum number of time slots is available for most of the time. In an interval with low throughput, the number of allocated time slots is compared to the maximum possible number, if the difference is greater than the Max Timeslot Delta threshold..

12.12.3.4 Coding scheme analysis

A lower coding scheme yields in lower throughput rates per definition. If low coding schemes are detected to be used constantly in a cell, the problem can be improved by using higher coding schemes if supported by the cell.

12.12.3.5 Retransmission rate analysis

The retransmission rate is calculated from the ACK/NACK statistics sent by the mobile. A high retransmission rate can be caused by several problems:

- When high coding schemes are used (refer to Good Coding Scheme Minimum threshold), the cell maybe overloaded, and it can make sense to share the available bandwidth among the users by reducing the maximum coding scheme.
- In the case low coding schemes are used, interference can be the problem that causes the low throughput (compared with the reduced expected throughput caused by the lower coding scheme).

12.12.4 Problem categories

As a result from the different analysis approaches described above, the E-GPRS processor is able to detect problems from the following list of categories:

Problem Category	Problem Description
Coverage Problem	More than 50% of the RxLev samples dropped below the Coverage Threshold in the time interval defined by the low transaction throughput.
Interference Problem	Interference situations are detected using the SNR values reported from the mobile in GPRS mode. Some mobiles report the RxQual, but this value is ignored completely. If there is no SNR value reported, the I_LEVEL values are evaluated to derive an interference status.
Test equipment problem	Such problems are reported when the mobile used for measurement does not deliver values required for the analysis, like SNR or I_LEVEL.
Network Problem	Such problems are detected when the number of allocated time slots is too low in the problem area (related to the maximum number possible), a high retransmission rate is found or low coding schemes are used constantly.

12.12.5 Decision matrix

From the single detection algorithms described above, the problems that are identified are derived according to the description in the following table.

Each row describes a problem, and the problems are checked from top to bottom. The single check in each row is performed from left to right. Once a matching row for the current condition is found, the problem category is derived.

Coverage	Interference (SNR)	Timeslot Assignment	MCS	Retransmission Rate	Problem Category
Bad + Cell Reselection					Report a warning: Due to cell reselection, throughput must be low here
Bad					Coverage Problem
Good	High				Interference Problem (measured)
Good	-	High			Interference Problem (derived from radio situation)
Good	Low[1]	High	Lower schemes		Network Problem due to missing improved MCS configuration
Good	Low[1]	Low	Higher schemes	High	Network Problem, use lower MCS
Good	-	Low	Lower schemes	High	Interference Problem (derived from radio situation)
Good	Low[1]	Low[2]	Higher schemes	Low	Network Problem due to overload

1)If Interference cannot be measured, it is assumed to be low for the detection in this matrix (not for the final evaluation result).

2)Means that timeslot assignment is low in terms of assignment frequency, i.e. the TBF is opened and closed constantly.

12.12.6 Control thresholds configuration

The result of the E-GPRS analyzer is influenced by several thresholds that control the detection of problems.

<table>
<tr><th>Parameter</th><th>Value Range</th><th>Default</th><th colspan="4">Description</th></tr>
<tr><td>Network Multislot Class</td><td>0 to 12</td><td>12</td><td colspan="4">The maximum multi-slot class the network accepts. Reported timeslot classes higher than this value is reduced to that class and influence the expected throughput.</td></tr>
<tr><td>Minimum Problem Time</td><td>100 msec to 100000 msec</td><td>5000 ms</td><td colspan="4">The minimum amount of time a problem condition must last to be considered being a valid reason for the throughput issue.</td></tr>
<tr><td>Coverage Threshold</td><td>-120 dBm to 40 dBm</td><td>-90</td><td colspan="4">If most of reception level measurements falls below this threshold for the problematic time interval, a coverage issue is reported.</td></tr>
<tr><td>Maximum SNR</td><td>0 dB to 30 dB</td><td>10 dB</td><td colspan="4">Maximum average SNR to derive an interference situation for the serving cell.</td></tr>
<tr><td rowspan="11">Good Coding Scheme Minimum</td><td rowspan="11">1 to 9</td><td rowspan="11">3</td><td colspan="4">The smallest coding scheme number considered being a coding scheme used for high data throughput in good radio conditions. The single values are translated as shown in the table below</td></tr>
<tr><td>Attribute Value</td><td>Coding Scheme</td><td>Max Throughput/TS [kbps]</td><td>Modulation</td></tr>
<tr><td>1</td><td>MCS-1</td><td>8.8</td><td>GMSK</td></tr>
<tr><td>2</td><td>MCS-2</td><td>11.2</td><td>GMSK</td></tr>
<tr><td>3</td><td>MCS-3</td><td>14.8</td><td>GMSK</td></tr>
<tr><td>4</td><td>MCS-4</td><td>17.6</td><td>GMSK</td></tr>
<tr><td>5</td><td>MCS-5</td><td>22.4</td><td>8-PSK</td></tr>
<tr><td>6</td><td>MCS-6</td><td>29.6</td><td>8-PSK</td></tr>
<tr><td>7</td><td>MCS-7</td><td>44.8</td><td>8-PSK</td></tr>
<tr><td>8</td><td>MCS-8</td><td>54.4</td><td>8-PSK</td></tr>
<tr><td>9</td><td>MCS-9</td><td>59.2</td><td>8-PSK</td></tr>
<tr><td>Max Timeslot Delta</td><td>0 to 8</td><td>1</td><td colspan="4">If the difference between the maximum achievable number of time slots and the actual allocated number is greater than this value for many of samples in the low throughput area, a Network Problem is detected.</td></tr>
<tr><td>Maximum Retransmission Rate</td><td>0 % to 100 %</td><td>40 %</td><td colspan="4">If more than the given number of packets has to be retransmitted during data transfer, retransmission is considered to be high.</td></tr>
<tr><td>Start Analysis Throughput [kbps] per Timeslot</td><td>0 kbps to 100 kbps</td><td>30 dB</td><td colspan="4">If the FTP DL/UL current data rate (related to the number of time slots possible for the multislot class) drops below this threshold for "Low Throughput Minimum Time" msec, the problem analysis is started.</td></tr>
<tr><td>Stop Analysis Throughput [kbps] per Timeslot</td><td>0 kbps to 110 kbps</td><td>40 kbps</td><td colspan="4">If the FTP DL/UL current data rate (related to the number of time slots) exceeds this threshold for "High Throughput Minimum Time" msec, the problem analysis is stopped.</td></tr>
</table>

12.13 Throughput analyzer - HSDPA analysis details

UMTS networks based on wideband code division multiple access (WCDMA) has been deployed worldwide as 3rd generation mobile communications systems. UMTS provides a clear evolution path to high-speed packet access (HSPA). HSPA refers to the combination of high speed downlink packet access (HSDPA) and high-speed uplink packet access (HSUPA). HSDPA allows data rates up to 14.4 Mbit/s in the downlink. HSPA also boosts capacity in UMTS networks and provides significant latency reductions.

The UMTS/ HSDPA/HSUPA analysis modules work as described in Throughput Analysis for FTP, HTTP and UDP jobs. Within data transactions intervals with bad throughput are identified and then analyzed. The analysis checks several different parameters and their interrelation, and derives conclusion about what problems can lead to the low throughput. Such parameters are the CQI statistics, finger usage and other technology-specific data.

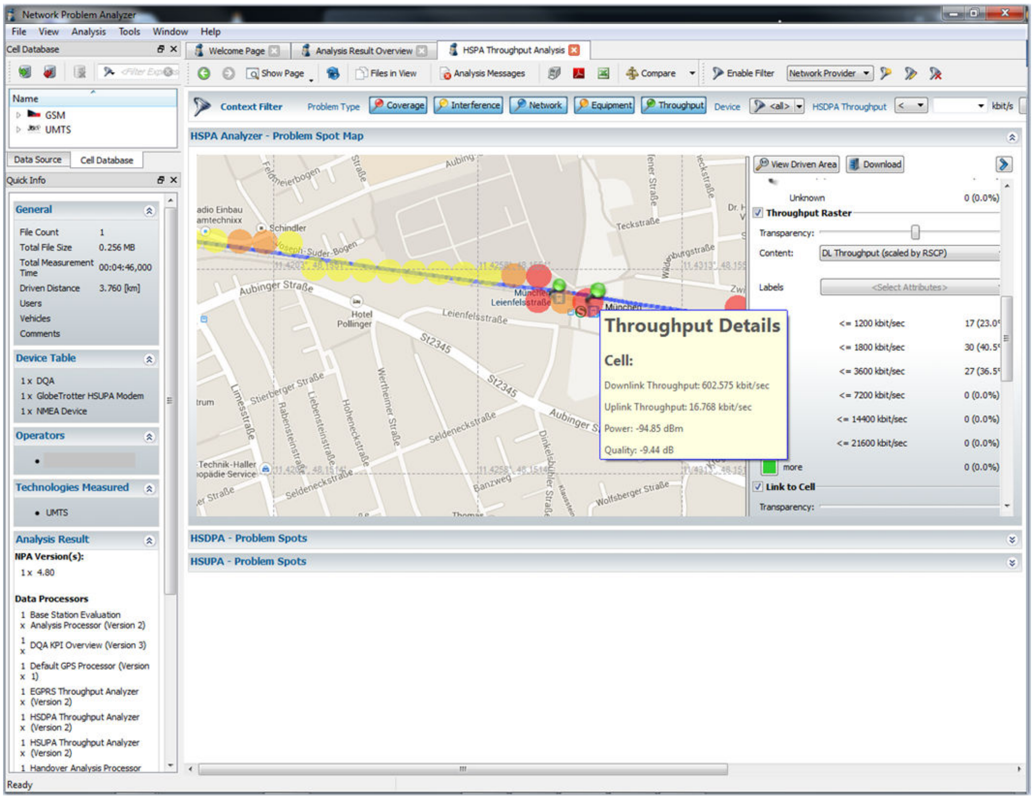


Figure 12-115: HSPA throughput analysis with problem spots highlighted on a map

UMTS/HSPA parameter analyses include the following specific analyses described in the following sections:

- Coverage & Interference analysis (HSDPA)
- CQI analysis (HSDPA)
- ACK/NACK (HSDPA/HSUPA)
- Discontinuous transmission (DTX) analysis (HSDPA/HSUPA)

- Serving grant (SG) analysis (HSUPA)
- HICH analysis (HSUPA)
- Cell set analysis (HSUPA)
- Finger analysis (HSDPA/HSUPA)
- RAT analysis (HSDPA/HSUPA)

The sections for HSDPA/HSUPA describe which problems can be detected and the analyzer modules used to do so. The special configuration settings are explained right next to the analyzers.

12.13.1 Problem categories

The HSDPA module can create the following problem categories from the detailed analysis algorithms.

Channel Quality Problem	This type of problem is reported when some quality indicator drops below the expected thresholds. Quality indicators are, for example the CQI, NACK and DTX rate.
Channel Quality Problem - Pollution	The problem is reported when the sum of the Ec/I0 samples of the enabled RAKE fingers is less than the sum of the remaining ones. In this case, too many NodeBs are visible to the UE and disturb the current data transaction.
Client/Core Problem	When the NodeB enters the DTX state repeatedly, degraded is the overall performance of the data transmission. The DTX Analyzer can generate this problem.
Coverage Problem	A high number of bad RSCP values during the problem area leads to the indication of a Coverage Problem.
Interference Problem	Good coverage combined with bad channel quality measurements lead to the Interference Problem conclusion.
No UMTS/HSDPA Network Available	The simplest problem for low data rates is that there is no high-speed network available. Such situations are reported into this type of problems.

12.13.2 General configuration

Some of the configurations below are depending on the HSDPA mobile category. For the mobile categories 1 through 12, the analysis module supports configuration of different thresholds. A mobile configuration has the attributes shown in the table below. The throughput defaults depend on the theoretical maximum of the HSDPA category. In the table there is no entry for these parameters in the "Default" column.

Table 12-9: HSDPA mobile configuration elements

Parameter	Value Range	Default	Description
Start Analysis Throughput	0.0 kbps to 30.0 kbps	-	If the FTP DL current data rate drops below this threshold for "Start Analysis Time" msec (defined in Throughput Analysis), the problem analysis is started.
Stop Analysis Throughput	0 kbps to 100 kbps	-	If the FTP DL current data rate exceeds this threshold for "Stop Analysis Time" msec, the problem analysis is stopped.
Bad Coverage Threshold	-120 dBm to -40 dBm	-97 dBm	Upper limit for an RSCP measurement value to classify as coverage problem.
Interference RSCP Threshold	-120 dBm to -40 dBm	-97 dBm	The RSCP sample must be above this threshold for Interference classification.
Interference Ec/No Threshold	-30 dB to 0 dB	-10 dB	Ec/No samples must be below this threshold to detect an Interference problem.
Ec/Io Finger Limit	-30 dB to 0 dB	-10 dB	Maximum value for the sum of all Ec/I0 finger values to indicate bad Ec/I0.

12.13.3 Analysis algorithm

12.13.3.1 CQI analysis

The CQI is a quality indicator of the CPICH that gives some hint on the general radio and transfer conditions at the given position. It is derived from the CPICH measurements, and can take one of 30 different values.

The channel quality indicator values are checked in this analyzer to stay above the "CQI Threshold" for the given "Bad CQI Ratio". If not, a "Channel Quality Problem" is reported.

Parameter	Value Range	Default	Description
CQI Threshold	0.0 to 30.0	15.0	CQI samples under this threshold are used to find CQI problems.
Bad CQI Ratio	0 % to 100 %	30 %	If the number of CQI samples below the CQI Threshold is higher than this ratio, a CQI problem is reported.

12.13.3.2 Coverage & interference analysis

Coverage checks are performed using the RSCP samples. If the number of samples below the Bad Coverage Threshold for the HSDPA category configuration exceeds the "Bad RSCP Percentage Threshold" limit, a coverage problem is reported.

If the RSCP is higher than the Interference RSCP Threshold and the Ec/No is lower than Interference Ec/No Threshold at the same time, the sample is counted as a hint for interference. If the relative number of hints is above the "Interference Ratio", an "Interference Problem" is reported.

Parameter	Value Range	Default	Description
Bad Coverage Ratio	0 % to 100 %	30 %	Number of RSCP samples that must be below Bad Coverage Threshold to find a coverage problem.
Interference Ratio	0 % to 100 %	50 %	If the relative number of interference samples calculated from RSCP and Ec/No is above this threshold, an interference problem is reported.

12.13.3.3 NACK analysis

The NACK rate in HSDPA network specifies how many packets have not been decoded successfully from the mobile. This value is used to control the properties of the transfer channel HS-DSCH. A high NACK rate indicates bad channel properties, since the mobile is not able to perform a proper CRC checksum calculation of the packets received.

A "Channel Quality Problem" is therefore found when the portion of NACK percentage samples above "Bad NACK Rate" exceeds "Bad NACK Percentage".

Parameter	Value Range	Default	Description
Bad NACK Rate	0 % to 100 %	10 %	The NACK percentage must be above this value to contribute to the problem detection.
Bad NACK Rate Ratio	0 % to 100 %	60 %	Total ratio of bad NACK rates that must be reached to raise a NACK-related problem.

12.13.3.4 DTX analysis

When the UE does not send NACKs to the NodeB or the packets are lost during transmission, the NodeB enters the DTX state. The Node B then tries to resend the packets again, which leads to throughput degradation on the mobile. A high DTX rate therefore indicates a "Client/Core Problem" because either the FTP Server does not send any data, or the UE does not process the received packages properly.

Detection of this problem is based on the DTX rate. If the number of rates below "Bad DTX Rate" in a problem area is higher than "Bad DTX Rate Ratio", the algorithm reports the previously mentioned problem cause.

Parameter	Value Range	Default	Description
Bad DTX Rate	0 % to 100 %	75 %	The DTX percentage must be above this value to contribute to the problem detection.
Bad DTX Rate Ratio	0 % to 100 %	70 %	Total ratio of bad DTX rates that must be reached to raise a DTX-related problem.

12.13.3.5 Finger condition analysis

R&S ROMES4 extracts the single multi-path related energies per finger from the UMTS RAKE receiver. The fingers that actually receive data from the connected cell are called active fingers, and a minimum Ec/Io must be guaranteed to keep proper throughput rates. Other fingers receive signals from the neighbor cells, which can cause interference problems within the current data transmission. If the total power received on that "disabled" fingers is higher than the one calculated for the "enabled" fingers, a pilot pollution problem exists.

Ec/Io values of the enabled fingers are used to check for problems. For each finger, the Ec/Io measurements are gathered and the linearized total sum is calculated. This value is compared with the Ec/Io Finger Limit from the HSDPA category configuration. If more than "Ec/Io Finger Ratio"% of the samples are below that threshold, a "Channel Quality Problem" is raised.

Finger analysis also checks if the sum of Ec/Io values associated with the currently enabled fingers is less than or equal to that of the disabled fingers. If such case occurs for the specified percentage in "Bad Enabled/Disabled Finger Ratio", a "Channel Quality Problem - Pilot Pollution" problem is reported.

Parameter	Value Range	Default	Description
Ec/Io Finger Ratio	0..100 %	10 %	Proportion of samples that must at least fulfill the \"Ec/Io Finger Limit\" to generate a Channel Quality Problem report.
Bad Enabled/Disabled Finger Ratio	0..100 %	10 %	If the ratio of samples of disabled fingers which have Ec/Io values out of range to the enabled ones is greater than the defined value, pilot pollution is reported.

12.13.3.6 RAT analysis

Finally, the HSDPA checks if there is an HSDPA network found at all. If not, a hint is created that the throughput can be increased in this area by establishing an HSDPA network here. It also reports if there is just GSM and no UMTS available. This analyzer cannot be configured, it simply observes the network state.

12.14 Throughput analyzer - HSUPA analysis details

UMTS networks based on wideband code division multiple access (WCDMA) have been deployed worldwide as a 3rd generation mobile communications systems. UMTS provides a clear evolution path to high-speed packet access (HSPA). HSPA refers to the combination of high speed downlink packet access (HSDPA) and high-speed uplink packet access (HSUPA). HSUPA makes uplink data rates of 5.76 Mbit/s possible. HSPA also boosts capacity in UMTS networks and provides significant latency reductions.

The HSUPA analysis module works as described FTP uploads as described in Throughput Analysis. Within data transactions intervals with bad throughput are identified and then analyzed. The analysis checks several different parameters and their interrelation, and derives conclusion about what problems can lead to the low throughput. Such parameters are the Serving Grants, ACK/NACK flow and other technology-specific data.

In the following section, the problems that can be detected and the analyzer used to do so are described in detail with their configuration.

12.14.1 Problem categories

Channel Quality Problem	This type of problem is reported when some quality indicator drops below the expected thresholds. Quality indicators are, for example, the Serving Grant reset rate, NACK and DTX rate.
HSUPA Network Problem	This category contains problems that are found when multiple cells take part in the transfer and influence each other in a negative way.
HSUPA Client Problem	A problem that can be associated with the UE is grouped into this category of problems.
Client/Core Problem	Problems detected in the payload limited analysis are part of this error class. They refer to issues that can be caused by the UE or by the Core Network components.
Coverage Problem	A high number of bad RSCP values during the problem area leads to the indication of a Coverage Problem.
Interference Problem	Good Coverage combined with bad channel quality measurements lead to the Interference Problem conclusion.
No UMTS/HSUPA Network Available	The simplest problem for low data rates is that there is no high-speed network available. Such situations are reported into this category.

12.14.2 General configuration

Some of the configuration elements listed in the table are associated with the HSUPA mobile category. For the mobile categories 1 through 7, the analysis module supports configuration of different thresholds. A mobile configuration has the attributes shown in the table below. The throughput defaults depend on the theoretical maximum of the HSUPA category. In the table's "Default" column there is no entry for these parameters.

Table 12-10: HSUPA mobile configuration elements

Parameter	Value Range	Default	Description
Start Analysis Throughput	0.0 kbps to 30.0 kbps	-	If the FTP UL current data rate drops below this threshold for "Start Analysis Time" ms (defined in Throughput Analysis), the problem analysis is started.
Stop Analysis Throughput	0 kbps to 100 kbps	-	If the FTP UL current data rate exceeds this threshold for "Stop Analysis Time" ms, the problem analysis is stopped.

Parameter	Value Range	Default	Description
Bad Coverage Threshold	-120 dBm to -40 dBm	-97 dBm	Upper limit for an RSCP measurement value to classify as coverage problem.
Interference RSCP Threshold	-120 dBm to -40 dBm	-97 dBm	The RSCP sample must be above this threshold for Interference classification.
Interference Ec/No Threshold	-30 dB to 0 dB	-10 dB	Ec/No samples must be below this threshold to detect an Interference problem.
Ec/I0 Finger Limit	-30 dB to 0 dB	-10 dB	Maximum value for the sum of all Ec/I0 finger values to indicate bad Ec/I0.

12.14.3 Analysis algorithm

12.14.3.1 Cell set analysis

To reach the maximum amount of throughput in an HSUPA network, only one cell can be involved in the transaction. When more cells participate, the neighbor cells also influence the sending power to reduce interference problems for the current UE. To find such situations, the number of the times where two or more cells are active is put into relation to all measurement samples found in the investigation interval. If the resulting value finally exceeds the "Bad Cell State Rate", an "HSUPA Network problem" is found.

Parameter	Value Range	Default	Description
Bad Cell State Rate	0% to 100 %	75 %	If the number of checks, where more than one cell is used in the transaction, exceeds this ratio, an HSUPA network problem is detected.

12.14.3.2 Serving grant analysis

In an HSUPA communication between the UE and the NodeB, the serving grant (SG) describes the block size of data pakets transfer and the needed power for the transfer. The smaller the value, the lower the throughput. The serving grant is calculated from the absolute grant and the relative grant from all the monitored NodeBs. The latter values are transmitted on the RGCH, and can take one of the values -1, 0 and +1 to decrease, hold or increase the serving grant. Neighbor cells can only decrease or keep the power, but cannot increase it.

Serving grant rate

The basic algorithm examines the SG of the time window which is detected as a problem area. If the SG is smaller than a configurable percentage of the theoretical maximum, this percentage is reported as possible reason.

Primary/secondary grant comparison

Furthermore, the relation between primary and secondary grants is scanned. The primary grant controls the power per UE, whereas the secondary grant controls the power for all UEs currently connected. If the secondary grant is sent more frequently than the primary grant during a throughput problem area, this case is reported as "HSUPA Network Problem".

Serving grant reset

Another potential issue in grant handling occurs if the serving grant is reset to 0 by the network many times. If these resets happen repeatedly, the NodeB is probably overpopulated and cannot provide more resources to the mobile. Again, the percentage between these resets and the total number of AG is calculated and compared with "AG Reset Ratio".

Combined RGCH down rate

When a whole set of neighbor cells tries to decrease the UE power and the serving cell at the same time wants to hold or increase it, a conflict in the network is found. The relative number of conflicts found must not raise above "Total Combined RGCH Down Ratio" over the whole problem area, otherwise an "HSUPA Network Problem" is reported.

Parameter	Value Range	Default	Description
Bad Serving Grant Rate	0..100 %	10 %	Serving Grants that are equal or less than this value are rated as bad Serving Grant sample.
Bad Serving Grant Ratio	0..100 %	10 %	If the relative of bad Serving Grant samples exceeds that value, an HSUPA Network Problem is reported.
Bad Secondary SG Ratio	0..100%	10 %	If the Secondary SG is sent more frequently than the Primary SG, the network keeps the throughput low for this specific mobile.

Parameter	Value Range	Default	Description
Combined RGCH Down Rate	0..100 %	20 %	The number of DOWN commands from all monitored cells on the RGCH is set into relation to the total number of commands. When the result ratio is higher than this number, and the Serving Cell does not want to decrease the power level, a bad RGCH Down Command is counted.
Total Combined RGCH Down Ratio	0..100 %	30 %	If the percentage of bad RGCH Down Commands calculated in "Combined RGCH Down Rate" to the total number of commands is above this threshold, a Network Problem is raised.
AG Reset Ratio	0..100 %	20 %	If the AG is reset to zero frequently (more often that this ratio), a Network Problem is indicated.

12.14.3.3 HICH analysis

In HSUPA transactions, a similar protocol for acknowledging the successful transmission of a packet is used as in HSDPA networks. An important difference is that in HSUPA networks, the ACK/NACK message can be sent from multiple NodeBs. The mobile accepts a packet as successfully transmitted when at least one NodeB (that must not necessarily belong to the Radio Link Set) confirms reception. Several checks on the ACK/NACK transmission are made in the analyzer to find potential issues.

12.14.3.4 Combined HICH success rate

A high success rate on the HICH (the channel where the ACK/NACK confirmations are sent) is required to get high throughputs. When this rate drops below "Bad HICH Success Rate" for at "Bad HICH Success Rate Ratio" % of the samples, a "Channel Quality" problem is reported.

Parameter	Value Range	Default	Description
Bad HICH Success Rate	0..100 %	60 %	Minimum HICH success rate that must be achieved to classify it as good sample.
Bad HICH Success Rate Ratio	0..100 %	30 %	Problem is found when the HICH Success Rate dropped below the "Bad HICH Success Rate" for more than X% of the samples.

12.14.3.5 ACK rate

Positive packet transmission is always confirmed using ACK messages. These messages not necessary are sent by the Serving Cell only. They can also be sent from the other NodeBs that the mobile communicates with. From all NodeBs in reach theoretically an ACK message can be sent. The sum of the ACKs can be set into relation to the total number of cells monitored. This value is called Combined ACK Rate. It is also checked using the same pattern as the other checks, applying "Bad ACK Rate" and "Bad ACK Rate Ratio" thresholds accordingly.

Also, the ratio of those samples is calculated where the Serving Cell does not confirm the reception, but at least one neighbor cell does. If this ratio is too high, an "HSUPA Network Problem" is indicated. For this check, the "No SC ACK Ratio" threshold is used.

Parameter	Value Range	Default	Description
Bad ACK Rate	0..100 %	50 %	The Combined ACK rate is considered to be bad when it drops below this threshold.
Bad ACK Rate Ratio	0..100 %	40 %	Bad ACK rates count is set in relation to the total number of samples and compared with this value to detect Channel Quality issues.
No SC ACK Ratio	0..100 %	30 %	The number of situations where the SC does not acknowledge a packet transmission and at least one neighbor cell must not exceed this value. Otherwise a Network problem is indicated.

12.14.3.6 DTX rate

Finally the DTX rate is compared using the same strategy as described in the according HSDPA section (see Chapter 12.13, "Throughput analyzer - HSDPA analysis details", on page 324). DTX rate problems are classified as "HSUPA Client Problem".

Parameter	Value Range	Default	Description
Bad DTX Rate	0..100 %	30 %	The DTX percentage must be above this value to contribute to the problem detection.
Bad DTX Rate Ratio	0..100 %	40 %	Total ratio of bad DTX rates that must be reached to raise a DTX-related problem.

12.14.3.7 Finger analysis

The HSUPA Analyzer also uses the same approach as described in the first part of Finger Condition Analysis to find "Channel Quality" problems. Please refer to the description there for more details on that specific analysis. It does not use the enabled/disabled finger comparison, however.

12.14.3.8 Payload limit analysis

The Qualcomm chip-sets used in R&S ROMES4 to measure HSUPA data are able to report data limitations internally. Five different problem types can be detected by the chip-set and are extracted by the HSUPA analyzer. All the types are expressed as rates, telling how likely the throughput has been limited by the specific reason. The analyzer aggregates these values to create an overall statistic over the problem area. All the problems derived from these statistics are put in the "Client/Core Problem" class.

Limited by Power Rate	Throughput is limited because the sending power is too low.
Limited by SG Rate	The current SG avoids achieving better throughput rates.
Limited by Buffer Occ. Rate	The internal memory of the UE is empty, there is no more data to send currently.
Limited by MUX Rate	The multiplexing unit limits the throughput.
Limited by HARQ Restriction Rate	The HARQ process used seems to be the problem for the low data rate.

12.14.3.9 RAT analysis

As in the HSDPA Analyzer, the HSUPA module checks if there is a HSUPA/HSPA network found at all. Refer to the RAT Analysis description on that page for more details.

12.15 Throughput analyzer - LTE throughput analysis details

One of the main purposes of LTE networks is providing high data throughput for web services. Testing such high throughput rates can be done efficiently with the FTP, HTTP and UDP protocols. The LTE throughput concerning the mentioned jobs is analyzed the same way as the GPRS/E-GPRS or HSPA services.

The "Throughput Raster" > "Content" drop-down menu offers the option to analyze DL/UL throughput based on LTE scale or mobile power, as shown in the following figure.

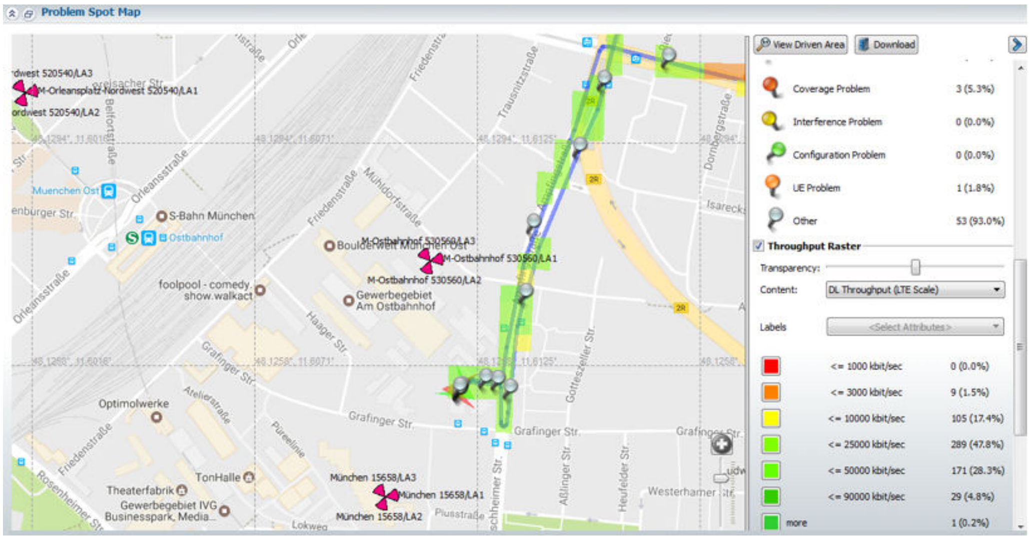


Figure 12-116: Raster setting for LTE throughput

The "Throughput Raster" > "Content" >"Mobile SINR" pane contains the default threshold values for SINR, shown in the following figure.

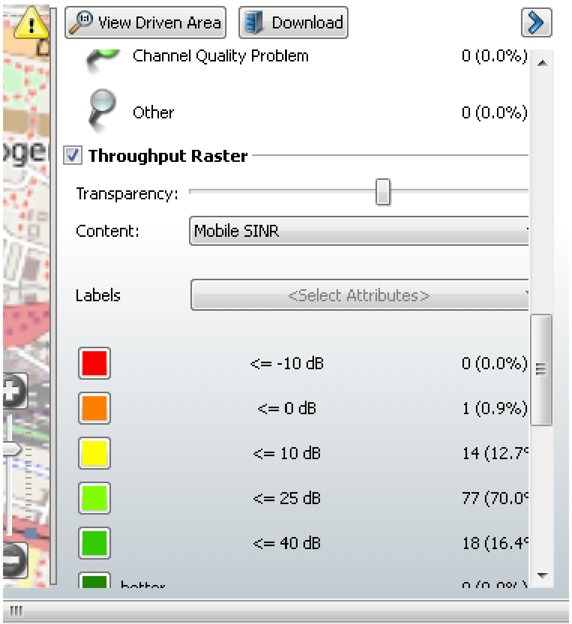


Figure 12-117: Default mobile SINR threshold for throughput raster

LTE parameter analysis includes the following specific analyses:

- Coverage analysis
- Interference analysis
- CQI analysis
- Resource blocks analysis
- Rank indicator analysis
- Spectral efficiency analysis

The tabs in the following figure show some of these analysis possibilities of the R&S ROMES4 NPA, for example, "Coverage", "Interference". In the figure highlighted is the problem spot related to the DL throughput.

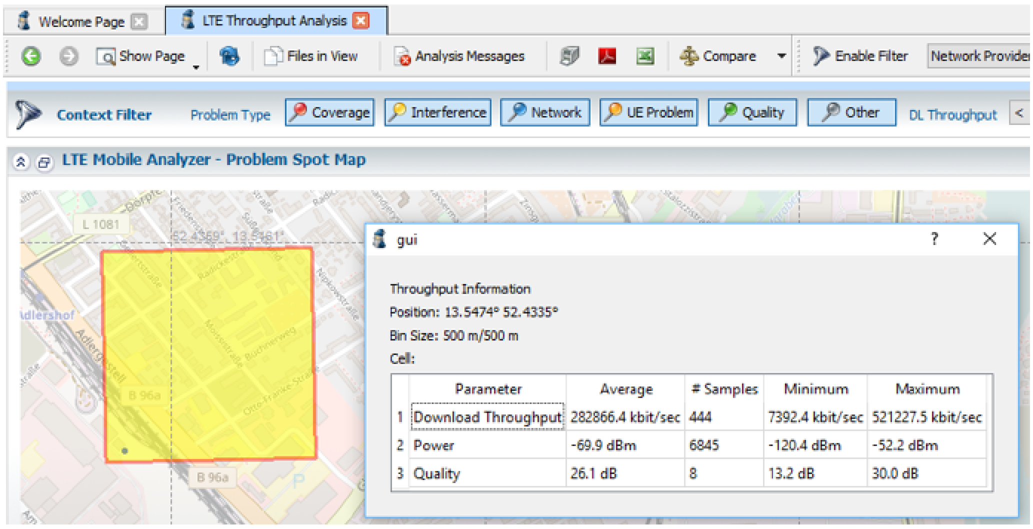


Figure 12-118: LTE network problem analyses - throughput problem

12.15.1 General configuration

The analysis logic is similar and described in the section above. However, the low throughput area detection is done slightly different in that case. There are two start triggers for the low throughput detection. One absolute, which can be configured differently for downlink and uplink communication, and one relative threshold. This relative threshold is set into the relation to the maximum throughput derived from the UE capabilities. If the throughput drops below one of those values, the analysis is started at that point.

Parameter	Value Range	Default	Description
Minimum Absolute Throughput DL Expected	1kbps to 84384kbps	10000kbps	If the FTP DL current data rate drops below this absolute throughput for "Start Analysis Time" msec, the problem analysis is started (can be superseded by "Minimum Relative Throughput").
Minimum Absolute Throughput UL Expected	1kbps to 84384kbps	1000kbps	If the FTP UL current data rate drops below this absolute throughput for "Start Analysis Time" msec, the problem analysis is started (can be superseded by min. rel. TP)
Minimum Relative Throughput	0% to 100%	20%	If the FTP DL / UL current data rate drops below this percentage of the maximum throughput (derived from the UE capability information) for "Start Analysis Time" msec, the problem analysis is started.

12.15.1.1 Cell reselection problem

Problems during LTE handovers are reported when a cell reselection is rejected by the network, or the cell reselection times out, which normally is a problem of the UE. The timeout value can be configured using the "Layer3 Messages Timeout" parameter.

Parameter	Value Range	Default	Description
Layer3 Messages Timeout	0msec to 300000msec	5000msec	If the expected subsequent message is not noticed within this time frame, a problem is reported.

12.15.2 CQI analysis

Non linear CQI/MCS relation

Normally CQI and MCS are directly proportional to each other: The higher the CQI, the higher the MCS. Abnormalities in that relation can hint on problems in the network, depending on the type of that abnormality.

Basically, two possible problems are distinguished. A "Network Problem" is reported when the MCS and CQI do not correlate properly, i.e., if the relation between both is not linear. The lack of correlation comes from the CQI scheduler in the eNodeB which considers the CQI reported by the UE to set a proper Coding Scheme.

The relation between CQI and MCS is calculated by matching both values to a set of tuples, and for each tuple calculate MCS/CQI. As long as the result of this division is within the interval [1.3;2.1] the sample is considered to be in a linear relation.

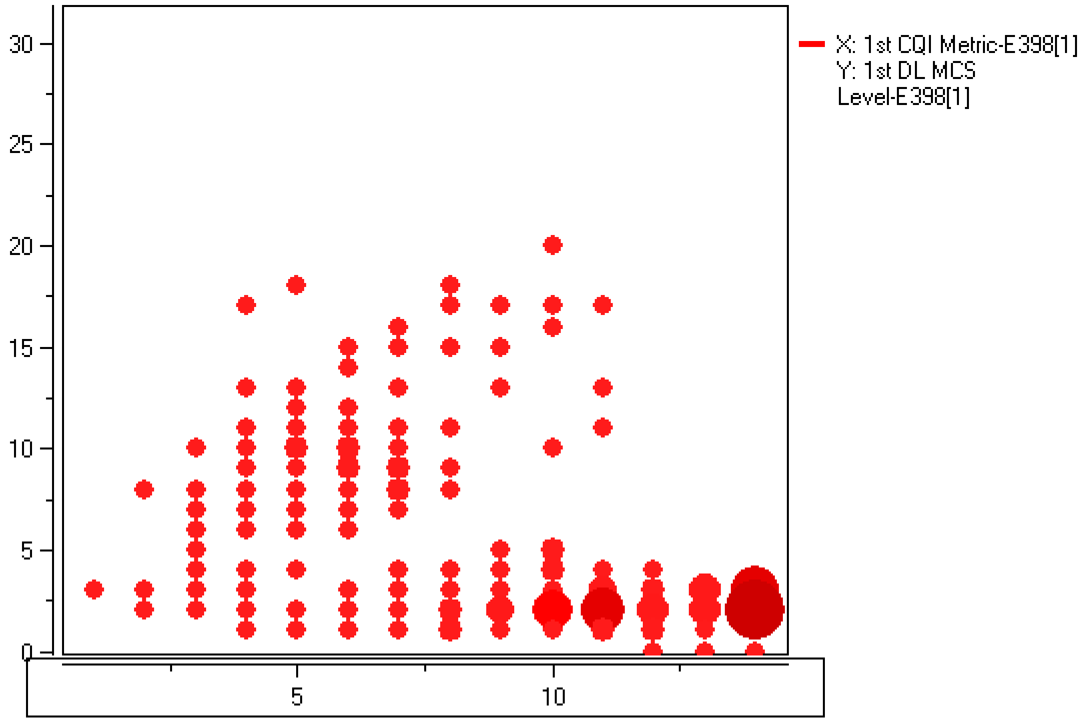


Figure 12-119: Relationship between CQI and MCS

High CQI/Low SINR

Another possibility is that there is low SINR measured, but a high CQI is detected. This situation seems like a general misbehavior of the mobile, and often leads to demodulation failures.

A low SINR is detected by comparing the SINR with the "SINR Threshold", and a high CQI must be greater than "CQI Threshold".

Both checks are performed on each antenna separately and are reported as such possibly two times.

Parameter	Value Range	Default	Description
SINR Threshold	-10dB to 40dB	6.0dB	SINR samples under this threshold are used to find SINR-CQI problems.
CQI Threshold	1..15	6.0	CQI samples above this threshold are used to find SINR-CQI problems.
CQI/MCS Not Linear - Bad Percentage Threshold	0% to 100%	10.0%	If the percentage of not linear CQI/MCS samples is higher than this threshold, a Network Problem is reported, related to the UE scheduler.

12.15.3 Resource block analysis

The number of resource blocks naturally influences the throughput directly. The more resource blocks are detected, the higher the throughput normally is. When an area of low throughput is analyzed, the change in the number of resource blocks compared to the last sequence with higher throughput is calculated. If the number of dropped resource blocks during the low throughput are detected, it is reported. However, it normal that a lower throughput is a logical consequence of the resource block decrease.

The opposite situation is a good indicator, which also can be a sign that something in the radio conditions is the problem. That problem is reported with a higher priority then.

A simpler check is done on the overall number of resource blocks. If in the area of lower throughput the ratio of few resource block allocations is above "Bad RB Ratio", a "Network RAN Problem" is reported. Such a situation can result from high network load. Many of those problems at one specific cell suggest a new eNodeB or neighbor relation.

Spectral Efficiency

Besides the change in the number of resource blocks, the spectral efficiency based for the problematic area is calculated. The calculation is done by putting the average number of resource blocks into relation to the averaged throughput. The calculation gives a value in the interval [0; 16.32], where the upper limit is also the maximum spectral efficiency for an LTE network. This value represents a value showing the throughput per resource block, basically.

The spectral efficiency per resource block is compared to "Min. Spectral Efficiency Threshold" and if it is below that value, a "Channel Quality Problem" is reported. This means that probably radio conditions are bad and even though a high amount of the resource blocks has been utilized, the throughput could not be increases significantly.

Parameter	Value Range	Default	Description
Low Resource Blocks DL Threshold	0..	96	The number of resource blocks assigned for DL must be below this threshold to contribute to the problem detection.
Bad RB Ratio	0% to 100%	10.0%	Total ratio of low RB occurrences that must be reached to raise an RB-related problem.
Min. Spectral Efficiency Threshold	0Bit/Hz/sec to 16.32Bit/Hz/sec	0.8Bit/Hz/sec	The spectral efficiency must be below this threshold to raise the problem.

12.15.3.1 Dependency on actual bandwidth

The LTE Data Processor considers the bandwidth of the LTE carrier during the resource block analysis.

The maximum number of resource blocks for 20 MHz bandwidth is 100. For other bandwidths, the expected number of resource blocks is adapted. The problem spots are listed in "LTE Throughput Analysis".

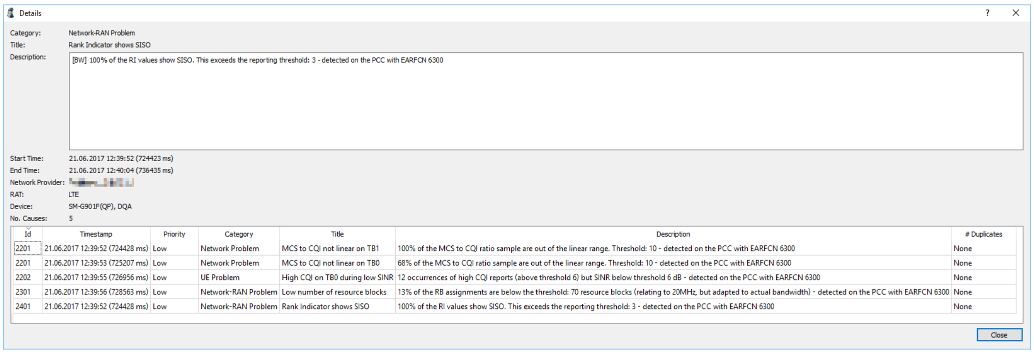


Figure 12-120: Network problem - RI shows SISO used

The analyses of resource blocks, CQI and RI consider the secondary carriers as well.

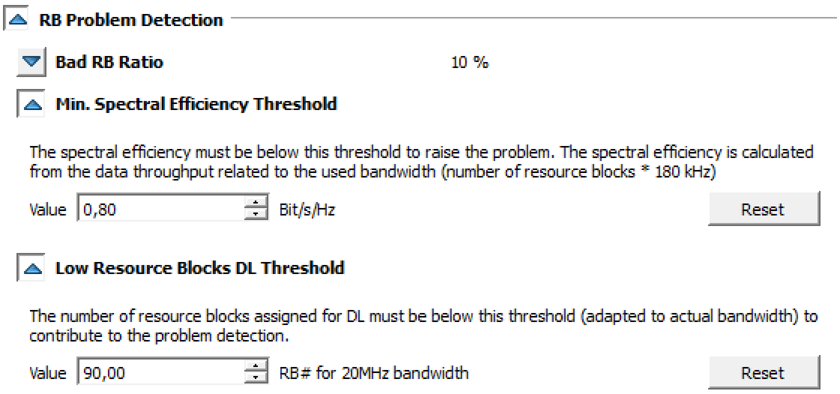


Figure 12-121: Configuration of RB problem detection

12.15.4 Coverage and interference analysis

Coverage and Interference are checked in the same way as in the other modules and described Coverage & Interference Analysis chapter.

12.15.5 Speed analysis

Some throughput problems can be related to high driving speed. A simple mechanism issues warnings when the vehicles speed was above a certain threshold. This is normally not classified as important problem, but it is reported nevertheless.

Within the period of low throughput the driving speed is monitored. If the "High Speed Sample Ratio" percent of the speed samples is above "High Vehicle Speed Threshold", the previously mentioned warning is issued.

Parameter	Value Range	Default	Description
High Vehicle Speed Threshold		100.0km/h	The driven speed of the vehicle must be above this threshold to contribute to the problem detection.
High Speed Sample Ratio	0% to 100%	10.0%	Total ratio of high speed occurrences that must be reached to raise a speed related problem.

12.15.6 Rank indicator analysis

Rank Indicator in LTE reports the multiplex modes currently active. The highest throughput rates are achieved when MIMO is used, of course. The lowest theoretical rates normally occur when SISO is used, which is equal to rank indicator 1.

In comparison to all the other checks, the Rank Indicator Analysis is not only performed in areas of low throughput, but it is calculated on all the data of the file. So this may be reported only once per file. If the amount of SISO samples is above the threshold, the a "Network-RAN Problem" is reported.

Parameter	Value Range	Default	Description
Bad RI Ratio	0% to 100%	3.0%	If the amount of occurrences with Rank Indicator SISO (RI=1) is higher than this ratio, RI problem is reported.

12.16 Coverage analyzer

When new technology is used to establish mobile network, one of the first steps in network optimization is to provide service in as many areas as possible. Even in existing networks coverage analysis is a day-to-day task that is required to guarantee high network quality.

The Coverage Analysis module calculates the coverage data based on measurements performed with the R&S TSMx, R&S TSMW and R&S TSME scanners. Different technologies can be measured with those scanners. The analyzer module is currently able to process the following technologies:

- GSM
- WCDMA
- CDMA 2000
- EvDO
- LTE
- NB-IoT
- TETRA
  Additional analysis methods exist in the case of TETRA. These are described in Chapter 12.16.9, "TETRA specific analysis", on page 368.

The R&S ROMES4 NPA provides the coverage analysis based on scanner measurements. This is the Coverage Cell Statistics that includes statistics of 3GPP RATs.

The "Analysis Result Overview" page contains the "Coverage Cell Statistics Scanner based" button. Click the button to open a result page with GSM, UMTS, LTE or NB-IoT cells statistics. Refer to Chapter 12.16.3, "Coverage cell statistics", on page 349.

Coverage analysis requires the R&S ROMES4N15 option.

The functionality described in following is only available if GPS is connected during the measurement. This is needed as all the results are created based on a geographical grid.

12.16.1 Coverage raster

The first step during the analysis for the coverage analysis module is to create a raster of the scanner data, since the raw data recorded by a scanner is normally too much to check manually. This is also an important data reduction strategy to use data from multiple files later on.

Rasterization is done as follows:

1. Geographic location is determined the for each measured power and quality pair. This might be an interpolated location if GPS was not available for a short time.
2. The current position is transformed into an UTM coordinate (refer to Raster configuration for a more detailed description).
3. The UTM coordinate is then used to calculate the grid position. The center of the grid is transformed back into a WGS 84 datum as delivered from the GPS.
4. Using the grid center, the world map is divided into a grid aligned to the longitude used as the center for the UTM zone of the size configured in the preferences dialog.
5. For each such grid center, the measured power and quality values are gathered and grouped by network provider and frequency.

   From these values, a TopN list is created, where each cell has an averaged power and quality value assigned to it. The TopN list is sorted by the power value. Additionally, several statistical values are stored for the TopN entry.

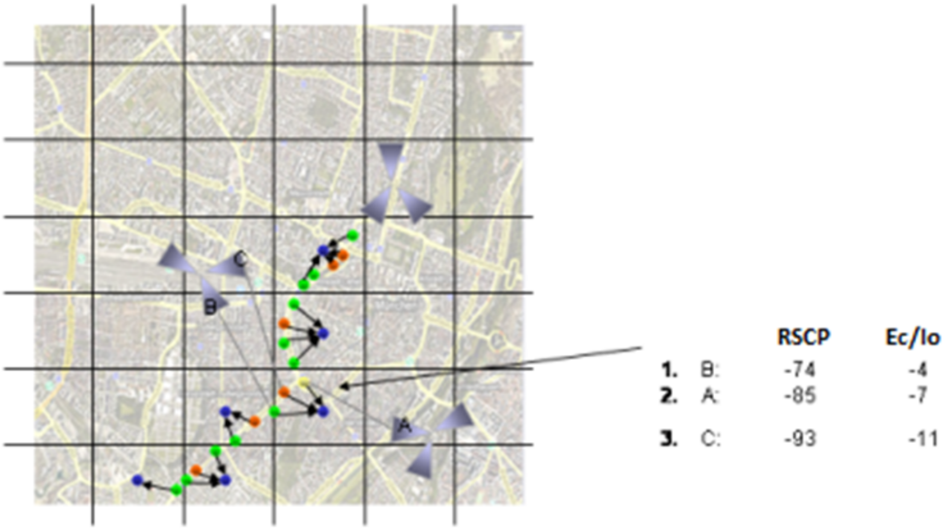


Figure 12-122: Coverage raster of the scanner data

An example of this algorithm is shown in Coverage raster of the scanner data. The TopN table is created from the measurements of the cells A, B and C which are marked by the arrow in the grid. Normally there are some more measurements for each cell available, but for simplicity the picture only contains one measurement for each cell. The resulting table is created from the (normally averaged) power values assigned to the cells. In this sample, UMTS measurements were used, but the same algorithm is applied to the other technologies.

This result is used in later steps to perform the problem spot analysis, for example. In the GUI, this result can be visualized using the coverage maps, see Chapter 5.3.2.1, "Coverage problem spot overview", on page 153.

12.16.2 Cell statistics

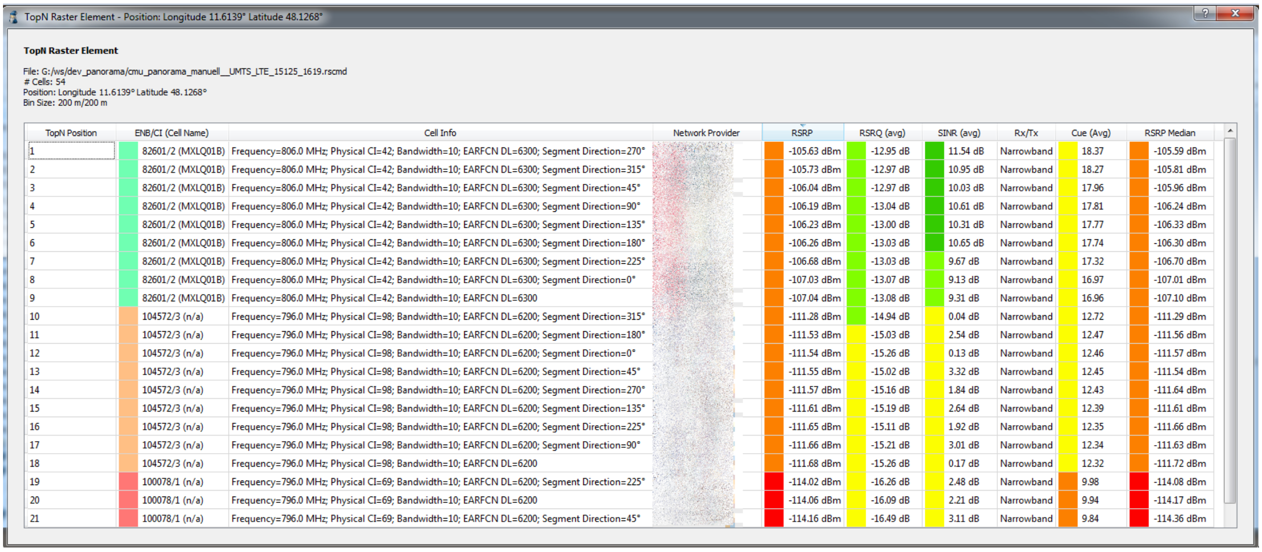
For all cells that are found during the rasterization steps in the TopN lists, a final statistic is created. That statistic contains how many times the cell was best server in the total grid, how many times it was part of the TopN list at all and some key statistical indicators related to the power and quality criteria found, like minimum, maximum and average. The power averages are calculated as linear average, i.e. the single power values are transformed into Watt, averaged and then converted back into dBm.

These results are also visualized on the Coverage pages related to one of the supported technologies, in a table below the coverage plot.

During the calculation of the TopN raster, the analysis module also checks the resulting TopN elements in the raster bins for specific constraints and reports potential problems in the network if these constraints cannot be fulfilled. Therefore, the final TopN list in one grid is evaluated and specific TopN entries are checked if they fulfill different conditions. Each of the problems detected is then related to one or more cells. For example, a coverage problem is always linked with the cell providing bad coverage, whereas an interference problem will be linked to the interfered cell and the possibly identified interferer(s).

12.16.2.1 Panorama measurement

The "Panorama Measurement" feature aggregates the segment direction of the antennas in the R&S ROMES4 NPA during a cell measurement and adds them to the "Cell Info" column of the "TopN Raster Element" table. Refer to Chapter 6.3.7, "Raster data layer", on page 176.



TopN Raster Element - Position: Longitude 11.6139° Latitude 48.1268°

TopN Raster Element

File: G:/ws/dev_panorama/cmu_panorama_manuell__UMTS_LTE_15125_1619.rscmd
Cells: 54
Position: Longitude 11.6139° Latitude 48.1268°
Bin Size: 200 m/200 m

TopN Position	ENB/CI (Cell Name)	Cell Info	Network Provider	RSRP	RSRQ (avg)	SINR (avg)	Rx/Tx	Cue (Avg)	RSRP Median
1	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300; Segment Direction=270°		-105.63 dBm	-12.95 dB	11.54 dB	Narrowband	18.37	-105.59 dBm
2	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300; Segment Direction=315°		-105.73 dBm	-12.97 dB	10.95 dB	Narrowband	18.27	-105.81 dBm
3	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300; Segment Direction=45°		-106.04 dBm	-12.97 dB	10.03 dB	Narrowband	17.96	-105.96 dBm
4	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300; Segment Direction=90°		-106.19 dBm	-13.04 dB	10.61 dB	Narrowband	17.81	-106.24 dBm
5	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300; Segment Direction=135°		-106.23 dBm	-13.00 dB	10.31 dB	Narrowband	17.77	-106.33 dBm
6	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300; Segment Direction=180°		-106.26 dBm	-13.03 dB	10.65 dB	Narrowband	17.74	-106.30 dBm
7	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300; Segment Direction=225°		-106.68 dBm	-13.03 dB	9.67 dB	Narrowband	17.32	-106.70 dBm
8	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300; Segment Direction=0°		-107.03 dBm	-13.07 dB	9.13 dB	Narrowband	16.97	-107.01 dBm
9	82601/2 (MXLQ01B)	Frequency=806.0 MHz; Physical CI=42; Bandwidth=10; EARFCN DL=6300		-107.04 dBm	-13.08 dB	9.31 dB	Narrowband	16.96	-107.10 dBm
10	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200; Segment Direction=315°		-111.28 dBm	-14.94 dB	0.04 dB	Narrowband	12.72	-111.29 dBm
11	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200; Segment Direction=180°		-111.53 dBm	-15.03 dB	2.54 dB	Narrowband	12.47	-111.56 dBm
12	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200; Segment Direction=0°		-111.54 dBm	-15.26 dB	0.13 dB	Narrowband	12.46	-111.57 dBm
13	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200; Segment Direction=45°		-111.55 dBm	-15.02 dB	3.32 dB	Narrowband	12.45	-111.54 dBm
14	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200; Segment Direction=270°		-111.57 dBm	-15.16 dB	1.84 dB	Narrowband	12.43	-111.64 dBm
15	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200; Segment Direction=135°		-111.61 dBm	-15.19 dB	2.64 dB	Narrowband	12.39	-111.61 dBm
16	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200; Segment Direction=225°		-111.65 dBm	-15.11 dB	1.92 dB	Narrowband	12.35	-111.66 dBm
17	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200; Segment Direction=90°		-111.66 dBm	-15.21 dB	3.01 dB	Narrowband	12.34	-111.63 dBm
18	104572/3 (n/a)	Frequency=796.0 MHz; Physical CI=98; Bandwidth=10; EARFCN DL=6200		-111.68 dBm	-15.26 dB	0.17 dB	Narrowband	12.32	-111.72 dBm
19	100078/1 (n/a)	Frequency=796.0 MHz; Physical CI=69; Bandwidth=10; EARFCN DL=6200; Segment Direction=225°		-114.02 dBm	-16.26 dB	2.48 dB	Narrowband	9.98	-114.08 dBm
20	100078/1 (n/a)	Frequency=796.0 MHz; Physical CI=69; Bandwidth=10; EARFCN DL=6200		-114.06 dBm	-16.09 dB	2.21 dB	Narrowband	9.94	-114.17 dBm
21	100078/1 (n/a)	Frequency=796.0 MHz; Physical CI=69; Bandwidth=10; EARFCN DL=6200; Segment Direction=45°		-114.16 dBm	-16.49 dB	3.11 dB	Narrowband	9.84	-114.36 dBm

Figure 12-123: LTE TopN with segment direction

12.16.2.2 RAN sharing - aggregation of additional PLMN IDs

A cell can be shared by several network providers. The feature is named RAN Sharing. R&S ROMES4 NPA can display the PLMN IDs of the network providers that share the cell.

Additional PLMN IDs contained in the MIB (UMTS) and SIB1 (LTE) messages are aggregated by R&S ROMES4 NPA and stored with power and quality measurements.

The additional aggregated PLMN IDs are included in the UMTS and LTE cell statistics tables. The cells shared by several PLMN are displayed in the tables for each operator (=repetition of same CIs). The additional operator(s) are mentioned in the column "add. PLMNs".

UMTS Cell Statistics

Network Provider / LAC / Cell Name	add. PLMNs	UARFCN	Frequency	CI	SC	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	RSCP Average [dBm]	RSCP Max [dBm]	Ec/Io Average [dB]	Ec/Io Max [dB]	Cue Average
Hutchison 3G Austria (232; 10)																			
2012																			
RAT=UMTS; MCC=232; MNC=10; LAC=2012; CI=15084	232/5	10761	2152.2 MHz	15084	65	1	0	0.0	0	0.0	0	0.0	1	100.0	-76.4	-73.7	-7.2	-4.0	10.8
RAT=UMTS; MCC=232; MNC=10; LAC=2012; CI=21315	232/5	10662	2132.4 MHz	21315	210	1	0	0.0	1	100.0	0	0.0	0	0.0	-62.8	-57.4	-5.7	-2.3	12.3
RAT=UMTS; MCC=232; MNC=10; LAC=2012; CI=22315	232/5	10687	2137.4 MHz	22315	210	1	0	0.0	0	0.0	0	0.0	1	100.0	-64.6	-57.2	-6.5	-2.4	11.5
RAT=UMTS; MCC=232; MNC=10; LAC=2012; CI=23315	232/5	10711	2142.2 MHz	23315	210	1	0	0.0	0	0.0	0	0.0	1	100.0	-64.2	-57.9	-5.3	-1.7	12.7
RAT=UMTS; MCC=232; MNC=10; LAC=2012; CI=24315	232/5	10736	2147.2 MHz	24315	210	1	0	0.0	0	0.0	0	0.0	1	100.0	-64.4	-59.5	-4.7	-2.0	13.3
Mobilkom Austria AG & Co KG (A1) (232; 1)																			
4101																			
RAT=UMTS; MCC=232; MNC=1; LAC=4101; CI=153		10588	2117.6 MHz	153	20	1	0	0.0	0	0.0	0	0.0	1	100.0	-77.5	-72.8	-6.9	-3.3	11.1
RAT=UMTS; MCC=232; MNC=1; LAC=4101; CI=6705		10613	2122.6 MHz	6705	92	1	0	0.0	0	0.0	0	0.0	1	100.0	-96.3	-92.9	-3.5	-1.7	14.5
RAT=UMTS; MCC=232; MNC=1; LAC=4101; CI=13051		10564	2112.8 MHz	13051	20	1	0	0.0	0	0.0	0	0.0	1	100.0	-78.6	-74.2	-9.6	-5.8	8.4
RAT=UMTS; MCC=232; MNC=1; LAC=4101; CI=13751		10564	2112.8 MHz	13751	15	1	0	0.0	0	0.0	0	0.0	1	100.0	-79.5	-77.0	-10.2	-6.7	7.8
One (232; 5)																			
2012																			
RAT=UMTS; MCC=232; MNC=5; LAC=2012; CI=15084	232/10	10761	2152.2 MHz	15084	65	1	0	0.0	0	0.0	0	0.0	1	100.0	-76.4	-73.7	-7.2	-4.0	10.8
RAT=UMTS; MCC=232; MNC=5; LAC=2012; CI=21315	232/10	10662	2132.4 MHz	21315	210	1	0	0.0	0	0.0	1	100.0	0	0.0	-62.8	-57.4	-5.7	-2.3	12.3
RAT=UMTS; MCC=232; MNC=5; LAC=2012; CI=22315	232/10	10687	2137.4 MHz	22315	210	1	0	0.0	0	0.0	0	0.0	1	100.0	-64.6	-57.2	-6.5	-2.4	11.5
RAT=UMTS; MCC=232; MNC=5; LAC=2012; CI=23315	232/10	10711	2142.2 MHz	23315	210	1	0	0.0	0	0.0	0	0.0	1	100.0	-64.2	-57.9	-5.3	-1.7	12.7
RAT=UMTS; MCC=232; MNC=5; LAC=2012; CI=24315	232/10	10736	2147.2 MHz	24315	210	1	0	0.0	0	0.0	0	0.0	1	100.0	-64.4	-59.5	-4.7	-2.0	13.3
T-Mobile A (232; 3)																			
58400																			
RAT=UMTS; MCC=232; MNC=3; LAC=58400; CI=9965		10836	2167.2 MHz	9965	358	1	1	100.0	0	0.0	0	0.0	0	0.0	-62.0	-59.3	-4.0	-2.4	12.0
RAT=UMTS; MCC=232; MNC=3; LAC=58400; CI=31086		10811	2162.2 MHz	31086	358	1	0	0.0	0	0.0	0	0.0	1	100.0	-64.5	-60.2	-5.0	-2.1	11.0
RAT=UMTS; MCC=232; MNC=3; LAC=58400; CI=35615		10786	2157.2 MHz	35615	239	1	0	0.0	0	0.0	0	0.0	1	100.0	-71.8	-69.2	-10.7	-5.8	5.3
RAT=UMTS; MCC=232; MNC=3; LAC=58400; CI=40654		10786	2157.2 MHz	40654	358	1	0	0.0	0	0.0	0	0.0	1	100.0	-66.3	-62.0	-6.0	-3.1	10.0
RAT=UMTS; MCC=232; MNC=3; LAC=58400; CI=40656		10786	2157.2 MHz	40656	197	1	0	0.0	0	0.0	0	0.0	1	100.0	-74.7	-72.0	-13.5	-8.4	2.5

Figure 12-124: UMTS cell statistics with aggregated PLMN IDs

LTE Cell Statistics

Network Provider / Cell Name	add. PLMNs	EARFCN	Frequency	Bandwidth	ENB/CI	PhyCI	Measurement Mode	#Tx Antennas	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	RSRP Average [dBm]
Hutchison 3G Austria (232; 10)																		
RAT=LTE; MCC=232; MNC=10; ECI=28728587; ENB/CI=112221/11	232/5	1814	1866.4 MHz	20	112221/11	127	Narrowband	2	1	0	0.0	1	100.0	0	0.0	0	0.0	-77.4
RAT=LTE; MCC=232; MNC=10; ECI=28773642; ENB/CI=112397/10	232/5	1814	1866.4 MHz	20	112397/10	503	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-85.7
RAT=LTE; MCC=232; MNC=10; ECI=28799242; ENB/CI=112497/10	232/5	1814	1866.4 MHz	20	112497/10	32	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-96.7
Mobilkom Austria AG & Co KG (A1) (232; 1)																		
RAT=LTE; MCC=232; MNC=1; ECI=148481; ENB/CI=580/1		2850	2630.0 MHz	20	580/1	375	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-96.6
RAT=LTE; MCC=232; MNC=1; ECI=292609; ENB/CI=1143/1		2850	2630.0 MHz	20	1143/1	210	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-92.1
RAT=LTE; MCC=232; MNC=1; ECI=292614; ENB/CI=1143/6		6250	801.0 MHz	20	1143/6	210	Narrowband	2	1	1	100.0	0	0.0	0	0.0	0	0.0	-68.0
RAT=LTE; MCC=232; MNC=1; ECI=340737; ENB/CI=1331/1		2850	2630.0 MHz	20	1331/1	141	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-101.3
RAT=LTE; MCC=232; MNC=1; ECI=99843; ENB/CI=390/3		2850	2630.0 MHz	20	390/3	8	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-107.5
One (232; 5)																		
RAT=LTE; MCC=232; MNC=5; ECI=28728587; ENB/CI=112221/11	232/10	1814	1866.4 MHz	20	112221/11	127	Narrowband	2	1	0	0.0	0	0.0	1	100.0	0	0.0	-77.4
RAT=LTE; MCC=232; MNC=5; ECI=28773642; ENB/CI=112397/10	232/10	1814	1866.4 MHz	20	112397/10	503	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-85.7
RAT=LTE; MCC=232; MNC=5; ECI=28799242; ENB/CI=112497/10	232/10	1814	1866.4 MHz	20	112497/10	32	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-96.7
T-Mobile A (232; 3)																		
RAT=LTE; MCC=232; MNC=3; ECI=10471168; ENB/CI=40903/0		3050	2650.0 MHz	20	40903/0	327	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-103.6
RAT=LTE; MCC=232; MNC=3; ECI=10473730; ENB/CI=40913/2		1575	1842.5 MHz	15	40913/2	303	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-103.3
RAT=LTE; MCC=232; MNC=3; ECI=12251392; ENB/CI=47857/0		3050	2650.0 MHz	20	47857/0	372	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-109.7
RAT=LTE; MCC=232; MNC=3; ECI=12252933; ENB/CI=47863/5		1575	1842.5 MHz	15	47863/5	187	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-105.7
RAT=LTE; MCC=232; MNC=3; ECI=18050566; ENB/CI=70510/6		6400	816.0 MHz	10	70510/6	90	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-116.3
RAT=LTE; MCC=232; MNC=3; ECI=18125064; ENB/CI=70801/8		6400	816.0 MHz	10	70801/8	65	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-112.3
RAT=LTE; MCC=232; MNC=3; ECI=18178308; ENB/CI=71009/4		1575	1842.5 MHz	15	71009/4	405	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-98.5
RAT=LTE; MCC=232; MNC=3; ECI=18481414; ENB/CI=72193/6		6400	816.0 MHz	10	72193/6	99	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-108.3
RAT=LTE; MCC=232; MNC=3; ECI=19890184; ENB/CI=77696/8		6400	816.0 MHz	10	77696/8	30	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-102.6
RAT=LTE; MCC=232; MNC=3; ECI=8882688; ENB/CI=34698/0		3050	2650.0 MHz	20	34698/0	324	Narrowband	2	1	0	0.0	0	0.0	0	0.0	1	100.0	-89.6

Figure 12-125: LTE cell statistics with aggregated PLMN IDs

These IDs can be also seen in the TopN Raster Element if hovering with a mouse over the network provider's name.

TopN Raster Element - Position: Longitude 16.3406° Latitude 48.1631°

TopN Raster Element

File: E:/ws/dev/RANSharing/Bosei-Wien-16-5-24.rscmd
Cells: 21
Position: Longitude 16.3406° Latitude 48.1631°
Bin Size: 0.000663889 °/0.000452778 °

TopN Position	ENB/CI (Cell Name)	Cell Info	Network Provider	RSRP	RSRQ (avg)	SINR (avg)	Rx/Tx	Cue (Avg)	RSRP Median
1	1143/6 (n/a)	Frequency=801.0 MHz; Physical CI=210; Bandwidth=20; EARFCN DL=6250	Mobilkom Austria AG & Co KG (A1)	-67.99 dBm	-12.91 dB	20.08 dB	Narrowband	58.01	-68.02 dBm
2	112221/11 (n/a)	Frequency=1866.4 MHz; Physical CI=127; Bandwidth=20; EARFCN DL=1814	Hutchison 3G Austria	-77.43 dBm	-12.98 dB	10.50 dB	Narrowband	50.57	-77.61 dBm
3	112221/11 (n/a)	Frequency=1866.4 MHz; Physical CI=127; Bandwidth=20; EARFCN DL=1814	One Hutchison 3G Austria - with add. PLMNs: 232/5		-12.98 dB	10.50 dB	Narrowband	50.57	-77.61 dBm
4	112397/10 (n/a)	Frequency=1866.4 MHz; Physical CI=503; Bandwidth=20; EARFCN DL=1814	Hutchison 3G Austria	-85.69 dBm	-17.16 dB	1.03 dB	Narrowband	42.31	-85.81 dBm
5	112397/10 (n/a)	Frequency=1866.4 MHz; Physical CI=503; Bandwidth=20; EARFCN DL=1814	One	-85.69 dBm	-17.16 dB	1.03 dB	Narrowband	42.31	-85.81 dBm
6	34698/0 (n/a)	Frequency=2650.0 MHz; Physical CI=324; Bandwidth=20; EARFCN DL=3050	T-Mobile A	-89.61 dBm	-10.81 dB	14.85 dB	Narrowband	32.38	-89.98 dBm
7	1143/1 (n/a)	Frequency=2630.0 MHz; Physical CI=210; Bandwidth=20; EARFCN DL=2850	Mobilkom Austria AG & Co KG (A1)	-92.12 dBm	-13.82 dB	9.46 dB	Narrowband	35.88	-92.35 dBm
8	580/1 (n/a)	Frequency=2630.0 MHz; Physical CI=375; Bandwidth=20; EARFCN DL=2850	Mobilkom Austria AG & Co KG (A1)	-96.63 dBm	-17.75 dB	4.33 dB	Narrowband	31.37	-96.91 dBm
9	112497/10 (n/a)	Frequency=1866.4 MHz; Physical CI=32; Bandwidth=20; EARFCN DL=1814	One	-96.68 dBm	-17.66 dB	-7.88 dB	Narrowband	31.32	-96.70 dBm
10	112497/10 (n/a)	Frequency=1866.4 MHz; Physical CI=32; Bandwidth=20; EARFCN DL=1814	Hutchison 3G Austria	-96.68 dBm	-17.66 dB	-7.88 dB	Narrowband	31.32	-96.70 dBm
11	71009/4 (n/a)	Frequency=1842.5 MHz; Physical CI=405; Bandwidth=15; EARFCN DL=1575	T-Mobile A	-98.49 dBm	-16.33 dB	-3.44 dB	Narrowband	23.51	-98.59 dBm
12	1331/1 (n/a)	Frequency=2630.0 MHz; Physical CI=141; Bandwidth=20; EARFCN DL=2850	Mobilkom Austria AG & Co KG (A1)	-101.26 dBm	-14.66 dB	-3.29 dB	Narrowband	24.74	-101.44 dBm
13	77696/8 (n/a)	Frequency=816.0 MHz; Physical CI=30; Bandwidth=10; EARFCN DL=6400	T-Mobile A	-102.57 dBm	-12.67 dB	3.77 dB	Narrowband	19.43	-102.64 dBm
14	40913/2 (n/a)	Frequency=1842.5 MHz; Physical CI=303; Bandwidth=15; EARFCN DL=1575	T-Mobile A	-103.34 dBm	-19.34 dB	-6.40 dB	Narrowband	18.66	-103.57 dBm
15	40903/0 (n/a)	Frequency=2650.0 MHz; Physical CI=327; Bandwidth=20; EARFCN DL=3050	T-Mobile A	-103.60 dBm	-13.95 dB	-3.22 dB	Narrowband	18.40	-103.70 dBm
16	47863/5 (n/a)	Frequency=1842.5 MHz; Physical CI=187; Bandwidth=15; EARFCN DL=1575	T-Mobile A	-105.70 dBm	-21.13 dB	-10.11 dB	Narrowband	16.30	-105.73 dBm
17	390/3 (n/a)	Frequency=2630.0 MHz; Physical CI=8; Bandwidth=20; EARFCN DL=2850	Mobilkom Austria AG & Co KG (A1)	-107.48 dBm	-16.45 dB	-8.99 dB	Narrowband	18.52	-107.62 dBm
18	72193/6 (n/a)	Frequency=816.0 MHz; Physical CI=99; Bandwidth=10; EARFCN DL=6400	T-Mobile A	-108.31 dBm	-20.67 dB	-0.92 dB	Narrowband	13.69	-108.40 dBm
19	47857/0 (n/a)	Frequency=2650.0 MHz; Physical CI=372; Bandwidth=20; EARFCN DL=3050	T-Mobile A	-109.71 dBm	-14.86 dB	-6.45 dB	Narrowband	12.29	-109.77 dBm
20	70801/8 (n/a)	Frequency=816.0 MHz; Physical CI=65; Bandwidth=10; EARFCN DL=6400	T-Mobile A	-112.29 dBm	-18.83 dB	-7.35 dB	Narrowband	9.71	-112.21 dBm
21	70510/6 (n/a)	Frequency=816.0 MHz; Physical CI=90; Bandwidth=10; EARFCN DL=6400	T-Mobile A	-116.31 dBm	-22.01 dB	-10.83 dB	Narrowband	5.69	-116.41 dBm

Figure 12-126: RAN sharing - aggregated PLMN IDs

12.16.3 Coverage cell statistics

Click the "Coverage Cell Statistics Scanner based" icon in the "Analysis Result Overview" page to get the GSM, UMTS, LTE, NB-IoT and LTE-M cell statistics result page.

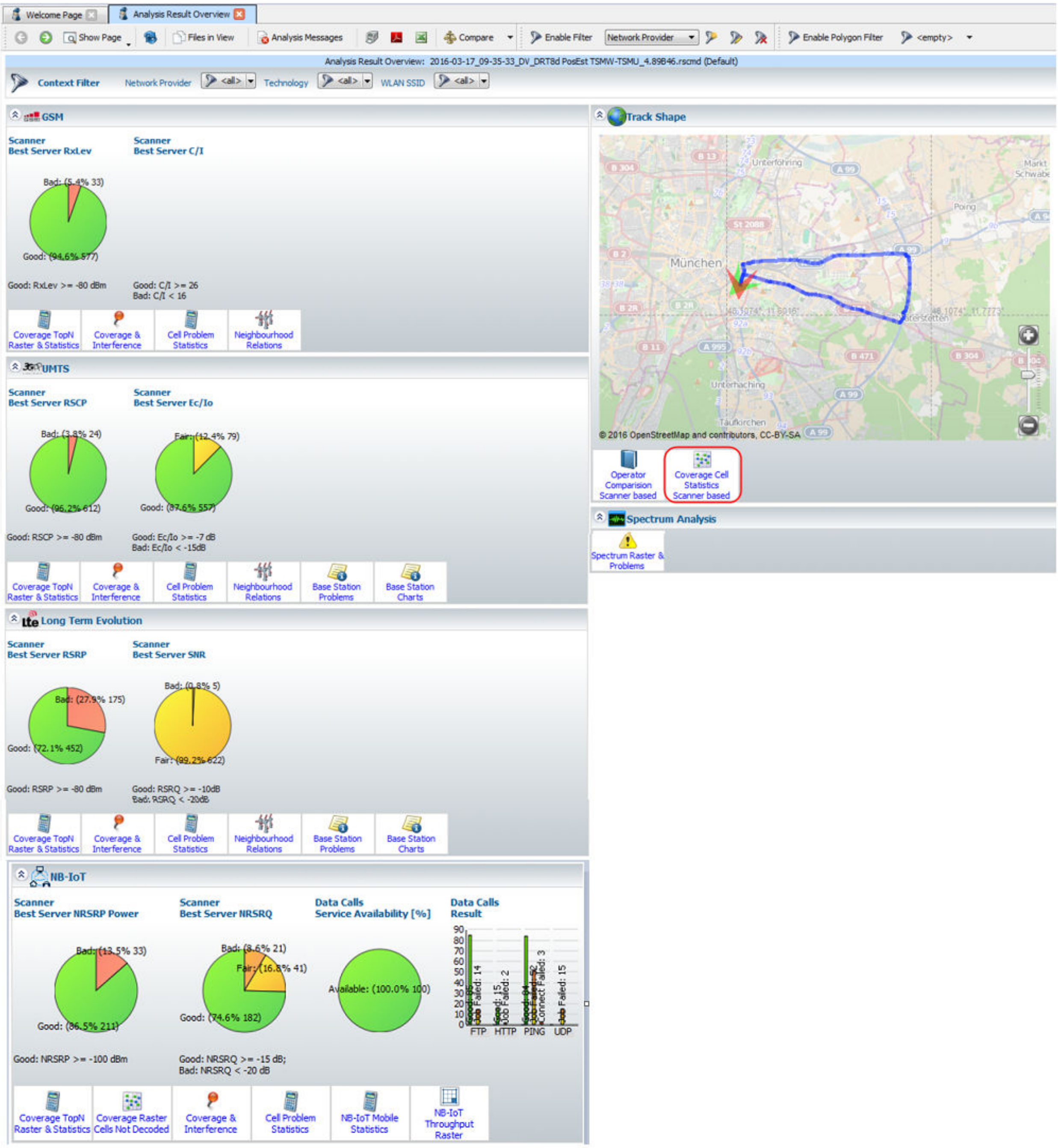


Figure 12-127: Coverage Cell Statistics buttons and result page

The coverage statistics lists for all measured cells of the 3GPP defined RATs are shown in the following figures.

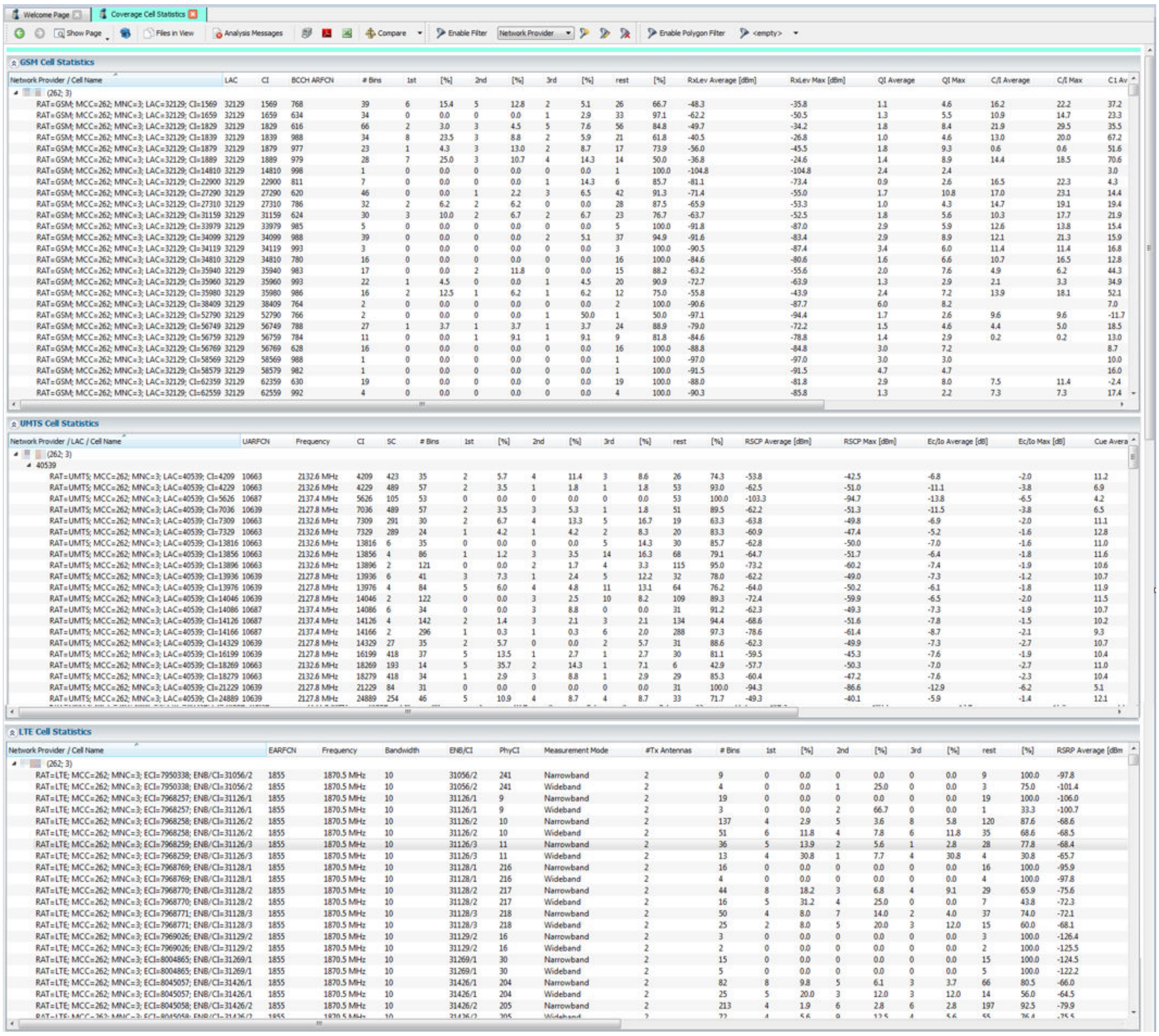


Figure 12-128: Coverage cell statistics lists for GSM, UMTS and LTE

The R&S ROMES4 NPA Report Configuration feature offers to export the coverage cell statistics in PDF or XLS (Excel) format, see Reporting.

In "Report Configuration" > "Format" select the format wanted for exporting the statistics. In "Content" check exporting of the RATs coverage cell statistics.

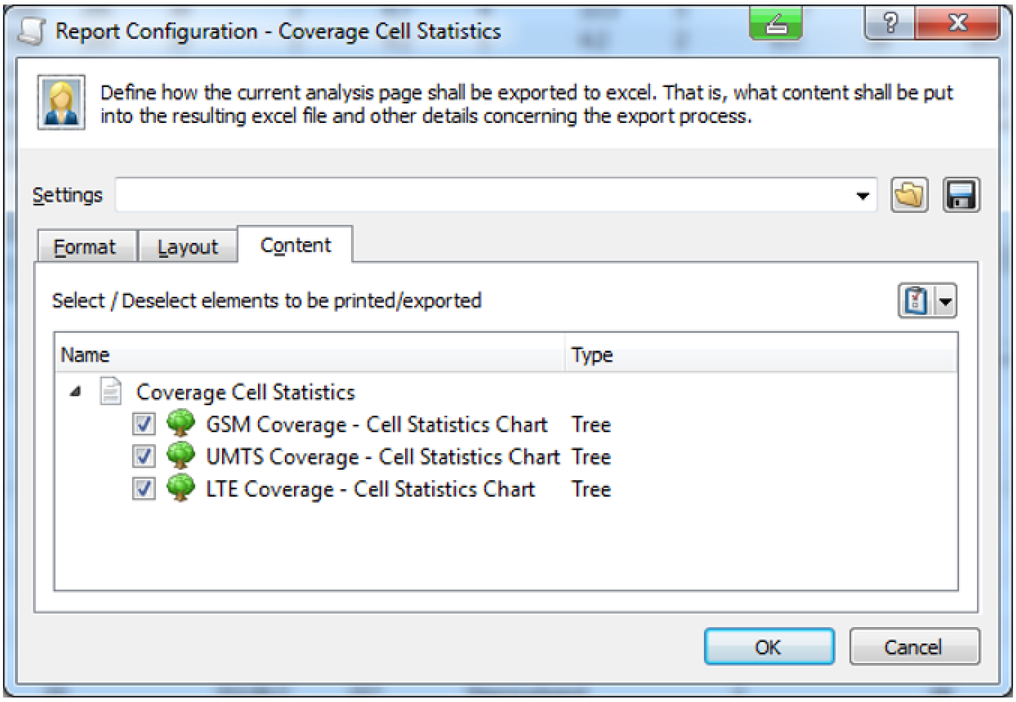
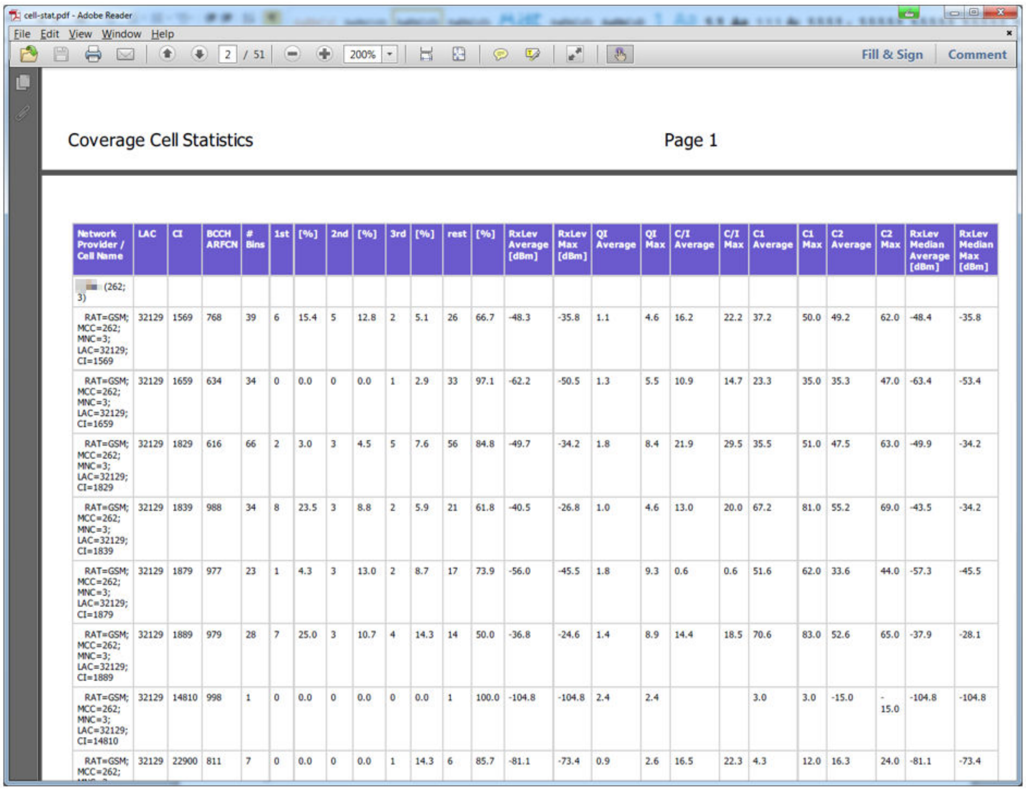


Figure 12-129: Configuration of the Coverage Cell Statistics PDF report



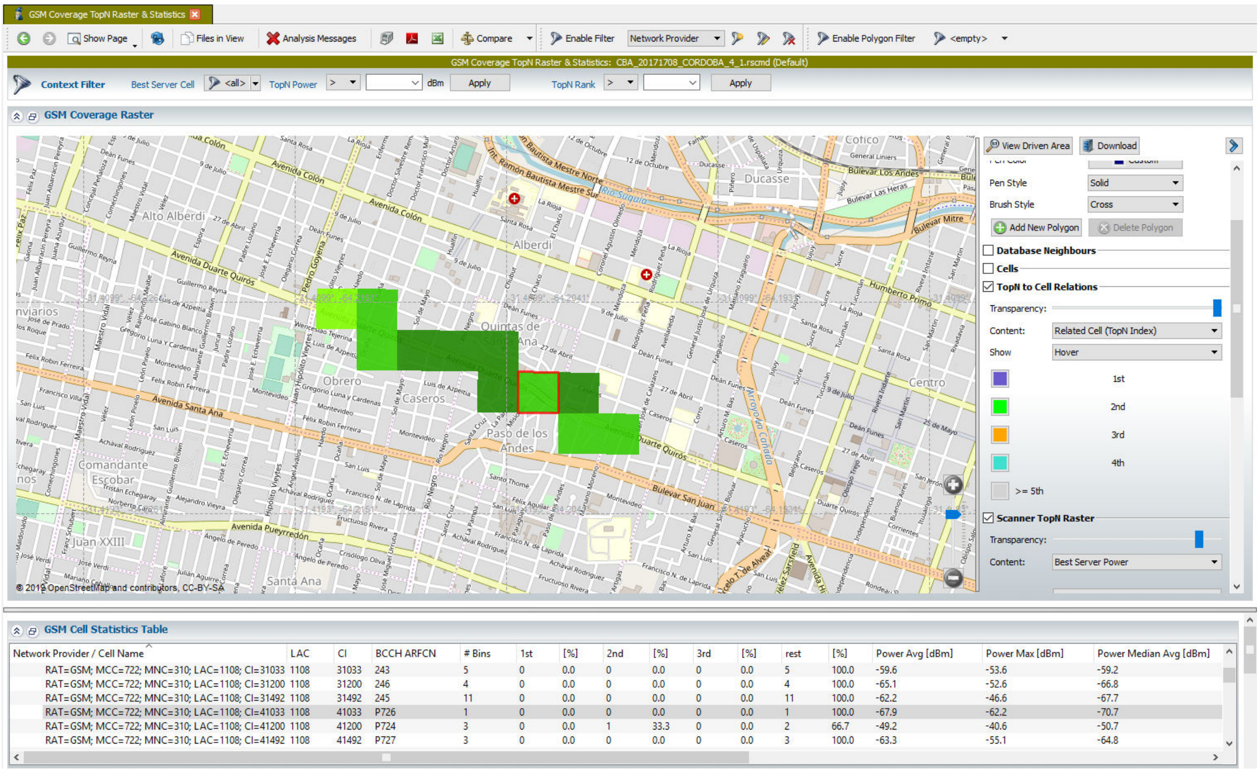
Coverage Cell Statistics
Page 1

Network Provider / Cell Name	LAC	CI	BCCH ARFCN	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	RxLev Average [dBm]	RxLev Max [dBm]	QI Average	QI Max	C/I Average	C/I Max	C1 Average	C1 Max	C2 Average	C2 Max	RxLev Median Average [dBm]	RxLev Median Max [dBm]
(262; 3)																								
RAT=GSM; MCC=262; MNC=3; LAC=32129; CI=1569	32129	1569	768	39	6	15.4	5	12.8	2	5.1	26	66.7	-48.3	-35.8	1.1	4.6	16.2	22.2	37.2	50.0	49.2	62.0	-48.4	-35.8
RAT=GSM; MCC=262; MNC=3; LAC=32129; CI=1659	32129	1659	634	34	0	0.0	0	0.0	1	2.9	33	97.1	-62.2	-50.5	1.3	5.5	10.9	14.7	23.3	35.0	35.3	47.0	-63.4	-53.4
RAT=GSM; MCC=262; MNC=3; LAC=32129; CI=1829	32129	1829	616	66	2	3.0	3	4.5	5	7.6	56	84.8	-49.7	-34.2	1.8	8.4	21.9	29.5	35.5	51.0	47.5	63.0	-49.9	-34.2
RAT=GSM; MCC=262; MNC=3; LAC=32129; CI=1839	32129	1839	988	34	8	23.5	3	8.8	2	5.9	21	61.8	-40.5	-26.8	1.0	4.6	13.0	20.0	67.2	81.0	55.2	69.0	-43.5	-34.2
RAT=GSM; MCC=262; MNC=3; LAC=32129; CI=1879	32129	1879	977	23	1	4.3	3	13.0	2	8.7	17	73.9	-56.0	-45.5	1.8	9.3	0.6	0.6	51.6	62.0	33.6	44.0	-57.3	-45.5
RAT=GSM; MCC=262; MNC=3; LAC=32129; CI=1889	32129	1889	979	28	7	25.0	3	10.7	4	14.3	14	50.0	-36.8	-24.6	1.4	8.9	14.4	18.5	70.6	83.0	52.6	65.0	-37.9	-28.1
RAT=GSM; MCC=262; MNC=3; LAC=32129; CI=14810	32129	14810	998	1	0	0.0	0	0.0	0	0.0	1	100.0	-104.8	-104.8	2.4	2.4			3.0	3.0	-15.0	-15.0	-104.8	-104.8
RAT=GSM; MCC=262;	32129	22900	811	7	0	0.0	0	0.0	1	14.3	6	85.7	-81.1	-73.4	0.9	2.6	16.5	22.3	4.3	12.0	16.3	24.0	-81.1	-73.4

Figure 12-130: PDF report

Exporting the statistics in Excel results in three separate files.

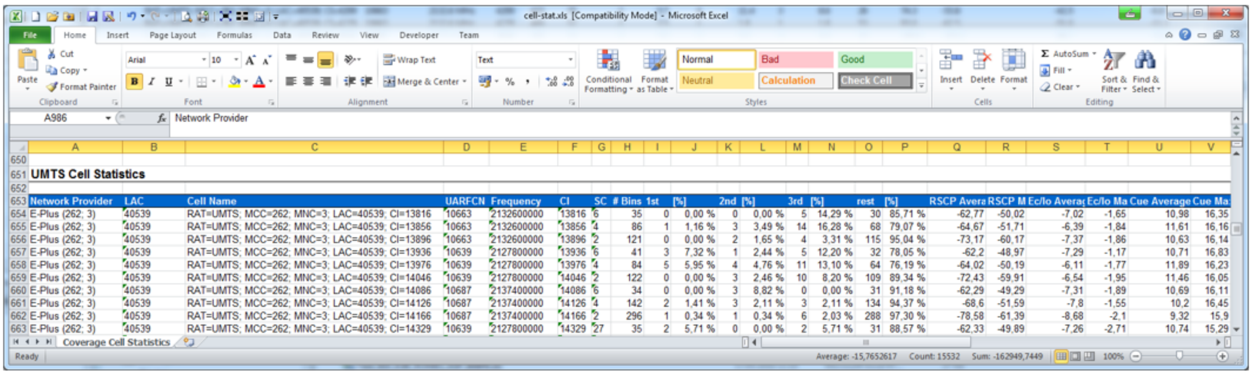
In the following figure shown is the Top N coverage raster and statistics of GSM cells. You can remark that the ARFCNs corresponding to frequencies belonging to PSC GSM (GSM 1900) are marked with letter P besides the number in the "BCCH ARFCN" column.



Network Provider / Cell Name	LAC	CI	BCCH ARFCN	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	Power Avg [dBm]	Power Max [dBm]	Power Median Avg [dBm]
RAT=GSM; MCC=722; MNC=310; LAC=1108; CI=31033	1108	31033	243	5	0	0.0	0	0.0	0	0.0	5	100.0	-59.6	-53.6	-59.2
RAT=GSM; MCC=722; MNC=310; LAC=1108; CI=31200	1108	31200	246	4	0	0.0	0	0.0	0	0.0	4	100.0	-65.1	-52.6	-66.8
RAT=GSM; MCC=722; MNC=310; LAC=1108; CI=31492	1108	31492	245	11	0	0.0	0	0.0	0	0.0	11	100.0	-62.2	-46.6	-67.7
RAT=GSM; MCC=722; MNC=310; LAC=1108; CI=41033	1108	41033	P726	1	0	0.0	0	0.0	0	0.0	1	100.0	-67.9	-62.2	-70.7
RAT=GSM; MCC=722; MNC=310; LAC=1108; CI=41200	1108	41200	P724	3	0	0.0	1	33.3	0	0.0	2	66.7	-49.2	-40.6	-50.7
RAT=GSM; MCC=722; MNC=310; LAC=1108; CI=41492	1108	41492	P727	3	0	0.0	0	0.0	0	0.0	3	100.0	-63.3	-55.1	-64.8

Figure 12-131: GSM cell statistics

The cell coverage statistics of UMTS and LTE cells is shown in the next two figures.



Network Provider	LAC	Cell Name	UARFCN	Frequency	CI	SC	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	RSCP Avera	RSCP M	Ec/Io Averaç	Ec/Io Ma	Cue Average	Cue Ma
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=13816	10663	2132600000	13816	6	35	0	0,00 %	0	0,00 %	5	14,29 %	30	85,71 %	-62,77	-50,02	-7,02	-1,65	10,98	16,35
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=13856	10663	2132600000	13856	4	86	1	1,16 %	3	3,49 %	14	16,28 %	68	79,07 %	-64,67	-51,71	-6,39	-1,84	11,61	16,16
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=13896	10663	2132600000	13896	2	121	0	0,00 %	2	1,65 %	4	3,31 %	115	95,04 %	-73,17	-60,17	-7,37	-1,86	10,63	16,14
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=13936	10639	2127800000	13936	6	41	3	7,32 %	1	2,44 %	5	12,20 %	32	78,05 %	-62,2	-48,97	-7,29	-1,17	10,71	16,83
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=13976	10639	2127800000	13976	4	84	5	5,95 %	4	4,76 %	11	13,10 %	64	76,19 %	-64,02	-50,19	-6,11	-1,77	11,89	16,23
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=14046	10639	2127800000	14046	2	122	0	0,00 %	3	2,46 %	10	8,20 %	109	89,34 %	-72,43	-59,91	-6,54	-1,95	11,46	16,05
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=14086	10687	2137400000	14086	6	34	0	0,00 %	3	8,82 %	0	0,00 %	31	91,18 %	-62,29	-49,29	-7,31	-1,89	10,69	16,11
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=14126	10687	2137400000	14126	4	142	2	1,41 %	3	2,11 %	3	2,11 %	134	94,37 %	-68,6	-51,59	-7,8	-1,55	10,2	16,45
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=14166	10687	2137400000	14166	2	296	1	0,34 %	1	0,34 %	6	2,03 %	288	97,30 %	-78,58	-61,39	-8,68	-2,1	9,32	15,9
E-Plus (262; 3)	40539	RAT=UMTS; MCC=262; MNC=3; LAC=40539; CI=14329	10639	2127800000	14329	27	35	2	5,71 %	0	0,00 %	2	5,71 %	31	88,57 %	-62,33	-49,89	-7,26	-2,71	10,74	15,29

Figure 12-132: UMTS cell statistics

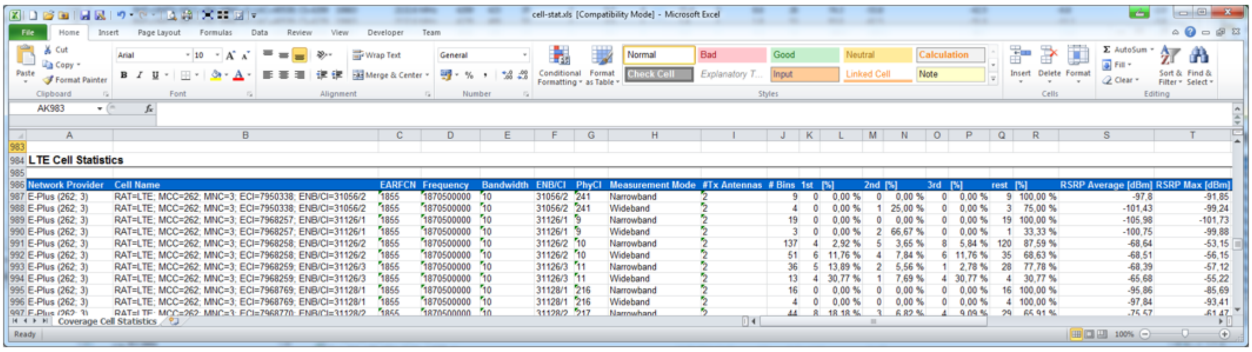
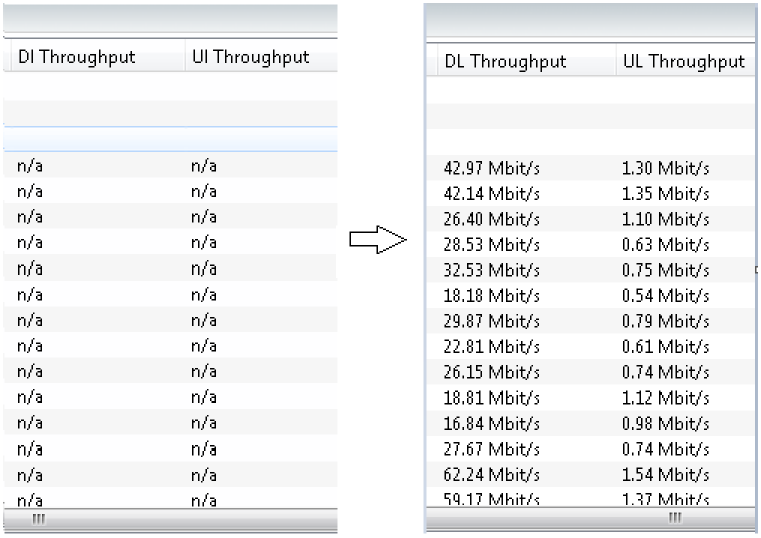


Figure 12-133: LTE cell statistics table

Mobile devices with the Samsung chipset can provide throughput values from the physical layer at the MCA plugin. The MCA reads and collects the LTE throughput values for downlink and uplink. The values include additional carriers in case carrier aggregation is activated.

The LTE cell statistic table is modified in that case. The columns for DL/UL throughput contain the values in Mbit/s.



DI Throughput	UI Throughput
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a
n/a	n/a

DL Throughput	UL Throughput
42.97 Mbit/s	1.30 Mbit/s
42.14 Mbit/s	1.35 Mbit/s
26.40 Mbit/s	1.10 Mbit/s
28.53 Mbit/s	0.63 Mbit/s
32.53 Mbit/s	0.75 Mbit/s
18.18 Mbit/s	0.54 Mbit/s
29.87 Mbit/s	0.79 Mbit/s
22.81 Mbit/s	0.61 Mbit/s
26.15 Mbit/s	0.74 Mbit/s
18.81 Mbit/s	1.12 Mbit/s
16.84 Mbit/s	0.98 Mbit/s
27.67 Mbit/s	0.74 Mbit/s
62.24 Mbit/s	1.54 Mbit/s
59.17 Mbit/s	1.37 Mbit/s

Figure 12-134: Additional values in the LTE cell statistics table with Samsung S8

12.16.4 General configuration for a problem detection

The following settings are used in the general problem detection mechanism for all technologies.

Parameter	Value Range	Default	Description
Report no 2nd	yes/no	no	If this is enabled, a Network Problem is detected when there is no second TopN entry in a bin for a detected Network Provider.
Report Problem - Minimum Measurements	1..100	3	This is the number of measurement samples that must be found in a bin for a TopN entry before it is considered in the problem detection process. Increasing this will normally decrease the number of problems detected.
Analysis up to this TopN position	3..100	8	Only check the N first TopN entries in the list according to the problem detection routines. This is used to avoid reporting problems with weak stations or non-important entries in a TopN list.

12.16.5 Problem categories

12.16.5.1 Coverage problem

Low Best Server Coverage

Within a raster element, the best averaged reception level of the first TopN is below a "Coverage Power Limit" threshold, see the following figure. This check is performed for the strongest server of each operator in the TopN list in a specific bin. When multiple such findings occur, the strongest occurrence is reported (in order to be as close to the cell boundary as possible).

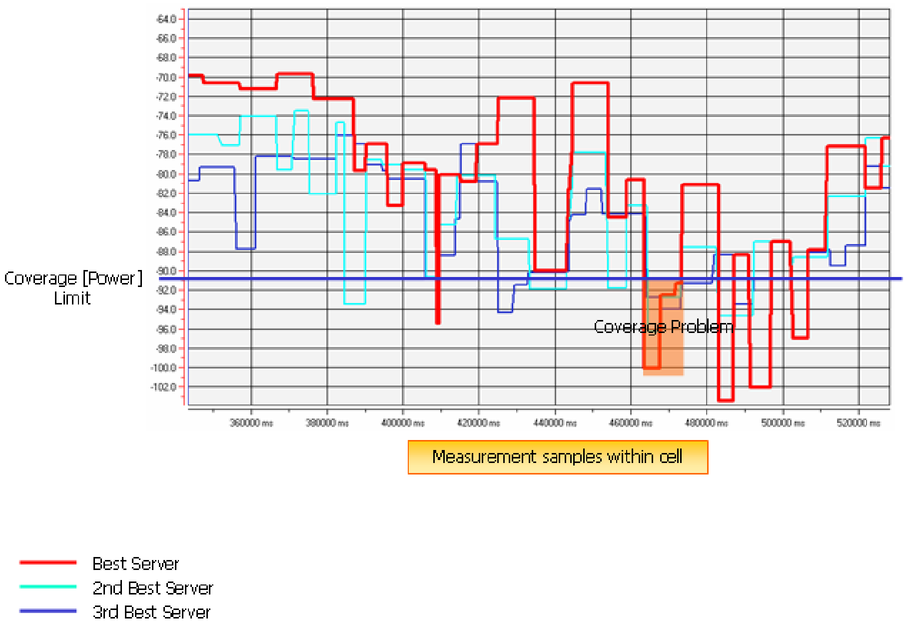


Figure 12-135: Coverage problem for the Best Server

Parameter	Value Range	Default	Description
Coverage - [Power] Limit	-120..-10 dBm	-105 dBm	Coverage Problems are reported if the averaged power level of the best cell entry in a raster is below this threshold. Unit: [dBm]

12.16.5.2 Interference problem

Interfered best server SINR

Within a raster element, an interference situation is detected if the overall reception level of the best cell is below the "Interference [Power] Minimum" and the quality criterion is below the "Interference [Quality] Maximum" parameter at the same time, see the following figure. All this is checked for the best cell in a grid element. The reception signal level and the quality criterion are indicators of possible interference, but not the only ones. In a situation of interference, the TopN members that transmit on the same channel in the same bin are also reported.

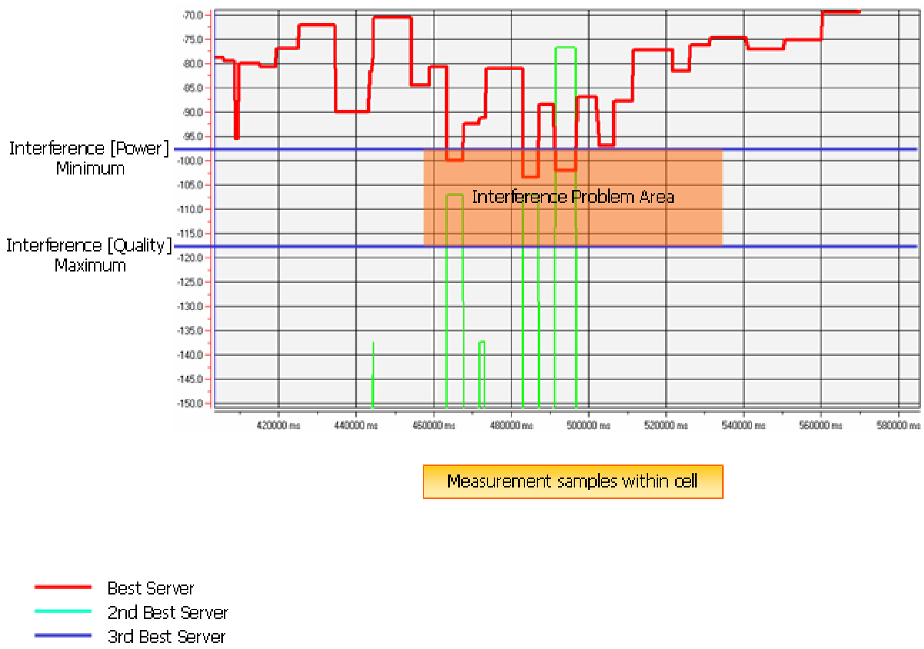


Figure 12-136: Interference problem area for the Best Server

Parameter	Value Range	Default	Description
Interference - [Power] Minimum	-120..-10 dBm	-97 dBm	An interference issue is reported only if the power value is above this value and the quality criterion is below the Interference [Quality] Maximum threshold. Unit: [dB]
Interference - [Quality] Maximum	-40..10 dB	-15 dBm	An interference issue is reported only if the power value is above the Interference Power Minimum value and the quality criterion is below this threshold. Unit: [dB]

There are two quality criteria values that can be used for LTEinterference analysis, RSRQ and SINR. Select the wanted quality criterion in the configuration page. Default is the SINR criterion.

Co-channel interference

A sender on the same channel is a pretty normal condition in CDMA, UMTS and LTE networks, but is nearly always a bad sign in a TETRA or GSM network. Such a potential interference situation is detected for these technologies in the same way as in the case of pollution analysis.

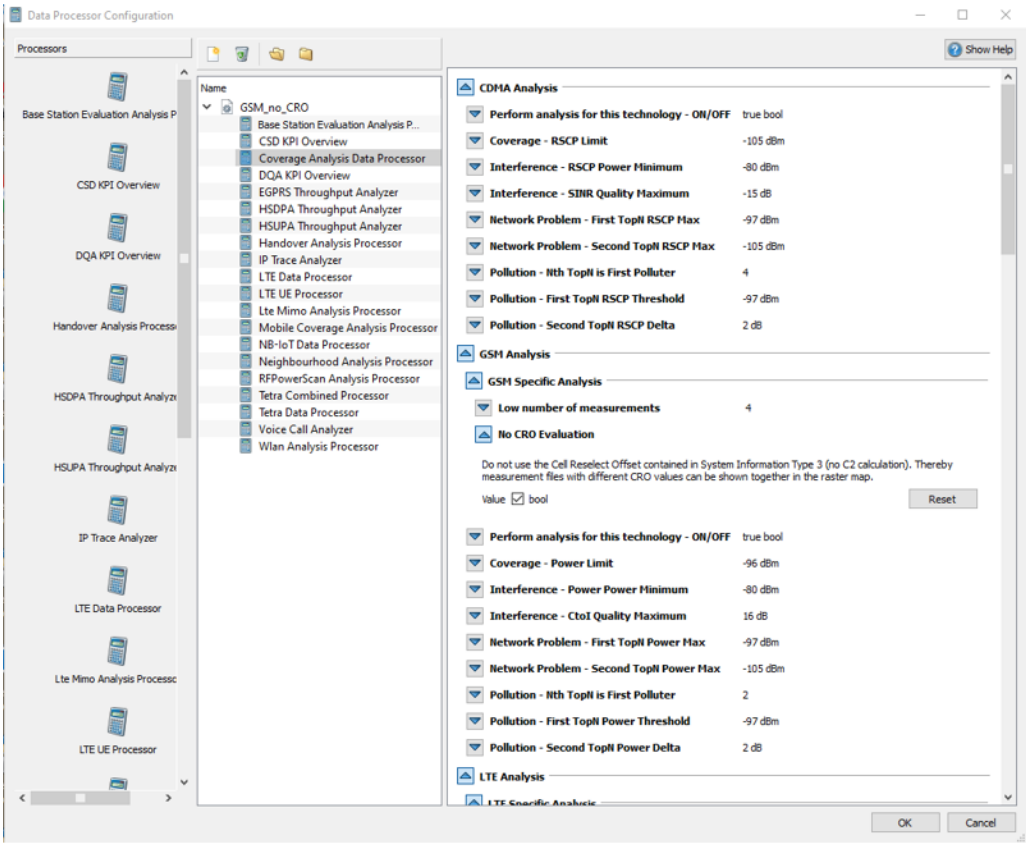


Figure 12-137: Coverage analysis data processor - CDMA and GSM parameters

The option "Perform analysis for this technology - ON/OFF" has to be ON to activate analysis functions of R&S ROMES4 NPA related to coverage, interference and pollution problem. The R&S ROMES4 NPA Co-Channel Interference analyzer lets you detect the potential problem cell.

The potential problem cell in the "Co-Channel Interference Details List" can be reported if the following conditions are fulfilled:

- Cell uses the same frequency.
- Number of the best server measurements is equal to or higher than the configured "Report Problem - Minimum Measurements" threshold. The entry is found on the top of the right pane and is common for all technologies.
- Power of the best server is higher than the configured threshold in the "Pollution - First TopN RxLev Threshold" value.
- Power difference between the best server and the found cell is smaller than the "Pollution - Second TopN RxLev Delta" value.

Co-Channel Interference result is optimized across signals from different provider. The result includes the interfering cell from other provider. The optimization algorithm considers if the cell is not fully decoded (e.g. missing LA). In addition, the bin based interference analysis works with cells from all measured provider.

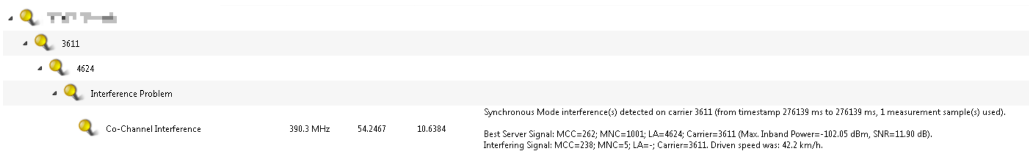


Figure 12-138: Detected co-channel interference - case 1

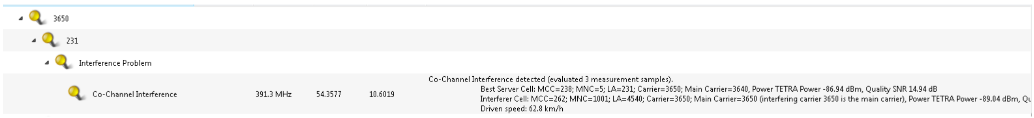


Figure 12-139: Detected co-channel interference - case 2

12.16.5.3 GSM Coverage Analysis

R&S GSM scanners can measure several BTSs using the same channel providing that their signal power does not differ by more than a few dB.

The GSM configuration parameters in the "Coverage Analysis Data Processor" > "GSM Analysis" are shown in the previous figure, Figure 12-137. Specify their threshold values to be used for analysis of problems related to coverage, interference or pollution.

Signals with the same channel number but different BSIC are marked in the R&S ROMES4 "GSM Scanner Transmitter View" with a vertical gray bar.

The length of the horizontal bars corresponds to the received SCH power and the C/I. The logner the colored bar is, the stronger is received SCH power or C/I ratio. These bars indicate also the interference, which as a consequence impacts the received signal quality.

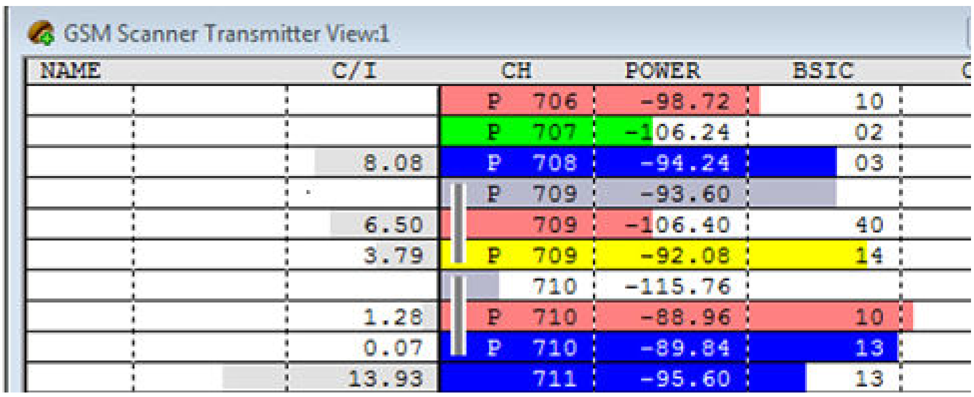


Figure 12-140: Marked channels that interfere each other

The R&S ROMES4 NPA GSM Interference Analyzer uses only C/I measurements.

The letter P besides the ARFCN values in the "CH" column indicates GSM 1900 (PCS GSM) channel. The R&S ROMES4 NPA analyzers preserve this channel type presentation.

The "GSM Specific Analysis" contains two additional parameters.

- "Low number of measurements"
  The number of the available cell measurements has to be equal to or higher than the configured threshold.
- "No CRO Evaluation"
  If the "Value" box is checked, the option prevents usage of the cell reselection offset (CRO) configured in a GSM BTS database and broadcasted in SIB3. The measurement files containing different values of cell reselection offset configured for the same cell are shown in the coverage raster map.

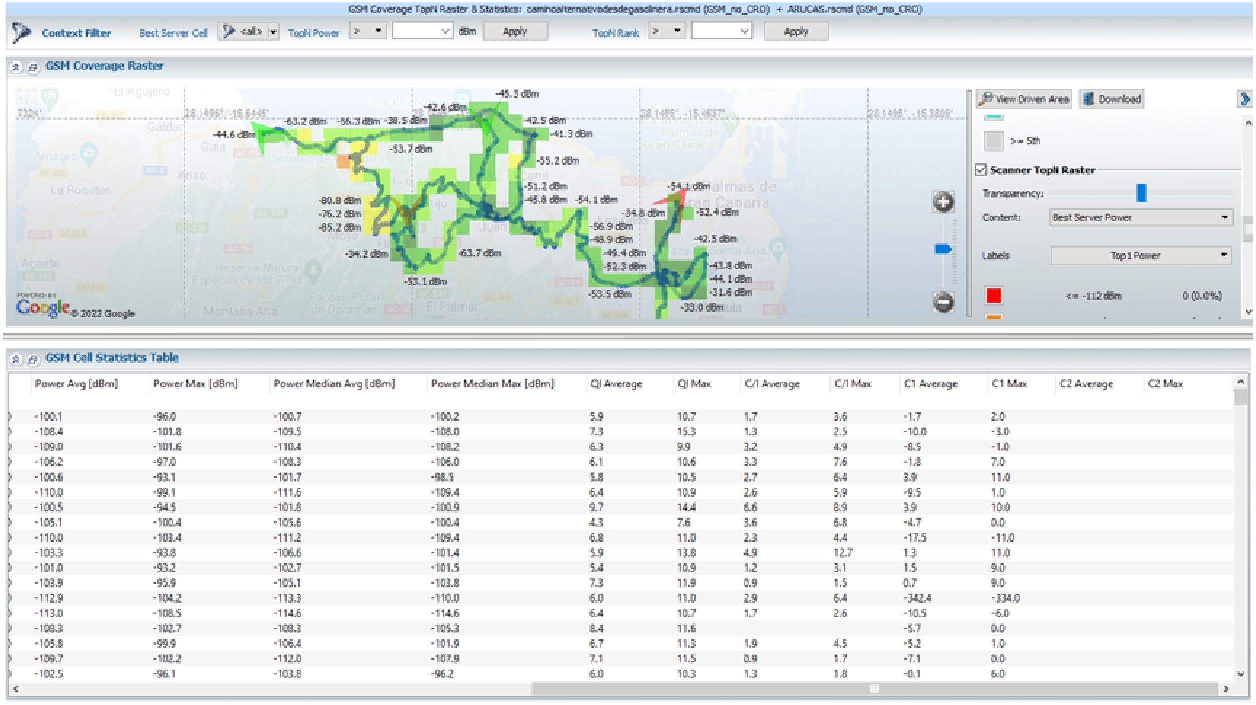


Figure 12-141: GSM coverage raster map

However, the analyzer reports the error during the analysis, as the C2 cannot be calculated.

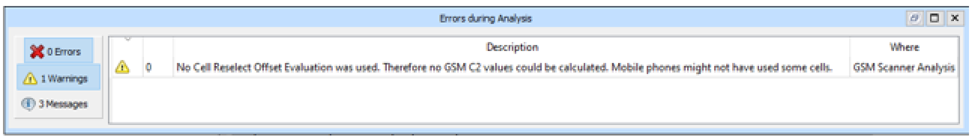


Figure 12-142: Reported error - C2 cannot be calculated

12.16.5.4 Network problem

Missing neighbor

A network problem is reported if the averaged power level of the best server does not exceed "First TopN [Power] Max" and the power value calculated for the second best is below the threshold "Second TopN [Power] Max". Such a constellation can indicate a problematic area where coverage from the best server is fair, but cell breathing or similar might lead to bad conditions and handovers could get necessary. If the second best cell cannot be reached then, there is a high chance requested services might not be available.

Possible neighbors at that location are derived from the TopN list, but a more detailed neighborhood analysis can be performed with the R&S ROMES4N17 option, see neighborhood Analyzer.

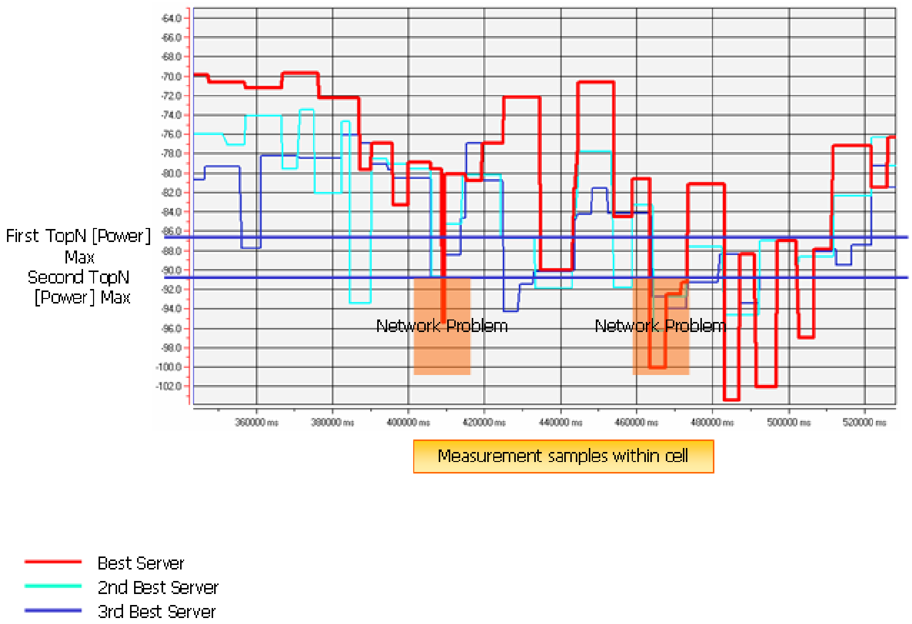


Figure 12-143: Network problem areas for the Best Server

Parameter	Value Range	Default	Description
Network Problem - First TopN [Power] Max	-120..-10 dBm	-90 dBm	A network problem is found if the power value of the first TopN in a cell is not above this and the second best is below the Second TopN [Power] Max threshold. Unit: [dBm]
Network Problem - Second TopN [Power] Max	-120..-10 dBm	-97 dBm	A network problem is found if the power value of the first TopN in a cell is above the First TopN [Power] Min value and the second below this threshold. Unit: [dBm]

12.16.5.5 Pollution problem

Pilot Pollution

When the first TopN entry in a raster grid element provides good coverage, but the difference to the averaged power of the second best cell is within a small range, this might influence the throughput in a bad way. For example, if HSDPA is used, the maximum performance can only be reached when one single cell is active. A second good cell is therefore a bad condition. The thresholds that define those limits are "Pollution - First TopN [Power] Threshold" resp. "Pollution - Second TopN [Power] Delta".

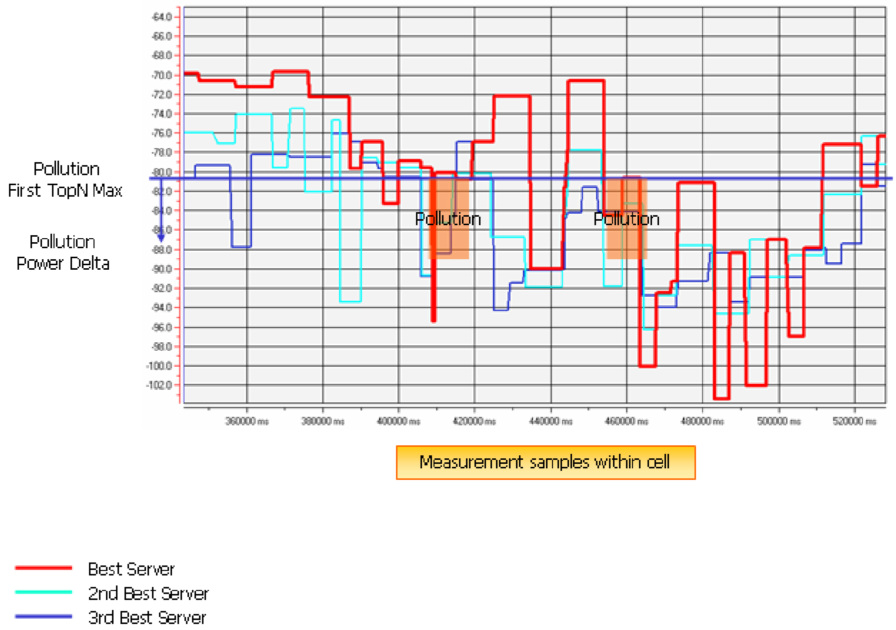


Figure 12-144: Pollution problem areas for the Best Server

12.16.6 LTE wideband specific analysis

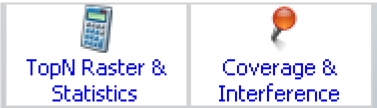
Interference Problem - External Interference

If LTE wideband measurements are active, a special analysis is performed to find problems where a good signal is available in the spectrum used by narrowband measurements, but the wideband signal quality is significantly below that quality. This can be used to report problems where the borders of the wideband signal are interfered.

Parameter	Value Range	Default	Description
External Interference - SINR/RSRQ Wideband Relative Threshold	-40..30 dB/dBm	-3 dB/dBm	Report problem if the Narrowband SINR/RSRQ is good and the Wideband SINR/RSRQ is below that value by at least the amount defined here. This is relative to Interference - SINR Narrowband Quality Maximum or Interference - RSRQ Narrowband Quality Maximum; Unit [dB]

12.16.7 LTE scanner

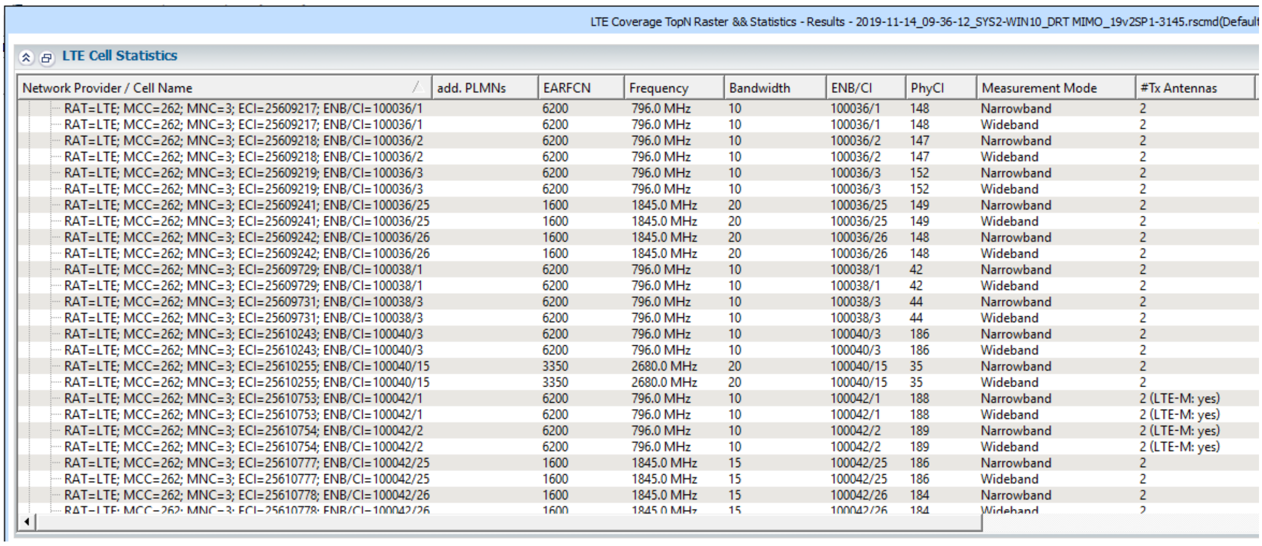
The LTE Scanner Coverage Plugin provides the "LTE Coverage TopN Raster & Statistics" page.



The potential capabilities of LTE-M, NB-IoT and 5G NR are reported in the"LTE Coverage TopN Raster & Statistics" > "LTE Cell Statistics" page.

If the LTE is configured to follow the mobile, different frequencies are scanned for a certain time (not mandatory the full duration of the measurement). The LTE frequency, bandwidth, RSRP, RSRQ and SINR measurements (narrowband and wideband) are aggregated in the R&S ROMES4 NPA to a geographical raster, cell list and CDF charts.

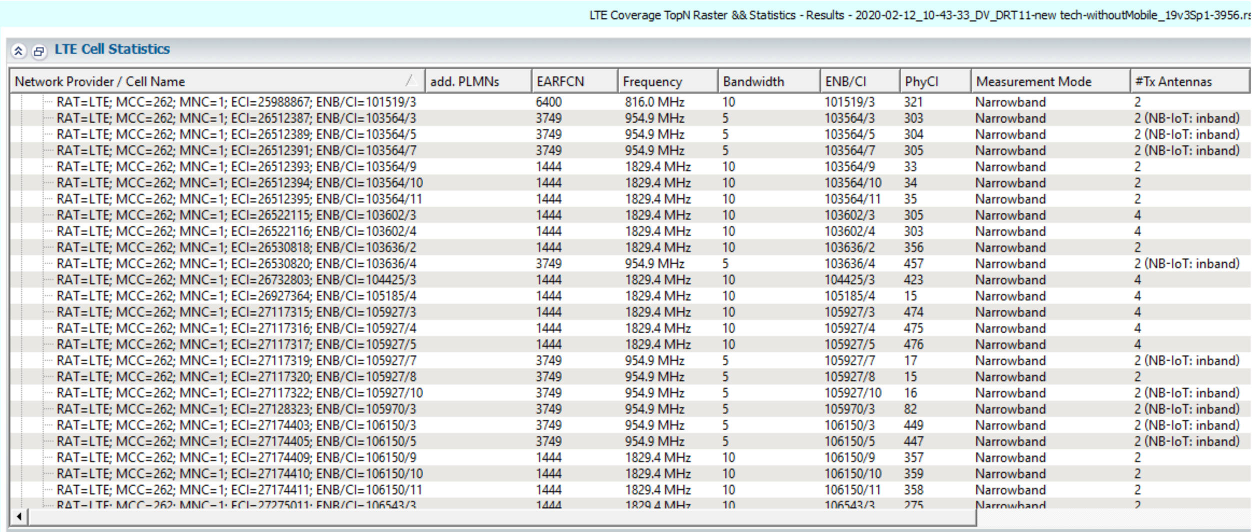
The measured cells and the aggregated cells parameters are displayed in the "LTE Cell Statistic" page. If a cell can support LTE-M, NB-IoT or 5G NR, these capabilities are also displayed, as shown in the following figures.


LTE Coverage TopN Raster && Statistics - Results - 2019-11-14_09-36-12_SYS2-WIN10_DRT MIMO_19v2SP1-3145.rscmd(Default

LTE Cell Statistics

Network Provider / Cell Name	add. PLMNs	EARFCN	Frequency	Bandwidth	ENB/CI	PhyCI	Measurement Mode	#Tx Antennas
RAT=LTE; MCC=262; MNC=3; ECI=25609217; ENB/CI=100036/1		6200	796.0 MHz	10	100036/1	148	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609217; ENB/CI=100036/1		6200	796.0 MHz	10	100036/1	148	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609218; ENB/CI=100036/2		6200	796.0 MHz	10	100036/2	147	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609218; ENB/CI=100036/2		6200	796.0 MHz	10	100036/2	147	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609219; ENB/CI=100036/3		6200	796.0 MHz	10	100036/3	152	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609219; ENB/CI=100036/3		6200	796.0 MHz	10	100036/3	152	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609241; ENB/CI=100036/25		1600	1845.0 MHz	20	100036/25	149	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609241; ENB/CI=100036/25		1600	1845.0 MHz	20	100036/25	149	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609242; ENB/CI=100036/26		1600	1845.0 MHz	20	100036/26	148	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609242; ENB/CI=100036/26		1600	1845.0 MHz	20	100036/26	148	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609729; ENB/CI=100038/1		6200	796.0 MHz	10	100038/1	42	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609729; ENB/CI=100038/1		6200	796.0 MHz	10	100038/1	42	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609731; ENB/CI=100038/3		6200	796.0 MHz	10	100038/3	44	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25609731; ENB/CI=100038/3		6200	796.0 MHz	10	100038/3	44	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25610243; ENB/CI=100040/3		6200	796.0 MHz	10	100040/3	186	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25610243; ENB/CI=100040/3		6200	796.0 MHz	10	100040/3	186	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25610255; ENB/CI=100040/15		3350	2680.0 MHz	20	100040/15	35	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25610255; ENB/CI=100040/15		3350	2680.0 MHz	20	100040/15	35	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25610753; ENB/CI=100042/1		6200	796.0 MHz	10	100042/1	188	Narrowband	2 (LTE-M: yes)
RAT=LTE; MCC=262; MNC=3; ECI=25610753; ENB/CI=100042/1		6200	796.0 MHz	10	100042/1	188	Wideband	2 (LTE-M: yes)
RAT=LTE; MCC=262; MNC=3; ECI=25610754; ENB/CI=100042/2		6200	796.0 MHz	10	100042/2	189	Narrowband	2 (LTE-M: yes)
RAT=LTE; MCC=262; MNC=3; ECI=25610754; ENB/CI=100042/2		6200	796.0 MHz	10	100042/2	189	Wideband	2 (LTE-M: yes)
RAT=LTE; MCC=262; MNC=3; ECI=25610777; ENB/CI=100042/25		1600	1845.0 MHz	15	100042/25	186	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25610777; ENB/CI=100042/25		1600	1845.0 MHz	15	100042/25	186	Wideband	2
RAT=LTE; MCC=262; MNC=3; ECI=25610778; ENB/CI=100042/26		1600	1845.0 MHz	15	100042/26	184	Narrowband	2
RAT=LTE; MCC=262; MNC=3; ECI=25610778; ENB/CI=100042/26		1600	1845.0 MHz	15	100042/26	184	Wideband	2

Figure 12-145: LTE cell statistics with LTE-M cells

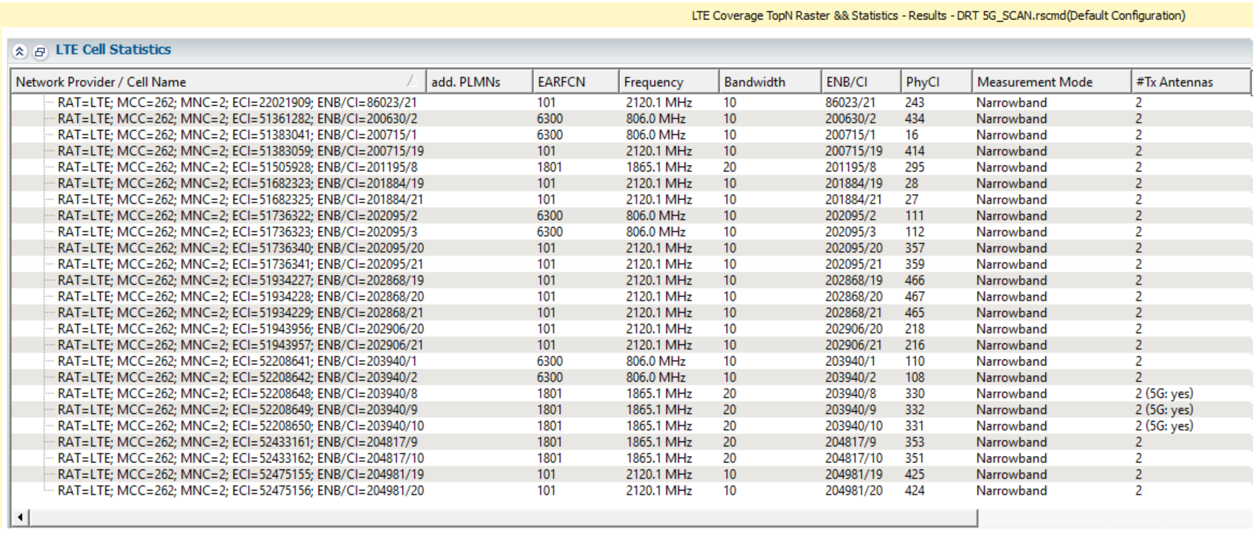


LTE Coverage TopN Raster && Statistics - Results - 2020-02-12_10-43-33_DV_DRT11-new tech-withoutMobile_19v3Sp1-3956.rs

LTE Cell Statistics

Network Provider / Cell Name	add. PLMNs	EARFCN	Frequency	Bandwidth	ENB/CI	PhyCI	Measurement Mode	#Tx Antennas
RAT=LTE; MCC=262; MNC=1; ECI=25988867; ENB/CI=101519/3		6400	816.0 MHz	10	101519/3	321	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=26512387; ENB/CI=103564/3		3749	954.9 MHz	5	103564/3	303	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=26512389; ENB/CI=103564/5		3749	954.9 MHz	5	103564/5	304	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=26512391; ENB/CI=103564/7		3749	954.9 MHz	5	103564/7	305	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=26512393; ENB/CI=103564/9		1444	1829.4 MHz	10	103564/9	33	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=26512394; ENB/CI=103564/10		1444	1829.4 MHz	10	103564/10	34	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=26512395; ENB/CI=103564/11		1444	1829.4 MHz	10	103564/11	35	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=26522115; ENB/CI=103602/3		1444	1829.4 MHz	10	103602/3	305	Narrowband	4
RAT=LTE; MCC=262; MNC=1; ECI=26522116; ENB/CI=103602/4		1444	1829.4 MHz	10	103602/4	303	Narrowband	4
RAT=LTE; MCC=262; MNC=1; ECI=26530818; ENB/CI=103636/2		1444	1829.4 MHz	10	103636/2	356	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=26530820; ENB/CI=103636/4		3749	954.9 MHz	5	103636/4	457	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=26732803; ENB/CI=104425/3		1444	1829.4 MHz	10	104425/3	423	Narrowband	4
RAT=LTE; MCC=262; MNC=1; ECI=26927364; ENB/CI=105185/4		1444	1829.4 MHz	10	105185/4	15	Narrowband	4
RAT=LTE; MCC=262; MNC=1; ECI=27117315; ENB/CI=105927/3		1444	1829.4 MHz	10	105927/3	474	Narrowband	4
RAT=LTE; MCC=262; MNC=1; ECI=27117316; ENB/CI=105927/4		1444	1829.4 MHz	10	105927/4	475	Narrowband	4
RAT=LTE; MCC=262; MNC=1; ECI=27117317; ENB/CI=105927/5		1444	1829.4 MHz	10	105927/5	476	Narrowband	4
RAT=LTE; MCC=262; MNC=1; ECI=27117319; ENB/CI=105927/7		3749	954.9 MHz	5	105927/7	17	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=27117320; ENB/CI=105927/8		3749	954.9 MHz	5	105927/8	15	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=27117322; ENB/CI=105927/10		3749	954.9 MHz	5	105927/10	16	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=27128323; ENB/CI=105970/3		3749	954.9 MHz	5	105970/3	82	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=27174403; ENB/CI=106150/3		3749	954.9 MHz	5	106150/3	449	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=27174405; ENB/CI=106150/5		3749	954.9 MHz	5	106150/5	447	Narrowband	2 (NB-IoT: inband)
RAT=LTE; MCC=262; MNC=1; ECI=27174409; ENB/CI=106150/9		1444	1829.4 MHz	10	106150/9	357	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=27174410; ENB/CI=106150/10		1444	1829.4 MHz	10	106150/10	359	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=27174411; ENB/CI=106150/11		1444	1829.4 MHz	10	106150/11	358	Narrowband	2
RAT=LTE; MCC=262; MNC=1; ECI=27275011; ENB/CI=106543/3		1444	1829.4 MHz	10	106543/3	275	Narrowband	2

Figure 12-146: LTE cell statistics with NB-IoT cells



LTE Coverage TopN Raster && Statistics - Results - DRT 5G_SCAN.rscmd(Default Configuration)

LTE Cell Statistics

Network Provider / Cell Name	add. PLMNs	EARFCN	Frequency	Bandwidth	ENB/CI	PhyCI	Measurement Mode	#Tx Antennas
RAT=LTE; MCC=262; MNC=2; ECI=22021909; ENB/CI=86023/21		101	2120.1 MHz	10	86023/21	243	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51361282; ENB/CI=200630/2		6300	806.0 MHz	10	200630/2	434	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51383041; ENB/CI=200715/1		6300	806.0 MHz	10	200715/1	16	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51383059; ENB/CI=200715/19		101	2120.1 MHz	10	200715/19	414	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51505928; ENB/CI=201195/8		1801	1865.1 MHz	20	201195/8	295	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51682323; ENB/CI=201884/19		101	2120.1 MHz	10	201884/19	28	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51682325; ENB/CI=201884/21		101	2120.1 MHz	10	201884/21	27	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51736322; ENB/CI=202095/2		6300	806.0 MHz	10	202095/2	111	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51736323; ENB/CI=202095/3		6300	806.0 MHz	10	202095/3	112	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51736340; ENB/CI=202095/20		101	2120.1 MHz	10	202095/20	357	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51736341; ENB/CI=202095/21		101	2120.1 MHz	10	202095/21	359	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51934227; ENB/CI=202868/19		101	2120.1 MHz	10	202868/19	466	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51934228; ENB/CI=202868/20		101	2120.1 MHz	10	202868/20	467	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51934229; ENB/CI=202868/21		101	2120.1 MHz	10	202868/21	465	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51943956; ENB/CI=202906/20		101	2120.1 MHz	10	202906/20	218	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=51943957; ENB/CI=202906/21		101	2120.1 MHz	10	202906/21	216	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=52208641; ENB/CI=203940/1		6300	806.0 MHz	10	203940/1	110	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=52208642; ENB/CI=203940/2		6300	806.0 MHz	10	203940/2	108	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=52208648; ENB/CI=203940/8		1801	1865.1 MHz	20	203940/8	330	Narrowband	2 (5G: yes)
RAT=LTE; MCC=262; MNC=2; ECI=52208649; ENB/CI=203940/9		1801	1865.1 MHz	20	203940/9	332	Narrowband	2 (5G: yes)
RAT=LTE; MCC=262; MNC=2; ECI=52208650; ENB/CI=203940/10		1801	1865.1 MHz	20	203940/10	331	Narrowband	2 (5G: yes)
RAT=LTE; MCC=262; MNC=2; ECI=52433161; ENB/CI=204817/9		1801	1865.1 MHz	20	204817/9	353	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=52433162; ENB/CI=204817/10		1801	1865.1 MHz	20	204817/10	351	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=52475155; ENB/CI=204981/19		101	2120.1 MHz	10	204981/19	425	Narrowband	2
RAT=LTE; MCC=262; MNC=2; ECI=52475156; ENB/CI=204981/20		101	2120.1 MHz	10	204981/20	424	Narrowband	2

Figure 12-147: LTE cell statistics with 5G NR cells

The problem analyses, for example, coverage, interference, pollution etc., are performed. Decoding the LTE cell identity from SIB1 (MCC, MNC, CI) and a valid geographical position are mandatory for the aggregation in the R&S ROMES4 NPA.

The number of transmit antennas is decoded during receiving the MIB of each cell. This information is collected for each available cell during the LTE scanner measurements and displayed in the table in the "#TxAntennas" column.

The LTE scanner measurements of the Tx/Rx antenna combinations is supported. You can see the combination of Tx/Rx antennas the scanner measurements are related to In the column Rx/Tx of the "TopN Raster Element" window. The mentioned antenna combinations are also included in the "BSE Problems" table, see Figure 12-235.

The aggregation of LTE scanner measurements with four R&S TSMEs is supported.

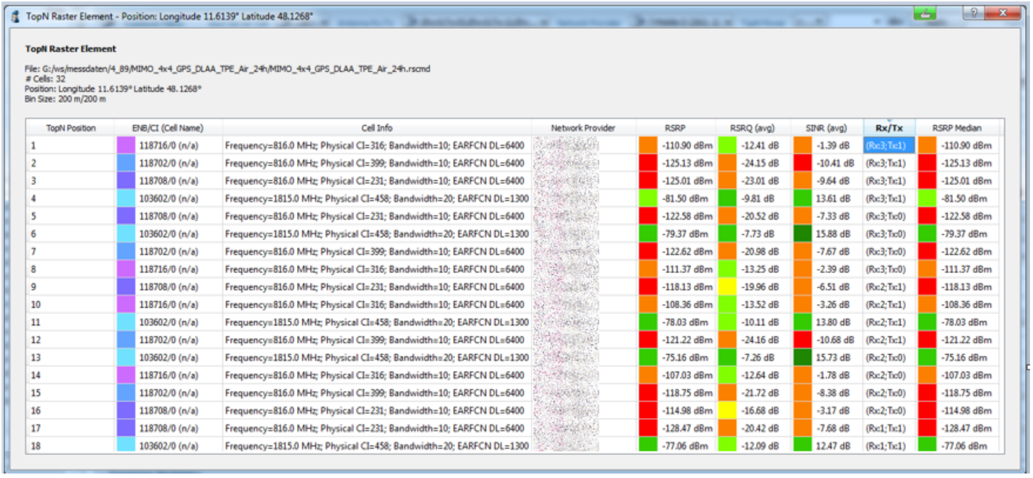


Figure 12-148: Antenna combination in Rx/Tx column

12.16.8 LTE operator based coverage analysis

This LTE coverage analysis aggregates the carriers per operator. The results of analysis show much better relevance of coverage problems. On another hand, the number of problem spots of bad coverage at certain locations is significantly reduced. These are the locations where some carriers are not in use due to other carriers of good coverage.

The analysis based on each single carrier providing poor coverage still can be reported, by activating the configuration switch in "Coverage Analysis Data Processor" > "LTE Analysis" > "LTE Specific Analysis", which is default.

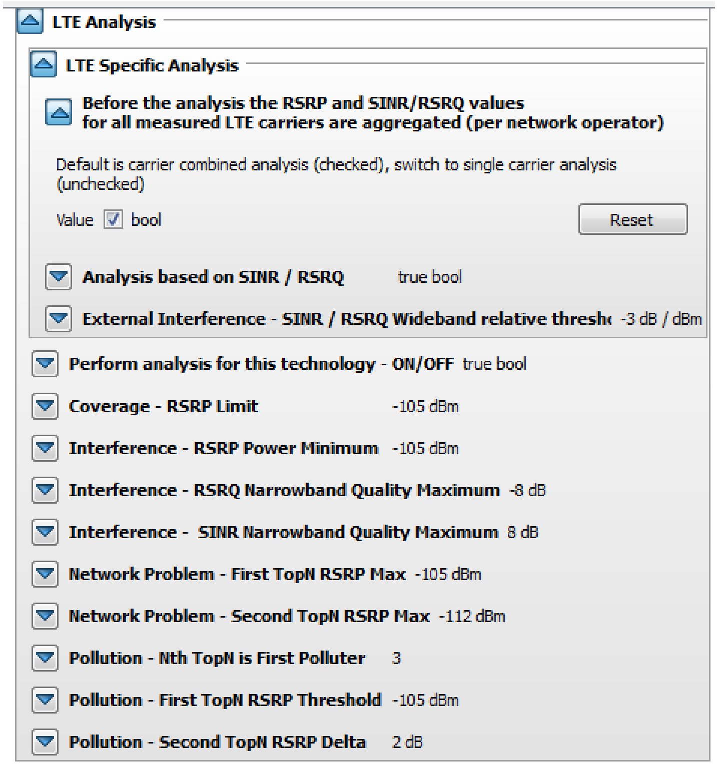
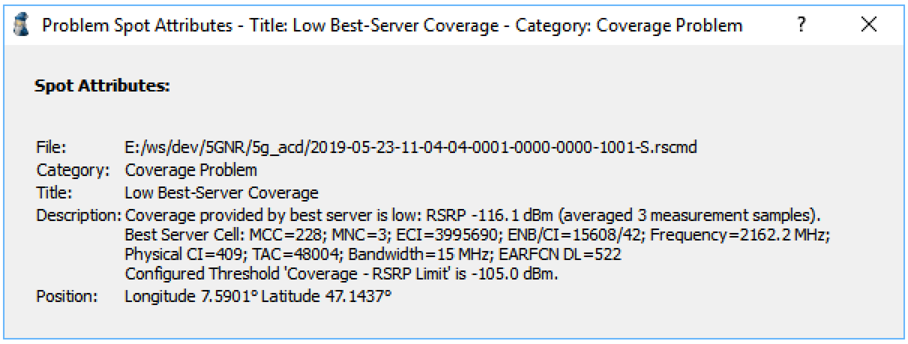


Figure 12-149: LTE single carrier configuration

The following example shows the single carrier coverage analysis.

Example:

On the selected EARFCN which corresponds to a specific carrier frequency (see the following figure, "Description"), a coverage problem is detected. The reported average RSRP is below the configured threshold (see "Coverage - RSRP Limit" in the previous figure,).



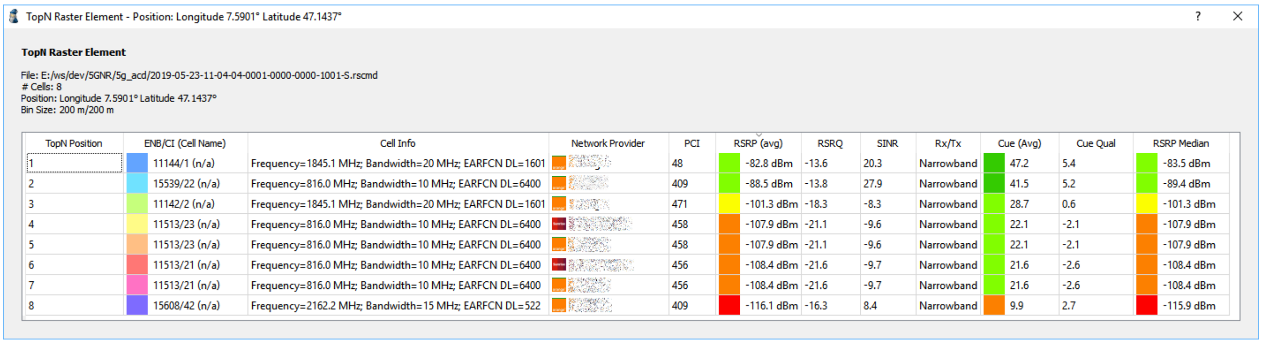
Problem Spot Attributes - Title: Low Best-Server Coverage - Category: Coverage Problem

Spot Attributes:

File: E:/ws/dev/5GNR/5g_acd/2019-05-23-11-04-04-0001-0000-0000-1001-S.rscmd
Category: Coverage Problem
Title: Low Best-Server Coverage
Description: Coverage provided by best server is low: RSRP -116.1 dBm (averaged 3 measurement samples).
Best Server Cell: MCC=228; MNC=3; ECI=3995690; ENB/CI=15608/42; Frequency=2162.2 MHz;
Physical CI=409; TAC=48004; Bandwidth=15 MHz; EARFCN DL=522
Configured Threshold 'Coverage - RSRP Limit' is -105.0 dBm.
Position: Longitude 7.5901° Latitude 47.1437°

Figure 12-150: Coverage problem on specified carrier

The "TopN Raster Element" table for this geographic location shows that the operator has two additional carriers in use. The table shows three other cells with better power.



TopN Raster Element - Position: Longitude 7.5901° Latitude 47.1437°

TopN Raster Element

File: E:/ws/dev/5GNR/5g_acd/2019-05-23-11-04-04-0001-0000-0000-1001-S.rscmd
Cells: 8
Position: Longitude 7.5901° Latitude 47.1437°
Bin Size: 200 m/200 m

TopN Position	ENB/CI (Cell Name)	Cell Info	Network Provider	PCI	RSRP (avg)	RSRQ	SINR	Rx/Tx	Cue (Avg)	Cue Qual	RSRP Median
1	11144/1 (n/a)	Frequency=1845.1 MHz; Bandwidth=20 MHz; EARFCN DL=1601		48	-82.8 dBm	-13.6	20.3	Narrowband	47.2	5.4	-83.5 dBm
2	15539/22 (n/a)	Frequency=816.0 MHz; Bandwidth=10 MHz; EARFCN DL=6400		409	-88.5 dBm	-13.8	27.9	Narrowband	41.5	5.2	-89.4 dBm
3	11142/2 (n/a)	Frequency=1845.1 MHz; Bandwidth=20 MHz; EARFCN DL=1601		471	-101.3 dBm	-18.3	-8.3	Narrowband	28.7	0.6	-101.3 dBm
4	11513/23 (n/a)	Frequency=816.0 MHz; Bandwidth=10 MHz; EARFCN DL=6400		458	-107.9 dBm	-21.1	-9.6	Narrowband	22.1	-2.1	-107.9 dBm
5	11513/23 (n/a)	Frequency=816.0 MHz; Bandwidth=10 MHz; EARFCN DL=6400		458	-107.9 dBm	-21.1	-9.6	Narrowband	22.1	-2.1	-107.9 dBm
6	11513/21 (n/a)	Frequency=816.0 MHz; Bandwidth=10 MHz; EARFCN DL=6400		456	-108.4 dBm	-21.6	-9.7	Narrowband	21.6	-2.6	-108.4 dBm
7	11513/21 (n/a)	Frequency=816.0 MHz; Bandwidth=10 MHz; EARFCN DL=6400		456	-108.4 dBm	-21.6	-9.7	Narrowband	21.6	-2.6	-108.4 dBm
8	15608/42 (n/a)	Frequency=2162.2 MHz; Bandwidth=15 MHz; EARFCN DL=522		409	-116.1 dBm	-16.3	8.4	Narrowband	9.9	2.7	-115.9 dBm

Figure 12-151: TopN servers

The configured coverage analysis based on combined carriers provides much less coverage and interference problems.

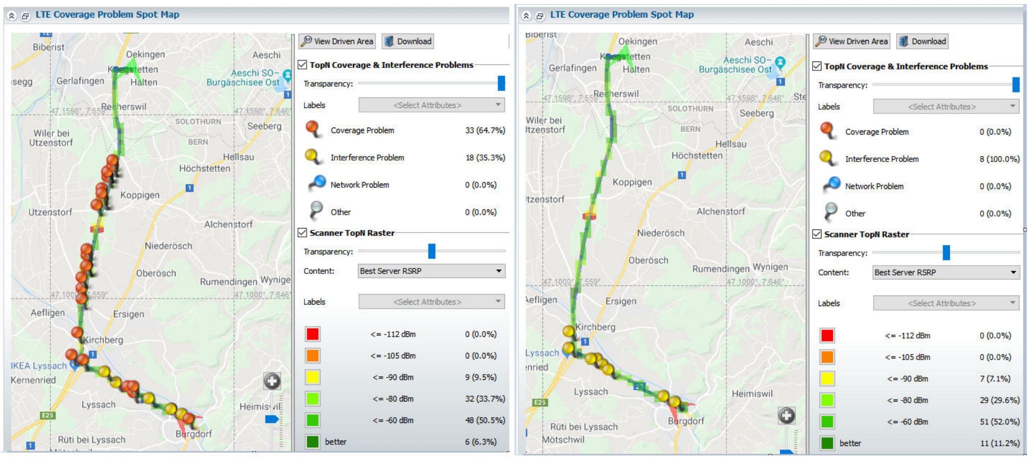


Figure 12-152: Comparison single to combined carriers coverage

In the previous figure compared are the LTE coverage problem spot reports of a single carrier and combined carriers per operator coverage analysis. The left screen shot shows the single carrier coverage analysis. The right one shows the combined carriers per operator coverage analysis.

12.16.9 TETRA specific analysis

The TETRA coverage analysis extensions enhance the problem spot detection algorithms by some technology specific parameter evaluations. Some are described in the following sections and apply only for the TETRA scanner results analysis.

The basic approach however is the same as described in the general problem list section. That is, each entry in the TopN list has some additionally calculated parameters and these are checked against the different constraints (thresholds) listed below.

The data on which the problem analysis is performed is structured in a way similar to data structuring in the R&S ROMES4 "TETRA Scanner Top N View", which is shown in the following figure. In comparison to the R&S ROMES4 NPA, R&S ROMES4 calculates the TopN based on the chronological order of measurement samples during the drive test.

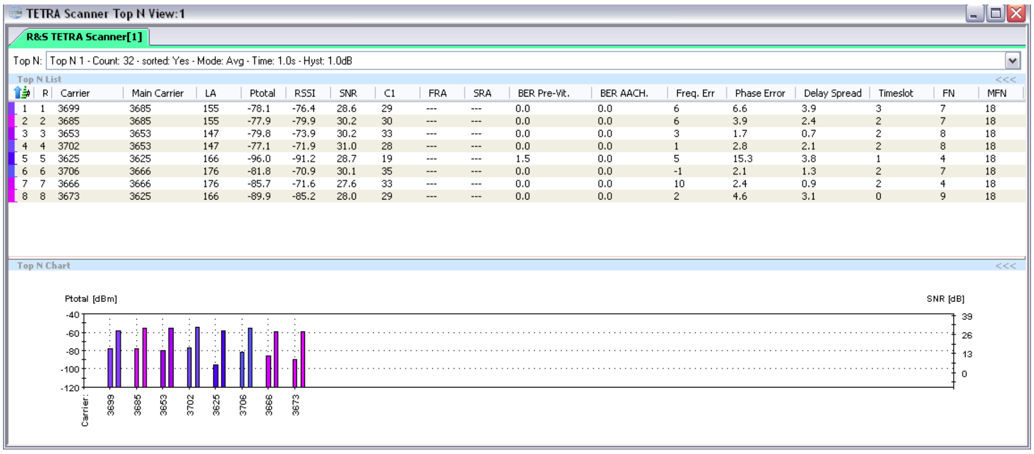


Figure 12-153: R&S ROMES4 TETRA Scanner TopN View

The TETRA coverage analyses problem tabs "TETRA Coverage Analysis Problem Spots" and "TETRA Coverage TopN Raster&Statistics" have in associated problem pages the filtering "TopN Rank" entry.

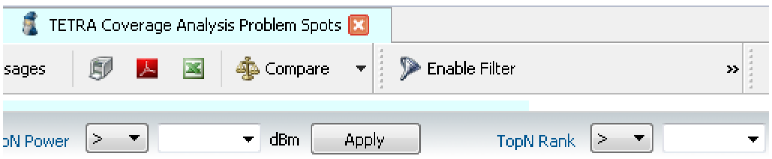


Figure 12-154: TopN rank filtering

12.16.9.1 Best server ambiguity problem

The TETRA specific analysis Best Server Ambiguity means there are other cells found showing a power level very close to the best server.

This analysis can be turned ON or OFF by a configuration switch. Default is OFF.

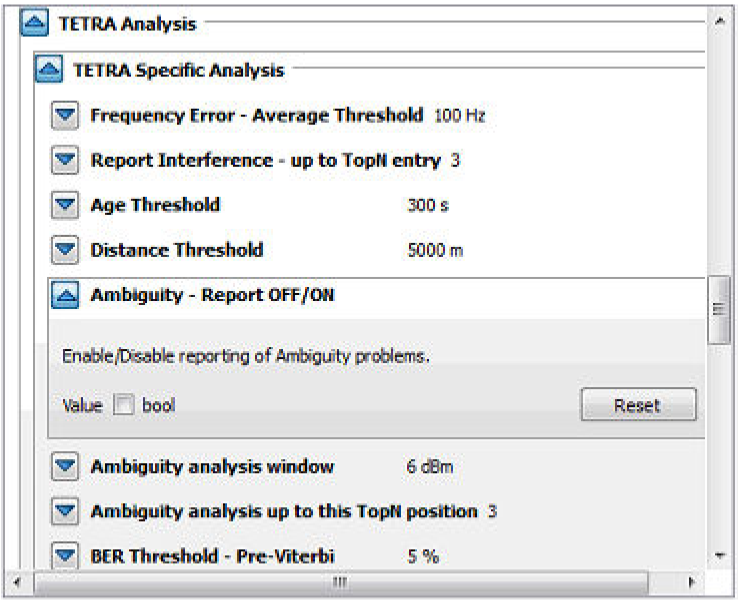


Figure 12-155: TETRA ambiguity configuration

The problem spots related to the server ambiguity are put in the Network Problem category. This can be seen in the following figure.

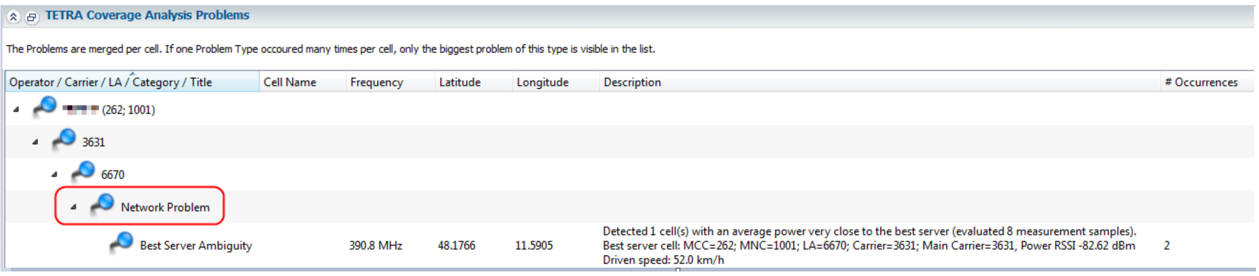


Figure 12-156: TETRA Best-Server ambiguity problem list

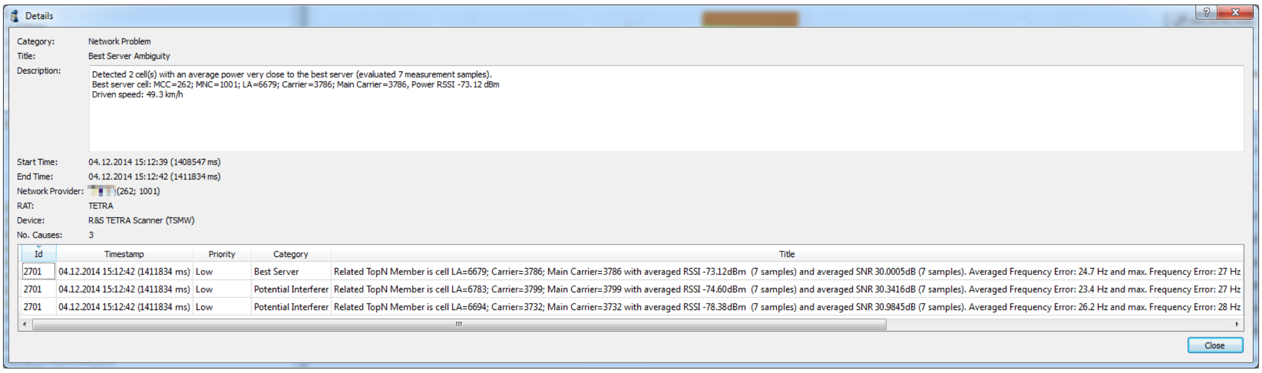


Figure 12-157: Best-Server ambiguity problem details

12.16.9.2 Low speech quality problem

If the aggregated speech quality is below the configured threshold (default 1.5), a problem spot is created.

The following figure shows the configuration of the speech sample threshold which will cause the problem spot speech quality.

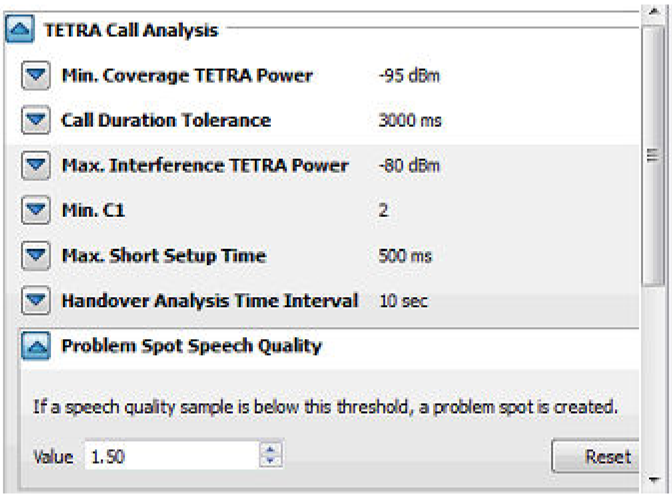


Figure 12-158: Speech quality sample threshold

If the speech quality sample is below the threshold, the analysis creates problem spot.

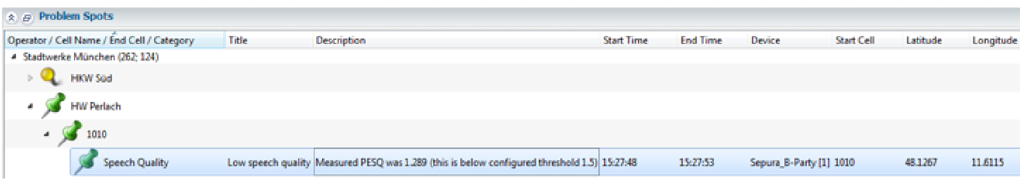
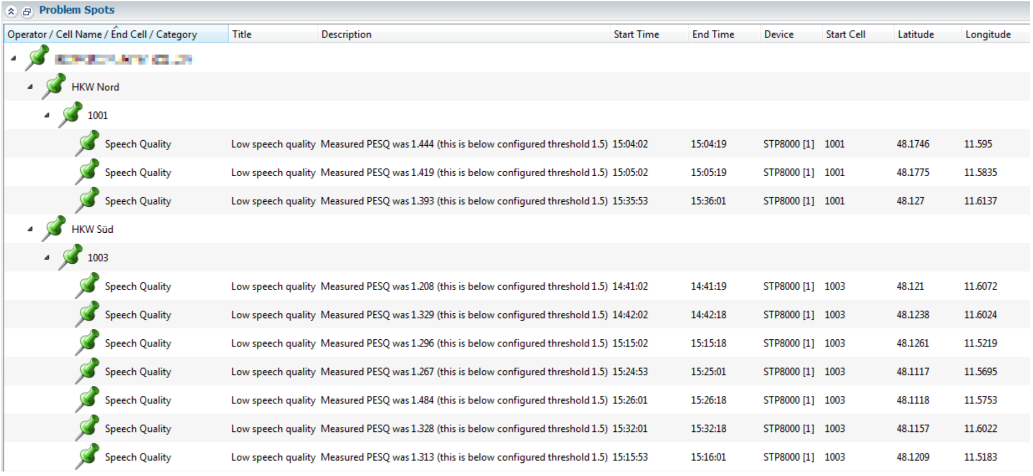


Figure 12-159: Highlighted problem spot due to exceeded threshold

At the moment there is no GPS position available for the merged B-Party. The position of the A-Party is used to identify the problem.



Problem Spots

Operator / Cell Name / End Cell / Category	Title	Description	Start Time	End Time	Device	Start Cell	Latitude	Longitude
HKW Nord								
1001								
Speech Quality	Low speech quality	Measured PESQ was 1.444 (this is below configured threshold 1.5)	15:04:02	15:04:19	STP8000 [1]	1001	48.1746	11.595
Speech Quality	Low speech quality	Measured PESQ was 1.419 (this is below configured threshold 1.5)	15:05:02	15:05:19	STP8000 [1]	1001	48.1775	11.5835
Speech Quality	Low speech quality	Measured PESQ was 1.393 (this is below configured threshold 1.5)	15:35:53	15:36:01	STP8000 [1]	1001	48.127	11.6137
HKW Süd								
1003								
Speech Quality	Low speech quality	Measured PESQ was 1.208 (this is below configured threshold 1.5)	14:41:02	14:41:19	STP8000 [1]	1003	48.121	11.6072
Speech Quality	Low speech quality	Measured PESQ was 1.329 (this is below configured threshold 1.5)	14:42:02	14:42:18	STP8000 [1]	1003	48.1238	11.6024
Speech Quality	Low speech quality	Measured PESQ was 1.296 (this is below configured threshold 1.5)	15:15:02	15:15:18	STP8000 [1]	1003	48.1261	11.5219
Speech Quality	Low speech quality	Measured PESQ was 1.267 (this is below configured threshold 1.5)	15:24:53	15:25:01	STP8000 [1]	1003	48.1117	11.5695
Speech Quality	Low speech quality	Measured PESQ was 1.484 (this is below configured threshold 1.5)	15:26:01	15:26:18	STP8000 [1]	1003	48.1118	11.5753
Speech Quality	Low speech quality	Measured PESQ was 1.328 (this is below configured threshold 1.5)	15:32:01	15:32:18	STP8000 [1]	1003	48.1157	11.6022
Speech Quality	Low speech quality	Measured PESQ was 1.313 (this is below configured threshold 1.5)	15:15:53	15:16:01	STP8000 [1]	1003	48.1209	11.5183

Figure 12-160: Low speech quality

12.16.9.3 Interference analysis

TETRA interference analysis is based on three criteria, BER (Pre-Viterbi), TETRA Power and SNR. Configuration of threshold values for these criteria is done in "Data Processor configuration" > "Coverage Analysis Data Processor" > "TETRA Analysis".

The interference analysis concerning the BER (Pre-Viterbi) criterion is performed in combination with the BER TETRA Power threshold, see TETRA BER threshold - Pre-Viterbi and power threshold.

An interference problem spot is reported only if the following is fulfilled:

- The average of the BER measurements is equal or above the "BER Threshold – Pre-Viterbi"
- The average of the power measurements for the best server cell is above the "Interference - TETRA Power Minimum" threshold
- The average of the SNR measurements is below the "Interference - SNR Quality Maximum" threshold

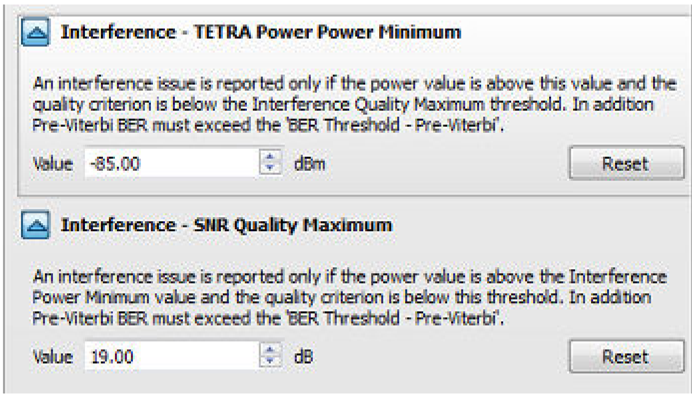


Figure 12-161: TETRA interference thresholds

An example of the TETRA coverage analysis resulting in problem spots detection is shown in the following figure.

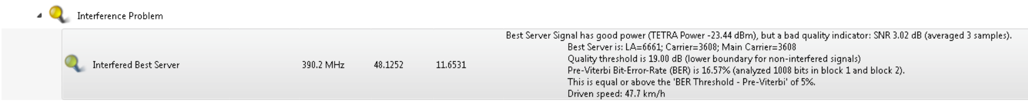


Figure 12-162: Interference and demodulation problems

12.16.9.4 Co-channel interference problem

TETRA interference analysis uses the TETRA Power and SNR thresholds as the criteria to detect a co-channel Interference problem spot. The problem is reported when both configured thresholds are exceeded, that is, the SNR of the best server has to be below the configured "Co-Channel Interference SNR Threshold".

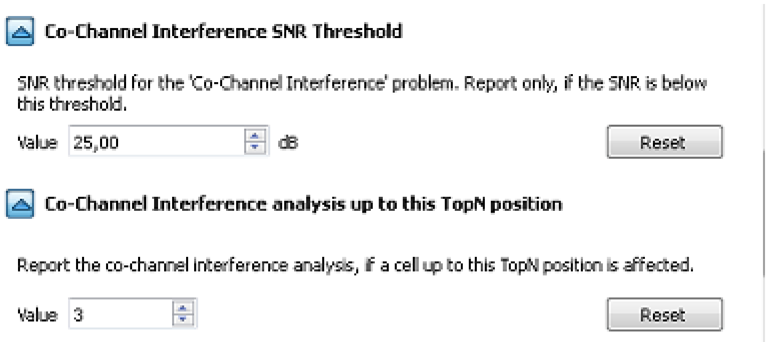


Figure 12-163: TETRA co-channel interference problem threshold

Detection of a co-channel interference problem spot generates a report which contains information whether the interferer is MCCH or TCH.

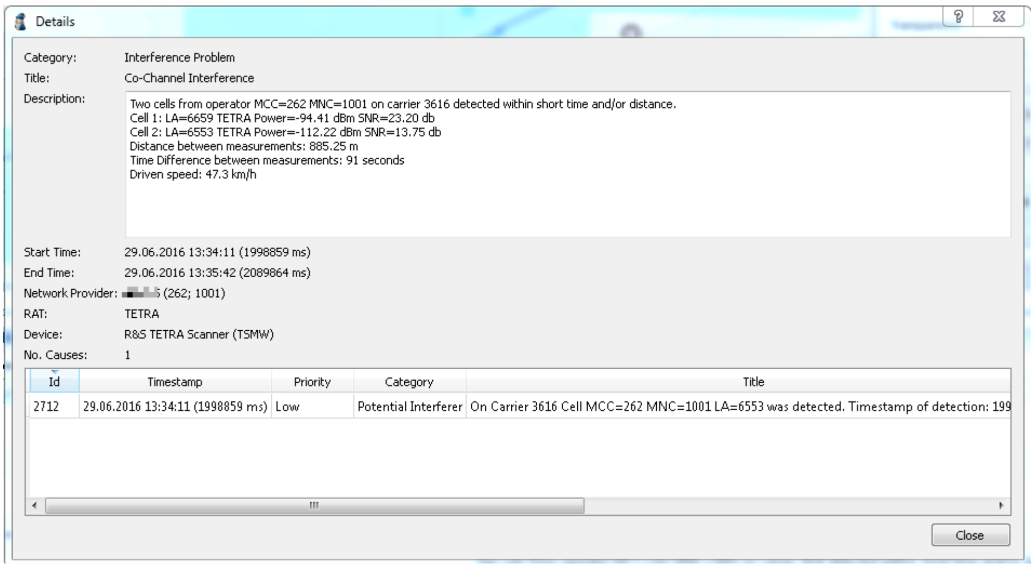


Figure 12-164: Co-channel interference problem

12.16.9.5 Interference problem - synchronous / asynchronous

The TETRA scanner software performs some interference detection automatically. The result of that interference detection is used in the analysis process to report problems in the base station as well. During that interference detection, the scanner distinguishes between synchronous and asynchronous interference. The difference between them is that in the former the interferer signal can be demodulated, whereas in the latter this is not possible.

12.16.9.6 BER - bit error probability problem

The Bit Error Probability is calculated for two different parts of a TETRA downlink slot:

- Pre-Viterbi BER is calculated on Block 1 and Block 2 (which contain the actual data)
- BCCH BER is calculated on the Broadcast Block

The former is calculated using a Pre-Viterbi decoder, and the latter using the Reed-Muller-Code.

Figure 12-165: TETRA BER threshold - Pre-Viterbi and power threshold

Both values can be monitored by the coverage problem detection and problem spots can be identified if they exceed certain thresholds.

Parameter	Value Range	Default	Description
BER Threshold - Pre-Viterbi	0 % to 100 %	17 %	Report problem, if the Pre-Viterbi BER (calculated on Block 1 and Block 2) of the best server is above this threshold. Unit: [%]
BER Threshold - Reed-Muller-Code	0 % to 100 %	17 %	Report problem, if the BER of the Broadcast Control part in a timeslot of the best server is above this threshold. Unit: [%]

12.16.9.7 Demodulation problem

A demodulation problem spot is reported for the best server if both the measured BER (Pre-Viterbi) and the BER TETRA Power are equal or above the configured threshold values. The configured thresholds for the BER parameters are shown in the previous figure.

If exceeding the thresholds, the problem is reported.

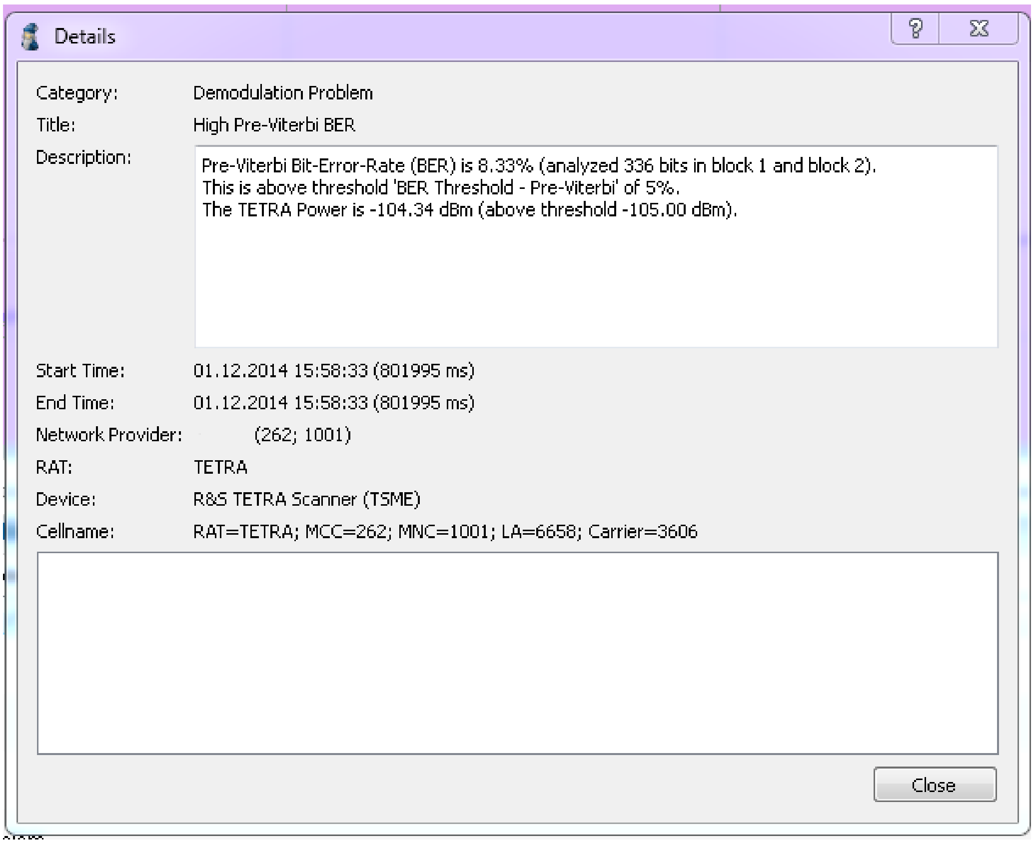


Figure 12-166: Demodulation problem

12.16.9.8 BLER - block error rate problem

Based on BER, the TETRA scanner also calculates a BLER for each of the Block 1, Block 2 and Broadcast Block entities, if such an entity contains too many bit errors. If the average of one of the BLER values is higher than the configured threshold, a problem is reported indicating the actual BLER value type.

Parameter	Value Range	Default	Description
BLER Threshold	0 % to 100 %	34 %	Report problem, if the Broadcast Block/Block1/ Block2 BLER of the best server is above this threshold. Unit: [%]

12.16.9.9 Frequency error

For each TopN entry, the average frequency error measured in the bin is calculated, and all those single values are combined into an overall average of the complete TopN. One potential problem is then reported if the combined averaged frequency error exceeds the "Frequency Error - Average Threshold" threshold. This might indicate that the scanner itself has some kind of problem when measuring cells, especially when that problem is found in many bins.

The other possible issue that can be detected in the context of frequency errors is done for each entry in the TopN list. Its frequency error is compared to the averaged error, and if it is higher than the average by at least "Frequency Error - Delta Threshold". In that case, the station itself might have some kind of problem.

Parameter	Value Range	Default	Description
Frequency Error - Average Threshold	0 Hz to 1000 Hz	100 Hz	Report problem, if the average frequency error of all entries in this TopN is above this threshold. Unit: [Hz]
Frequency Error - Delta Threshold	0 Hz to 1000 Hz	100 Hz	Report problem, if the delta of one base stations freq. error to the average is above this threshold. Unit: [Hz]

12.16.9.10 Delay spread

The TETRA scanner measures the difference between the different paths that contribute to a measurement for a specific base station. If that delay is too high (according to the configured settings), it is possible to report a problem.

Parameter	Value Range	Default	Description
Delay Spread Threshold	1 ms to 1000000 ms	4 ms	Report problem, if the delay spread of the best server is above this threshold. Unit: [ms]

12.16.9.11 Phase error

Optionally, it is possible to perform phase error detection. This feature is disabled per default. Again, the actual root-mean-square phase error is compared to the given threshold. If the averaged error over all measurements for the best server in a bin is higher than the configured threshold and reporting is enabled, the problem is put into the overall result of a file.

Parameter	Value Range	Default	Description
Phase Error - Report OFF/ON	true, false	false	Enable/Disable reporting of Phase Error problems. Unit: [bool]
Phase Error - Threshold	0 ° to 90 °	15 °	Report problem, if the phase error of the best server is above this threshold. Unit: [°]

12.16.9.12 Hyper frame number divergence

The hyper frame number (HFN) is contained in the SYSINFO PDU which is sent periodically by the TETRA base stations.

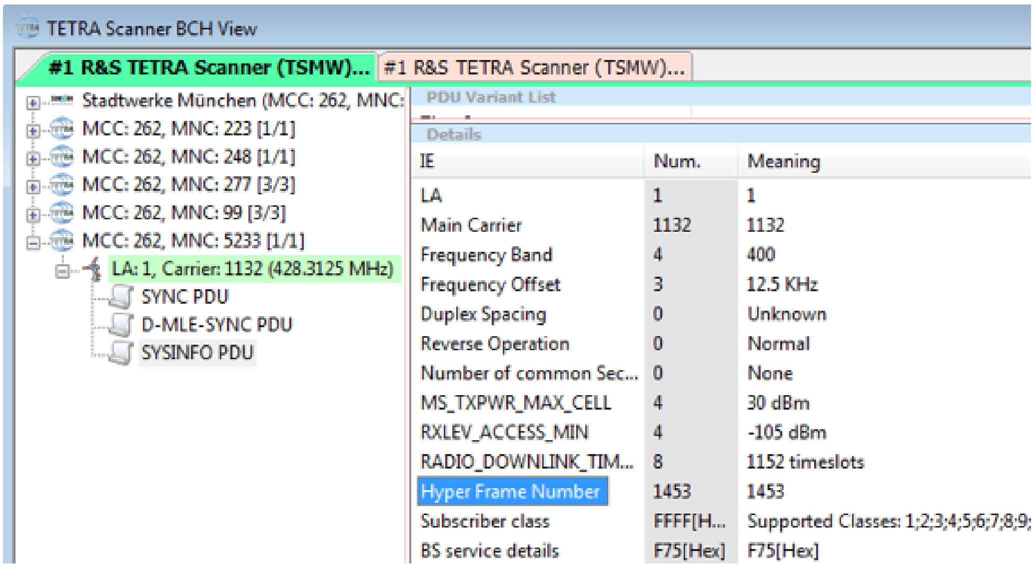


Figure 12-167: Info elements contained in PDU

The TETRA specific analysis for differences in the hyper frame number expects a minimum number of channels (default = 5) per network operator (specified by MCC and MNC) and in addition a minimal number of synchronous channels (default = 3).

Thereby, network operators not using a synchronized hyper frame number will not be further analyzed. Default for the minimal difference of the hyper frame number is 2. This can be lowered to 1 to report all hyper frame number differences.

By default the hyper frame number analysis is turned off but can be enabled if requested, as shown in the following figure.

Figure 12-168: Hyper frame number enabled

The problem spots related to hyper-frame number difference are put in the "Network Problem" category

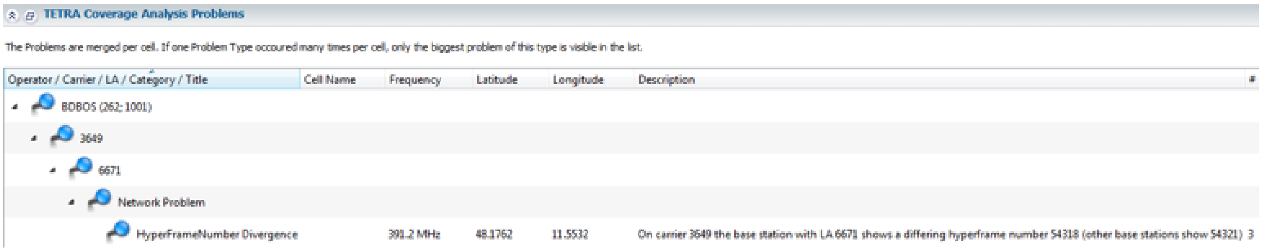


Figure 12-169: Hiper-frame number divergence

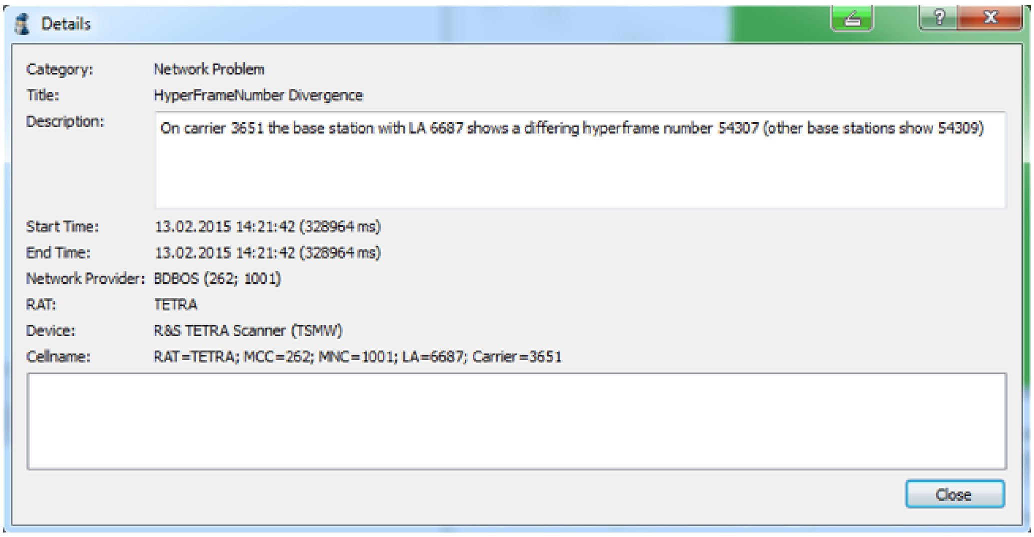


Figure 12-170: HFN divergence details

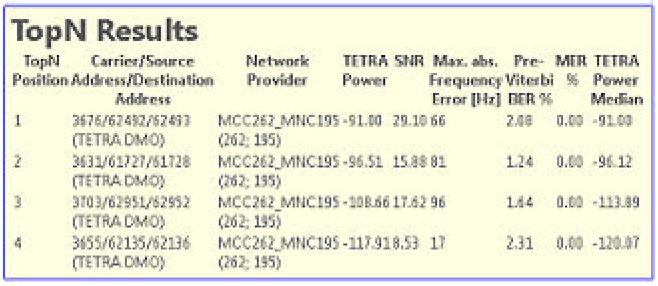
12.16.9.13 Aggregation of TETRA measurements

TETRA measurements can be:

- Direct Mode of Operation (DMO)
- Trunked Mode of Operation (TMO)

TETRA DMO Measurements Only

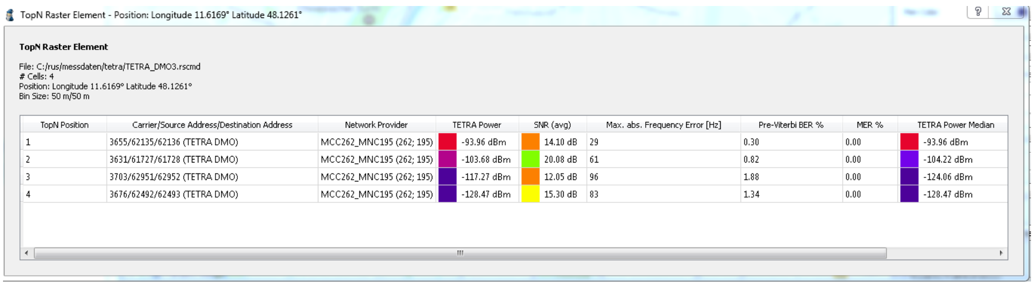
TETRA DMO scanner measurements can be aggregated as shown in the following figures for the Coverage Raster, TopN Raster Elements and Cell Statistics.



TopN Results

TopN Position	Carrier/Source Address/Destination Address	Network Provider	TETRA Power	SNR	Max. abs. Frequency Error [Hz]	Pre-Viterbi BER %	MER %	TETRA Power Median
1	3676/62492/62493 (TETRA DMO)	MCC262_MNC195 (262; 195)	-91.00	29.10	66	2.08	0.00	-91.00
2	3631/61727/61728 (TETRA DMO)	MCC262_MNC195 (262; 195)	-96.51	15.88	81	1.24	0.00	-96.12
3	3703/62951/62952 (TETRA DMO)	MCC262_MNC195 (262; 195)	-108.66	17.62	96	1.64	0.00	-113.89
4	3655/62135/62136 (TETRA DMO)	MCC262_MNC195 (262; 195)	-117.91	8.53	17	2.31	0.00	-120.07

Figure 12-171: Tooltip TopN (TETRA DMO)



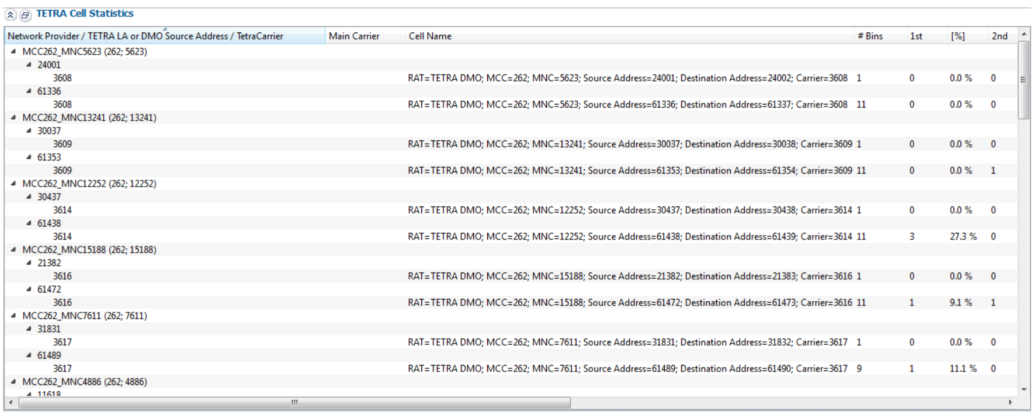
TopN Raster Element - Position: Longitude 11.6169° Latitude 48.1261°

TopN Raster Element

File: C:/rus/messdaten/tetra/TETRA_DMO3.rscmd
Cells: 4
Position: Longitude 11.6169° Latitude 48.1261°
Bin Size: 50 m/50 m

TopN Position	Carrier/Source Address/Destination Address	Network Provider	TETRA Power	SNR (avg)	Max. abs. Frequency Error [Hz]	Pre-Viterbi BER %	MER %	TETRA Power Median
1	3655/62135/62136 (TETRA DMO)	MCC262_MNC195 (262; 195)	-93.96 dBm	14.10 dB	29	0.30	0.00	-93.96 dBm
2	3631/61727/61728 (TETRA DMO)	MCC262_MNC195 (262; 195)	-103.68 dBm	20.08 dB	61	0.82	0.00	-104.22 dBm
3	3703/62951/62952 (TETRA DMO)	MCC262_MNC195 (262; 195)	-117.27 dBm	12.05 dB	96	1.88	0.00	-124.06 dBm
4	3676/62492/62493 (TETRA DMO)	MCC262_MNC195 (262; 195)	-128.47 dBm	15.30 dB	83	1.34	0.00	-128.47 dBm

Figure 12-172: TopN (TETRA DMO) window



TETRA Cell Statistics

Network Provider / TETRA LA or DMO Source Address / TetraCarrier	Main Carrier	Cell Name	# Bins	1st	[%]	2nd
MCC262_MNC5623 (262; 5623)						
24001						
3608		RAT=TETRA DMO; MCC=262; MNC=5623; Source Address=24001; Destination Address=24002; Carrier=3608	1	0	0.0 %	0
61336						
3608		RAT=TETRA DMO; MCC=262; MNC=5623; Source Address=61336; Destination Address=61337; Carrier=3608	11	0	0.0 %	0
MCC262_MNC13241 (262; 13241)						
30037						
3609		RAT=TETRA DMO; MCC=262; MNC=13241; Source Address=30037; Destination Address=30038; Carrier=3609	1	0	0.0 %	0
61353						
3609		RAT=TETRA DMO; MCC=262; MNC=13241; Source Address=61353; Destination Address=61354; Carrier=3609	11	0	0.0 %	1
MCC262_MNC12252 (262; 12252)						
30437						
3614		RAT=TETRA DMO; MCC=262; MNC=12252; Source Address=30437; Destination Address=30438; Carrier=3614	1	0	0.0 %	0
61438						
3614		RAT=TETRA DMO; MCC=262; MNC=12252; Source Address=61438; Destination Address=61439; Carrier=3614	11	3	27.3 %	0
MCC262_MNC15188 (262; 15188)						
21382						
3616		RAT=TETRA DMO; MCC=262; MNC=15188; Source Address=21382; Destination Address=21383; Carrier=3616	1	0	0.0 %	0
61472						
3616		RAT=TETRA DMO; MCC=262; MNC=15188; Source Address=61472; Destination Address=61473; Carrier=3616	11	1	9.1 %	1
MCC262_MNC7611 (262; 7611)						
31831						
3617		RAT=TETRA DMO; MCC=262; MNC=7611; Source Address=31831; Destination Address=31832; Carrier=3617	1	0	0.0 %	0
61489						
3617		RAT=TETRA DMO; MCC=262; MNC=7611; Source Address=61489; Destination Address=61490; Carrier=3617	9	1	11.1 %	0
MCC262_MNC4886 (262; 4886)						
11618						

Figure 12-173: Cell list (TETRA DMO)

Combined TETRA Measurements

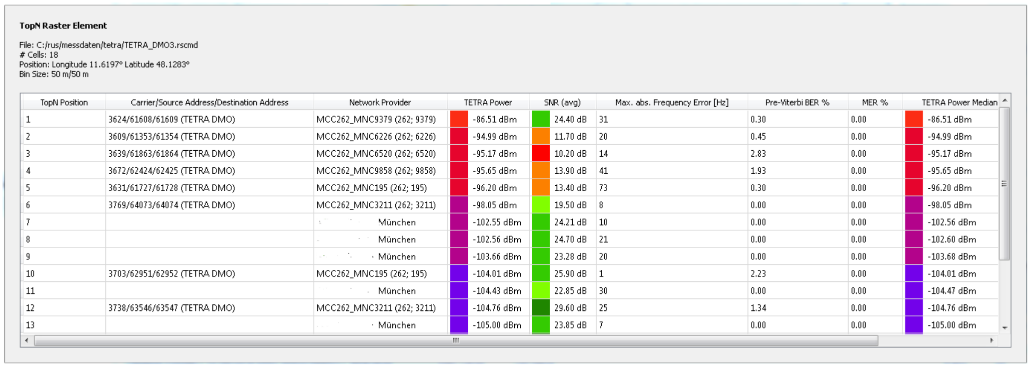
R&S ROMES4 NPA can display measurement file which contains the combination of TETRA base stations measurement and TETRA DMO measurements. Therefore, the presentation is the TopN combined.

TopN Results

TopN Position	Carrier/Source Address/Destination Address	Network Provider	TETRA Power	SNR	Max. abs. Frequency Error [Hz]	Pre-Viterbi BER %	MER %	TETRA Power Median
1	3769/64073/64074 (TETRA DMO)	MCC262_MNC3211 (262; 3211)	-85.51	10.80	16	1.79	0.00	-85.51
2	3672/62424/62425 (TETRA DMO)	MCC262_MNC9858 (262; 9858)	-90.55	19.72	73	1.84	0.00	-90.54
3	3655/62135/62136 (TETRA DMO)	MCC262_MNC195 (262; 195)	-91.51	28.75	86	2.16	0.00	-95.41
4	3732/63444/63445 (TETRA DMO)	MCC262_MNC3211 (262; 3211)	-94.98	15.50	62	1.19	0.00	-105.90
5	3624/61608/61609 (TETRA DMO)	MCC262_MNC9379 (262; 9379)	-95.00	23.28	88	1.69	0.00	-97.76
6	3608/61336/61337 (TETRA DMO)	MCC262_MNC6226 (262; 6226)	-96.86	9.50	33	0.15	0.00	-96.86
7	3614/61438/61439 (TETRA DMO)	MCC262_MNC6226 (262; 6226)	-97.60	22.94	77	0.89	0.00	-114.79
8	3617/61489/61490 (TETRA DMO)	MCC262_MNC13564 (262; 13564)	-99.04	8.31	87	1.88	0.00	-107.16
9	3703/62951/62952 (TETRA DMO)	MCC262_MNC195 (262; 195)	-100.25	20.04	74	2.33	0.00	-111.52
10		[illegible] München	-102.77	24.69	12	0.00	0.00	-102.94
11		[illegible] München	-103.29	24.70	22	0.00	0.00	-103.29
12		[illegible] München	-104.58	22.73	19	0.00	0.00	-104.58
13	3760/63920/63921 (TETRA DMO)	MCC262_MNC13725 (262; 13725)	-104.83	12.81	90	2.18	0.00	-114.45
14		[illegible] München	-105.27	22.54	32	0.00	0.00	-105.44
15		[illegible] München	-106.22	22.01	9	0.00	0.00	-106.04
16	3609/61353/61354 (TETRA DMO)	MCC262_MNC6226 (262; 6226)	-106.63	14.70	5	0.30	0.00	-106.63
17	3623/61591/61592 (TETRA DMO)	MCC262_MNC13564 (262; 13564)	-107.20	19.40	47	1.93	0.00	-107.20
18	3639/61863/61864 (TETRA DMO)	MCC262_MNC6520 (262; 6520)	-108.02	24.23	61	1.49	0.00	-116.23
19	3629/61693/61694 (TETRA DMO)	MCC262_MNC13564 (262; 13564)	-110.45	28.80	52	2.23	0.00	-110.45
20	3631/61727/61728 (TETRA DMO)	MCC262_MNC195 (262; 195)	-119.59	19.67	49	1.09	0.00	-119.05
21	3786/64362/64363 (TETRA DMO)	MCC262_MNC3211 (262; 3211)	-121.77	10.54	98	0.74	0.00	-123.20
22	3616/61472/61473 (TETRA DMO)	MCC262_MNC1393 (262; 1393)	-124.06	27.80	58	2.31	0.00	-124.39
23	3615/61455/61456 (TETRA DMO)	MCC262_MNC9171 (262; 9171)	-126.86	0.40	22	0.15	0.00	-126.86
24	3676/62492/62493 (TETRA DMO)	MCC262_MNC195 (262; 195)	-127.63	19.10	89	0.15	0.00	-127.63

...

Figure 12-174: Tooltip TopN combined

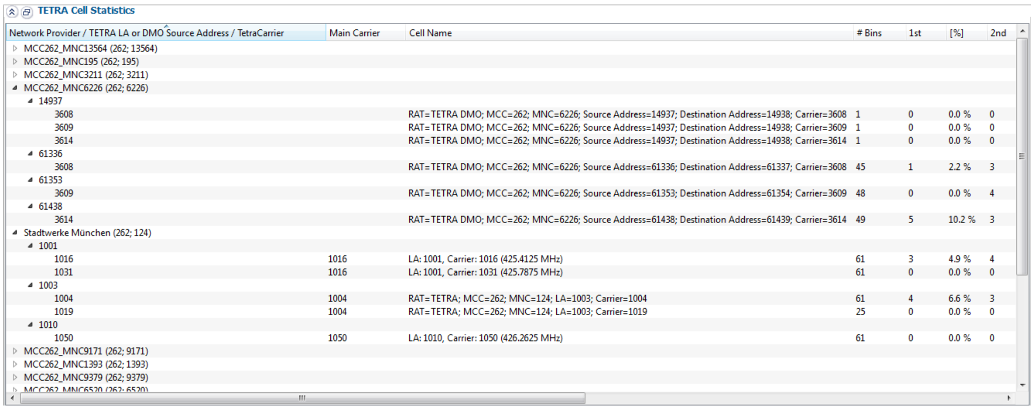


TopN Raster Element

File: C:/rus/messdaten/tetra/TETRA_DMO3.rscmd
Cells: 18
Position: Longitude 11.6197° Latitude 48.1283°
Bin Size: 50 m/50 m

TopN Position	Carrier/Source Address/Destination Address	Network Provider	TETRA Power	SNR (avg)	Max. abs. Frequency Error [Hz]	Pre-Viterbi BER %	MER %	TETRA Power Median
1	3624/61608/61609 (TETRA DMO)	MCC262_MNC9379 (262; 9379)	-86.51 dBm	24.40 dB	31	0.30	0.00	-86.51 dBm
2	3609/61353/61354 (TETRA DMO)	MCC262_MNC6226 (262; 6226)	-94.99 dBm	11.70 dB	20	0.45	0.00	-94.99 dBm
3	3639/61863/61864 (TETRA DMO)	MCC262_MNC6520 (262; 6520)	-95.17 dBm	10.20 dB	14	2.83	0.00	-95.17 dBm
4	3672/62424/62425 (TETRA DMO)	MCC262_MNC9858 (262; 9858)	-95.65 dBm	13.90 dB	41	1.93	0.00	-95.65 dBm
5	3631/61727/61728 (TETRA DMO)	MCC262_MNC195 (262; 195)	-96.20 dBm	13.40 dB	73	0.30	0.00	-96.20 dBm
6	3769/64073/64074 (TETRA DMO)	MCC262_MNC3211 (262; 3211)	-98.05 dBm	19.50 dB	8	0.00	0.00	-98.05 dBm
7		München	-102.55 dBm	24.21 dB	10	0.00	0.00	-102.56 dBm
8		München	-102.56 dBm	24.70 dB	21	0.00	0.00	-102.60 dBm
9		München	-103.66 dBm	23.28 dB	20	0.00	0.00	-103.68 dBm
10	3703/62951/62952 (TETRA DMO)	MCC262_MNC195 (262; 195)	-104.01 dBm	25.90 dB	1	2.23	0.00	-104.01 dBm
11		München	-104.43 dBm	22.85 dB	30	0.00	0.00	-104.47 dBm
12	3738/63546/63547 (TETRA DMO)	MCC262_MNC3211 (262; 3211)	-104.76 dBm	29.60 dB	25	1.34	0.00	-104.76 dBm
13		München	-105.00 dBm	23.85 dB	7	0.00	0.00	-105.00 dBm

Figure 12-175: TopN combined



TETRA Cell Statistics

Network Provider / TETRA LA or DMO Source Address / TetraCarrier	Main Carrier	Cell Name	# Bins	1st	[%]	2nd
MCC262_MNC13564 (262; 13564)						
MCC262_MNC195 (262; 195)						
MCC262_MNC3211 (262; 3211)						
MCC262_MNC6226 (262; 6226)						
14937						
3608		RAT=TETRA DMO; MCC=262; MNC=6226; Source Address=14937; Destination Address=14938; Carrier=3608	1	0	0.0 %	0
3609		RAT=TETRA DMO; MCC=262; MNC=6226; Source Address=14937; Destination Address=14938; Carrier=3609	1	0	0.0 %	0
3614		RAT=TETRA DMO; MCC=262; MNC=6226; Source Address=14937; Destination Address=14938; Carrier=3614	1	0	0.0 %	0
61336						
3608		RAT=TETRA DMO; MCC=262; MNC=6226; Source Address=61336; Destination Address=61337; Carrier=3608	45	1	2.2 %	3
61353						
3609		RAT=TETRA DMO; MCC=262; MNC=6226; Source Address=61353; Destination Address=61354; Carrier=3609	48	0	0.0 %	4
61438						
3614		RAT=TETRA DMO; MCC=262; MNC=6226; Source Address=61438; Destination Address=61439; Carrier=3614	49	5	10.2 %	3
Stadtwerke München (262; 124)						
1001						
1016	1016	LA: 1001, Carrier: 1016 (425.4125 MHz)	61	3	4.9 %	4
1031	1016	LA: 1001, Carrier: 1031 (425.7875 MHz)	61	0	0.0 %	0
1003						
1004	1004	RAT=TETRA; MCC=262; MNC=124; LA=1003; Carrier=1004	61	4	6.6 %	3
1019	1004	RAT=TETRA; MCC=262; MNC=124; LA=1003; Carrier=1019	25	0	0.0 %	0
1010						
1050	1050	LA: 1010, Carrier: 1050 (426.2625 MHz)	61	0	0.0 %	0
MCC262_MNC9171 (262; 9171)						
MCC262_MNC1393 (262; 1393)						
MCC262_MNC9379 (262; 9379)						
MCC262_MNC6520 (262; 6520)						

Figure 12-176: Cell list combined

12.16.9.14 TETRA scanner analysis at the border

The TETRA coverage analyses with R&S ROMES4 NPA offers improvements that let you select the best TopN server and view all the available channels at the country border.

Provider Selection for Bin Color in Coverage Problem Spot Map

The coverage analyses problem spot page for TETRA provides the possibility to select a provider in the "Select Provider" drop-down list.

The color of the active layer is than defined by that provider. The selection of the provider in comparison to the general filtering does not influence the bin information and content.

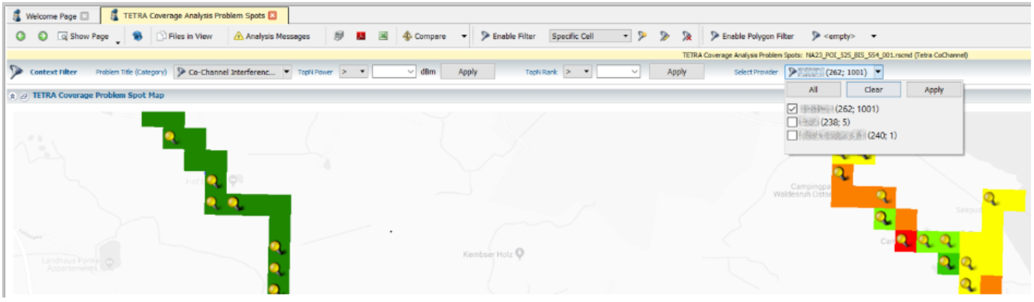


Figure 12-177: Selection of the best TopN server

You can still see all cells in the bin window to investigate the complete TopN pool (from all providers). You can see the SNR value layer in the map for your own provider only, but the results of all measured cells is displayed in the TopN list. You can check easily the interference situations in this way.

TopN Results

TopN Position	TETRA LA/Carrier (Cell Name)	Cell Info	Network Provider	TETRA Power	SNR	Max. abs. Frequency Error [Hz]	Pre-Viterbi BER %	MER %	TETRA Power Median
1	343/3695 (n/a)	Main Carrier=3685		-85.8	11.3	42	12.2	0.0	-85.8
2	4770/3643 (n/a)	Main Carrier=3643		-86.2	11.0	53	5.5	4.2	-86.2
3	411/3651 (n/a)	Main Carrier=3651		-86.3	18.6	14	1.3	1.7	-86.8
4	343/3715 (n/a)	Main Carrier=3685		-87.0	24.1	25	0.0	0.0	-86.2
5	4772/3695 (n/a)	Main Carrier=3695		-87.1	16.6	72	4.2	0.5	-87.0
6	202/3652 (n/a)	Main Carrier=3642		-87.9	12.8	65	6.0	7.5	-89.5
7	411/3661 (n/a)	Main Carrier=3651		-88.3	19.8	18	4.2	2.2	-90.1
8	4899/3686 (n/a)	Main Carrier=3686		-88.9	15.3	43	2.0	1.3	-90.0
9	202/3663 (n/a)	Main Carrier=3642		-89.7	15.3	23	11.9	10.0	-89.8
10	272/3744 (n/a)	Main Carrier=3744		-90.2	21.7	20	3.8	1.4	-90.2

...

Figure 12-178: TopN list of best TETRA servers

Differentiation of Co-channel Interference Spots

The R&S ROMES 4NPA TETRA interference problem analyzer differentiates between three types of co-channel interference spots.

The bin based co-channel interference problem contains the complete cell information for the 2 interfering cells. The analysis takes all measured provider into account.

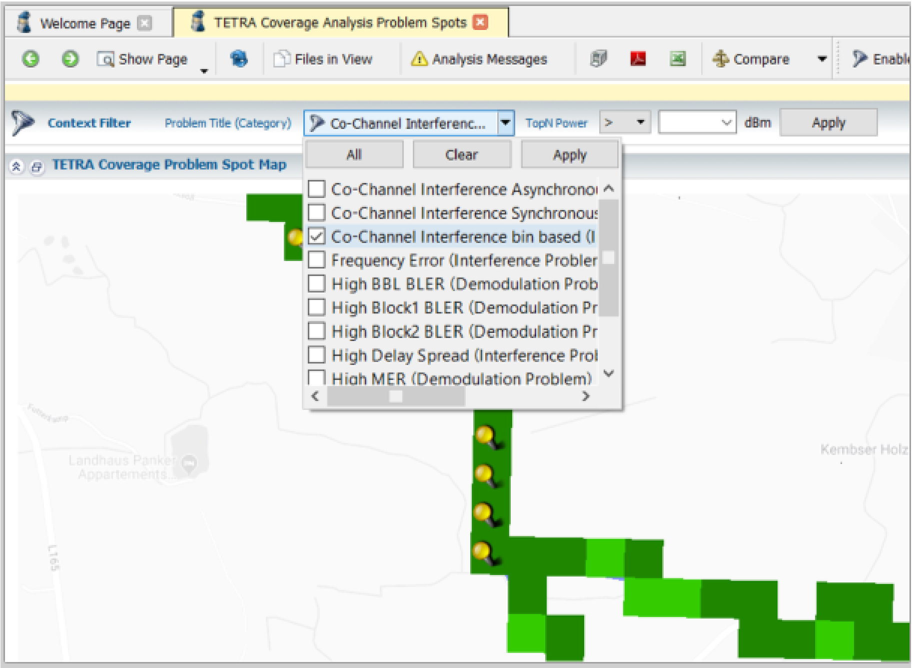


Figure 12-179: Co-channel interference problems selection for display

With the different problem types you can filter for each co-channel problem title with one click in the "Co-Channel Interference" context filter drop down list.

The problem table provides an overview of the ProblemSpots. The spots are consolidated per cell (carrier/LA) and the number of occurrences is stated in the table too. This is opposite to the map, where each problem spots are shown with the pin symbol.

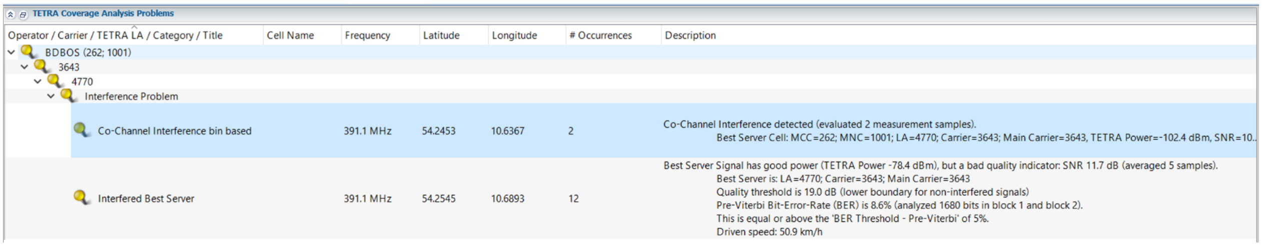


Figure 12-180: Result of the analyses of co-channel interference problems

Co-channel Interference Problem Statistic

This statistic shows the count of bin-based co-channel interferences per provider.

The count is divided in two categories. Category “Own Network” counts all generated Co-Channel problems where the interferer is a cell from the same provider (own cell).

In the other category “Other Provider”, all problems are count, where the interferer is a cell from any other provider.

- "Own Network"
  This category counts all generated co-channel problems where the interferer is a cell from the same provider (own cell).
- "Other Provider"
  This category counts all problems where the interferer is a cell from any other provider.

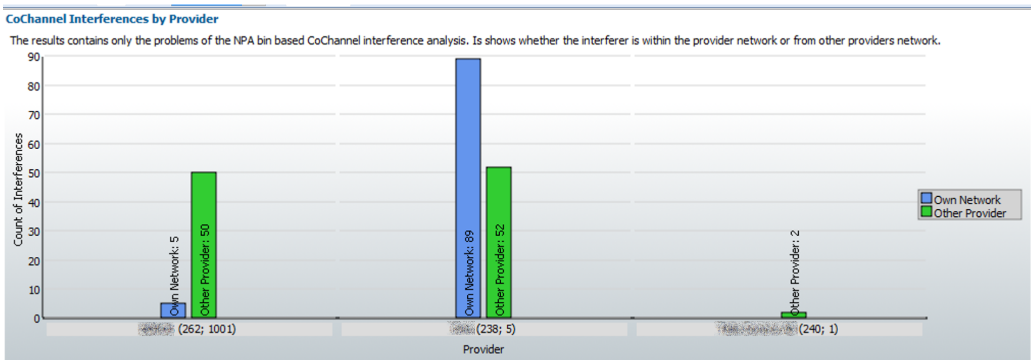


Figure 12-181: Co-channel interference by provider

12.17 Mobile coverage analyzer

If a new technology is used to establish a mobile network, one of the first steps in the network optimization is to provide services in as many areas as possible. In the existing networks, the coverage analysis is a day-to-day required to guarantee high network quality.

The Mobile Coverage Analysis (MCA) plugin calculates coverage data based on measurements performed by mobiles. It shows the mobile view of the networks, the decisions the mobile made and the distribution of main mobile parameters.

The analyzer module is able to process the following technologies:

- GSM
- WCDMA
- LTE
- NB-IoT
- TETRA (limited due to availability of parameters)

The mobile coverage cell statistics tables for WCDMA and LTE contain the column showing the DL channel UARFCN and EARFCN, respectively.

MCA plugin support of LTE

- Carrier Aggregation

To run the CA analysis and to see the analysis results in the GUI, the R&S ROMES4N22 option is required. For more details, see Chapter 12.25, "LTE carrier aggregation analysis", on page 446.

- Narrowband IoT
  The R&S ROMES4 scanner measurements for NB IoT are aggregated. For unique identification of the NRSRP, NRSRQ and NSINR measurements the frequency, NPCI and the BTS id dedicated by the scanner are used.
- Mobile devices with the Samsung chipsets can provide throughput values from the physical layer.

12.17.1 Coverage raster

The functionality described in the following is only available if a GPS is connected during the measurement. The reason is as all the results are created based on a geographical grid.

The first step during the analysis for the mobile coverage analysis module is to create a raster of the measured data. This is also an important data reduction strategy to use data from multiple files later on.

Rasterization is done as follows:

1. For each measured parameter the geographic location is determined. This might be an interpolated location if GPS was no available for a short time.
2. The current position is transformed into an UTM coordinate (refer to "Rasterization Settings" for a more detailed description).
3. The UTM coordinate is then used to calculate the grid position.
4. The center of the grid is transformed back into a WGS 84 datum as delivered from the GPS.
5. Using the grid center, the world map is divided into a grid aligned to the longitude used as the center for the UTM zone of the size configured in the preferences dialog.

   For each such grid center, the described parameter grouped by the current serving cell of the mobile are shown. There are filters available to reduce the visible result only for a special device, operator or technology.

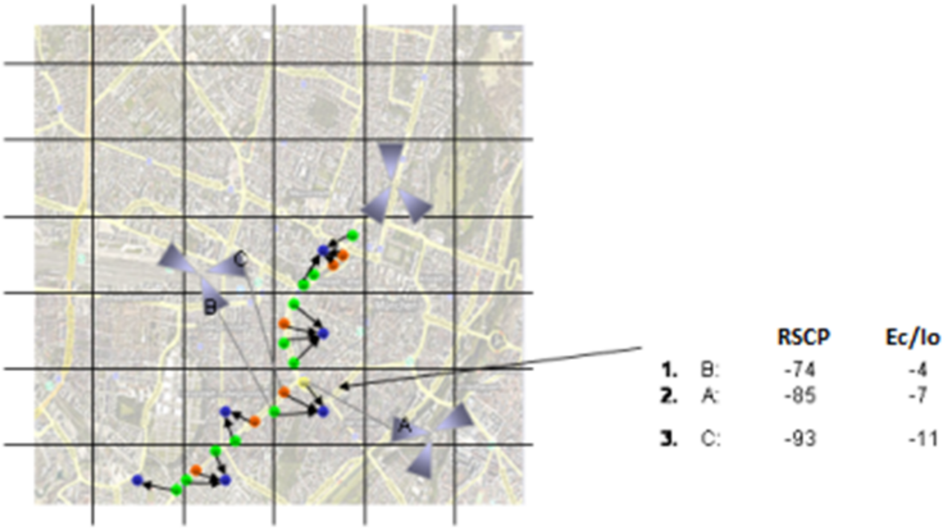


Figure 12-182: Coverage raster of the scanner data

Table 12-11: Parameters per technology relevant for coverage analysis

LTE	UMTS	GSM	TETRA
RSRP	RSCP	RxLev	TETRA Power
RS SINR / RSRQ	Ec/Io	C/I	C1
CQI	CQI	RxQual / BEP (EDGE)	BER Threshold
TxPower	TxPower	TxPower	---
Physical Throughput (PDSCH/PUSCH)	---	---	---
Used RB and MCS	---	---	---
CA - number of used carriers, cumulated DL throughput and bandwidth per UE/operator	---	---	---

This result is used in later steps, for example, to perform the problem spot analysis. This result can be visualized using the coverage maps in the GUI. For most of the parameters in the table and for the band of the cell are selectable for display as graphical layer in the map.

The default value for the minimum number of samples per bin to produce an entry in the final analysis result for the serving cell statistics is 7.

If no bins should be displayed, reduce the value of the samples to 1 in the "Min Raster Sample" option of the "Data Processor Configuration" > "Mobile Coverage Analysis Processor" page.

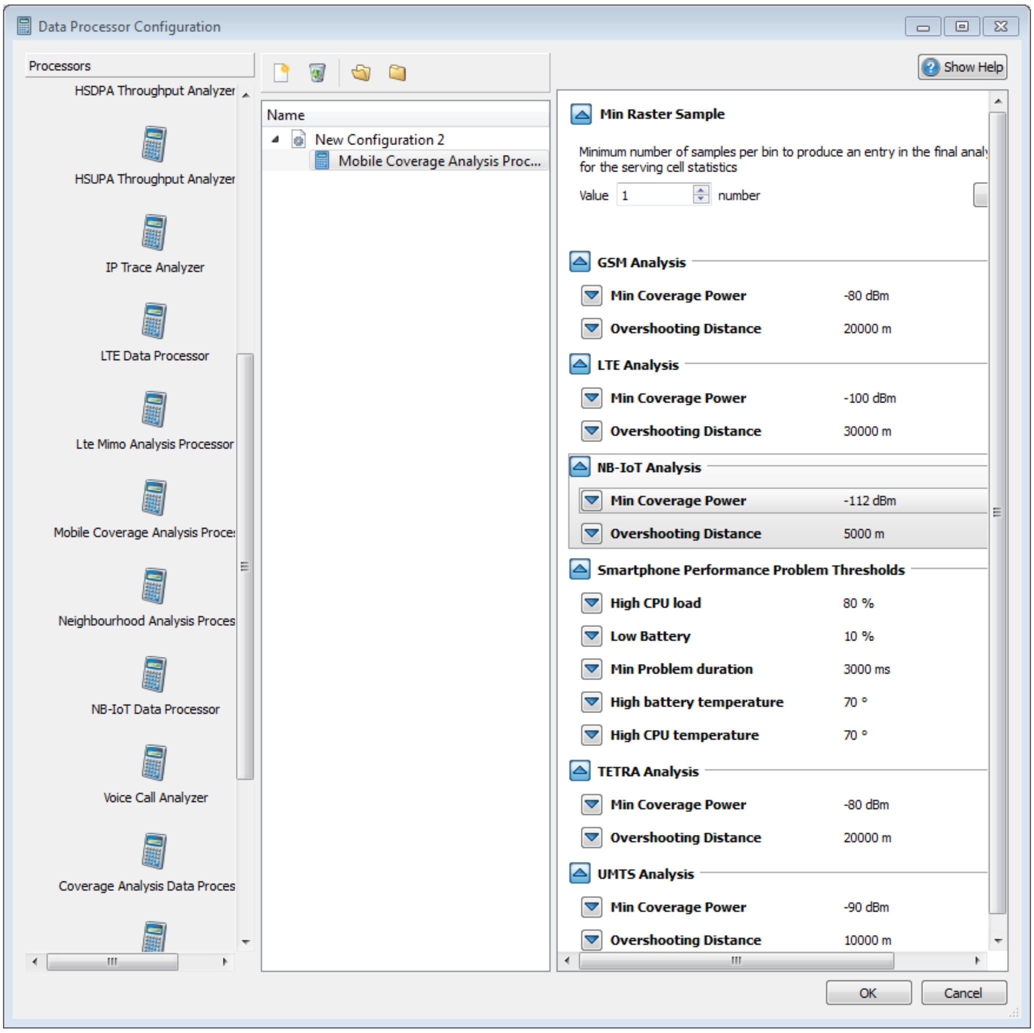


Figure 12-183: Configuring the MCA processor

The page offers for each technology the option to specify the minimum coverage power and the thresholds for the overshooting distance. The latest mentioned option allows detection of overshooting for the distances between a BTS and the UE bigger that 20 km.

12.17.2 Mobile coverage problem categories

Based on the receiving signal power the analysis module checks if the average power value of a raster element id below a threshold as well as the distance the signal covers. There is also a minimum number of values which have to be measured in the raster element.

For reporting the coverage and overshooting problems the condition for the minimum number of values measured in the raster element has to be fulfilled.

12.17.2.1 Coverage problem

The coverage problem is detected and reported if the averaged received power level of the raster element is below the coverage [power] limit threshold. The "Mobile Coverage Raster & Problems" page shows the detected coverage problems as the red pins in the "Mobile Coverage Map" and "Mobile Coverage Problems" fields.

The threshold value should be configured differently per technology.

Parameter	Value Range	Default	Description
Coverage - [Power] Limit	-150 dBm to -40 dBm	-100 dBm (LTE) / -90 dBm (WCDMA) / -80 dBm (GSM) / -80 dBm (TETRA)	Coverage problems are reported if the averaged power level of the raster is below this threshold. Unit: [dBm]

12.17.2.2 Overshooting problem

The overshooting problem is detected and reported if the signal power level exceeds the min value at the distances higher than specified.

The "Mobile Coverage Raster & Problems" page shows the detected overshooting problems as the blue pins in the "Mobile Coverage Map" and "Mobile Coverage Problems" fields.

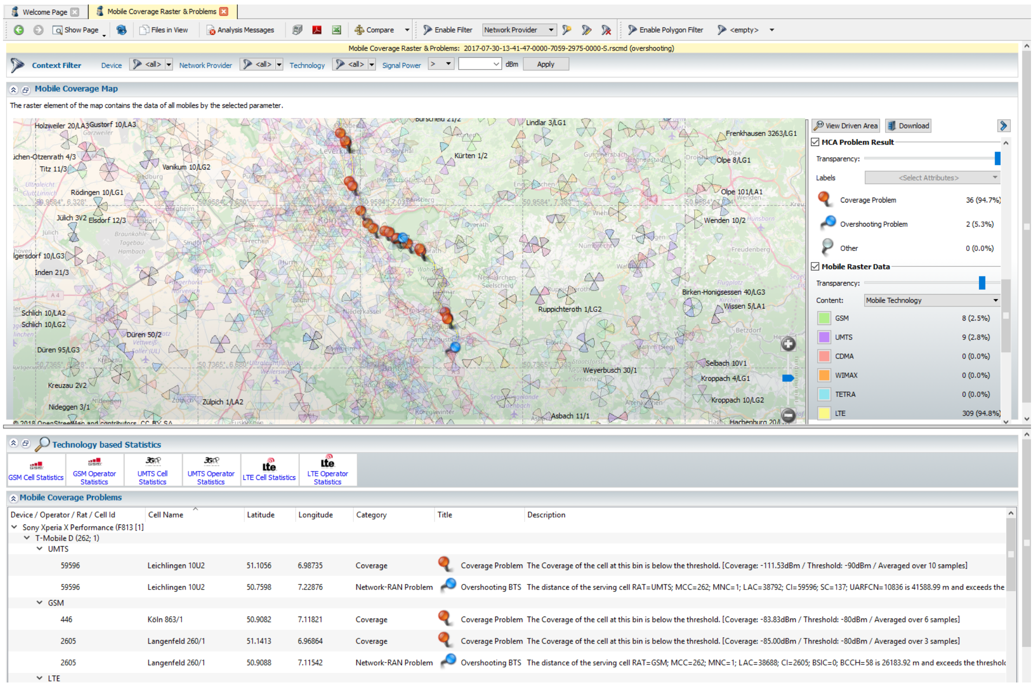


Figure 12-184: Problems detected with MCA

12.17.3 Cell statistics

For all cells that are found during the rasterization steps a final statistic is created. That statistics contains how many raster elements for this cell in the total grid and some key statistical indicators related to parameter, like minimum, maximum and average.

These results are also visualized in the coverage pages of the supported technologies. The following figure shows the coverage plot.

12.17.4 Operator statistics

To characterize the network from the mobile perspective, the statistical page is used which shows the CDF charts and tables.

If the measurement results for different network operators are contained in one measurement file or multiple files, the charts and the tables show the results separated by operators, see the following figure.

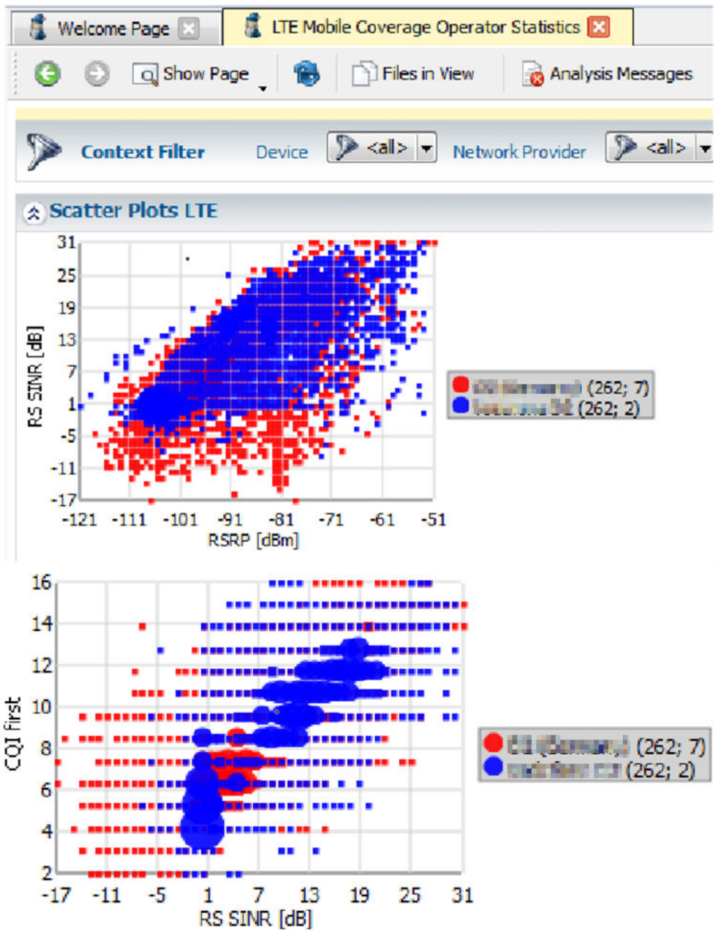


Figure 12-185: Mobile coverage - two operators statistics example

You can filter the display of the statistics page per operator or per several selected operators, as shown in the following figure. In the figure a single operator is selected.

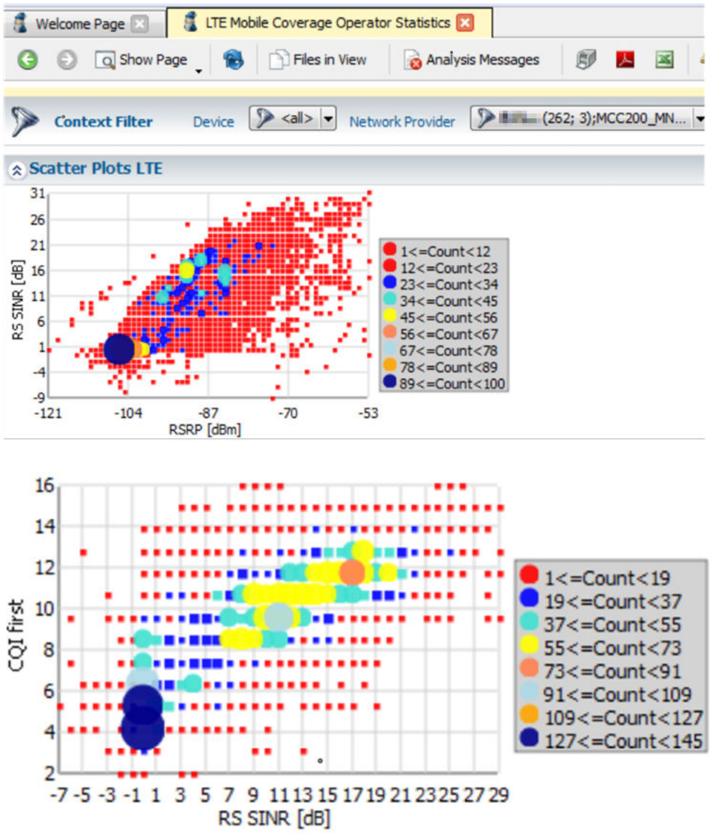


Figure 12-186: Mobile coverage - statistics for filtered operator

If you hover with a mouse over a point of the plot, a Tooltip is shown containing the name of the operator and the measured values at that point.

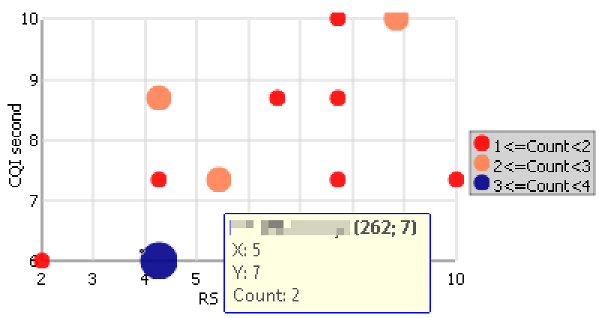


Figure 12-187: Tooltip for the selected point in the scattered plot

The scattered plot shows, for example, the relationship between the received signal power and interference, interference and quality, throughput and quality and so on.

The Mobile Coverage plugin informs when no valid serving cell could be found in the complete measurement file or in the first 20% of the file. For a complete serving cell information, all parameters, that is MCC, MNC, CellId and technology based LA or LAC or carrier, are required.

12.17.5 Smartphone performances analysis

The R&S ROMES4 NPA Mobile Coverage Analyzer is able to analyze the following smartphone performance values:

- Battery level
- Battery temperature
- CPU total level
- CPU temperature

The values are used for distribution bar charts and a problem analysis.

If a measured value is below (battery level) or higher (other 3 values) than the configured threshold and this stays over a long time (duration threshold), a problem is created.

The user can configure thresholds which when exceeded trigger the problem analysis.

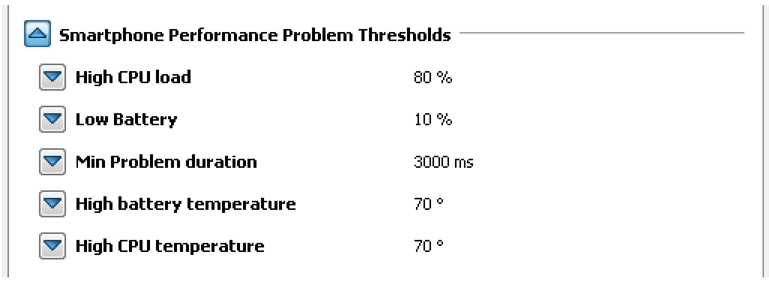


Figure 12-188: Configuration of thresholds for smartphone performance problems

The values are collected per device. The values are visible at the "Mobile Performance Analysis" page. The page can be selected via overview page and page menu.

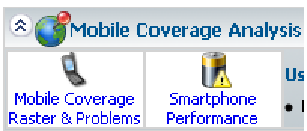


Figure 12-189: Tab to start the smartphone performance analysis

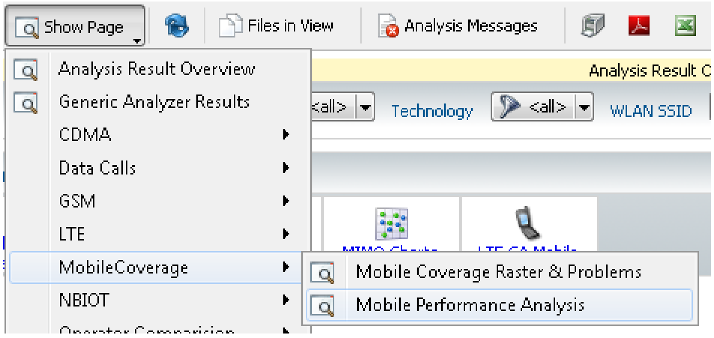
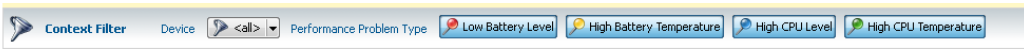


Figure 12-190: Menu to start the smartphone performance analysis

There are filters for the device and the problem types on top of the page, shown in the following figure.



The page contains a map and a table to see the problem results.

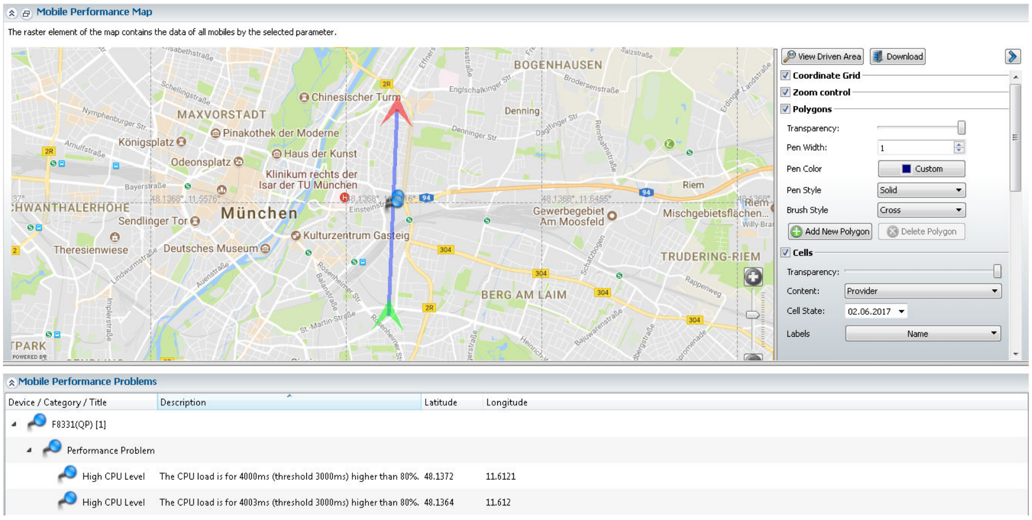


Figure 12-191: Mobile performance map and problems

12.17.5.1 Smartphone performance charts

For each of the previously mentioned smartphone performance values, whose exceeded threshold indicates a problem, a distribution in [%] per device is available as a bar chart.

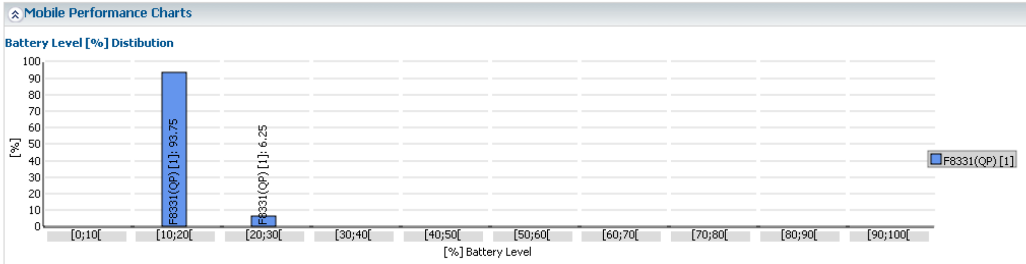


Figure 12-192: Distribution of battery level

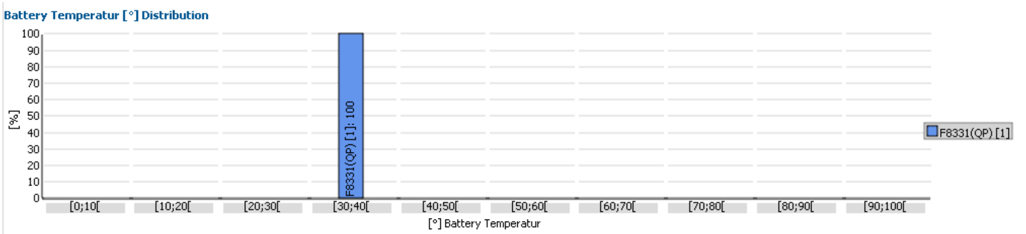


Figure 12-193: Distribution of battery temperature

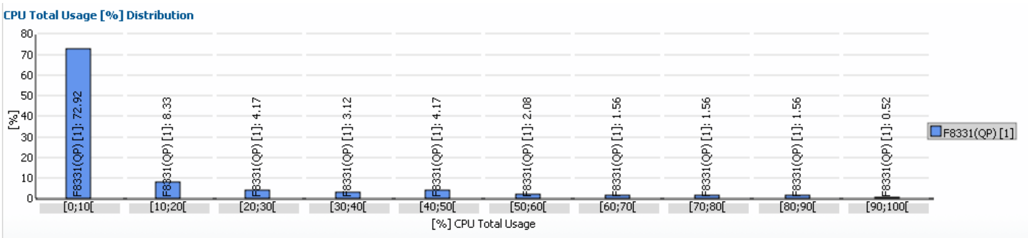


Figure 12-194: Distribution of CPU total usage

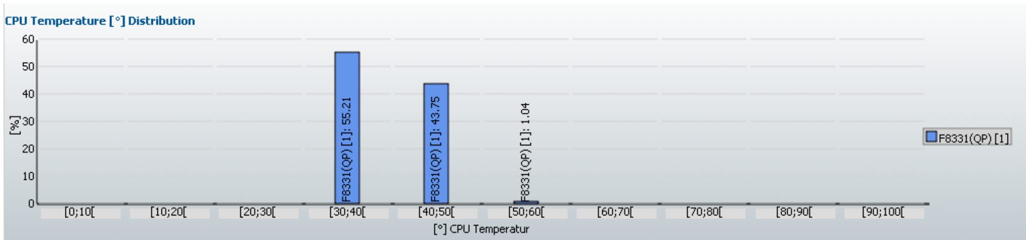


Figure 12-195: Distribution of CPU temperature

12.18 neighborhood analyzer

Providing radio services to mobile users requires all modern networks to offer hand-over capabilities between the cells. In nearly all possible scenarios a single cell will probably not suffice to serve all users, especially when coverage decreases significantly.

Most of the time a cell shall not allow handovers to any other possible cell. The set of cells to which handovers are allowed is normally determined in the network planning stage and fine-tuned in the optimization phase. Modern self-organizing networks even try to derive such neighborhood relations from local measurements and/or user statistics. Nevertheless it is crucial when operating a network to have a means of verifying the current settings. The R&S ROMES4 NPA supports such verification with its neighborhood Analyzer.

neighborhood Analyzer supposes that the R&S ROMES4N17 option is available.

Neighborhood analysis requires the R&S ROMES4N17 option.

12.18.1 Algorithm

Serving cell assignment from measured cell list is performed by operator and by frequency.

To verify if the current lists are sufficient and what possible changes could make sense, the analyzer uses data from at least a scanner and mobile of a technology, if available. When both devices are available, the overall results are improved by combining the measurement samples in a meaningful way, where the mobile provides the best server in a raster grid and the scanner data is used to find possible neighborhood relations.

From the scanner power measurement samples, a raster is created, which is basically the same as created in the Coverage Data Processor. Such a raster element contains a designated serving-cell and a list of other cells received ranked by their average power. For each cell that is at least one time a serving cell, those raster elements are aggregated to form a list of potential neighbors. The entries in that list are classified whether they could be meaningful neighbors or not, depending on their averaged power reception level and quality.

Besides the coverage values provided by those devices, the current network configuration is taken from the technology specific messages sent by the base stations. These lists are compared to the calculated neighbor lists, and possible problems are then reported to the user. This way the algorithm can detect the following situations:

- Missing In-Band neighbor
- Missing Out-Of-Band neighbor
- Unused neighbor
- Confirmed neighbor

It is also possible to compare the neighbor relations from the broadcast messages in the network with the cell database content if there is any. This can help finding differences in the current planning state and in the operating network, or gives a hint on an outdated local cell database content. Additionally, it is possible to measure the distance between two neighbors and indicate if they are far away from each other. The following situations can be detected:

- Data Inconsistency
- Long Distance Relationship

12.18.1.1 Missing in-band neighbor

If a neighbor has been measured in a set of raster elements with strong power and quality (i.e. better than Min Received Power and Min Quality thresholds), but is not currently part of the neighborhood list transmitted in the system information messages, it is classified as (potentially) missing neighbor.

12.18.1.2 Missing out-of-band neighbor

Same as above, but the potential neighbor has been detected in a band different to the one where the serving cell is located. The band is displayed in the neighborhood analysis table for convenience.

12.18.1.3 Unused neighbor

If a neighbor is configured but has not been measured, it is marked as potentially unused neighbor. This is only a hint since it might be the case that a drive test simply did not pass through the covering area of the neighbor cell.

12.18.1.4 Confirmed neighbor

If a neighbor is considered as potential neighbor and if it is already part of the neighbor list, it is marked as confirmed relation that makes sense based on the currently analyzed set of drive test data.

12.18.1.5 Data inconsistency

If the system type information and cell database content do not match this problem occurs.

The neighborhood Analyzer compares the broadcast message 'neighbors' with the 'neighbors' message in the database. There are two possible reasons for a mismatch:

- A neighbor relation has been found in the broadcast message from the network but not in the database
- A neighbor relation was stored in the database but not found in the broadcast message

If the first case occurs and the measured neighbor is strong, the "SIB Entry not in DB, but Strong neighbor" information is added to the problem definition table, see the following figure.

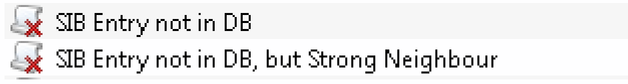


Figure 12-196: neighbor cell not in the database

Both cases indicate that you are possibly working with an outdated cell database and a new one should be imported, or the neighbor is not setup properly in the base station configuration.

12.18.1.6 Long distance relationship

If the locations of two towers that have a neighbor relation are at least a certain distance away from each other they are marked as long distance relationship.

The longer the distance, the higher the likeliness that this is a not wanted configuration. Up to 15 km distance this is considered as no problem and will not be reported. Ranging from 15 to 30 km this is rated as informational message with the title "Medium Distance Relationship", starting from 30 km this is issued as warning with the aforementioned title.

12.18.2 Analyzing results

If there are any possible problems detected with the neighborhood Analyzer, a hint is shown in the "Analysis Overview" page that directly links to the specialized analysis page. In that page a map view visualizes the cells in a map view and shows the calculated neighbor list and comments on that list in a table, see Figure 12-197.

To make the cells shown, a fitting cell data file must be available in the transmitter database. With the data from the cell database, the distances between the stations can also be calculated.

Selecting items in the tree view will synchronize to the related analysis result icon the map. If the cell database is filled with appropriate data, the best server and neighbor cell are selected in the "Cell Database" window, and those cells are selected in the map. The cell used for synchronization is the serving cell of the selected entries. Besides that, the connection lines from the analysis result icon to the two cells are also painted.

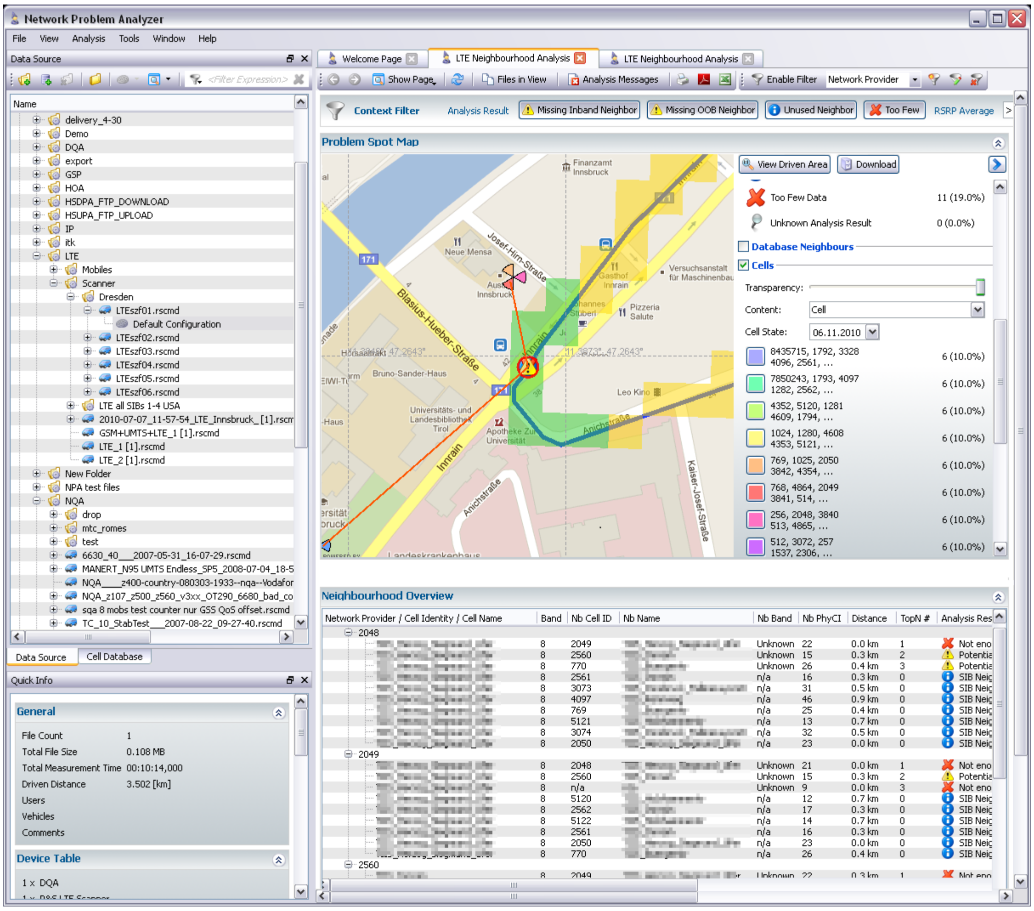


Figure 12-197: LTE neighborhood analysis

The "neighborhood Overview" window of neighbor cells for LTE has added a column showing the bandwidth. Both neighbor cell cases, that is, the intra-/inter-RAT neighbor cells' bandwidths are supported.

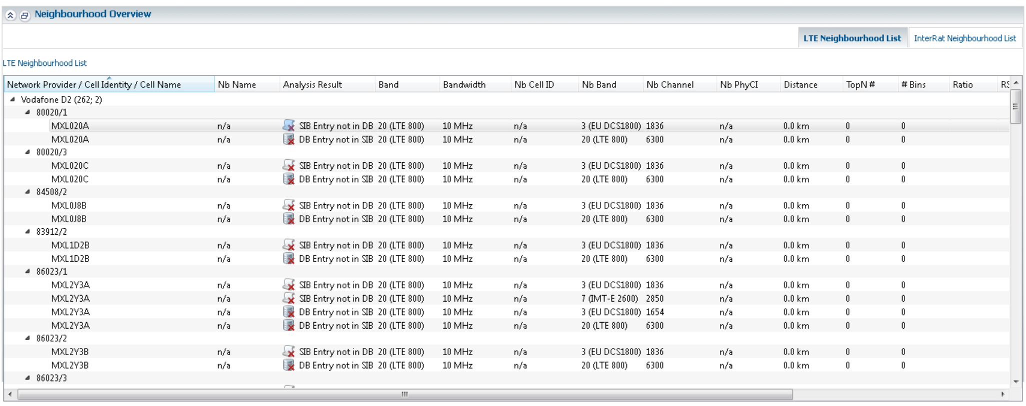


Figure 12-198: Intra-RAT neighborhood cells list

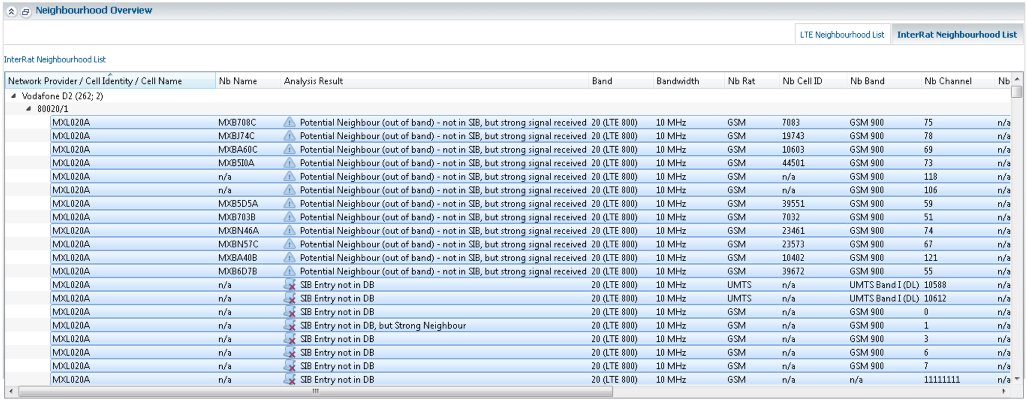


Figure 12-199: Inter-RAT neighborhood cells list

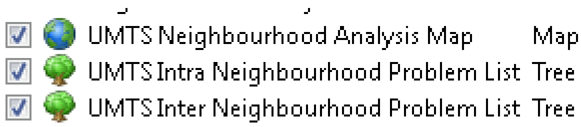
12.18.3 General configuration

Most of the logic in the neighborhood Analyzer does not require any input from the user, so the configuration offers only a few options for modification. These are described in the following table.

Table 12-12: neighborhood Analyzer - Configuration

Parameter	Value Range	Default	Description
Calculate Scanner/ Mobile Offset	true, false	true	If this is enabled, an offset between scanner and mobile measurements is calculated and considered when comparing TopN entries from both sources.
Min Received Power	-140..30 dBm	-100 dBm	Min. Power for missing neighbor. TopN entries with an averaged power below that threshold will not be part of the "missing neighbors" list.
Min Quality	-100..100 dB	-25 dB	Min Quality for missing neighbor. TopN entries with an averaged quality below that threshold will not be part of the "missing neighbors" list.

The names of the page elements in the report configuration tab look like these shown for UMTS neighbourhood analysis.



12.19 Handover analyzer

One of the most crucial procedures in cellular networks compared to stationary ones is the handover procedure when a mobile needs to disconnect from one cell to another one in order to improve speech quality or data throughput. In case of voice calls the time where communication is not possible must be minimized, and in case of data high throughput rates are the most important target. So analyzing these procedures is highly important when look at mobile data, especially when lots of data is available.

The R&S ROMES4 NPA offers such handover analysis at the procedure level by looking at the Layer3 and RRC messaging for LTE, NB-IoT, UMTS, GSM and TETRA currently. It detects successful and failed handovers and prepares the most important statistics to be available in a concise overview. Handover analysis results in the R&S ROMES4 NPA can be reached from the analysis result overview page and the visualization looks similar as depicted below.

Additionally, the handover procedures themselves are analyzed for several problems. One such problem can be the ping-pong handover, where a handover from cell A to cell B and the reverse handover occur within a short time interval. These problems are described in the Handover Problems section.

The Handover Analysis module can be used only if the R&S 4N17 is available.

12.19.1 Evaluation

The final result page of handovers is structured in the same way for all technologies. On the top of the page shown are the handover events on the track shape where successful and failed handovers are visualized differently. Selecting such an event will show lines to the originating and destination cell in orange, respectively in green if a cell database with those cells is available. The cell names are also shown in the handover table at the bottom of the page.

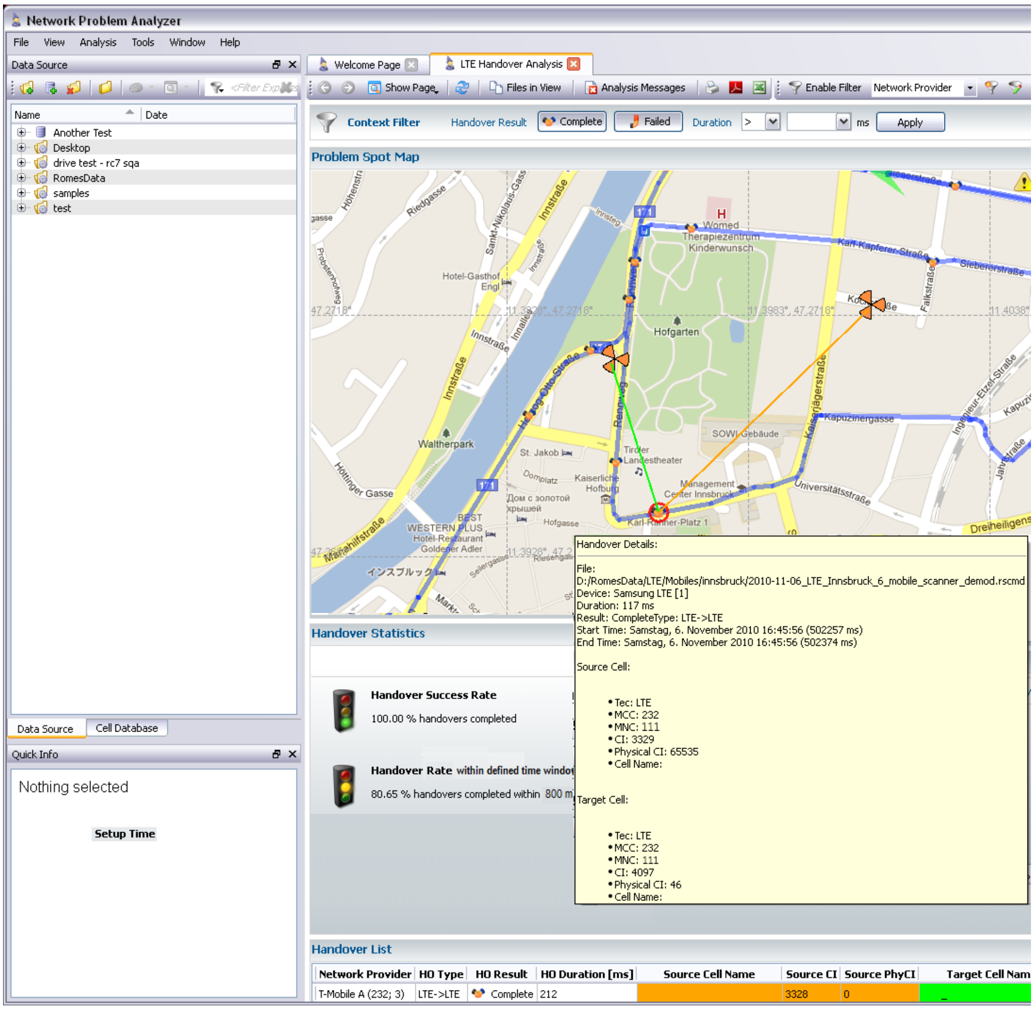


Figure 12-200: Handover details Tooltip

On the very beginning of the page the context sensitive filter supports hiding or revealing events with a special result and/or a designated handover duration.

The middle section shows some basic handover specific KPIs, statistical information and the detected handover problems. It offers different visualization of success rate and handover rate within defined time window. The duration threshold is changeable, see Figure 5-4.

If you select an entry in the "Handover List", the fitting process in the map view will be selected and possibly zoomed showing the connections for the current selection, remark the orange and green lines in the "Problem Spot Map". The same applies vice versa when elements are selected in the map view.

12.19.2 Handover procedures

All handover procedures across different technologies basically work in the same way: A handover need is determined, a handover command is sent and the procedure is either completed successfully, rejected or a timeout occurs.

This flow can be illustrated easily with a so called state machine, which is shown in the picture below. Such a state machine consists of several state, which are IDLE, START and END in this case, and transitions that map from one state to the other based on some event. Here the events are HO_START, HO_END, HO_REJECT and HO_COMPLETE. These events are derived from technology specific trigger points as described in the subsequent sections.

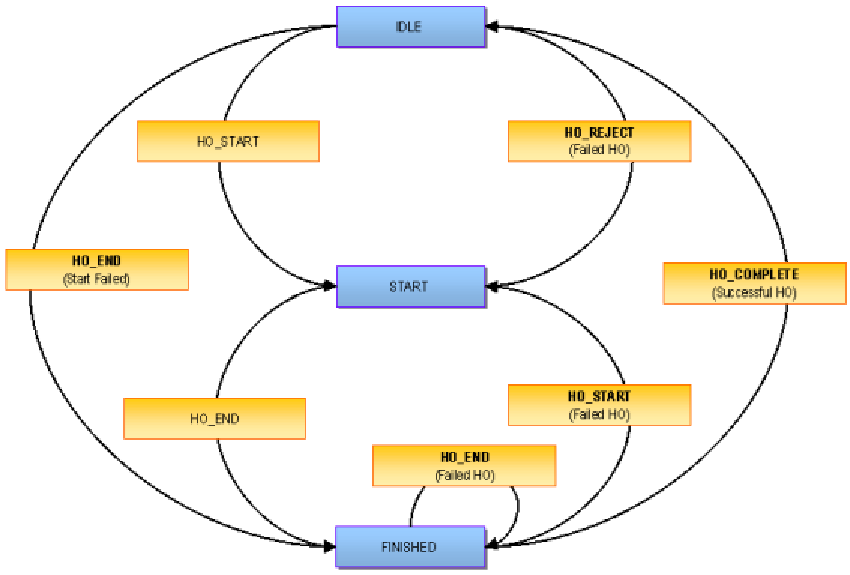


Figure 12-201: State machine illustrating handover procedure

During a transition from one state to another a classification of handovers can be done. For example, when the HO_COMPLETE event arrives in the HO_END state, the complete handover procedure is classified as "successful handover". Each such handover procedure will be recorded by the handover analysis plugin and be available in the handovers result table as shown above for both idle and connected mode.

Besides the result of the whole procedure, the duration of the handover is an interesting value, too. The handover analysis processor also calculates the handover duration based on the trigger points HO_START and HO_COMPLETE for most of the technologies (details follow in the next sections).

One handover event therefore consists of the following information:

- Handover Results
- Handover Duration
- Start Cell
- End Cell

- Position(s) of HO Start and HO End
- Timestamps of HO Start and HO End

12.19.2.1 General configuration

The handover problem analysis module can be configured by adjusting the time-out values for different types of problems.

Parameter	Value Range	Default	Description
Fast HO Interval	0..10000 msec	3000 msec (LTE), 5000 msec (TETRA), 3000 msec (GSM), 3000 msec (UMTS)	If two successive handovers occur within this time window, a problem is reported. If the two handovers involve the same two cells, the problem is titles Ping-Pong Handover.
Min Power Threshold	-150.0..-50.0 dBm	-105 dBm (LTE), -115 dBm (TETRA), -96 dBm (GSM), -96 dBm(UMTS)	After a successful handover, the initial power measurement of the destination cell must exceed this value, or a Coverage Problem is indicated.
Timeout Interval	0..10000 msec	5000 msec (LTE), 15000 msec (TETRA), 5000 msec (GSM), 5000 msec (UMTS)	Expected handover messages must arrive within this time frame to avoid Timeout problems being reported.

12.19.3 Handover results

The "Handover Results" bar chart shows statistics for each handover type.

The statistics is the absolute count of the events related to handover procedure. See Figure 12-51 for an illustration of HO results.

Additional statistics for VoLTE requires the VoLTE license ROMES4N22.

12.19.4 Handover problem detection

Besides the statistics and event list created in the handover analysis processor, there is also a handover problem detection algorithm that can recognize the following types of problems when it checks for inconsistencies and strange behavior in the handovers sequences. The results of this analysis are shown on the page of the statistics and procedures in an additional "Handover Problems" section. Selecting entries in the list, show the related problem spots displayed in the map.

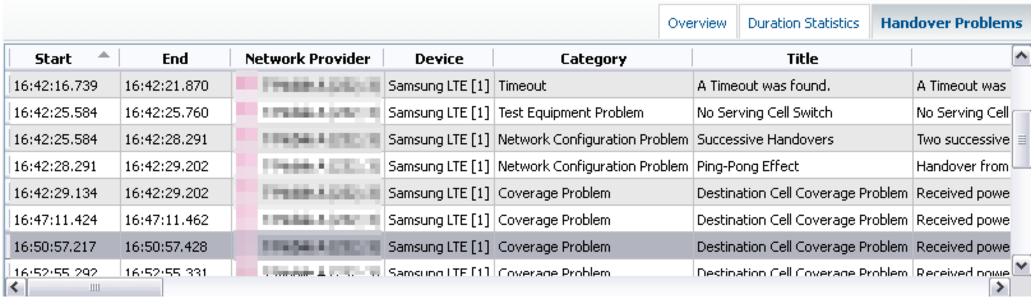


Figure 12-202: List of detected handover problems

Successive Handovers

A successive handover chain is detected when two handovers are performed closely related in time. I.e. a handover from cell A to cell B and another one to cell C is found within the "Fast HO Interval" threshold.

Ping-Pong-Handover

When a handover from cell A to cell B and an immediate (within the time interval "Fast HO Interval") handover back to A is detected, this is classified as a ping-pong handover. Normally you do not want such a behavior in the network and the standard approach is to adjust the hysteresis settings or to check the cell coverage and overlapping areas.

Call Dropped

When a call drops between a handover, the call drop ceases the whole handover procedure since there is no longer a need for the mobile to perform a switch to the new cell.

Coverage Problem

If the new cell after the handover is below the "Min Power Threshold" limit, a Coverage Problem is detected.

Messaging Problems

As a minor possible problems missing Layer3 messages are reported as well. Each start and end trigger of the related technology handover is tracked. Some of them can indicate a problem in the mobile, like it does no show all Layer3 messages. The problem can be that the messages are manually removed in the R&S ROMES4 configuration step. The time to wait for a message to arrive is configurable using the "Timeout Interval" setting.

12.19.4.1 Problem spot at TETRA handover analyzer for consecutive layer3 messages

The handover analyzer for TETRA provides a problem spot at the category Messages Problems (green pin).

The problem spot shows a consecutive number of the same Layer3 message type during a fixed time span. Currently is available only problem spot detection for the consecutive D-New-Cell messages.

The time span (in seconds) and the minimum number of detected messages during the time span is user configurable. This configuration is available in the plugin configuration of the "Handover Analyzer" > "TETRA Analysis".

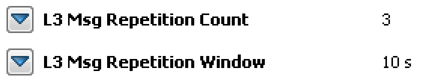


Figure 12-203: Parameters to set Layer 3 repetition problem spot

If the problem spot is detected, it is shown in the "Handover Problems" page.

Figure 12-204: Handover problems tab - detail

The problem is shown at the map as a green pin as well.

Figure 12-205: TETRA Layer3 messaging problem at the map

The details of a detected problem are shown in the "Problem Spot Attributes" page.

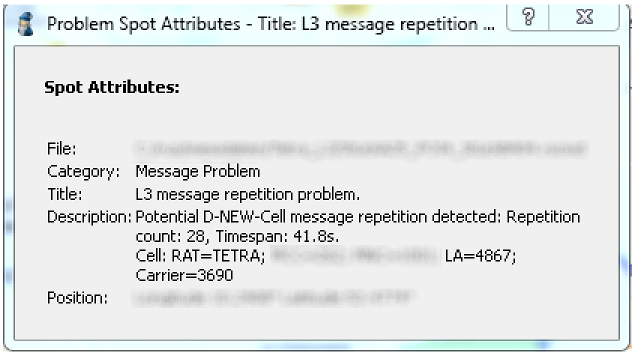


Figure 12-206: TETRA L3 message repetition problem

12.19.5 Handover analysis for LTE

Reselection in LTE

The trigger points for this type are the "RRC Connection Reconfiguration" and "RRC Connection Reconfiguration Complete" messages. The first message has to contain a targetPhyiscalCellId field and the second to match the transaction identifier from the initial message.

The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	RRC Connection Reconfiguration	targetPhysicalCellId must be set
HO_END	RRC Connection Reconfiguration Complete	transaction Identifier field must match the one from the initial RRC Connection Reconfiguration
HO_REJECT	n/a	
HO_COMPLETE	New Physical Cell ID for Serving Cell	

Redirection to GSM

The trigger points for this type are the "RRC Connection Release" and "Assignment Complete" messages. The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	RRC Connection Release	LTE message with redirectedCarrierInfo = geran
HO_END	Assignment Complete	GSM message and / or valid GSM Serving Cell
HO_REJECT	n/a	
HO_COMPLETE	Valid GSM Serving Cell	

Handover to UMTS

The trigger points for this type are the "Mobility From EUTRA Command" and "Handover to UTRAN Complete" messages, where the first must contain the target technology UMTS.

The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	Mobility From EUTRA Command	LTE message with target technology UMTS
HO_END	Handover to UTRAN Complete	UMTS message
HO_REJECT	n/a	
HO_COMPLETE	Valid UMTS Serving Cell	

Redirection to UMTS

The trigger points for this type are the "RRC Connection Release" and "Radio Bearer Setup Complete" messages, where the first must contain a DL UARFCN field. The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	RRC Connection Release	LTE message with redirectedCarrierInfo = utra_FDD and Target UARFCN
HO_END	Radio Bearer Setup Complete	UMTS message
HO_REJECT	n/a	
HO_COMPLETE	Valid UMTS Serving Cell	UARFCN match for UMTS Serving Cell

12.19.6 GSM handover

Handover in GSM

The trigger points for this type are the "Handover Command" and "Handover Complete or Handover Failure" messages, where the first must contain a BCCH ARFCN field.

The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	Handover Command	BCCH ARFCN must be set
HO_END	Handover Complete	
HO_REJECT	Handover Failure	
HO_COMPLETE	New BCCH ARFCN for Serving Cell	

Cell Reselection to UMTS

The trigger points for this type are the "RRC Connection Request" and "Location Updating Accept" messages.

The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	RRC Connection Request	UMTS message with establishmentCause = interRAT_CellReselection
HO_END	Location Updating Accept	
HO_REJECT	n/a	
HO_COMPLETE	Valid UMTS Serving Cell	

12.19.7 UMTS handover

Active Set Update

Currently only the Active Set Event types E1A / E1B and E1C are analyzed. The trigger points for this type are the "Last Measurements Report of this Event" and "Active Set Update Complete or Active Set Update Failure" messages.

The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	Last Measurements Report of this Event	Event Id
HO_COMPLETE	Active Set Update Complete	
HO_REJECT	Active Set Update Failure	

CS Handover to GSM

The trigger point for this type is the "HandoverFromUTRANCommand_GSM" messages.

The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	HandoverFromUTRANCommand_GSM	BCCH ARFCN must be set
HO_END	Valid GSM Serving Cell	
HO_REJECT	n/a	
HO_COMPLETE	Valid GSM Serving Cell	

PS Handover to GSM

The trigger point for this type is the "Cell change Order from UTRAN" message.

The following table provides a summary of the technology-specific trigger point to event matching.

Event	Trigger Point	Comment
HO_START	Cell change Order from UTRAN	Target technology GSM
HO_END	Valid GSM Serving Cell	
HO_REJECT	n/a	
HO_COMPLETE	Valid GSM Serving Cell	

12.19.8 TETRA handover

For TETRA, the Handover Analyzer only works when the SAIL interface is used for measurements. For details, refer to R&S ROMES4 TED.

The handover plug-in analyzes five handover types:

- Undeclared
- Unannounced
- Announced Type 1 to 3

The following table provides a summary of the TETRA-specific trigger points to event matching for each handover type.

Event	Undeclared	Unannounced	Announced 1	Announced 2	Announced 3
Identification	MLE-BREAK-IND	MLE-BREAK-IND	idle	MLE-BREAK-IND	MLE-BREAK-IND
HO_START	MLE-BREAK-IND	U-RESTORE	D-NEW-CELL	D-NEW-CELL	D-NEW-CELL
HO_END	MLE-RESUME-IND	D-RESTORE-ACK	New LA/Carrier	D-RESTORE-ACK	D-RESTORE-ACK
HO_REJECT	n/a	D-RESTORE-FAIL	n/a	D-RESTORE-FAIL	D-RESTORE-FAIL
HO_COM-PLETE	New LA/Carrier	New LA/Carrier	New LA/Carrier	New LA/Carrier	New LA/Carrier

TETRA handovers of unknown type are marked as "idle" instead of n/a. “Idle” identifies better the situation if the mobile does not call during handover.

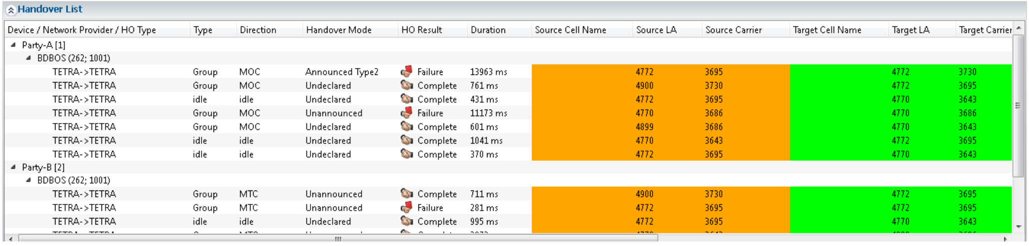
The TETRA handover result page contains the following two filters as the quick filters at the top of the page.

- Device filter
- Call direction filter (for example, MOC/MTC)

Figure 12-207: Filters in the result page for TETRA HO

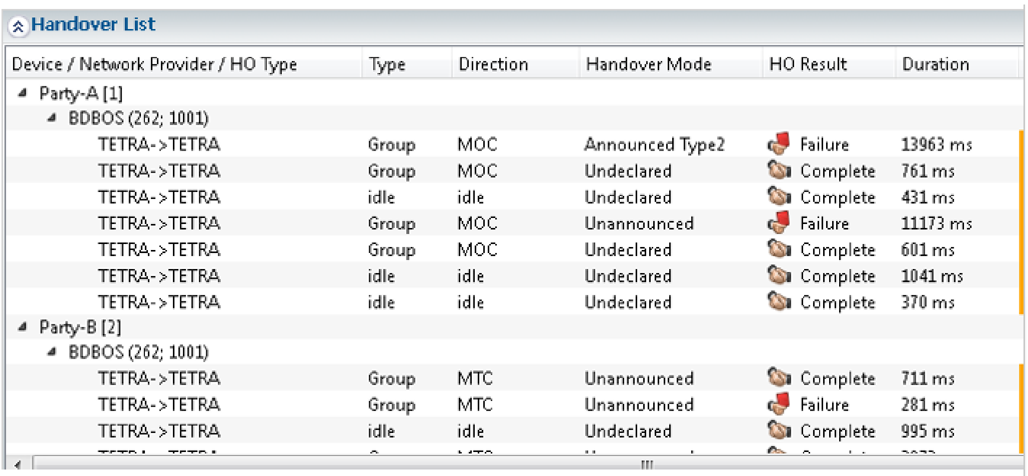
The results of handover analysis can be distinguished by the call type, that is,

- Currently active call (group or single)
- Call direction (MOC or MTC)


Handover List

Device / Network Provider / HO Type	Type	Direction	Handover Mode	HO Result	Duration	Source Cell Name	Source LA	Source Carrier	Target Cell Name	Target LA	Target Carrier
Party-A [1]											
BDBOS (262; 1001)											
TETRA->TETRA	Group	MOC	Announced Type2	Failure	13963 ms		4772	3695		4772	3730
TETRA->TETRA	Group	MOC	Undeclared	Complete	761 ms		4900	3730		4772	3695
TETRA->TETRA	idle	idle	Undeclared	Complete	431 ms		4772	3695		4770	3643
TETRA->TETRA	Group	MOC	Unannounced	Failure	11173 ms		4770	3686		4770	3686
TETRA->TETRA	Group	MOC	Undeclared	Complete	601 ms		4899	3686		4770	3643
TETRA->TETRA	idle	idle	Undeclared	Complete	1041 ms		4770	3643		4772	3695
TETRA->TETRA	idle	idle	Undeclared	Complete	370 ms		4772	3695		4770	3643
Party-B [2]											
BDBOS (262; 1001)											
TETRA->TETRA	Group	MTC	Unannounced	Complete	711 ms		4900	3730		4772	3695
TETRA->TETRA	Group	MTC	Unannounced	Failure	281 ms		4772	3695		4772	3695
TETRA->TETRA	idle	idle	Undeclared	Complete	995 ms		4772	3695		4770	3643

Figure 12-208: List of TETRA handovers


Handover List

Device / Network Provider / HO Type	Type	Direction	Handover Mode	HO Result	Duration
Party-A [1]					
BDBOS (262; 1001)					
TETRA->TETRA	Group	MOC	Announced Type2	Failure	13963 ms
TETRA->TETRA	Group	MOC	Undeclared	Complete	761 ms
TETRA->TETRA	idle	idle	Undeclared	Complete	431 ms
TETRA->TETRA	Group	MOC	Unannounced	Failure	11173 ms
TETRA->TETRA	Group	MOC	Undeclared	Complete	601 ms
TETRA->TETRA	idle	idle	Undeclared	Complete	1041 ms
TETRA->TETRA	idle	idle	Undeclared	Complete	370 ms
Party-B [2]					
BDBOS (262; 1001)					
TETRA->TETRA	Group	MTC	Unannounced	Complete	711 ms
TETRA->TETRA	Group	MTC	Unannounced	Failure	281 ms
TETRA->TETRA	idle	idle	Undeclared	Complete	995 ms

Figure 12-209: List of TETRA handovers - focused

The Handover Statistics provides two additional statistics:

- Handover types per provider
- Total handover per device

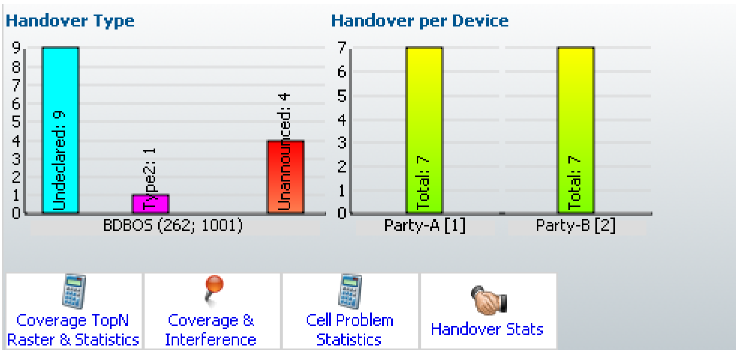


Figure 12-210: Added TETRA handover statistics - HO type and HO per device

The measurement files, which are recorded with R&S ROMES4 version 4.71 or later, contain the MLE-BREAK-IND. A part of these messages is the handover type field, which is used to define the handover type. For older files, a message flow is used. The message flow is the same for the handover Announced Type 2 and Announced Type 3.

12.19.8.1 Call restoration

The R&S ROMES4 NPA TETRA handover analyzer supports the call restoration procedure. The procedure makes it possible to differentiate between a handover and a simple call restoration.

Figure 12-211: TETRA handover type filters

The trigger points for call restoration procedure are:

- U-Restore
- D-Restore-ACK/FAIL
- There was no additional MLE Break indication before to start a handover

The results are shown in the handover result table with the icons shown in the following figure.

Figure 12-212: Icons for TETRA call restoration

The same icons are used at the map to indicate the new handover type and show the result of it.

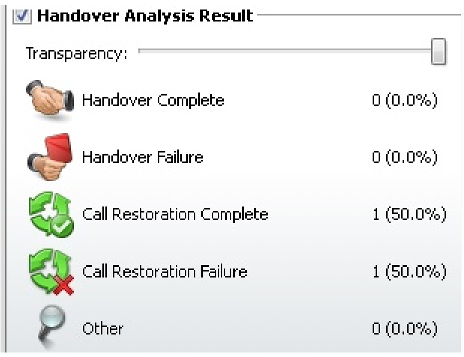


Figure 12-213: Map legend

The "Handover Type" chart has a separate block for call restoration.

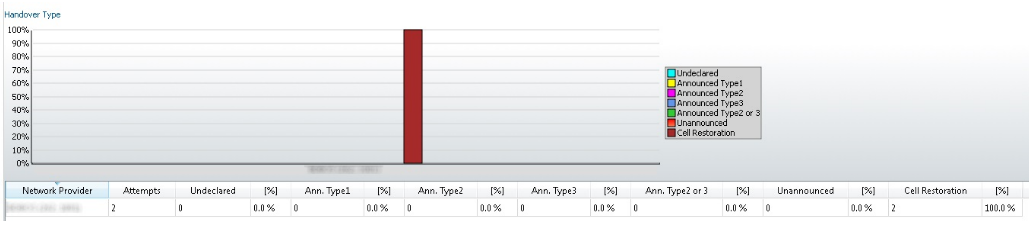


Figure 12-214: Bar chart shows the TETRA call restoration

The details of the call restoration at the map icon have a changed title.

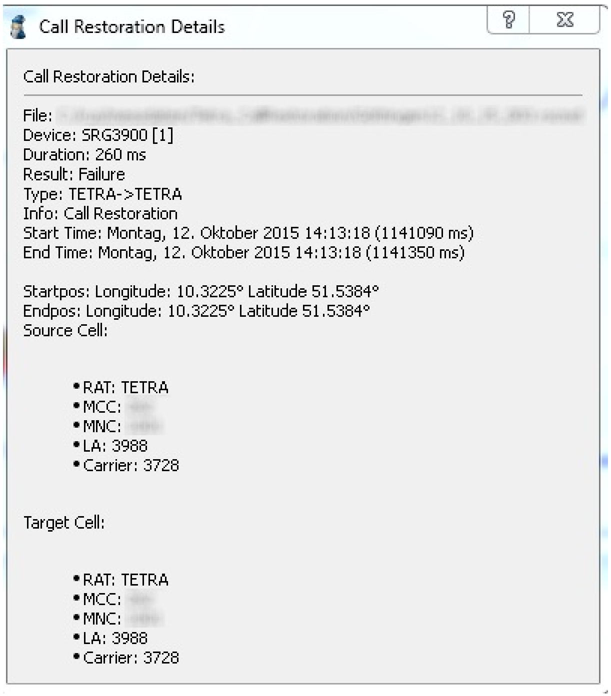


Figure 12-215: TETRA call restoration details

12.20 Spectrum analyzer

There is a problem for network operators in many countries to clear "their" spectrum, once they purchased a frequency band for setting up a new network technology. Older networks of other providers can occupy parts of that band as well. Such situations can be observed in the RF Power Scan measurement mode of the R&S ROMES4, similar to a spectrum analysis.

The task of the R&S ROMES4 NPA is to detect automatically such situations and provide the situations' concise and convenient presentation.

Spectrum analysis data is only shown if the R&S ROMES4N18 option is available.

12.20.1 Evaluation

Data resulting from the spectrum analysis is shown in the "Spectrum Analysis" page. This page is reachable from the "Analysis Results Overview" page if any measurement data of the R&S ROMES4 RF Power Scan driver is found. That page consists of a context filter, a geographic view and a Problem spot table.

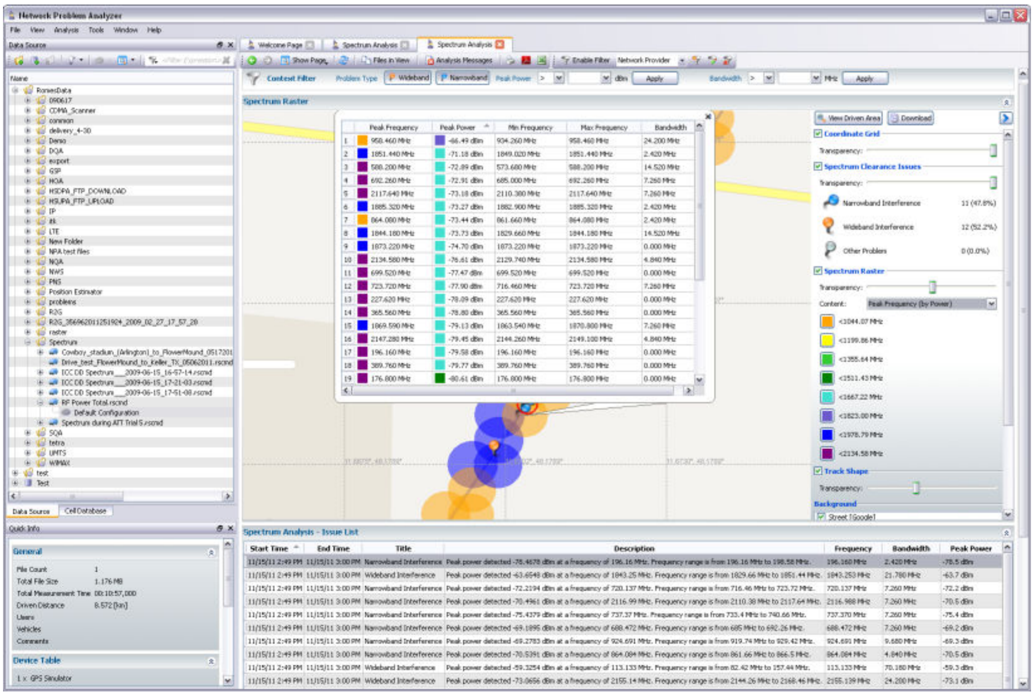


Figure 12-216: Analysis overview page

The context filter offers means to filter for narrowband and wideband problems and to restrict the displayed problems to those ones that fulfill either power or bandwidth constraints. The filter is applied to the map view and the problem spot table contents.

The map view shows the problem spots detected and a raster of the peak frequency/ range combinations of the detected ranges. A range is a time interval in which the power samples exceed a minimum power level in a bandwidth. These ranges are tracked through the whole file and for that ranges a raster is created, similar to the TopN raster in the Coverage Analyzer module. The raster is initially colored by the strongest peak power measured at that bin. The coloring can be changed to show the dynamically scaled frequency or by a combined display of frequency and power. The color is also based on the frequency and the raster is shown as circles. The radius of the circles is scaled with the power, i.e. stronger peak power values lead to bigger circles.

Click a raster element to get in tabular form details, that is, the peak frequencies, power values and bandwidths measured at that point.

The problem spot table shows the list of problems that have been identified (see below for an explanation of the problem detection mechanisms). Selecting an entry here synchronizes the map view to show and select the same problem spot. From the problem spot table, it is possible to load the measurement data into R&S ROMES4 and do some detailed spectrum analysis there. Use the Synchronize ROMES to Location function in the context menu.

12.20.2 Analysis details

The Spectrum Analysis plugin processes the R&S ROMES4 aggregated data collected by RF Power Scan of the R&S TSME driver.

The RF power scan data is the result of some kind of frequency and time aggregation method, and produces a spectrum of a frequency range (sweep). Within that spectrum, a fixed number of result points is created through the internal post-processing logic and each point maps a frequency to some power value. The purpose of the Spectrum Analysis plugin is then to find those areas in that spectrum where the power is above the Min Peak Power threshold. These ranges have a minimum and maximum frequency (the lowest resp. highest frequency where the associated power is above the threshold) and a peak frequency (the frequency with the absolute power maximum in the range). In one sweep many such ranges can exist. An example is depicted below.

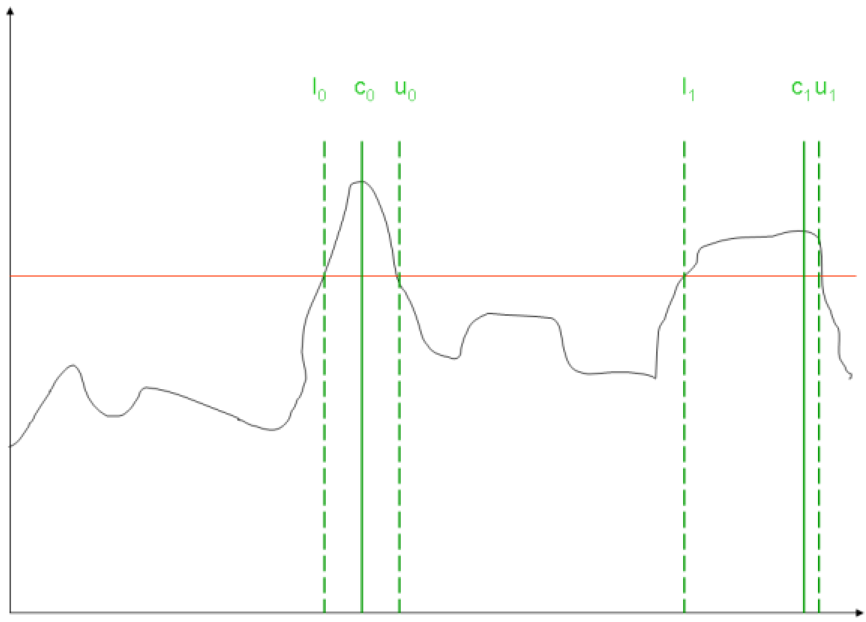


Figure 12-217: Min and max frequencies of the rages to be scanned

These ranges are now to be observed over time. Ranges can change their position in the spectrum. However, they are considered to be the same range if there is at least one other range in the next sweep that intersects with the previous range. In such a case, the range duration is extended so that it covers the first occurrence of the range up to the most recent occurrence. To build finally a problem from such a range, the "Min Peak Power" threshold has to be exceeded for at least "Min Peak Duration" milliseconds within that range.

The following figure shows two scenarios:

- The range R_0 consisting of l_0 to u_0 intersects with the range R'_0. Therefore, two ranges are considered to be from the same interfering source.

- The range R_1 has no direct successor, but there is a similar range R_2 in the neighborhood. However, these ranges are not considered to be related to the same source.

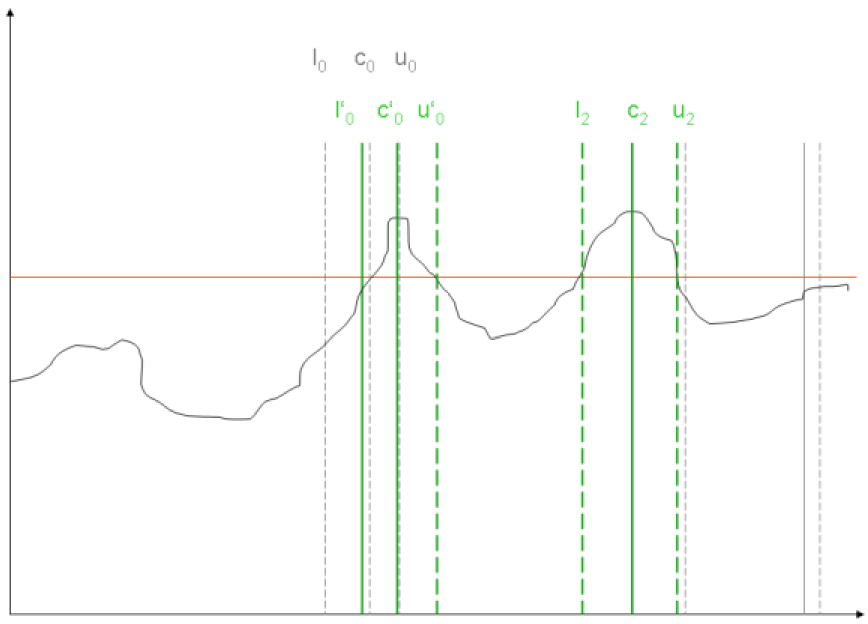


Figure 12-218: Interaction of two ranges (R0 and R'0)

It can happen that two ranges intersect with the same range in the next sweep. In this case, both "merge" interferers merge into the same range, which takes the older start time as its initial detection time. The other way round, a single range can be merged into two other ranges in the next sweep, where both are tracked separately.

Once a range is considered to be a problem, it is determined whether it can be classified as Narrowband or Wideband problem. The detection is done using the averaged maximum power and the averaged RMS of the single sweep ranges. If the difference between both is smaller than the configured Narrowband Peak/RMS Delta, then the problem can be classified as wideband problem, otherwise as narrowband. This approach is depicted below:

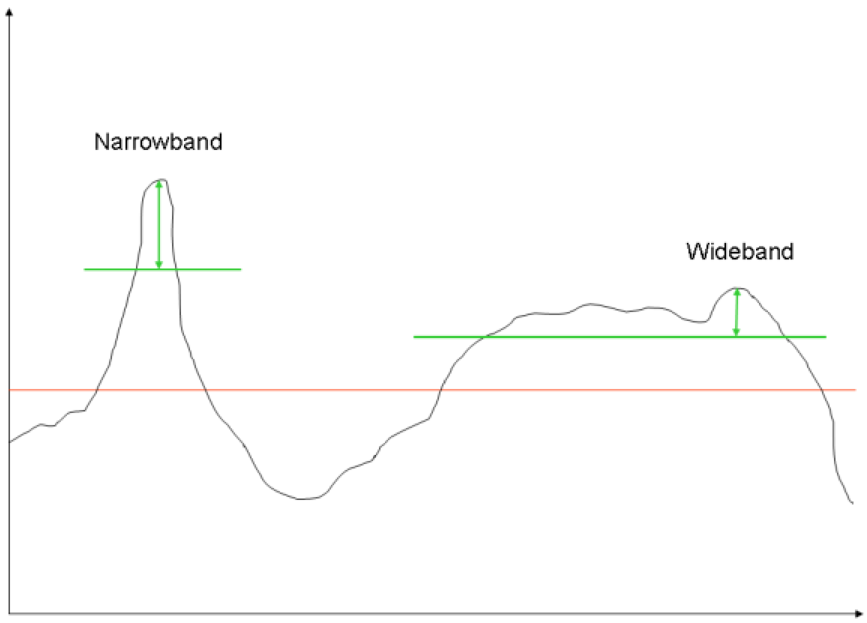


Figure 12-219: Problem classification

However, there are two exceptions to that rule: If the bandwidth is below the Max Narrowband Bandwidth threshold, the problem is always classified as "Narrowband Issue". The same applies to Wideband issues, which are always the result for problems with a bandwidth greater than the Min Wideband Bandwidth threshold.

Two problems with intersecting frequency ranges found at different time frames are considered to belong together if the time delta between them is below the "Problem Creation Hysteresis" threshold. The approach reduces the number of problems, as the first problem is extended to include also the second problem.

12.20.2.1 RF powerscan analysis limitation

RF PowerScan analysis can be limited to a specific frequency range.

To limit the analysis to a specific frequency range, activate the processing Band Filter.

The filter is available in the "Analysis" > "Data Processor Configuration" > "RFPowerScan Analysis Processor" configuration list. By default, the filter is off.

The user has to define the low and the high frequency value of the filter. In that way, only the measurements within the frequency range bounded with the defined frequencies are aggregated and stored in the NPA XML result file.

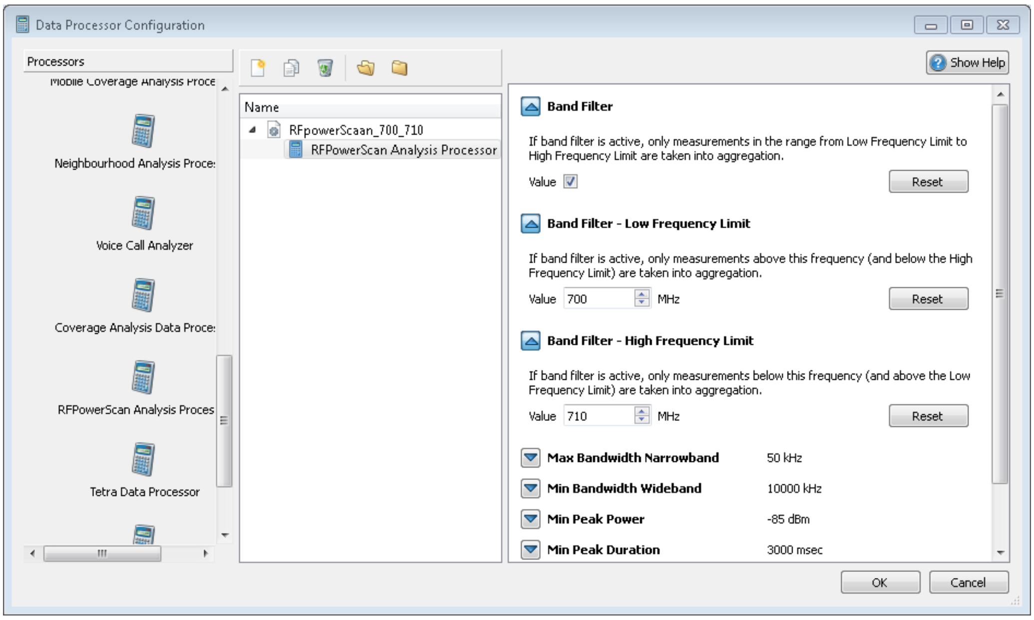
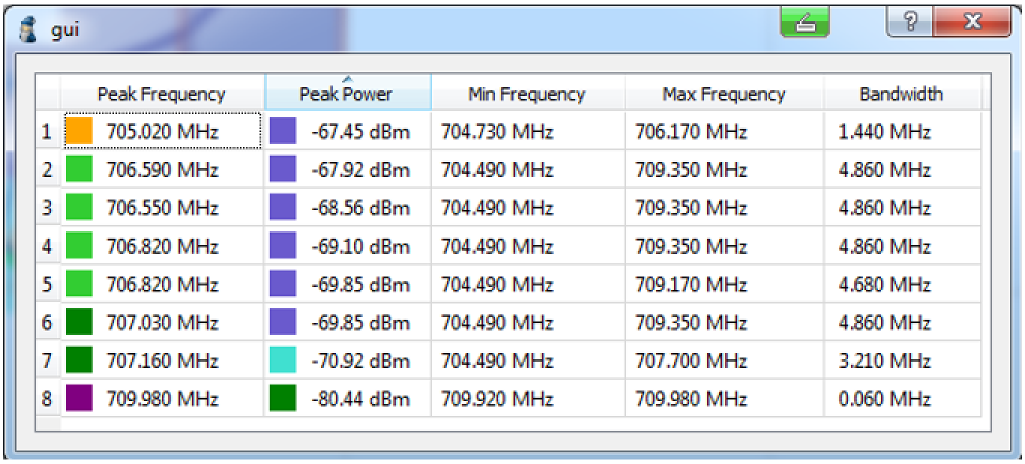


Figure 12-220: Configuration of RF PowerScan filter

The following figure shows aggregated measurements collected in the specified frequency range 700 MHz to 710 MHz.



	Peak Frequency	Peak Power	Min Frequency	Max Frequency	Bandwidth
1	705.020 MHz	-67.45 dBm	704.730 MHz	706.170 MHz	1.440 MHz
2	706.590 MHz	-67.92 dBm	704.490 MHz	709.350 MHz	4.860 MHz
3	706.550 MHz	-68.56 dBm	704.490 MHz	709.350 MHz	4.860 MHz
4	706.820 MHz	-69.10 dBm	704.490 MHz	709.350 MHz	4.860 MHz
5	706.820 MHz	-69.85 dBm	704.490 MHz	709.170 MHz	4.680 MHz
6	707.030 MHz	-69.85 dBm	704.490 MHz	709.350 MHz	4.860 MHz
7	707.160 MHz	-70.92 dBm	704.490 MHz	707.700 MHz	3.210 MHz
8	709.980 MHz	-80.44 dBm	709.920 MHz	709.980 MHz	0.060 MHz

Figure 12-221: Filtered RF PowerScan analysis results

The measurements below 700 MHz and above 710 MHz are not contained anymore and consequently not displayed on the geographical raster.

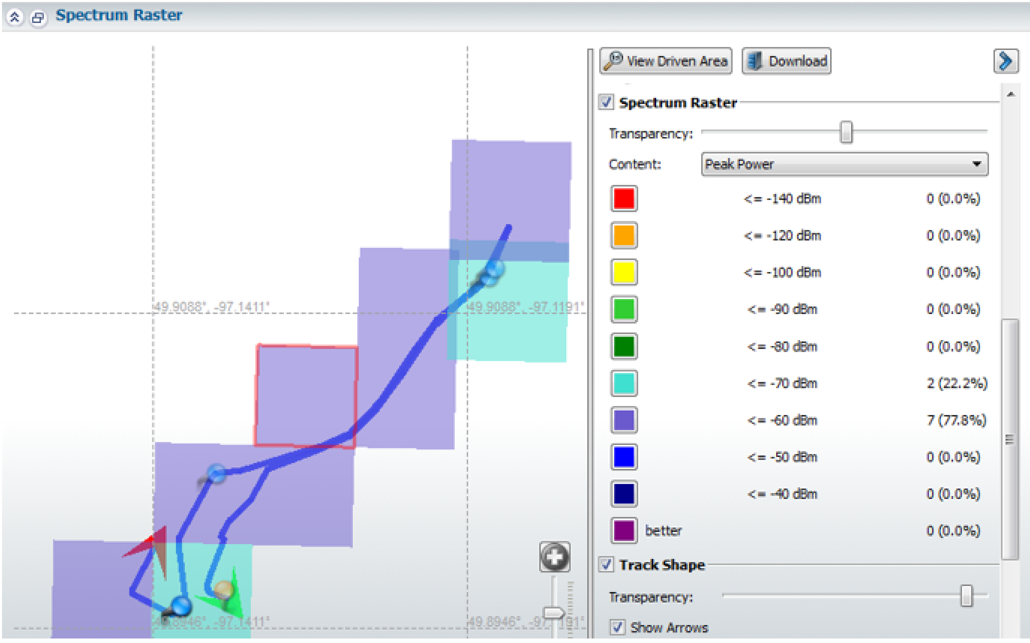


Figure 12-222: Spectrum raster of the spectrum analysis page

12.20.3 General configuration

The problem detection process can be controlled by changing the attributes shown in the following table.

Parameter	Value Range	Default	Description
Min Peak Power	-130 dBm to dBm	-85 dBm	A peak is detected if the Maximum Power in a spectrum is above that threshold.
Min Peak Duration	0 ms to 10000 ms	3000 ms	If a peak is above Min Peak Power for this number of milliseconds, a problem spot is created.
Narrowband Peak/RMS Delta	0 dB to 100 dB	10 dB	Minimum difference between the peak and the overall signals RMS to make the problem is labeled as narrowband problem, otherwise wideband problem is found.
Min Bandwidth Wideband	10000 kHz to 100000 kHz	10000 kHz	Problems with a bandwidth greater than this value are always classified as wideband issues

Parameter	Value Range	Default	Description
Max Bandwidth Narrow-band	0 kHz to 10000 kHz	50 kHz	Problems with a band-width smaller than this value are always classi-fied as narrowband issues
Problem Creation Hyste-resis	0 ms to 120000ms	2000 ms	Two problems for the same frequency range are merged into one problem if their end and start time are within this time interval.

12.21 Aggregation of ACD scanner measurements

A network measurement made with multiple scanner devices can be aggregated with R&S ROMES4 NPA for analysis.

The aggregation implies that the multiple scanner measurements are collected within one measurement file. The number and frequency of the configured channels varies from a measurement to the next measurement. The aggregation of scanner measurement results is based on ACD.

Different RATs use the ACD feature to find out all available channels in the specified band.

Panorama measurement

12.21.1 Aggregation of CDMA2000/EVDO ACD scanner measurements

R&S ROMES4 NPA aggregates the scanner measurements of CDMA2000 and extension EVDO networks.

The ADC configuration is supported.

To do the aggregation of the scanner measurements in R&S ROMES4 NPA, the related base station has to be identified by SID, NID, Base ID and Pilot PN. Otherwise, the power RSCP and the quality Ec/Io measurement values are not aggregated to the geographical raster.

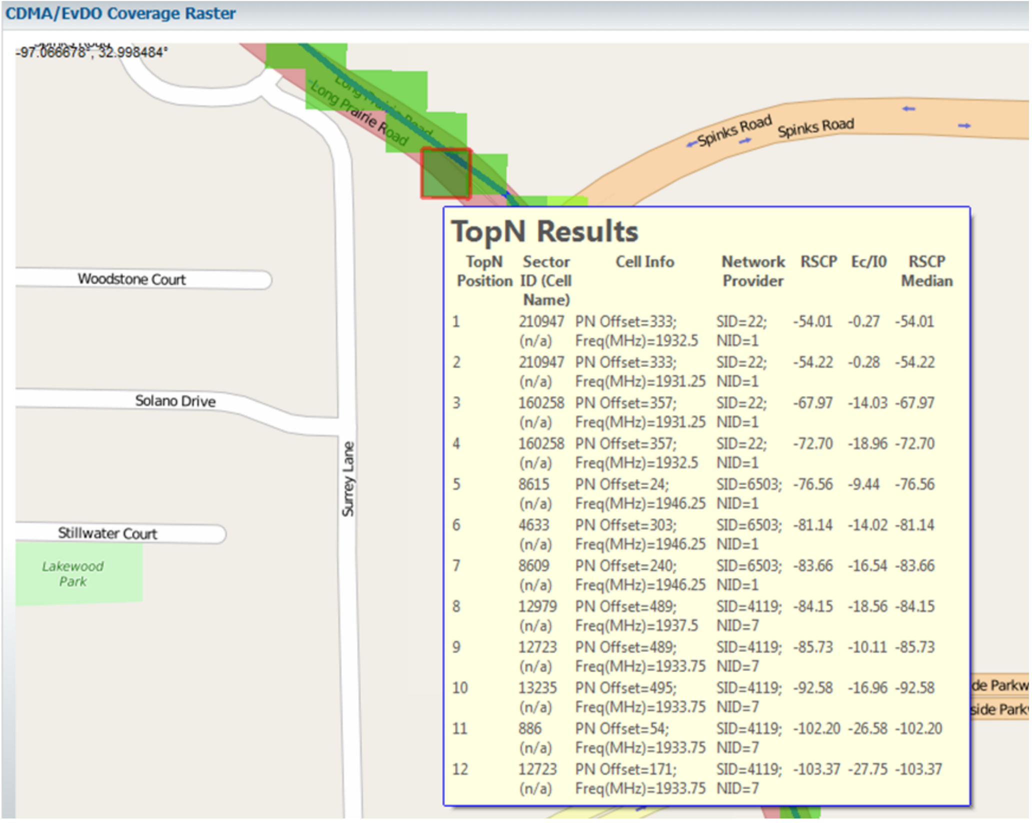


Figure 12-223: TopN Tooltip for the 50mx50m raster bin

The following figure shows the TopN raster element window for the previously shown TopN results.

TopN Raster Element - Position: Longitude -97.0666° Latitude 32.9985°

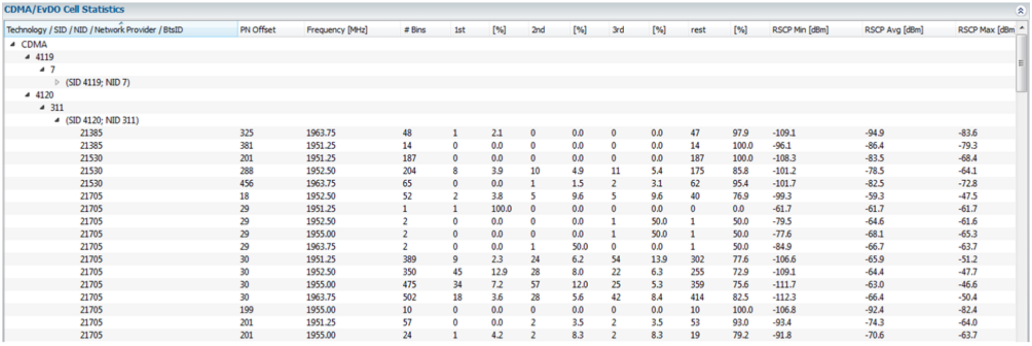
TopN Raster Element

File: E:/ws/dev_acd/dallas/finaldrive.rscmd
Cells: 12
Position: Longitude -97.0666° Latitude 32.9985°
Bin Size: 32 m/32 m

TopN Position	Sector ID (Cell Name)	Cell Info	Network Provider	RSCP (avg)	CINR (avg)	RSCP Median
1	210947 (n/a)	PN Offset=333; Freq(MHz)=1932.5	SID=22; NID=1	-54.01 dBm	-0.27 dB	-54.01
2	210947 (n/a)	PN Offset=333; Freq(MHz)=1931.25	SID=22; NID=1	-54.22 dBm	-0.28 dB	-54.22
3	160258 (n/a)	PN Offset=357; Freq(MHz)=1931.25	SID=22; NID=1	-67.97 dBm	-14.03 dB	-67.97
4	160258 (n/a)	PN Offset=357; Freq(MHz)=1932.5	SID=22; NID=1	-72.70 dBm	-18.96 dB	-72.70
5	8615 (n/a)	PN Offset=24; Freq(MHz)=1946.25	SID=6503; NID=1	-76.56 dBm	-9.44 dB	-76.56
6	4633 (n/a)	PN Offset=303; Freq(MHz)=1946.25	SID=6503; NID=1	-81.14 dBm	-14.02 dB	-81.14
7	8609 (n/a)	PN Offset=240; Freq(MHz)=1946.25	SID=6503; NID=1	-83.66 dBm	-16.54 dB	-83.66
8	12979 (n/a)	PN Offset=489; Freq(MHz)=1937.5	SID=4119; NID=7	-84.15 dBm	-18.56 dB	-84.15
9	12723 (n/a)	PN Offset=489; Freq(MHz)=1933.75	SID=4119; NID=7	-85.73 dBm	-10.11 dB	-85.73
10	13235 (n/a)	PN Offset=495; Freq(MHz)=1933.75	SID=4119; NID=7	-92.58 dBm	-16.96 dB	-92.58
11	886 (n/a)	PN Offset=54; Freq(MHz)=1933.75	SID=4119; NID=7	-102.20 dBm	-26.58 dB	-102.20
12	12723 (n/a)	PN Offset=171; Freq(MHz)=1933.75	SID=4119; NID=7	-103.37 dBm	-27.75 dB	-103.37

Figure 12-224: TopN raster element

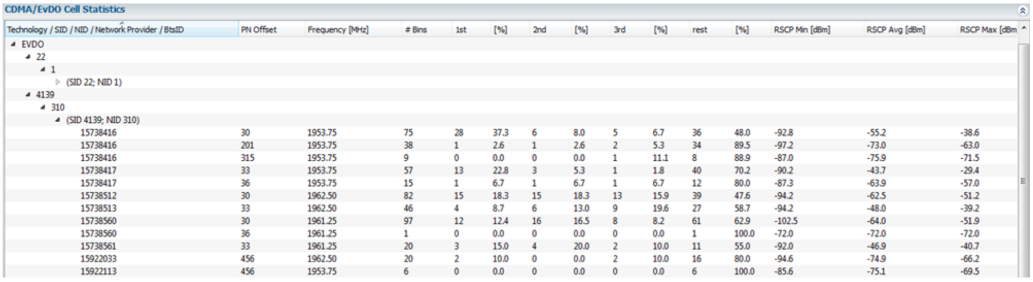
The following figures show further details of the CDMA2000 and EVDO cells.



CDMA/EvDO Cell Statistics

Technology / SID / NID / Network Provider / BtsID	PN Offset	Frequency [MHz]	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	RSCP Min [dBm]	RSCP Avg [dBm]	RSCP Max [dBm
CDMA														
4119														
7														
(SID 4119; NID 7)														
4120														
311														
(SID 4120; NID 311)														
21385	325	1963.75	48	1	2.1	0	0.0	0	0.0	47	97.9	-109.1	-94.9	-83.6
21385	381	1951.25	14	0	0.0	0	0.0	0	0.0	14	100.0	-96.1	-86.4	-79.3
21530	201	1951.25	187	0	0.0	0	0.0	0	0.0	187	100.0	-108.3	-83.5	-68.4
21530	288	1952.50	204	8	3.9	10	4.9	11	5.4	175	85.8	-101.2	-78.5	-64.1
21530	456	1963.75	65	0	0.0	1	1.5	2	3.1	62	95.4	-101.7	-82.5	-72.8
21705	18	1952.50	52	2	3.8	5	9.6	5	9.6	40	76.9	-99.3	-59.3	-47.5
21705	29	1951.25	1	1	100.0	0	0.0	0	0.0	0	0.0	-61.7	-61.7	-61.7
21705	29	1952.50	2	0	0.0	0	0.0	1	50.0	1	50.0	-79.5	-64.6	-61.6
21705	29	1955.00	2	0	0.0	0	0.0	1	50.0	1	50.0	-77.6	-68.1	-65.3
21705	29	1963.75	2	0	0.0	1	50.0	0	0.0	1	50.0	-84.9	-66.7	-63.7
21705	30	1951.25	389	9	2.3	24	6.2	54	13.9	302	77.6	-106.6	-65.9	-51.2
21705	30	1952.50	350	45	12.9	28	8.0	22	6.3	255	72.9	-109.1	-64.4	-47.7
21705	30	1955.00	475	34	7.2	57	12.0	25	5.3	359	75.6	-111.7	-63.0	-46.6
21705	30	1963.75	502	18	3.6	28	5.6	42	8.4	414	82.5	-112.3	-66.4	-50.4
21705	199	1955.00	10	0	0.0	0	0.0	0	0.0	10	100.0	-106.8	-92.4	-82.4
21705	201	1951.25	57	0	0.0	2	3.5	2	3.5	53	93.0	-93.4	-74.3	-64.0
21705	201	1955.00	24	1	4.2	2	8.3	2	8.3	19	79.2	-91.8	-70.6	-63.7

Figure 12-225: CDMA2000 cells statistics



CDMA/EvDO Cell Statistics

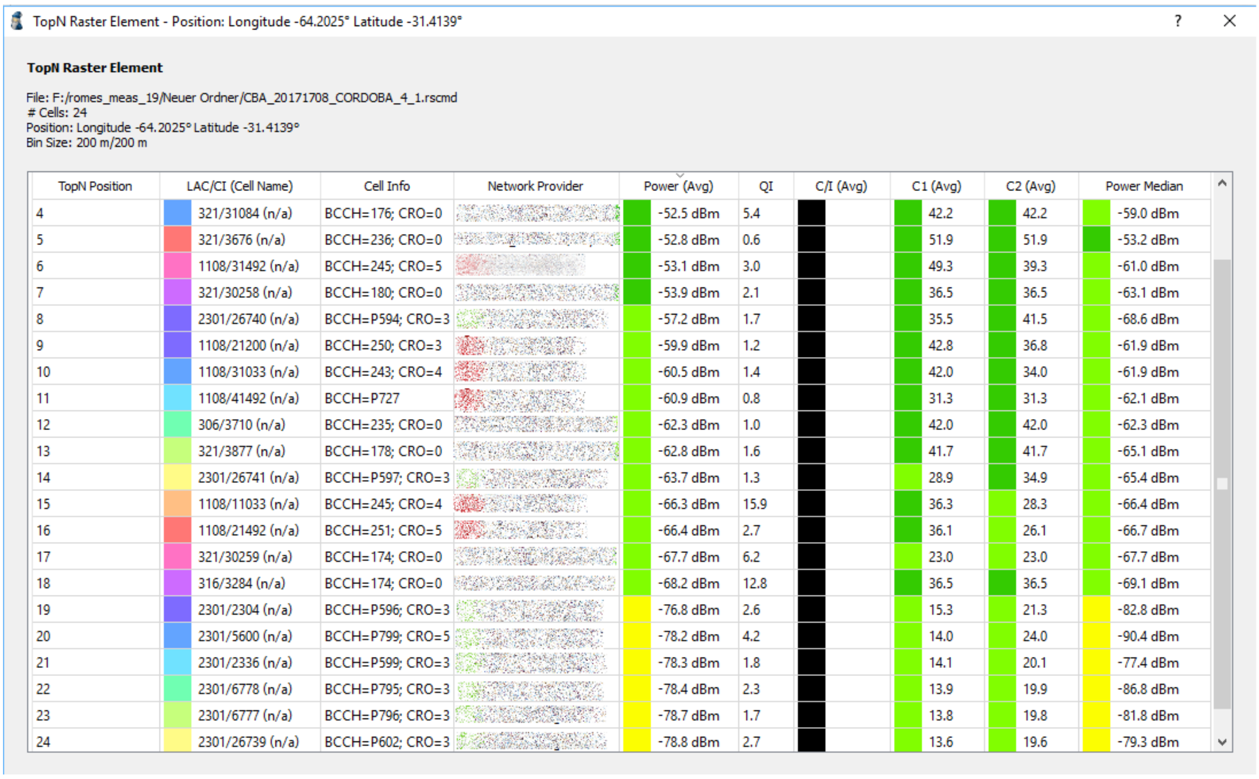
Technology / SID / NID / Network Provider / BtsID	PN Offset	Frequency [MHz]	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	RSCP Min [dBm]	RSCP Avg [dBm]	RSCP Max [dBm
EVDO														
22														
1														
(SID 22; NID 1)														
4139														
310														
(SID 4139; NID 310)														
15738416	30	1953.75	75	28	37.3	6	8.0	5	6.7	36	48.0	-92.8	-55.2	-38.6
15738416	201	1953.75	38	1	2.6	1	2.6	2	5.3	34	89.5	-97.2	-73.0	-63.0
15738416	315	1953.75	9	0	0.0	0	0.0	1	11.1	8	88.9	-87.0	-75.9	-71.5
15738417	33	1953.75	57	13	22.8	3	5.3	1	1.8	40	70.2	-90.2	-43.7	-29.4
15738417	36	1953.75	15	1	6.7	1	6.7	1	6.7	12	80.0	-87.3	-63.9	-57.0
15738512	30	1962.50	82	15	18.3	15	18.3	13	15.9	39	47.6	-94.2	-62.5	-51.2
15738513	33	1962.50	46	4	8.7	6	13.0	9	19.6	27	58.7	-94.2	-48.0	-39.2
15738560	30	1961.25	97	12	12.4	16	16.5	8	8.2	61	62.9	-102.5	-64.0	-51.9
15738560	36	1961.25	1	0	0.0	0	0.0	0	0.0	1	100.0	-72.0	-72.0	-72.0
15738561	33	1961.25	20	3	15.0	4	20.0	2	10.0	11	55.0	-92.0	-46.9	-40.7
15922033	456	1962.50	20	2	10.0	0	0.0	2	10.0	16	80.0	-94.6	-74.9	-66.2
15922113	456	1953.75	6	0	0.0	0	0.0	0	0.0	6	100.0	-85.6	-75.1	-69.5

Figure 12-226: EVDO cells statistics

12.21.2 Aggregation of TETRA ACD scanner measurements

The R&S ROMES4 NPA provides extended aggregation of the TETRA networks scanner measurements for multiple scanner devices with overlapping frequencies.

The ADC configuration is supported.


TopN Raster Element - Position: Longitude -64.2025° Latitude -31.4139°

TopN Raster Element

File: F:/romes_meas_19/Neuer Ordner/CBA_20171708_CORDOBA_4_1.rscmd
Cells: 24
Position: Longitude -64.2025° Latitude -31.4139°
Bin Size: 200 m/200 m

TopN Position	LAC/CI (Cell Name)	Cell Info	Network Provider	Power (Avg)	QI	C/I (Avg)	C1 (Avg)	C2 (Avg)	Power Median
4	321/31084 (n/a)	BCCH=176; CRO=0		-52.5 dBm	5.4		42.2	42.2	-59.0 dBm
5	321/3676 (n/a)	BCCH=236; CRO=0		-52.8 dBm	0.6		51.9	51.9	-53.2 dBm
6	1108/31492 (n/a)	BCCH=245; CRO=5		-53.1 dBm	3.0		49.3	39.3	-61.0 dBm
7	321/30258 (n/a)	BCCH=180; CRO=0		-53.9 dBm	2.1		36.5	36.5	-63.1 dBm
8	2301/26740 (n/a)	BCCH=P594; CRO=3		-57.2 dBm	1.7		35.5	41.5	-68.6 dBm
9	1108/21200 (n/a)	BCCH=250; CRO=3		-59.9 dBm	1.2		42.8	36.8	-61.9 dBm
10	1108/31033 (n/a)	BCCH=243; CRO=4		-60.5 dBm	1.4		42.0	34.0	-61.9 dBm
11	1108/41492 (n/a)	BCCH=P727		-60.9 dBm	0.8		31.3	31.3	-62.1 dBm
12	306/3710 (n/a)	BCCH=235; CRO=0		-62.3 dBm	1.0		42.0	42.0	-62.3 dBm
13	321/3877 (n/a)	BCCH=178; CRO=0		-62.8 dBm	1.6		41.7	41.7	-65.1 dBm
14	2301/26741 (n/a)	BCCH=P597; CRO=3		-63.7 dBm	1.3		28.9	34.9	-65.4 dBm
15	1108/11033 (n/a)	BCCH=245; CRO=4		-66.3 dBm	15.9		36.3	28.3	-66.4 dBm
16	1108/21492 (n/a)	BCCH=251; CRO=5		-66.4 dBm	2.7		36.1	26.1	-66.7 dBm
17	321/30259 (n/a)	BCCH=174; CRO=0		-67.7 dBm	6.2		23.0	23.0	-67.7 dBm
18	316/3284 (n/a)	BCCH=174; CRO=0		-68.2 dBm	12.8		36.5	36.5	-69.1 dBm
19	2301/2304 (n/a)	BCCH=P596; CRO=3		-76.8 dBm	2.6		15.3	21.3	-82.8 dBm
20	2301/5600 (n/a)	BCCH=P799; CRO=5		-78.2 dBm	4.2		14.0	24.0	-90.4 dBm
21	2301/2336 (n/a)	BCCH=P599; CRO=3		-78.3 dBm	1.8		14.1	20.1	-77.4 dBm
22	2301/6778 (n/a)	BCCH=P795; CRO=3		-78.4 dBm	2.3		13.9	19.9	-86.8 dBm
23	2301/6777 (n/a)	BCCH=P796; CRO=3		-78.7 dBm	1.7		13.8	19.8	-81.8 dBm
24	2301/26739 (n/a)	BCCH=P602; CRO=3		-78.8 dBm	2.7		13.6	19.6	-79.3 dBm

Figure 12-227: TopN for 200m x 200m bin size

The R&S ROMES4 NPA cannot aggregate older measurement files (up to R&S ROMES 4.50) due to different internal structures for storing base station information.

12.22 WLAN analyzer

During deployment of WLAN Networks (HotSpots), one of the first steps in network optimization is to provide service in as many areas as possible. Even in existing networks coverage analysis is a day-to-day task that is required to guarantee high network quality.

The WLAN Analysis module calculates coverage data based on measurements performed by a WLAN stick or built-in device. It shows the device view of the networks, mainly the availability of the networks and access points.

The functionality described below is only available if a GPS is connected during the measurement, as all the results are created based on a geographical grid. The analysis works for geographical referenced indoor measurements (not with different floors) as well.

12.22.1 Coverage raster

The first step during the analysis for the WLAN analysis module is to create a raster of the measured data. This is also an important data reduction strategy to use data from multiple files later on.

Rasterization is done in the following way.

1. For each measured parameter, the geographic location is determined. This location can be an interpolated location if GPS was no available for a short time.

2. The current position is transformed into an UTM coordinate. Refer to Chapter 5.2.3, "Raster configuration", on page 146 for a more detailed description.

3. The UTM coordinate is then used to calculate the grid position.

4. The center of the grid is transformed back into a WGS 84 datum as delivered from the GPS.

Using the grid center, the world map is divided into a grid aligned to the longitude used as the center for the UTM zone of the size configured in the preferences dialog. For each such grid center, the described parameter grouped by the current Serving Cell of the mobile is shown. There are filters available to reduce the visible result only for a special device, operator or technology.

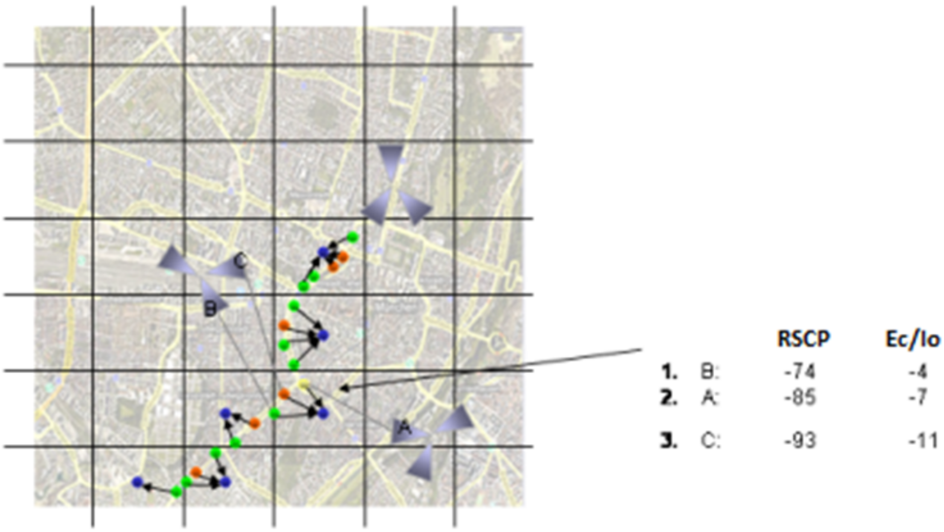


Figure 12-228: Coverage raster of the scanner data

Because of the size limited coverage of WLAN networks a bin size of smaller than 32.0 m is suggested. Otherwise you have too many networks within one raster element and too much problem found.

The WLAN networks are identified by their SSID, that is, a network provider in mobile communications. For one SSID, you can have multiple access points, each with the own MAC address. As parameters, the Signal Power (RSSI in dBm) and Quality in % are available.

The result is used in later steps, to perform the problem spot analysis for example. In the GUI, this result can be visualized using the coverage maps. Both parameters mentioned above and also information for the access point are selectable for showing as graphical layer in the map.

12.22.2 Problem categories

Coverage Problem

Within a raster element, the averaged signal power of the strongest WLAN Access Point is below the Coverage [RSSI] Limit threshold.

Parameter	Value Range	Default	Description
Coverage - [RSSI] Limit	-130..0 dBm	-70	Coverage Problems are reported if the averaged power level of the strongest Access Point at the raster is below this threshold. Unit: [dBm]

Good Power but Bad Quality Problem

Within a raster element, the averaged signal power of the strongest WLAN Access Point is above the Coverage - [RSSI] Limit threshold and below the Interference [Quality] Limit threshold.

Parameter	Value Range	Default	Description
Interference - [Quality] Limit	0..100%	20	Good power but bad quality problem is reported if both parameter of the strongest Access Point if Quality is below this threshold. Unit: [%]

Delta Top1/Top2 Problem

Within a raster element, the difference of averaged signal power between the Top1 and Top2 WLAN Access Point is above the Delta [RSSI] Limit threshold. Top2 is the first Access Point inside the raster which is on the same channel or the same secondary channel like the Top1.

Parameter	Value Range	Default	Description
Delta - [RSSI] Limit	0..20 dBm	6	Delta Top1 / Top2 is reported in case the RSSI delta is below this threshold. Unit: [dB]

12.22.3 Access point list

For all SSID and Access Points that are found during the rasterization steps a final statistic is created. That statistics contains how many raster elements for this cell in the total grid and some key statistical indicators related to parameter, like minimum, maximum and average.

12.23 Base station evaluation analysis

The optimization of a mobile network is a day-to-day task that is required to guarantee high network quality. One point to dothe optimization is at base station side - changing parameter, swapping hardware or switching on new base stations. After such a work, it is required to get a smart overview of the affected base stations. The results provided by this analysis give an overview of the selected base station.

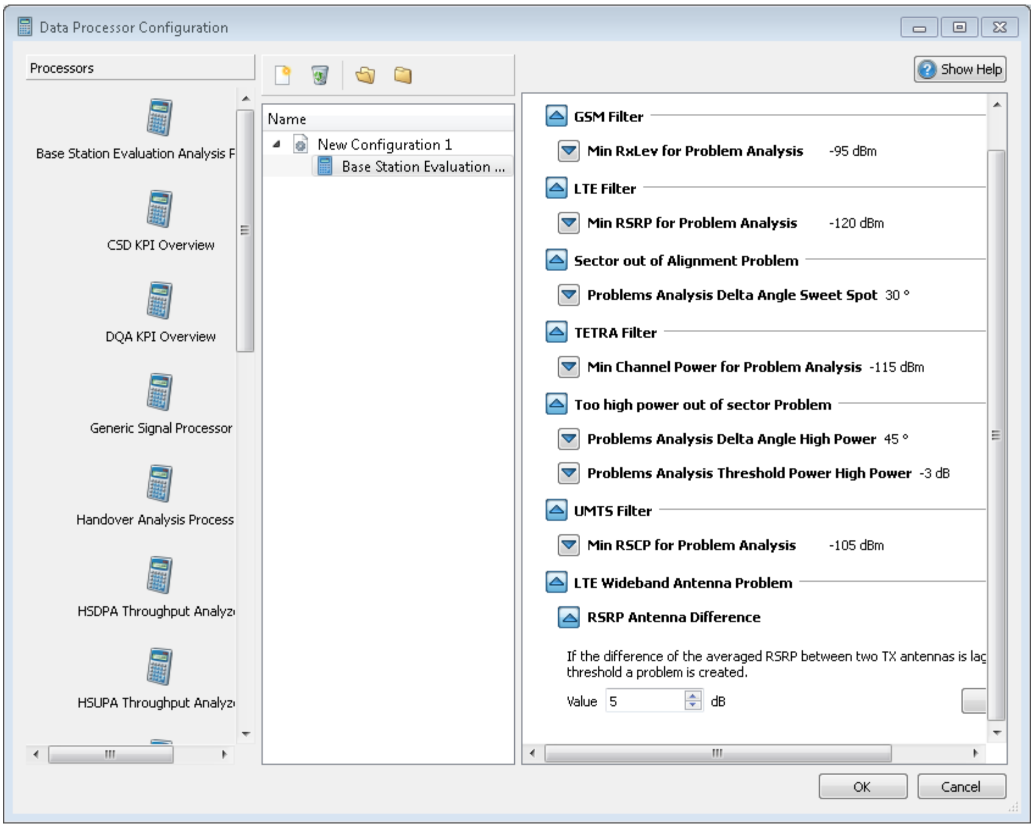


Figure 12-229: Base station evaluation analysis processor

The Base Station Analyzer detects the problems related to direction and connection of base station antennas. Relevant changes are visible at the result page “[RAT] Base Station Evaluation Problems”.

The Base Station Evaluation Analysis requires the R&S ROMES4N19 option.

The Base Stations Evaluation Analysis plugin uses scanner (for example, the R&S TSME) based data to provide the results.

The analyzer is able to process the following RATs:

- GSM
- WCDMA
- LTE
- TETRA

The functionality described below is only available if a GPS is connected during the measurement, as all the results are created based on a geographical measurement position. A valid cell database with position and antenna direction of the base stations is required.

If antenna direction is unavailable, the problem analysis cannot be done.

MIMO problems are only available at the LTE page.

12.23.1 Parameters to cell distance analysis

Parameters Signal Power and Quality for the technologies GSM, UMTS, LTE and TETRA are calculated. The average of each parameter is split into segments based on the distance to the cell. There are two analyses available:

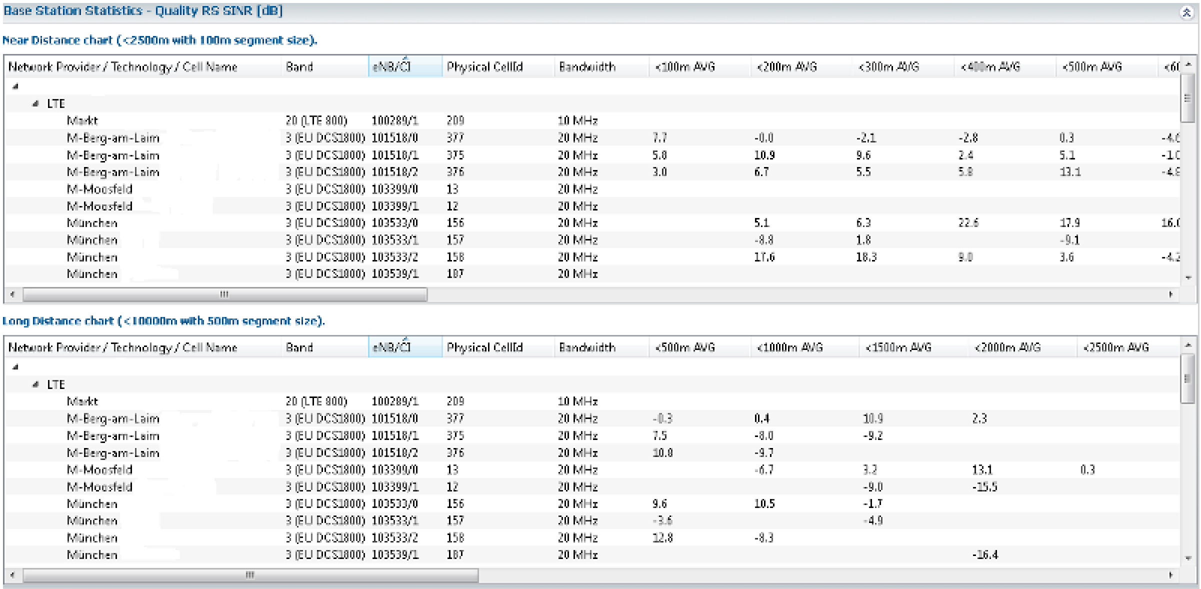
- Near distance analysis with a fixed length of 2500 m and a segment size of 100 m
- Long-distance analysis with a fixed length of 10000 m and a segment size of 500 m

The following table shows the parameters per technology:

LTE	UMTS	GSM	TETRA
RSRP	RSCP	Channel Power	Channel Power
RS SNR / RSRQ	Ec/No	C/I	SNR

After opening the result page, the table shows the results for all cells. If the results are filtered to only one cell, a bar chart is also visible for this cell. At the long distance analyze, the values from the distance larger than the maximum size of 1000 m are calculated in a separate segment. That segment is the last column and has a description "<inf".

The following example shows the table with a list of base stations before filtering to one specific cell.



Base Station Statistics - Quality RS SINR [dB]

Near Distance chart (<2500m with 100m segment size).

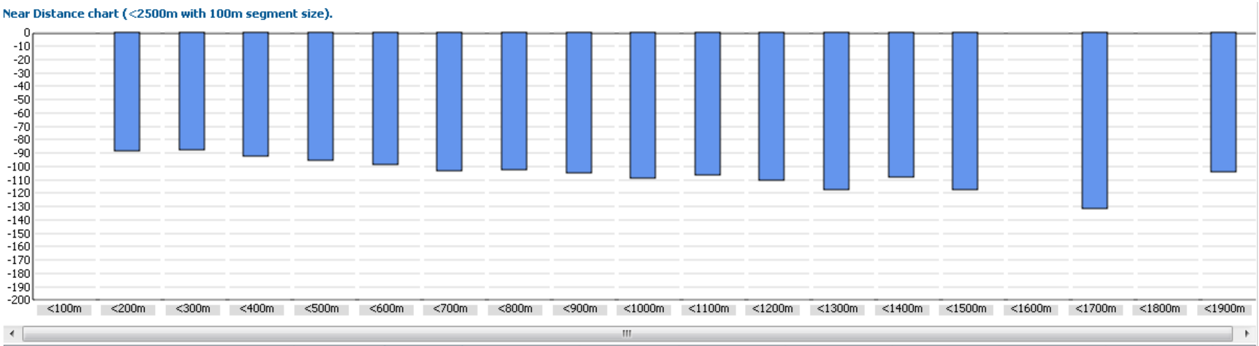
Network Provider / Technology / Cell Name	Band	eNB/CI	Physical CellId	Bandwidth	<100m AVG	<200m AVG	<300m AVG	<400m AVG	<500m AVG	<6(
LTE										
Markt	20 (LTE 800)	100289/1	209	10 MHz						
M-Berg-am-Laim	3 (EU DCS1800)	101518/0	377	20 MHz	7.7	-0.0	-2.1	-2.8	0.3	-4.0
M-Berg-am-Laim	3 (EU DCS1800)	101518/1	375	20 MHz	5.8	10.9	9.6	2.4	5.1	-1.0
M-Berg-am-Laim	3 (EU DCS1800)	101518/2	376	20 MHz	3.0	6.7	5.5	5.8	13.1	-4.8
M-Moosfeld	3 (EU DCS1800)	103399/0	13	20 MHz						
M-Moosfeld	3 (EU DCS1800)	103399/1	12	20 MHz						
München	3 (EU DCS1800)	103533/0	156	20 MHz		5.1	6.3	22.6	17.9	16.0
München	3 (EU DCS1800)	103533/1	157	20 MHz		-8.8	1.8		-9.1	
München	3 (EU DCS1800)	103533/2	158	20 MHz		17.6	18.3	9.0	3.6	-4.2
München	3 (EU DCS1800)	103539/1	107	20 MHz						

Long Distance chart (<10000m with 500m segment size).

Network Provider / Technology / Cell Name	Band	eNB/CI	Physical CellId	Bandwidth	<500m AVG	<1000m AVG	<1500m AVG	<2000m AVG	<2500m AVG
LTE									
Markt	20 (LTE 800)	100289/1	209	10 MHz					
M-Berg-am-Laim	3 (EU DCS1800)	101518/0	377	20 MHz	-0.3	0.4	10.9	2.3	
M-Berg-am-Laim	3 (EU DCS1800)	101518/1	375	20 MHz	7.5	-8.0	-9.2		
M-Berg-am-Laim	3 (EU DCS1800)	101518/2	376	20 MHz	10.8	-9.7			
M-Moosfeld	3 (EU DCS1800)	103399/0	13	20 MHz		-6.7	3.2	13.1	0.3
M-Moosfeld	3 (EU DCS1800)	103399/1	12	20 MHz			-9.0	-15.5	
München	3 (EU DCS1800)	103533/0	156	20 MHz	9.6	10.5	-1.7		
München	3 (EU DCS1800)	103533/1	157	20 MHz	-3.6		-4.9		
München	3 (EU DCS1800)	103533/2	158	20 MHz	12.8	-8.3			
München	3 (EU DCS1800)	103539/1	107	20 MHz				-16.4	

Figure 12-230: List of base stations (not filtered to one specific cell)

To get the charts together with the table, filter to a special base station. The mentioned filtering is possible with the filter "Cell Names" on or with the "Quick Filter". Refer to Chapter 10, "R&S ROMES4 NPA filters", on page 195 for a more detailed description.



Network Provider / Technology / Cell Name	Band	eNB/CI	Physical CellId	Bandwidth	<100m AVG	<200m AVG	<300m AVG	<400m AVG	<500m AVG	<600m
LTE										
M	3 (EU DCS1800)	103602/0	341	20 MHz		-89.1	-88.0	-93.2	-96.0	-99.0

Figure 12-231: Near distance chart

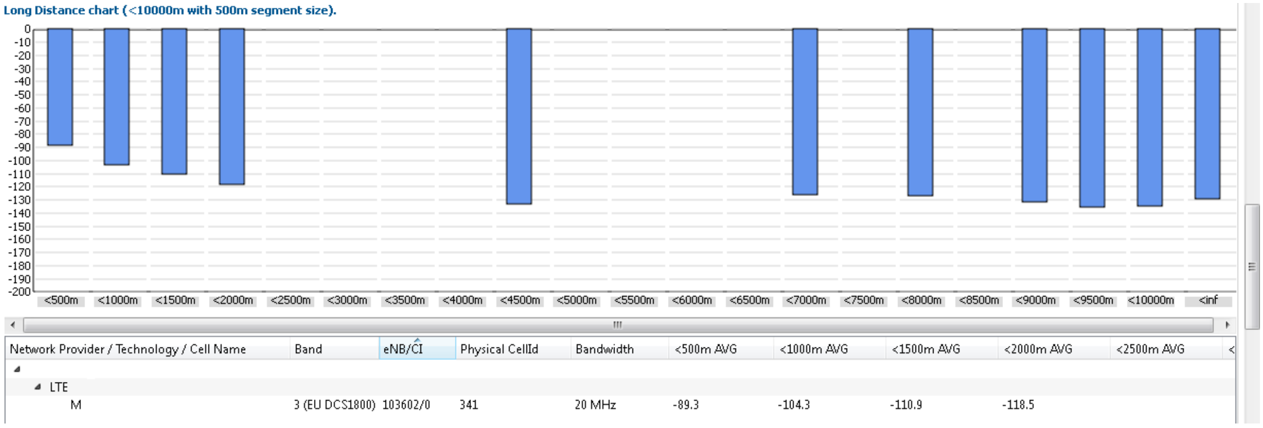


Figure 12-232: Long-distance chart

12.23.2 Scanner results on angle

The angle is calculated for each measurement point to the base station with 0° as north direction from the base station. The measurement values are averaged over an area of 15°. This averaging is done for every cell. The results are available as a table and, if filtered to only one cell, as a bar chart, see the following figure.

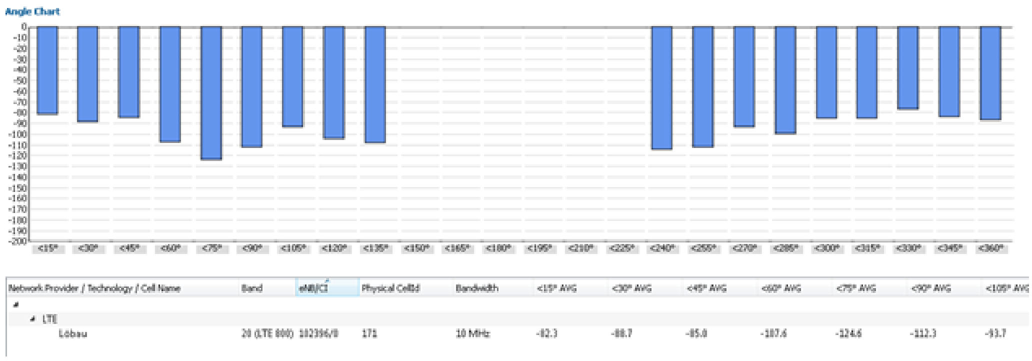


Figure 12-233: Angle chart and table

The feature prerequisite is a valid cell database with cell position.

12.23.3 Map all cells from site visible

The cell layer at the map on the "BTS" pages is improved. All cells which are placed at the same GPS position are visible as sites, not only the cells where the spot results are calculated.

The feature prerequisite is a valid cell database.

12.23.4 BSE problem analysis

The BSE problem analysis tries to detect problems with antenna direction using the correlation between cell database. The antenna direction is normally the direction in the field. A Sweetspot is calculated from the measurement values.

The Sweetspot defines a direction with the best received power from the antenna. The measurement scenario/route and the environment (e.g. urban/suburban) influence the calculation of direction. The position is placed in the measurement track.

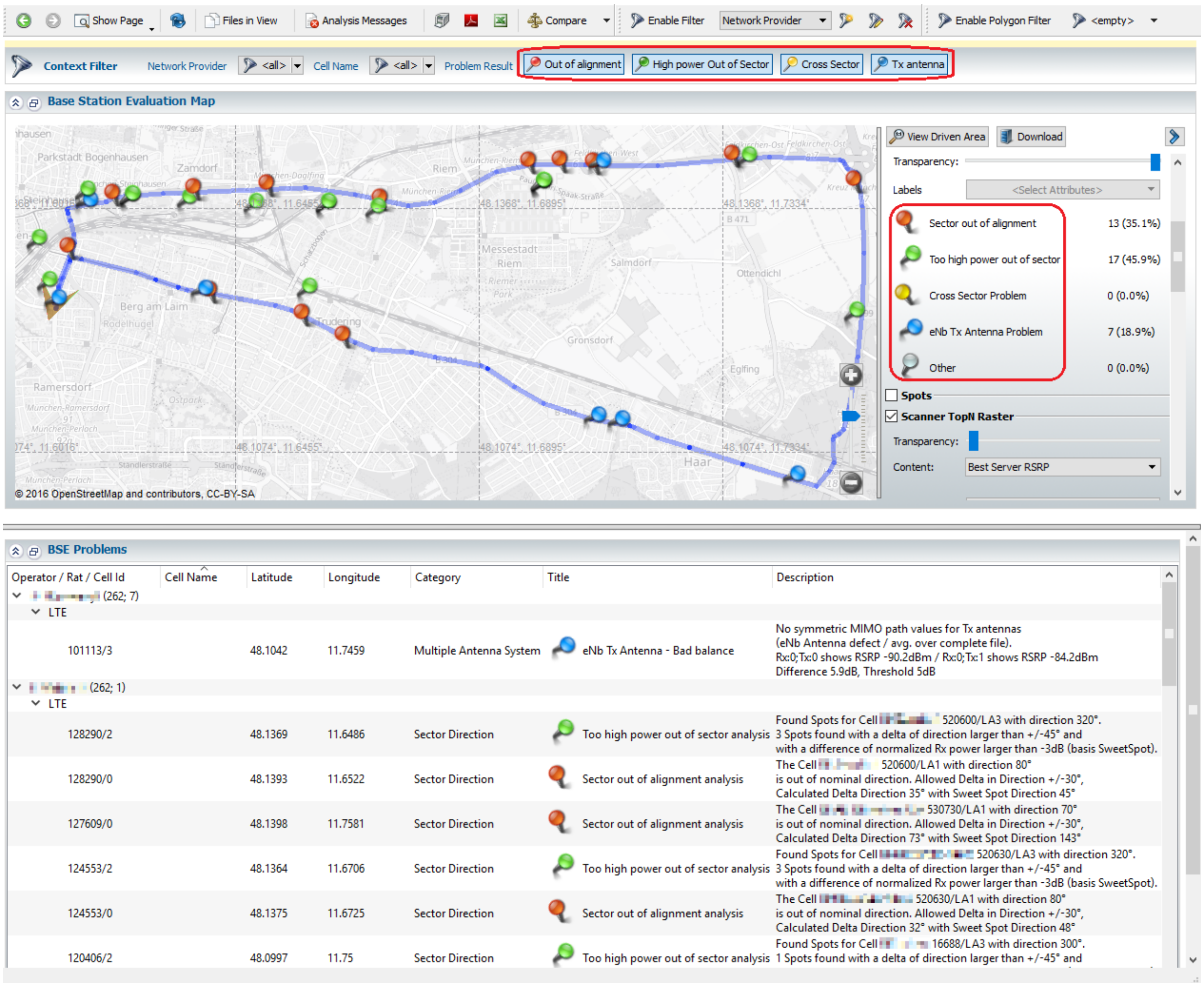


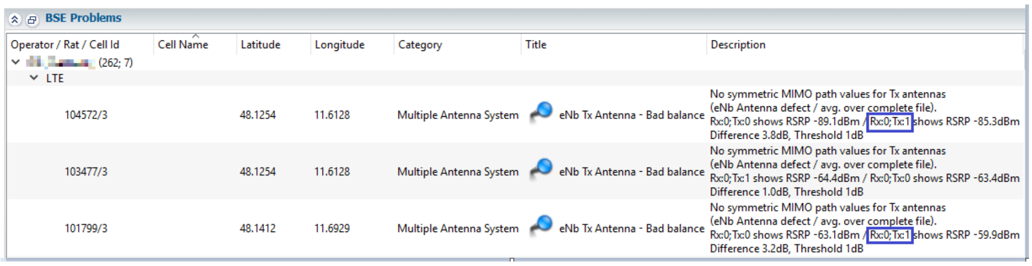
Figure 12-234: Base stations with associated problem spots

The problem analysis method checks the measured power around a base station in correlation to the antenna direction. Only measurement values where the Coverage [Power] Limit is larger than a minimum value are used for the calculation. These values are different for each technology part of the plugin properties. Refer to Processor configuration for a more detailed description.

The BSE problem analysis requires a valid cell database with an antenna direction.

Parameter	Value Range	Default	Description
Coverage - [Power] Limit	-120 to 0	-120 (LTE) -105 (WCDMA) -95 (GSM) -115 (TETRA)	Only higher values are used for the problem spot analysis Unit: [dBm]

The measured antenna combinations are mentioned in the "Description" column of the "Base Station Evaluation Problem" table.



BSE Problems

Operator / Rat / Cell Id	Cell Name	Latitude	Longitude	Category	Title	Description
(262; 7)						
LTE						
104572/3		48.1254	11.6128	Multiple Antenna System	eNb Tx Antenna - Bad balance	No symmetric MIMO path values for Tx antennas (eNb Antenna defect / avg. over complete file). Rx:0;Tx:0 shows RSRP -89.1dBm / Rx:0;Tx:1 shows RSRP -85.3dBm Difference 3.8dB, Threshold 1dB
103477/3		48.1254	11.6128	Multiple Antenna System	eNb Tx Antenna - Bad balance	No symmetric MIMO path values for Tx antennas (eNb Antenna defect / avg. over complete file). Rx:0;Tx:1 shows RSRP -64.4dBm / Rx:0;Tx:0 shows RSRP -63.4dBm Difference 1.0dB, Threshold 1dB
101799/3		48.1412	11.6929	Multiple Antenna System	eNb Tx Antenna - Bad balance	No symmetric MIMO path values for Tx antennas (eNb Antenna defect / avg. over complete file). Rx:0;Tx:0 shows RSRP -63.1dBm / Rx:0;Tx:1 shows RSRP -59.9dBm Difference 3.2dB, Threshold 1dB

Figure 12-235: BSE problems with marked antenna combination

12.23.4.1 Sector out of alignment analysis

If the measurement track is crossing the base station sector antenna direction and enough measurement values are available, the algorithm calculates a Sweetspot with a direction from the antenna. If the absolute delta of this direction to the antenna direction is above the value of "Delta Angle Sweet Spot", a problem spot with the title "Sector out of nominal direction" is created.

Parameter	Value Range	Default	Description
Delta Angle Sweet Spot	0..180°	30°	The Delta Angle in ° between the Cell Antenna Direction and the Measurement Point Direction for the Sweetspot problem analysis. Unit: [°]

12.23.4.2 Too high power out of sector analysis

If the algorithm defines a Sweetspot and "no Problem Spot" was created for the antenna direction, all other measurement points are compared to the Sweetspot receiving power. If the absolute delta of the direction is larger than the "Delta Angle To High Power" and the absolute difference of the receiving power is below the "Delta Power Difference" of the measurement point, a problem spot with the title "Too high power out of sector" is created.

If the measured normalized power in the problem spot "Too high power out of sector" is higher than the power at the sweetspot, the spot is always reported as a problem spot. If the "delta of power" is set to 0 dB, the "Too high power out of sector" problem spot is still present.

Table 12-13: Plugin Parameters

Parameter	Value Range	Default	Description
Delta Angle To High Power	0..180°	45°	The Delta Angle in ° between the Cell Antenna Direction and the Measurement Point Direction for the High Power out of Sector Problem analysis. This and normalized power difference must be true to get the problem spot. Unit: [°]
Delta Power Difference	0..50 dB	3 dB	The normalized Power difference between the Sweet Spot and the Measurement Point for the High Power out of Sector Problem analysis. This measurement point and the delta angle must be true to get the prob-lem spot.

12.23.4.3 Cross sector problem

The cross sector problem is common to all previously mentioned RAT technologies.

All cells (sectors) which have the same GPS position are processed as a site. Based on the calculated Sweespot, done for every cell where enough values are available, the order of the cell is checked. If you rotate clockwise around the site, the order is the same as in the cell database.

If there is a mismatch in the order of a cell, a problem spot with title "A mismatch in the order of cells between the database and the calculated Sweets pot is detected" is cre-ated. The problem spot is placed at the site position.

The "BSE Problem" page contains the possibility to report two more problem spots related to cross sector problems for LTE cells with activated wideband measurements, see Chapter 12.24.3, "LTE wideband antenna problem", on page 445.

12.24 LTE cell with MIMO and resource usage analysis

R&S ROMES4 NPA offers some properties added to the LTE MIMO plug-in analyzer to process the LTE MIMO measurement files. These files, obtained from both the R&S TSME scanner and a mobile device, are used to show the LTE network performances and detect existing problems in the network, if any.

The LTE cell with MIMO and resource usage analyses requires the R&S ROMES4N31 option.

To get the LTE MIMO mobile and scanner analyses pages, the configuration has to be done in "Data Processor Configuration" > "Lte Mimo Analysis Processor".

The pages visualize the LTE MIMO mobile and scanner measurement results. The pages can be selected from the overview page via tabs.

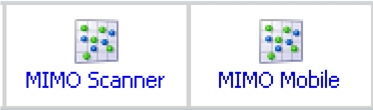


Figure 12-236: MIMO scanner/mobile tab

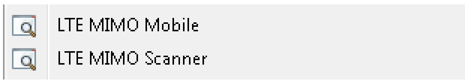


Figure 12-237: MIMO scanner/mobile command line

R&S ROMES4 NPA LTE MIMO analyzer includes the same statistical and problem analysis for downlink and uplink resource allocation. The results are mostly based on a cell or aggregated for a provider. The values obtained from scanner's demodulation of the LTE control channels are the basis for this analysis. The result overview page contains the tabs for downlink and uplink analysis result pages.

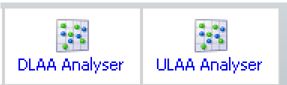


Figure 12-238: Tabs for DL and UL result pages

The MIMO Scanner/Mobile pages contain the icon in menu bar which allows directly to access"Filter Definition" page. In the page you can define filter name (example given, filtering per EARFCN) which can be run later.

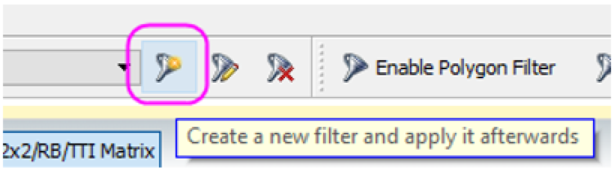


Figure 12-239: Icon to create filter

For filter definition and the values to be filtered, see Chapter 4.5.3, "How to define filters", on page 91.

The resource usage and resource allocation problems analysis is supported for both directions, uplink and downlink. The corresponding pages for them look the same.

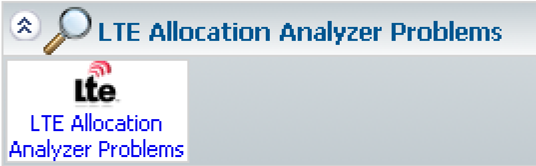


Figure 12-240: LTE Allocation Analyzer Problems page/icon

The problem types in UL and DL are the same.

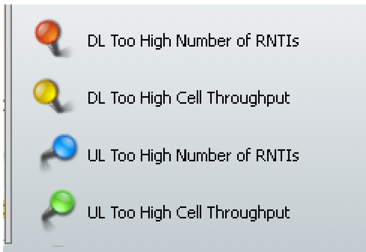


Figure 12-241: Problems in Dl and Ul

Click "LTE Allocation Analyzer Problems" for the problem map tables. The "Scanner Coverage Analyzer" results are also visible in the map.

For how to configure an analyzer module, see Chapter 4.7, "Configuring analyzer modules", on page 110.

Use a valid cell database to find the problem inside a map.

12.24.1 LTE MIMO analyzer

If you include the "Lte Mimo Analysis Processor" in the data processor configuration, the LTE MIMO plug-in list is available and MIMO processing runs.

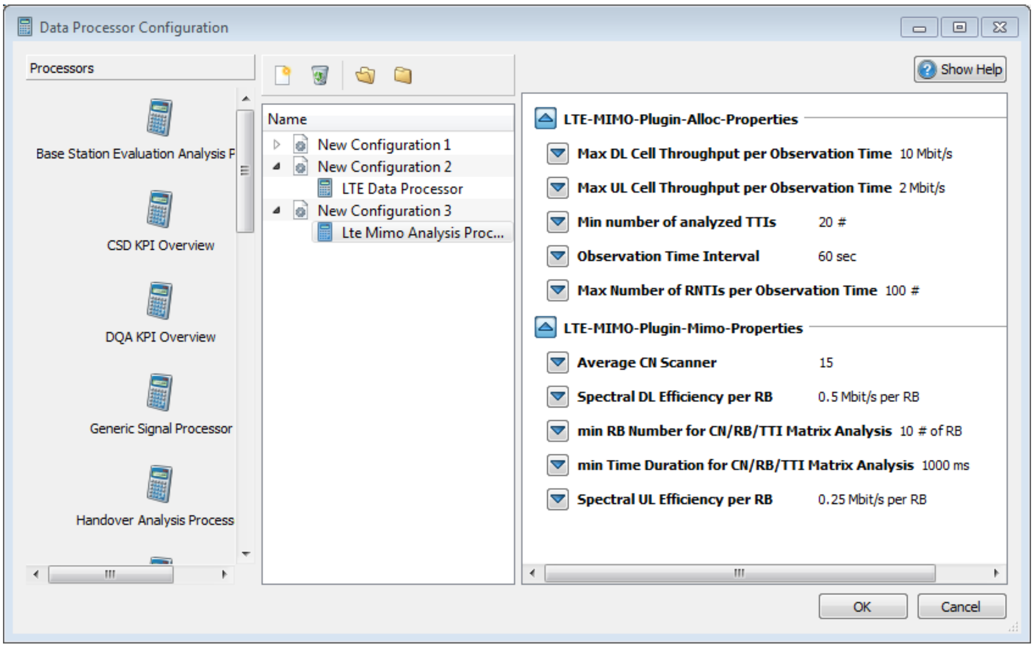


Figure 12-242: LTE MIMO Analysis Processor

The list contains configurable parameters for LTE MIMO analysis and problem spot analysis. The configured values represent the thresholds for the problem spot analysis.

The scanner analysis is based on the calculated Condition Number (CN) and Rank Indicator (RI). The rank represents the maximum number of possible independent layers (data streams). The CN is a measure for the channel quality. CNs depend on the rank and cannot be compared between different ranks.

The calculation method of CN and RI values is described in the "R&S ROMES4 Operating Manual". If the LTE MIMO measurements are activated for the scanner device, both values are obtained.

The statistical analysis, like the CDF chart or scatter plots, is visible in the "MIMO Charts".

Support of MIMO 4x4 Measurement

For a true MIMO 4x4 measurement, four receivers and four RX antennas have to be measured. The measurement is used to determine the so-called H-matrix of the 4x4 setup, including the 16 individual paths Tx_i/Rx_j (i,j=0,1,2,3).

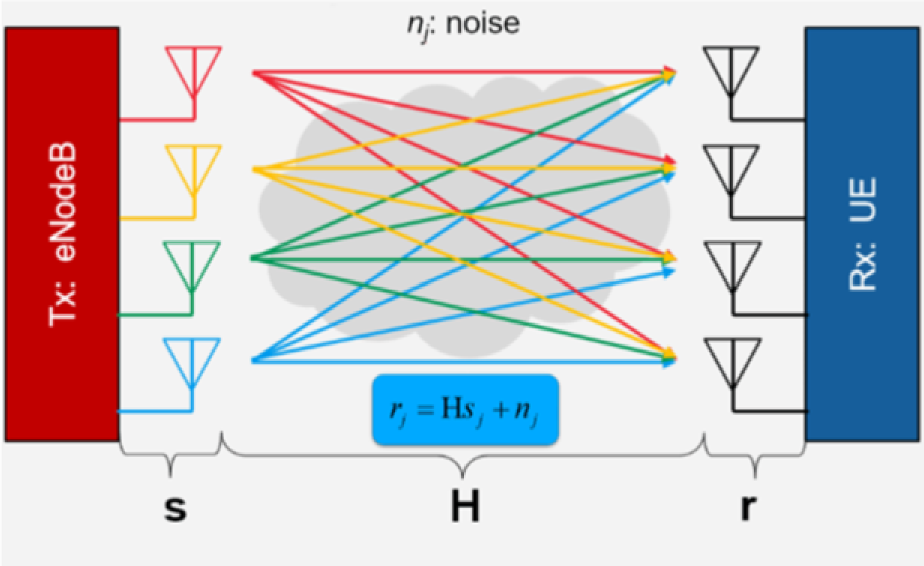


Figure 12-243: MIMO principle

The R&S ROMES4 NPA MIMO analyzer can handle rank values 1...4, obtained by the mobile and scanner for MIMO mode 2x2, 4x2 and 4x4. The LTE 4x4 MIMO RI analysis results of the mobile and scanner measurements are visualized via the "MIMO Mobile", respectively "MIMO Scanner" pages, see Figure 12-236 and Figure 12-237.

12.24.1.1 LTE MIMO mobile page

Click the "MIMO Mobile" tab or command line to get the "LTE MIMO Mobile" page.

The page contains the following entries:

- Map which shows the following:
  - Mobile problems
  - Binned values with the mobile efficiency layers for DL/UL

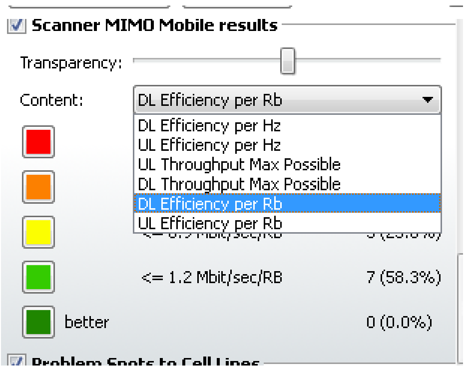


Figure 12-244: Content - DL efficiency per RB

- Scatter plots of mobile values from PCC cells up to rank 4

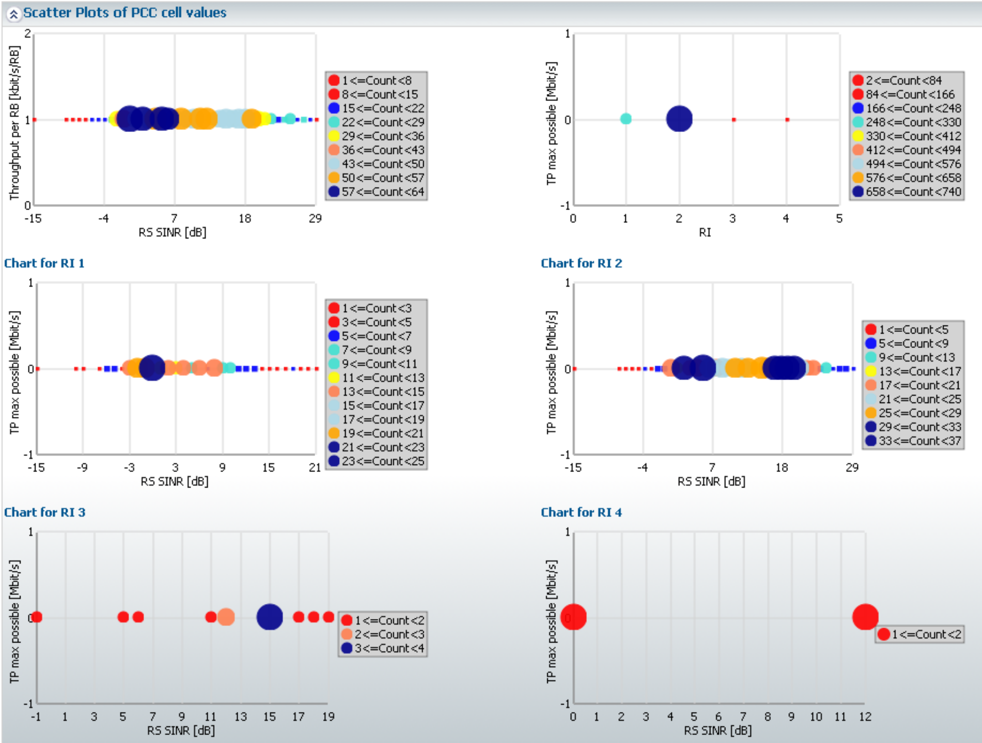


Figure 12-245: Scatter plot from PCC cells

- Pie charts of the mobile rank per device from the PCC cells

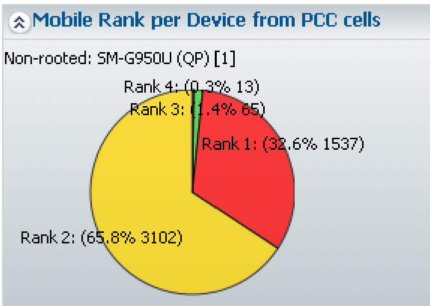


Figure 12-246: Pie chart of mobile rank per device

12.24.1.2 LTE MIMO scanner page

Click the "MIMO Scanner" tab or command line to get the "LTE MIMO Scanner" page.

Click the "Scanner MIMO Scanner results" option and select a map layer you want to be shown in the page.

The color of the raster element is set by the best cell value.

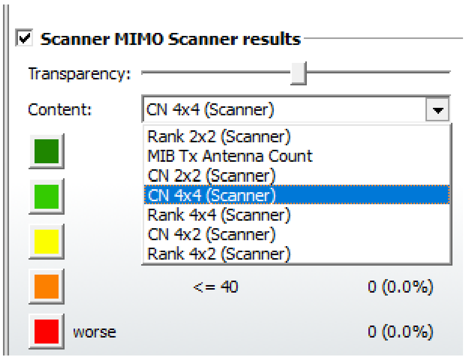


Figure 12-247: Selected map content - CN 4x4

The "LTE MIMO Scanner" page consists of the following areas:

- Map layers showing the scanner problems, the binned values with the MIB Tx antenna counts, the Rank and Condition Number (CN) layers for MIMO modes 2x2, 4x2 and 4x4.
- Bar charts of the scanner Rank distribution (each cell from each bin) for MIMO modes 2x2, 4x2 and 4x4.

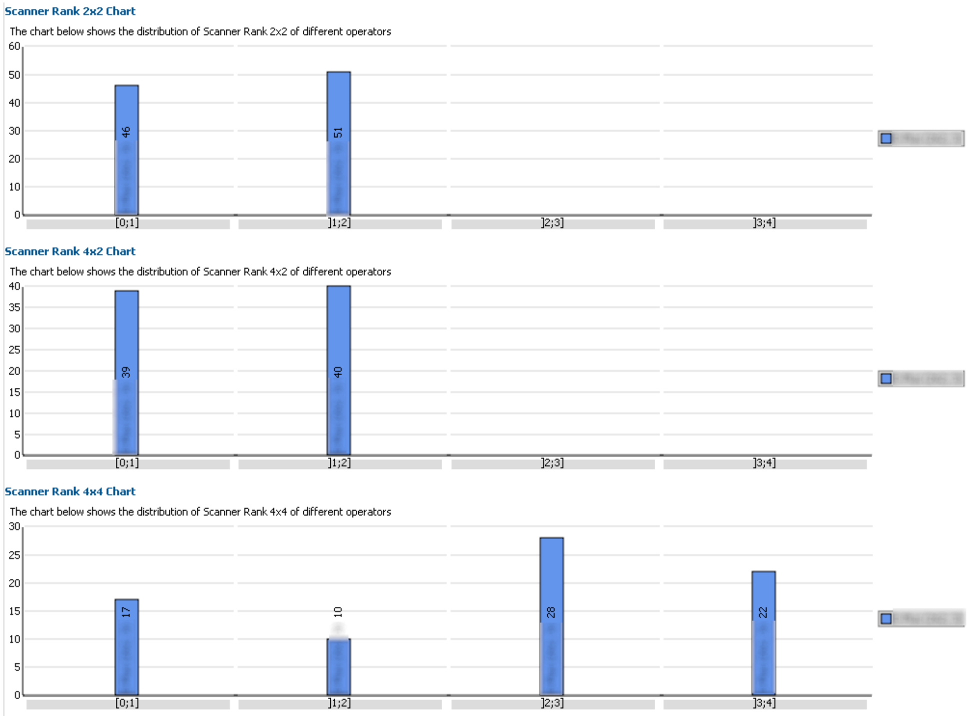


Figure 12-248: Bar chart for scanner ranks

- Pie charts of the distribution of eNB Tx antenna cell count per provider.

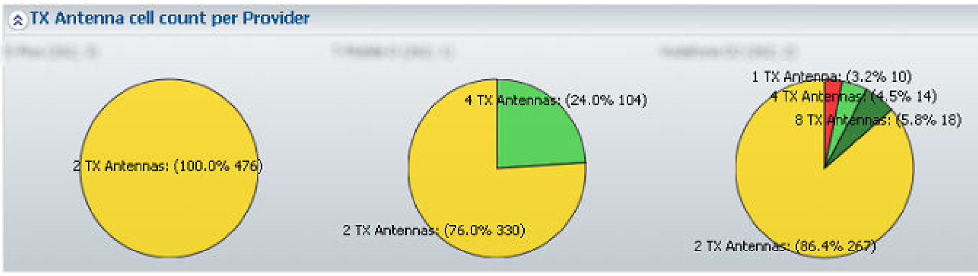


Figure 12-249: Pie chart for the MIB Tx antenna count

- Table of raster elements and the table showing the found scanner problems.

LTE MIMO Raster Element - Position: Longitude Latitude

LTE MIMO Raster Element

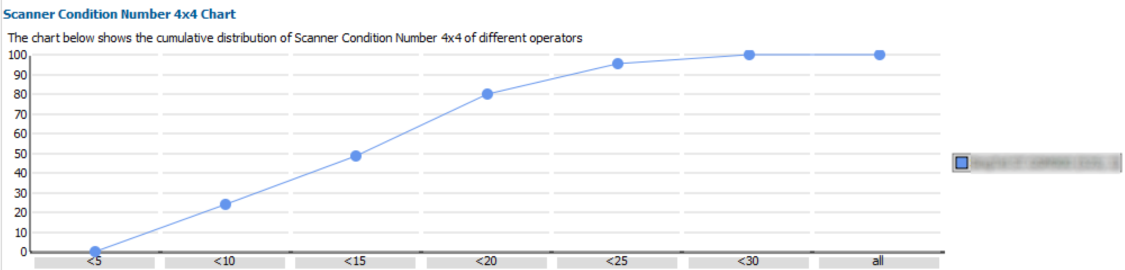
File:
Position: Longitude Latitude
Bin Size: 50 m/50 m

Phy CellId	Earfcn	CA-Mode	CN2x2 Avg	CN4x2 Avg	CN4x4 Avg	Rank2x2 Avg	Rank4x2 Avg	Rank4x4 Avg
458	1300	No CA	14.863			1.098		
445	3250	No CA	14.939			1.323		
335	38125	No CA	14.974	9.886	16.423	1.49	1.947	3.289
271	3725	No CA	15.055			1.411		
458	1444	No CA	15.063			1.08		
458	3725	No CA	15.095			1.567		
244	1300	No CA	15.315			1.213		
338	38125	No CA	16.9			1.36		
296	1300	No CA	17.067	9.59	16.053	0.857	1.24	3.122
210	1444	No CA	17.37	11.84	17.328	1.38	2	3.244
466	38125	No CA	17.752	16.217	25.246	1.473	1.673	3.189
458	3250	No CA	18.98			1.16		
466	3250	No CA	19.137			1.02		
30	1444	No CA	24			0	0.01	
64	3250	No CA			17.134			3.162

Figure 12-250: LTE MIMO raster element table

The table of each raster element shows the 4x4 CN value and the 4x2 CN value if they are available for this measured cell. Not shown in the previous figure, but present is the column showing the MIB Tx antenna counts.

- Cumulative Distribution Function Charts
  The Cumulative Distribution Function charts for CN 4x4 and 4x2 are shown at the bottom of the "LTE MIMO Scanner" result page.



Network Provider	# Values	<5	[%]	[5; 10[	[%]	[10; 15[	[%]	[15; 20[	[%]	[20; 25[	[%]	[25; 30[	[%]	>=30	[%]
[illegible]	285	0	0.0 %	67	23.5 %	70	24.6 %	91	31.9 %	43	15.1 %	14	4.9 %	0	0.0 %

Figure 12-251: An example of scanner CN 4x4 CDF chart

12.24.1.3 LTE MIMO properties analysis

The "LTE-MIMO-Plugin-Mimo-Properties" field in the Figure 12-242 shows the default values of the parameters relevant for the MIMO properties and problem spots analysis. Instead, you can configure the preferred values for your analysis.

The analysis uses scanner measurements of the LTE control channel. The scanner analysis is based on the calculated Condition Number (CN) and Rank Indicator (RI).

Mobile devices use the following calculated values, available for DL and UL.

- Efficiency per Hz (bit/s/Hz)
- Efficiency per RB
- Maximal throughput (Mbit/s)

The calculation of these efficiency values is based on the requested physical layer throughput and the used number of RB per second. The maximum throughput is calculated as the efficiency per RB multiplied by the number of available RBs. This number depends on the cell bandwidth.

Geographical analysis (raster analysis) is available for all calculated values. The analysis results are visible in a map view window with different layers.

The list of layers used to visualize the results inside the map view window are shown in the following figure.

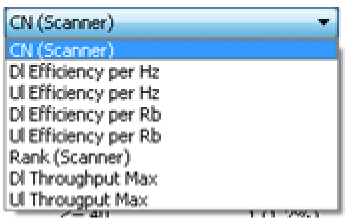
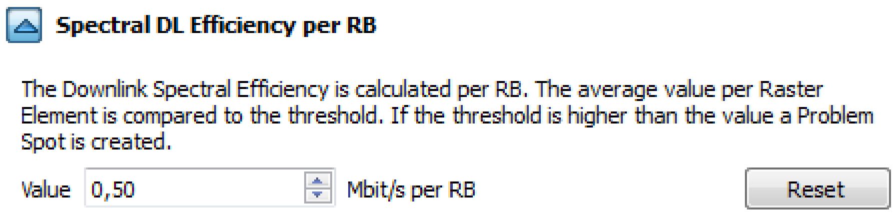


Figure 12-252: MIMO problem map layers

- "Average CN Scanner"
  CN is calculated by scanner. The calculated value is compared to the configured threshold and if higher, the problem spot is created.
- "Spectral DL(UL) Efficiency per RB" (Mbit/s/RB)



- "min RB Number for CN/RB/TTI Matrix Analysis"
  The measured number of RBs must be larger than the min. configured number of RB to get a problem spot created, see LTE MIMO problem spots analysis.
- "min Time Duration for CN/RB/TTI Matrix Analysis"
  Duration of a problem must be longer than the configured threshold.

12.24.1.4 LTE MIMO allocation analysis

The "LTE-MIMO-Plugin-Alloc-Properties" entry is used to configure parameters for downlink and uplink allocation analysis (DLAA/ULAA). The configuration of the LTE MIMO plugin includes a part for the allocation analysis.

The analysis is based on scanner measurements of the LTE control channel.

The Figure 12-242 shows the default values of the parameters relevant for DLAA/ ULAA.

- "Max DL Cell Throughput per Observation Time"
  The throughput is calculated per TTI and based on the MCS and the number of used RBs of all scheduled RNTIs.

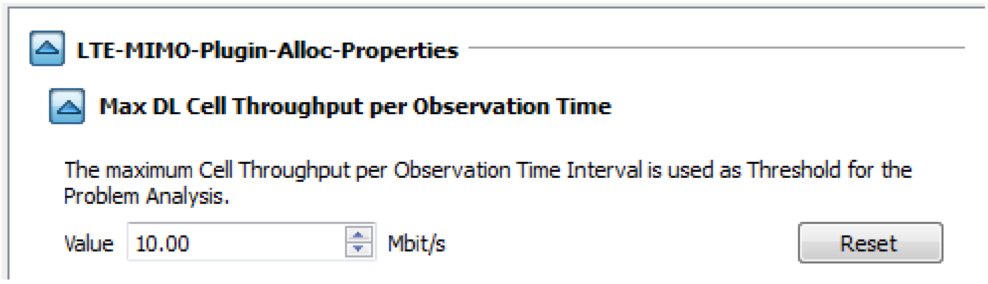


Figure 12-253: Max DL cell throughput per observation time

- "Max UL Cell Throughput per Observation Time"
  The uplink throughput is also a part of the problem analysis, based on configured threshold. The parameter has the same meaning as the previous one.
- "Min number of analyzed TTIs"
  The measurement result of a cell is only available and analyzed if at least a minimum number of TTIs are measured.
- "Observation Time Interval"
  The interval based on the measurement time; starts with the first measured TTI per cell.
- "Max Number of RNTIs per Observation Time"
  Used as the threshold for the problem analysis.

12.24.1.5 LTE MIMO allocation analyzer results

The available result pages for DL allocation analysis are:

- Allocation Result Cell Table with all cells fulfilling the condition for the enough results data. The maximum and average cell throughput for the cells fulfilling the mentioned condition is also shown in the table, in the "Max Cell TP" and "Avg Cell TP" columns, respectively. The following figure shows the table.

Allocation Result Cell Table

Network Provider / Band / Earfcn	Cell Name	Cell Identity	Physical Cell Id	# Measured TTIs	# different RNTIs	#Obs Intervals	Max Cell TP	Avg Cell TPs
[redacted] (262;2)								
20 (LTE 800)								
6300	n/a	82601/2	42	2343	617	253	26.8 Mbit/s	3.2 Mbit/s
[redacted] (262;7)								
20 (LTE 800)								
6200	n/a	100078/1	66	16845	1389	268	28.8 Mbit/s	2.9 Mbit/s
[redacted] (262;1)								
3 (EU DCS1800)								
1300	n/a	103602/0	103	9191	4162	268	66.6 Mbit/s	6.5 Mbit/s

Figure 12-254: Allocation result cell table

- Problem spot analysis, see DL allocation problem spots due to RNTI.
- Statistics of distribution of different RNTIs, see DL allocation statistics.

The result page of UL allocation analysis contains the similar views.

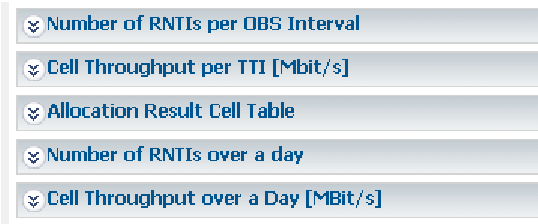


Figure 12-255: Views in the ULAA result page

12.24.1.6 LTE allocation analyzer chart

The user can monitor the cell throughput per operator and the throughput distribution per day using the "LTE Allocation Analyzer Charts" page. Downlink and uplink allocations of the resources can be analyzed separately as the page offers tabs for each analysis.

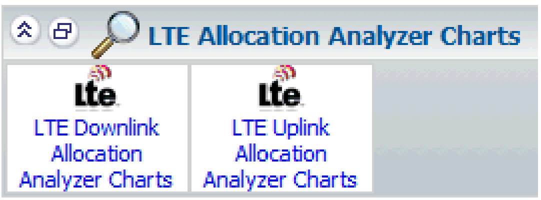


Figure 12-256: LTE DLAA/ULAA Charts

A part of the allocation analysis is based on the mobile and scanner reports.

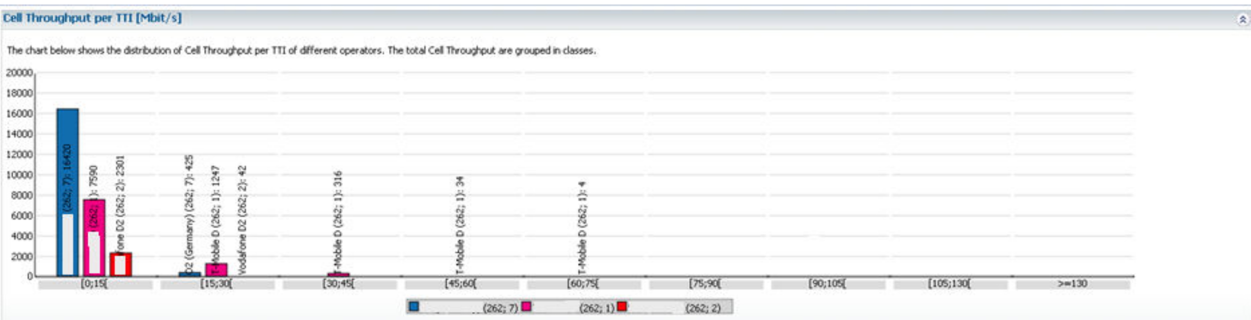
If activated, LTE mobile device reports the currently used RNTI for the data transmission between the mobile and the serving cell. These values are used for the scanner DLAA. The data are only analyzed for a cell in which the mobile device is active.

The RNTI-based data concerning throughput and number of PRBs are split into:

- Mobile used RNTI
- Other RNTIs (used by other devices)

Cell throughput per TTI and operator

The cell throughput distribution per TTI of different operators is shown in the following figure as chart and table.



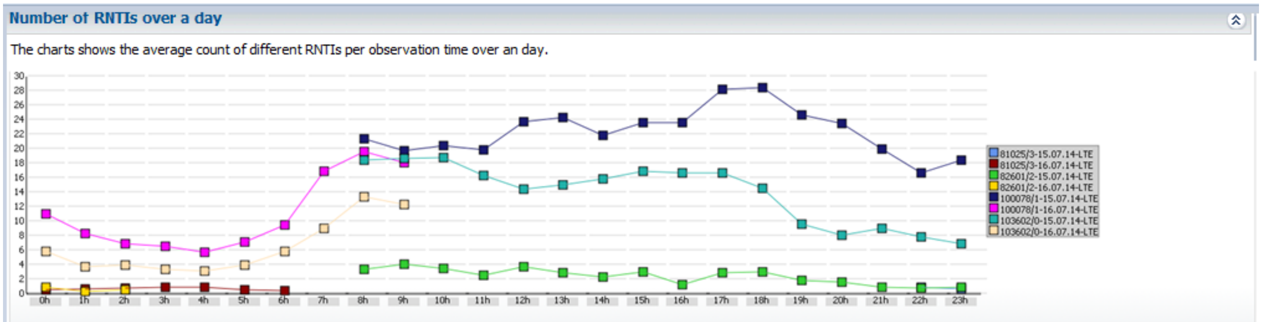
Network Provider	# TTIs	[0; 15[	[%]	[15; 30[	[%]	[30; 45[	[%]	[45; 60[	[%]	[60; 75[	[%]	[75; 90[	[%]	[90; 105[	[%]	[105; 130[	[%]	>=130	[%]
(262; 2)	2343	2301	98.2 %	42	1.8 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %
(262; 1)	9191	7590	82.6 %	1247	13.6 %	316	3.4 %	34	0.4 %	4	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %
(262; 7)	16845	16420	97.5 %	425	2.5 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %

Figure 12-257: Cell throughput per TTI

Number of RNTIs over a day

The chart Number of RNTIs over a day shows the average of different RNTIs per hour as a line chart. If multiple result files are added to the results page, the data are added to the chart.

"Per Day" is a different line of the same cell in the available chart.

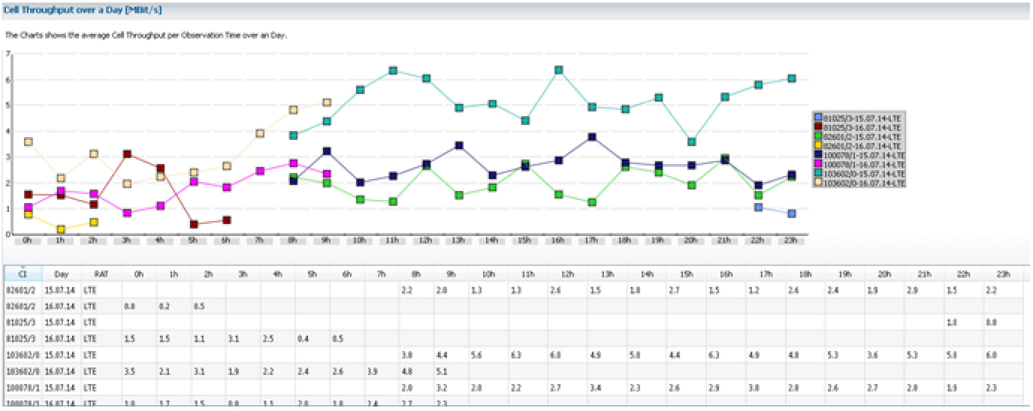


CI	Day	RAT	0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
82601/2	15.07.14	LTE									3.2	3.9	3.4	2.4	3.6	2.8	2.2	2.9	1.1	2.8	2.9	1.7	1.4	0.8	0.7	0.8
82601/2	16.07.14	LTE	0.8	0.1	0.4																					
81025/3	15.07.14	LTE																							0.8	0.5
81025/3	16.07.14	LTE	0.4	0.5	0.6	0.7	0.8	0.5	0.3																	
103602/0	15.07.14	LTE									18.2	18.5	18.7	16.2	14.3	14.8	15.7	16.7	16.5	16.5	14.4	9.5	8.0	8.9	7.8	6.7
103602/0	16.07.14	LTE	5.8	3.6	3.8	3.2	3.0	3.8	5.7	8.8	13.2	12.2														
100078/1	15.07.14	LTE									21.3	19.6	20.3	19.8	23.6	24.2	21.7	23.5	23.4	28.1	28.3	24.5	23.4	19.8	16.5	18.3

Figure 12-258: Number of RNTIs over a day

Throughput per cell over a day

The chart showing the all throughput per cell over a day is also available. It looks like the previously mentioned chart.



CI	Day	RAT	0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
82601/2	15.07.14	LTE									2.2	2.0	1.3	1.3	2.6	1.5	1.8	2.7	1.5	1.2	2.6	2.4	1.9	2.9	1.5	2.2
82601/2	16.07.14	LTE	0.8	0.2	0.5																					
81025/3	15.07.14	LTE																							1.0	0.8
81025/3	16.07.14	LTE	1.5	1.5	1.1	3.1	2.5	0.4	0.5																	
103602/0	15.07.14	LTE									3.8	4.4	5.6	6.3	6.0	4.9	5.0	4.4	6.3	4.9	4.8	5.3	3.6	5.3	5.8	6.0
103602/0	16.07.14	LTE	3.5	2.1	3.1	1.9	2.2	2.4	2.6	3.9	4.8	5.1														
100078/1	15.07.14	LTE									2.0	3.2	2.0	2.2	2.7	3.4	2.3	2.6	2.9	3.8	2.8	2.6	2.7	2.8	1.9	2.3

Figure 12-259: Throughput per cell over a day

Throughput estimation result table

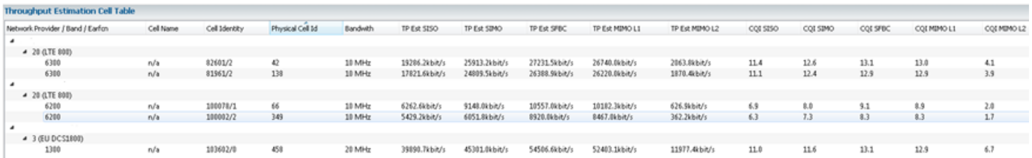
The LTE MIMO plugin is extended to show the results of the throughput estimation in a tabular way. For the configuration details, see the "R&S ROMES4 Operating Manual", chapter "Display and Evaluation of Results - Scanner Views - LTE Scanner Views".

To get the throughput result table, measured and analyzed are:

- CQI
- Estimated Throughput (based on the CQI)

Both measured values are arithmetically averaged per cell over the complete measurement file and shown in a table of the "LTE Downlink Allocation Charts" page.

The measured values are analyzed separately for the following transmission modes: SISO, SIMO, SFBC, MIMO Layer 1 and MIMO Layer 2.



Throughput Estimation Cell Table

Network Provider / Band / Earfcn	Cell Name	Cell Identity	Physical Cell Id	Bandwith	TP Est SISO	TP Est SIMO	TP Est SFBC	TP Est MIMO L1	TP Est MIMO L2	CQI SISO	CQI SIMO	CQI SFBC	CQI MIMO L1	CQI MIMO L2
20 (LTE 800)														
6300	n/a	82601/2	42	10 MHz	19286.2kbit/s	25913.2kbit/s	27231.5kbit/s	26740.0kbit/s	2063.8kbit/s	11.4	12.6	13.1	13.0	4.1
6300	n/a	81961/2	138	10 MHz	17821.6kbit/s	24809.5kbit/s	26388.9kbit/s	26220.0kbit/s	1870.4kbit/s	11.1	12.4	12.9	12.9	3.9
20 (LTE 800)														
6200	n/a	100078/1	66	10 MHz	6262.6kbit/s	9148.0kbit/s	10557.0kbit/s	10182.3kbit/s	626.9kbit/s	6.9	8.0	9.1	8.9	2.0
6200	n/a	100002/2	349	10 MHz	5429.2kbit/s	6051.8kbit/s	8920.0kbit/s	8467.0kbit/s	362.2kbit/s	6.3	7.3	8.3	8.3	1.7
3 (EU DCS1800)														
1300	n/a	103602/0	458	20 MHz	39890.7kbit/s	45301.0kbit/s	54506.6kbit/s	52403.1kbit/s	11977.4kbit/s	11.0	11.6	13.1	12.9	6.7

Figure 12-260: Throughput estimation cell table

DLAA scatter plot

The data are cumulated over the configured observation interval and the average is used for the analysis. A scatter plot with data for the "Scanner My" (mobile RNTI) and the "Scanner Other" (other RNTIs) for throughput and number of PRBs is available, see the following figure.

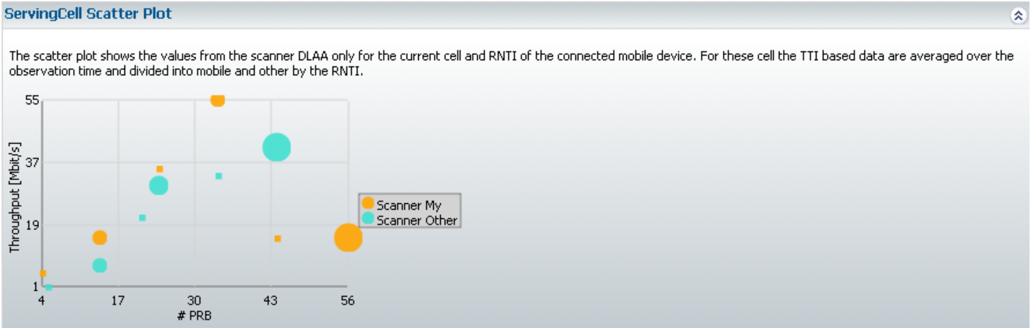


Figure 12-261: Scatter plot layout

12.24.1.7 MCS statistic derived from averaged itb

The output of MCS in mobile coverage raster is based on iTBS.

The MCS used by LTE mobile device is not analyzed at the raster elements (bin). Instead, the index of the TBS (iTBS) is used and averaged. The values are available in the map layers, table and Tooltip of the raster element (bin).

Before the average is calculated, every iTBS is converted into TBS in bits based on 10 resource blocks and later converted back to an iTBS value.

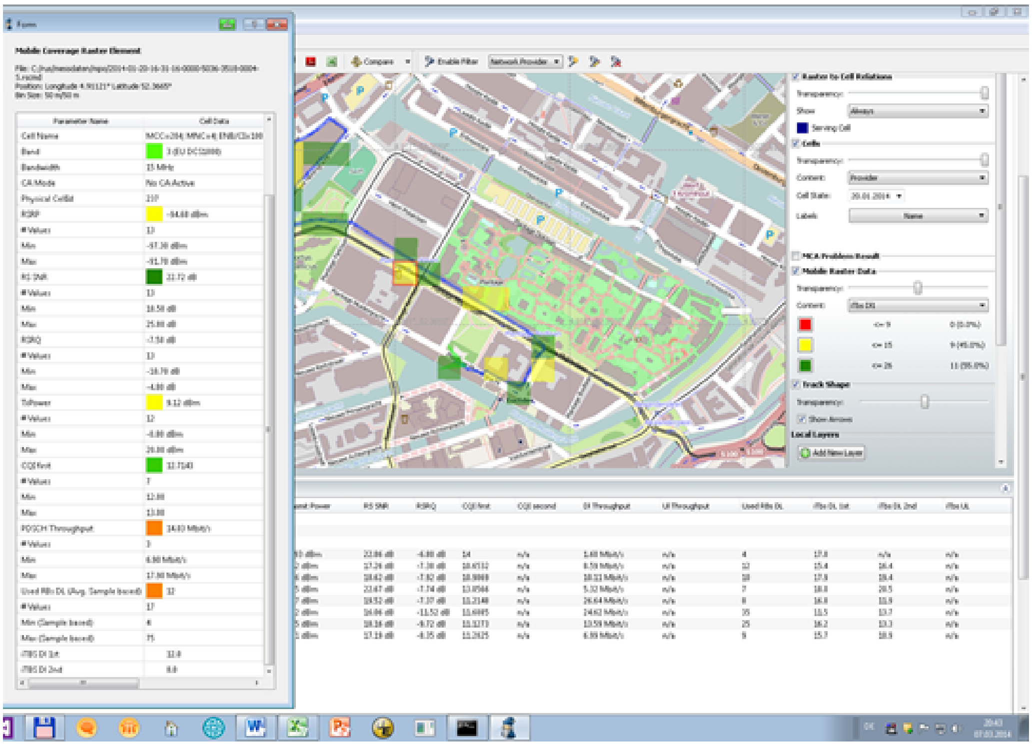
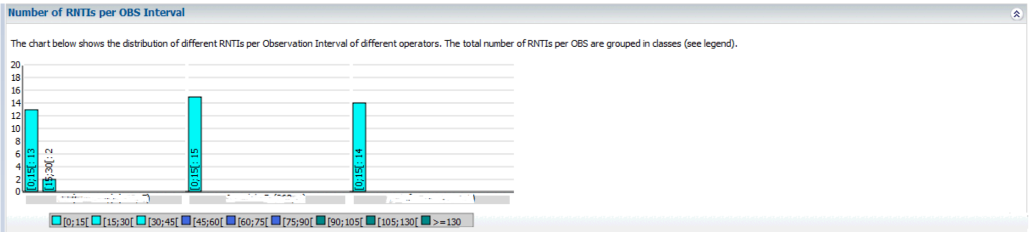


Figure 12-262: Map layer for LTE UE

12.24.1.8 Downlink allocation statistics

The results of LTE MIMO downlink allocation analysis are given as a distribution of total number of different RNTIs per observation interval.



Network Provider	# OBS	[0; 15[	[%]	[15; 30[	[%]	[30; 45[	[%]	[45; 60[	[%]	[60; 75[	[%]	[75; 90[	[%]	[90; 105[	[%]	[105; 130[	[%]	>=130	[%]
	14	14	100.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %
	15	15	100.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %
	15	13	86.7 %	2	13.3 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %	0	0.0 %

Figure 12-263: DL allocation statistics

12.24.2 LTE MIMO problem spots analysis

The following problem spots are available:

- Condition Number Problem
  The best value (the lower is the better) of a raster element (bin) is compared to the defined threshold. If the value is higher than the threshold, a problem spot for this raster and cell is created. The problem spots are combined for the same cell and only the worst case is shown in the description. The occurrence is given in a separate column of the table.
- Efficiency per RB Problem
  The best value (the higher is the better) of a raster element (bin) is compared to the defined threshold. If the value is below the threshold a problem spot for this raster and cell is created. The problem spots are combined for the same cell and only the worst case is shown in the description. The occurrence is given in a separate column of the table.
- Condition Number Matrix Problem
  The analysis is based on the CN matrix which contains a CN value for each resource block. The number of matrixes per cell and the duration between two matrixes depends on the R&S ROMES4 configuration of the MIMO measurements.

The possible problem spots are shown with the name and colored pin in the "Analysis Results Overview" > "Driven Area".

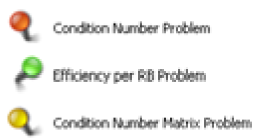


Figure 12-264: Problem spots

If the average value of the complete matrix is higher than the threshold, the bad condition is assumed. The complete matrix is analyzed to find out the ranges of resource blocks with bad conditions. This analysis is done within every matrix to analyze the time duration for these ranges. If the range of resource blocks and of the time duration is larger than the defined threshold, a problem spot is created. All problem spots of the cells with nearly the same position are combined. The single problem spot is visible as a course after a double click at the problem.

12.24.2.1 Downlink allocation problem spot

A DL allocation problem spot is created in the following cases:

- If a cell with more different RNTIs than configured in the plug-in properties was found within an observation time interval

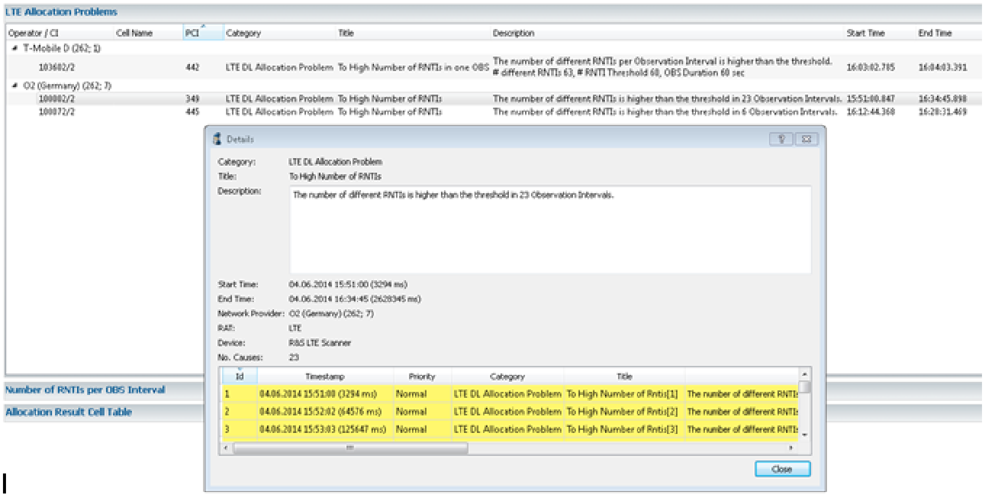


Figure 12-265: DL allocation problem spots due to RNTI

- If a cell throughput in an observation time interval is larger than the configured threshold

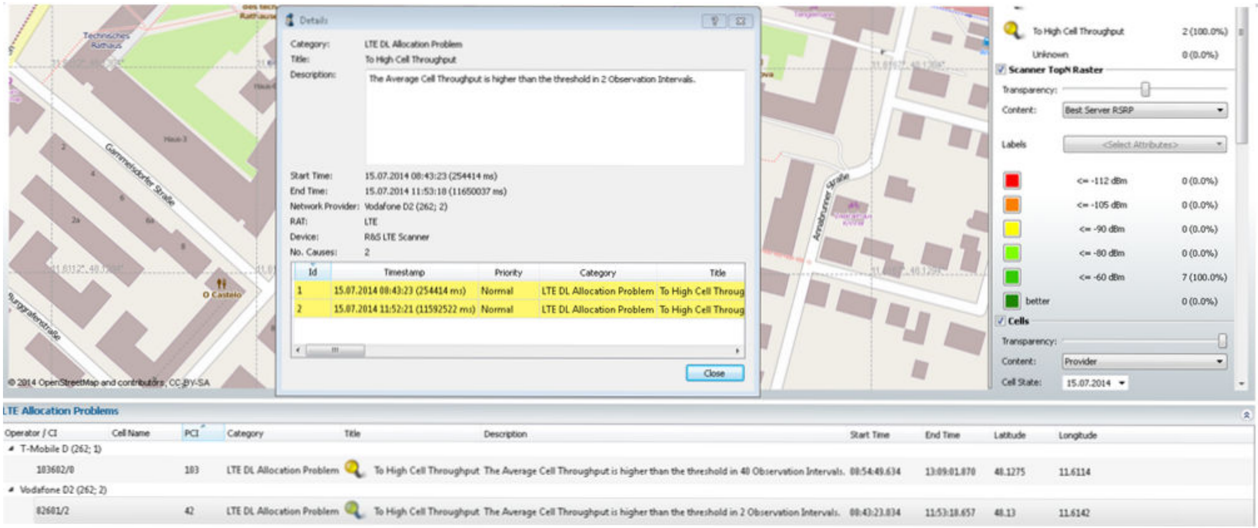


Figure 12-266: DL allocation problem spots due to throughput

All problems of one cell are cumulated into one problem spot with a problem cause per problem observation interval. The previous figure shows the number of problems and a problem description within "Details".

12.24.3 LTE wideband antenna problem

The Base Station Analyzer detects the base station problems related to cross sector directions as the problem spots.

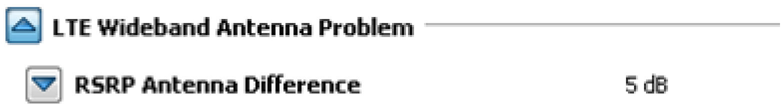


Figure 12-267: Configured threshold for RSRP antenna difference

For LTE base stations with activated wideband measurements, three additional sector direction problem spots are supported with the BSE analyzer. All them belong to the category Multiple Antenna System.

- eNb Tx antenna count mismatch
  First, the received RSRP values are collected for each combination of receive and transmit antennas, separately per each cell. Later is compared the count of transmit antennas from the cell's MIB decoding and from the wideband measurements, see Coverage Cell Statistics buttons and result pageChapter 12.16.7, "LTE scanner", on page 363. If this count is different, a problem spot is created.
- eNb Tx antenna bad balance
  The problem occurs if at path Rx0 the delta between the RSRP values of any antenna combination is larger than the configurable threshold.
- eNb Tx antenna path imbalance in two sectors

The problem occurs if the previously mentioned problem is detected for at least two sectors of a base station. A valid cell database file is required to group the sectors to a base station.

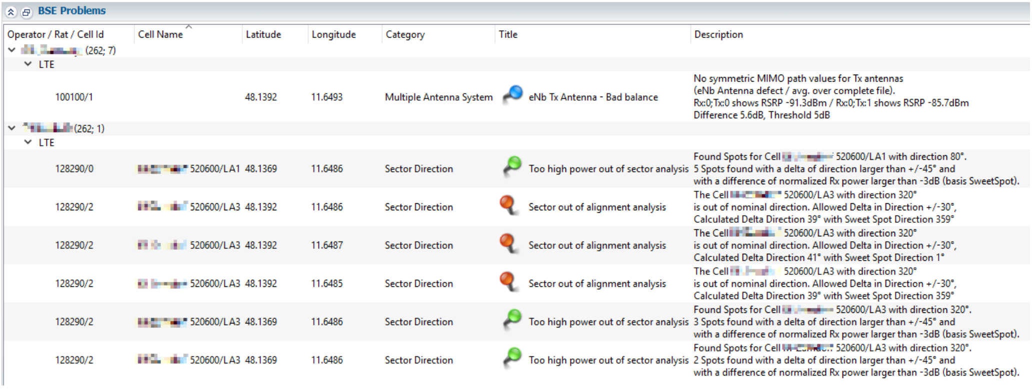


Figure 12-268: Different LTE cell problem spots

12.25 LTE carrier aggregation analysis

The R&S ROMES4 NPA Mobile Coverage Analyzer module supports the Carrier Aggregation analysis with the corresponding license.

The R&S ROMES4N21 license is needed to run this option.

Five component carrier analysis in downlink is supported, that means, primary component carrier and four secondary component carriers.

The uplink CA analysis is also supported by R&S ROMES4 NPA. As UE can use up to two carriers for UL data transmission, two CC aggregation analysis in uplink is supported.

If the CA results in analyzed file exist, the "LTE CA Mobile" icon is available in the "Overview Result" page. Click the icon to open the "LTE Mobile Coverage Carrier Aggregation" result page. The DL or UL CA analysis results are shown in map raster layer and cell table.

Information, like a cell details, carriers and the physical layer data are processed in the geographical bins.

12.25.1 DL carrier aggregation analysis

The page "LTE Mobile Coverage Carrier Aggregation" shows the results of the analyzer.

The DL CA result page contains the following:

- Map raster layers

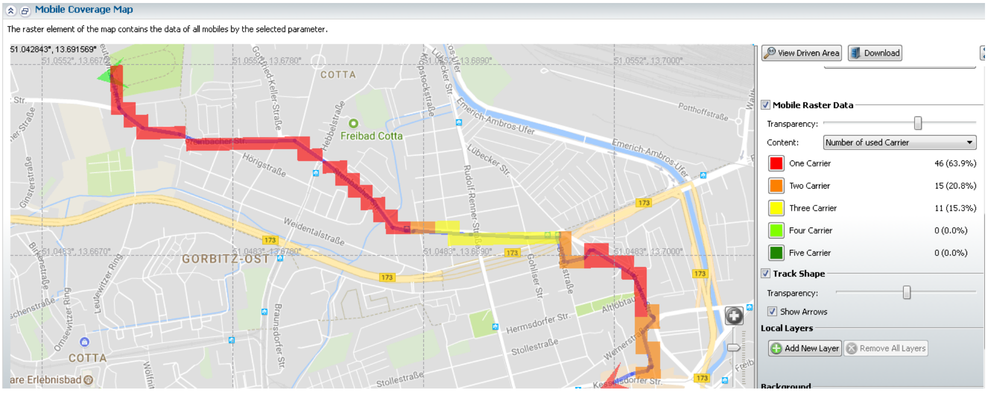


Figure 12-269: Adding the number of used carriers layer

- Cell table with all cells and values, similar to the normal "LTE Mobile Coverage" page

Mobile Coverage Cell Table

DeviceId / Network Provider / Technology / Cell Name	Band	eNB/CI	Physical CellId	EARFCN	CA Modes	Bandwidth	# Bins	RSRP	Transmit Power	RS SNR	RSRQ	CQI first	CQI second	Dl Throughput	Ul Throu
SM-G928F [1]															
MCC255_MNC123 (255; 123) (255;123)															
LTE															
n/a	7 (IMT-E 2600)	991/4	499	2850	PCC	20 MHz	1	-61.00 dBm	-17.76 dBm	29.32 dB	-9.38 dB	15.00	15.00	88.85 Mbit/s	4.06 Mbit
n/a	20 (LTE 800)	n/a	199	6300	SCC	20 MHz	1	-66.45 dBm	n/a	24.59 dB	-7.75 dB	15.00	15.00	88.53 Mbit/s	n/a
n/a	3 (EU DCS1800)	n/a	399	1808	SCC2	20 MHz	1	-57.00 dBm	n/a	30.97 dB	-8.60 dB	15.00	15.00	88.67 Mbit/s	n/a

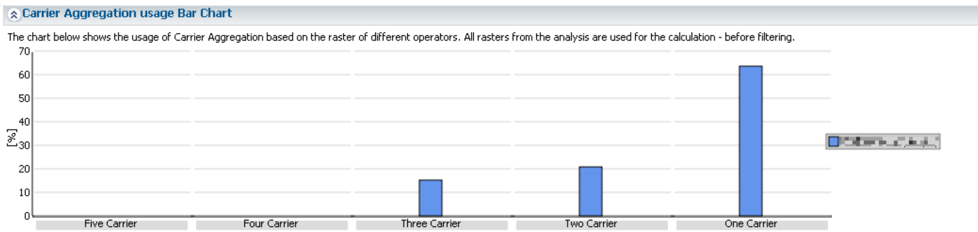
Figure 12-270: LTE CA mobile coverage cell table - DL

The following parameters can be selected for coloring in the CA coverage map raster:

- Number of used component carrier by phone/operator
- Cumulated DL bandwidth over all channel by phone/operator
- Cumulated used average RBs over all channels by phone/operator
- Cumulated DL throughput over all channel by phone/operator

At the "Mobile Coverage Map" following layer for binned results is added:

- Bar chart showing used CC number and the percentage of their usage per operator, calculated over the bins.



Network Provider	# Bins	Five Carrier	[%]	Four Carrier	[%]	Three Carrier	[%]	Two Carrier	[%]	One Carrier	[%]
	72	0	0.0 %	0	0.0 %	11	15.3 %	15	20.8 %	46	63.9 %

Figure 12-271: Number of used component carriers

- Bar chart with used DL cumulated bandwidth per operator, calculated over the bins.

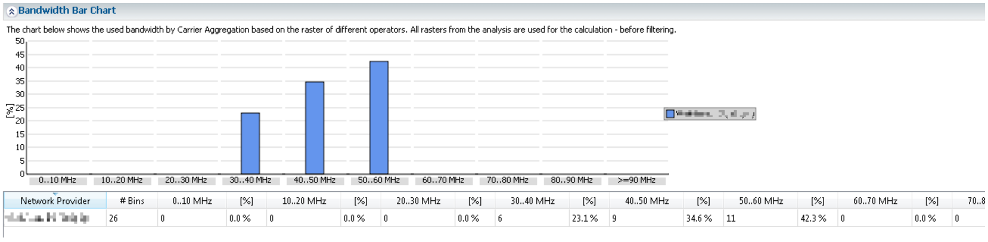


Figure 12-272: Usage of bandwidth with CA

- Resource Blocks CA

The ranges for each value are updated to fit better to the possible ranges.

12.25.2 UL carrier aggregation analysis

The UL throughput data of the SCC cells are analyzed by the following R&S ROMES4 NPA LTE mobile data analysis modules:

- Mobile coverage analyzer
- LTE MIMO analyzer
- LTE mobile problem analyzer

The UL CA result page contains the following:

- Map raster layers

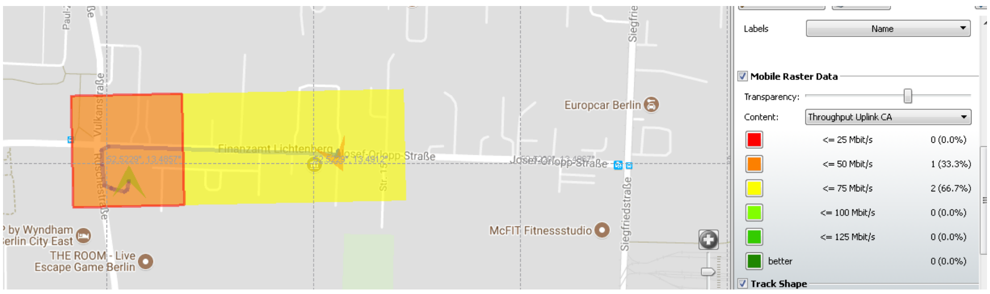


Figure 12-273: Map rater layer - UL

- Cell table with all cells and values, similar to the normal "LTE Mobile Coverage" page

CA Modes	Bandwidth	# Bins	RSRP	Transmit Power	RS SNR	RSRQ	CQI first	CQI second	Dl Throughput	Ul Throughput	Used RBs DL	Used RBs UL	iTbs DL 1st	iTbs DL 2nd	iTbs UL
PCC	20 MHz	1	-70.11 dBm	12.99 dBm	28.63 dB	-7.83 dB	14.94	n/a	2.56 Mbit/s	43.08 Mbit/s	3	68	18.8	18.2	25.8
PCC	10 MHz	2	-70.84 dBm	5.09 dBm	17.81 dB	-8.30 dB	11.66	n/a	1.68 Mbit/s	14.24 Mbit/s	3	24	14.1	12.9	25.5
PCC	10 MHz	2	-77.98 dBm	12.58 dBm	12.99 dB	-9.35 dB	11.50	n/a	1.11 Mbit/s	13.39 Mbit/s	3	27	18.7	16.0	25.7
PCC	10 MHz	2	-83.39 dBm	13.58 dBm	10.55 dB	-13.08 dB	11.35	n/a	0.74 Mbit/s	12.11 Mbit/s	2	25	19.1	13.1	25.6
PCC	20 MHz	1	-112.01 dBm	23.00 dBm	11.20 dB	-8.92 dB	9.71	n/a	0.88 Mbit/s	4.94 Mbit/s	3	59	16.9	16.6	5.7
SCC1	20 MHz	2	-80.24 dBm	8.59 dBm	19.83 dB	-8.57 dB	12.12	n/a	0.00 Mbit/s	46.32 Mbit/s	2	83	3.9	2.8	25.2
SCC1	20 MHz	2	-73.83 dBm	0.00 dBm	26.03 dB	-7.93 dB	14.12	n/a	0.00 Mbit/s	42.67 Mbit/s	3	74	2.4	2.2	23.0

Figure 12-274: LTE CA mobile coverage cell table - UL

The following parameters can be selected for coloring in the UL coverage map raster:

- Throughput sum
- RB usage

12.26 LTE mobile statistics

The LTE Mobile Statistics function of the R&S ROMES4 NPA aggregates and displays many parameters related to, for example, Layer 1, CQI, MIMO, usage of MCS or Resource Blocks. Activating of a mobile statistic aggregation type is done in the "Data Processor Configuration" > "LTE Data Processor" page, see Figure 12-276.

The function derives and displays statistics for the following LTE parameters:

- RSRP
- RSRQ
- SINR
- CQI
- MCS DL 1st
- MCS DL 2nd
- MCS UL Total
- Resource Blocks DL
- Rank Indicator
- PMI
- TxPower

The LTE Mobile Statistics function is enhanced with an option in the "LTE Data Processor" page that allows to activate aggregation of the statistics (e.g. RSRP, RSRQ, RB, CQI, modulation type, etc.) all the time, not only when an FTP, HTTP or UDP job generates large amount of data. By default the option is inactive.

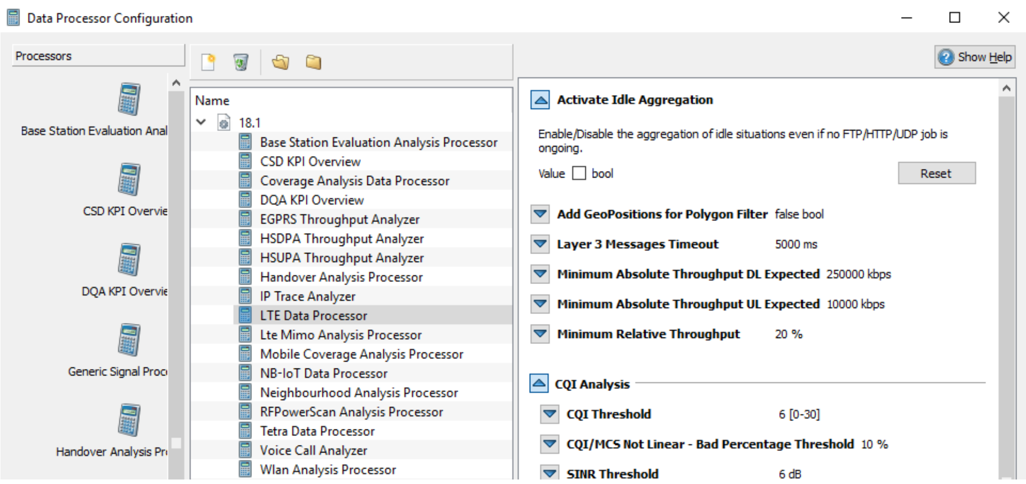


Figure 12-275: Activation of idle aggregation

12.26.1 Handling the LTE mobile statistics

The "LTE Data Processor" page allows to choose whether to aggregate the statistics for Layer1, CQI, MIMO, MCS, RBs and RI or to omit each of them. Deactivating the LTE mobile statistics is useful when the statistics consumes much of analysis time.

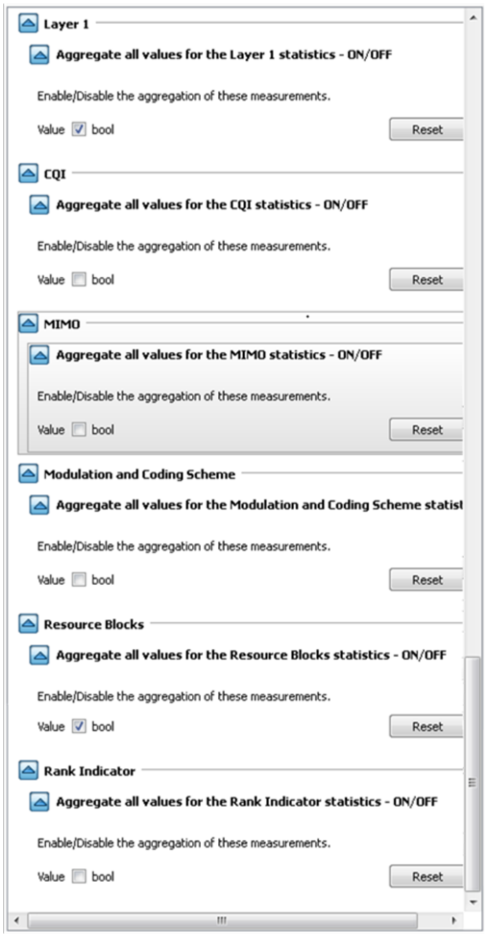


Figure 12-276: Default configuration for LTE mobile statistics aggregation

By default, only Layer 1 and RB statistics aggregation are active. This aggregation improve the R&S ROMES4 NPA performance during processing the measurement files.

The default result "LTE Mobile Statistics" page is shown in the following figure where the two default tabs are highlighted.

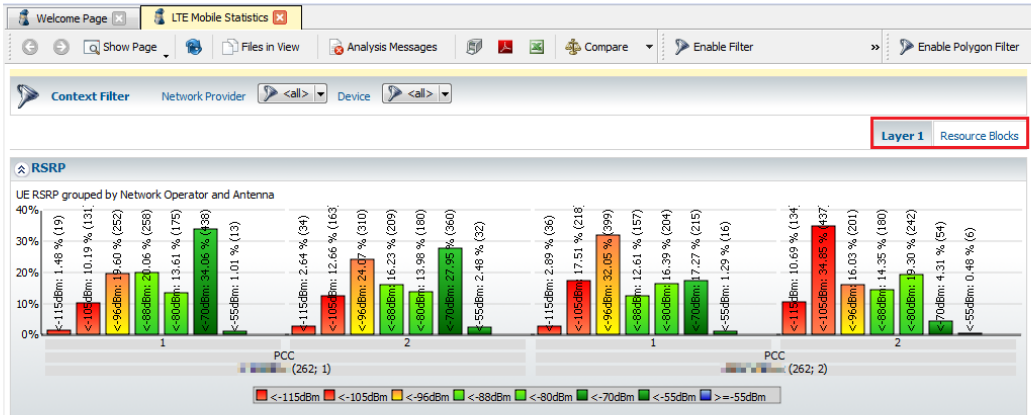


Figure 12-277: LTE mobile statistics display - default

The range of RSRQ in the "LTE Mobile Statistic Layer 1" is given as shown in the following figure.

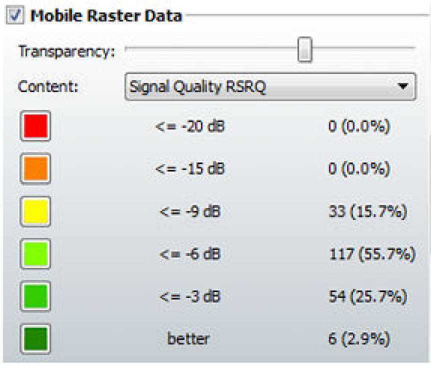


Figure 12-278: RSRQ range

Adding the GeoPositions to the statistical results is configurable to improve the performances.

If activated, the "Add GeoPositions for Polygon Filter" adds the GeoPositions to the statistical results. It is disabled by default.

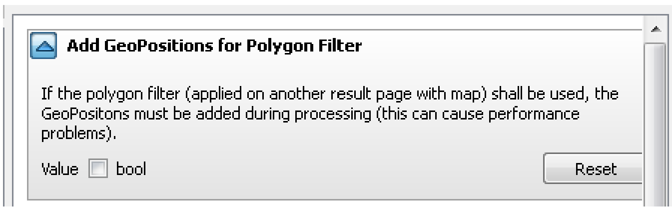


Figure 12-279: GeoPositions configuration option

12.26.2 LTE-M mobile statistics

The R&S ROMES4 NPA LTE Mobile Statistics function aggregates the statistics for LTE-M.

The following parameters are aggregated:

- CE level/PSH/eDRX
- PRACH Tx power/repetitions
- PUSCH Tx power/repetitions
- eMTC layer1 (eMTC)
- QPing/NPing

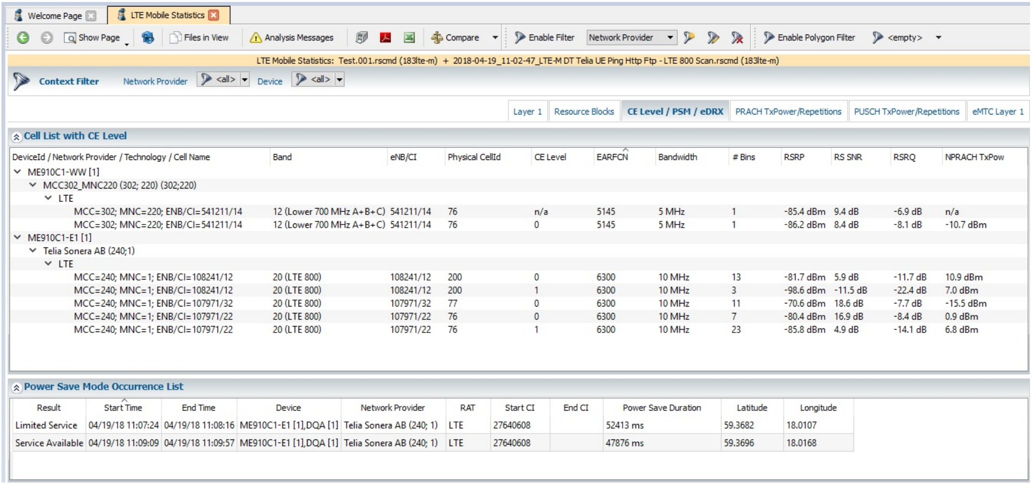


Figure 12-280: LTE-M statistics

The R&S ROMES4 NPA retrieves the EUTRAN timers T3324 and T3412 extended from EMM_TAU_ACCEPT message. The eDRX paging cycle is based on the R&S ROMES4 signal.

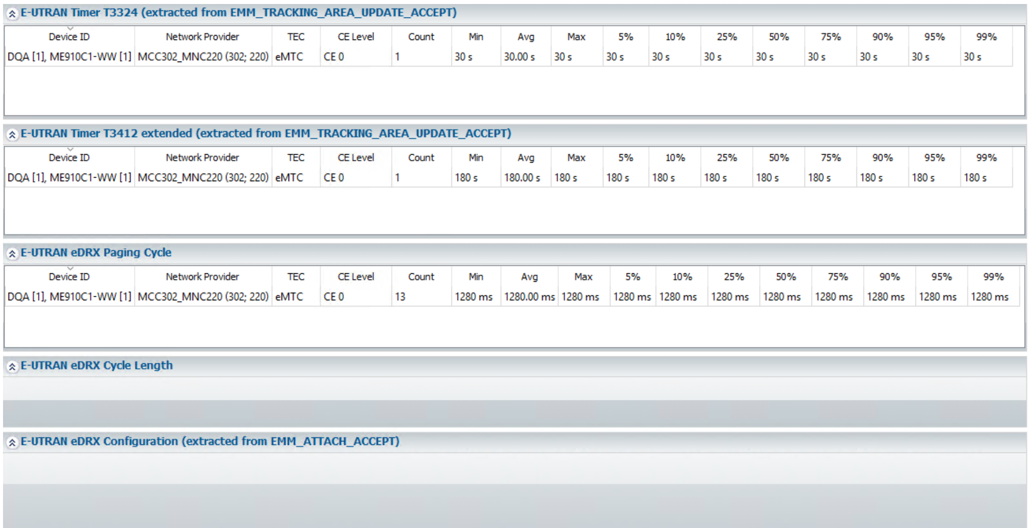


Figure 12-281: Retrieved timers T3324 and T3412 and paging cycle values

There is at the moment no measurement file showing an eDRX Cycle Length > 0. Also, there is no measurement file showing the eDRX configuration in the EMM_ATTACH_ACCEPT message.

12.26.3 LTE mobile statistics examples

The LTE cell Layer 1 mobile statistics supports the 3GPP Rel.10 feature Carrier Aggregation (in DL direction only). Displayed are for both cells, that is, the PCC and the SCC RSRP, RSRQ and SINR.

The derived statistics is grouped and marked as:

- PCC for primary cell
- SCC for secondary cells (currently supported four SCC)

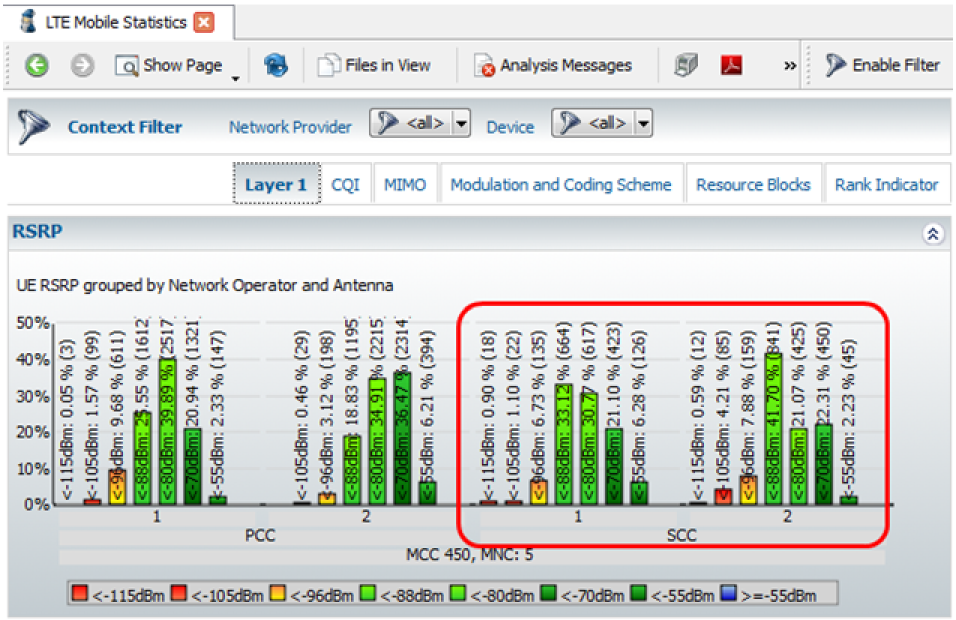


Figure 12-282: RSRP statistics for PCC and SCC

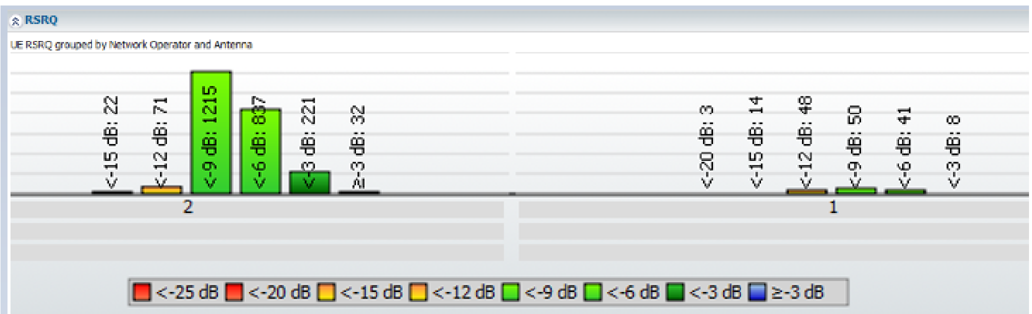


Figure 12-283: RSRQ statistics for PCC and SCC

The step size of the SINR histogram is changed to: < -10, < 0, < 5, <10, <15, <20, <30, <40, <50.

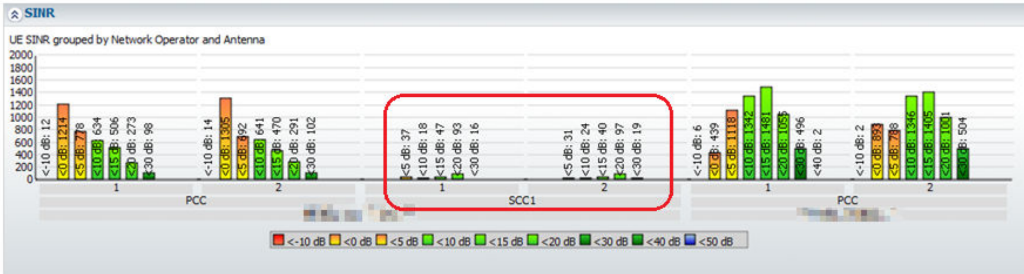


Figure 12-284: SINR statistics for PCC and SCC

The Channel Quality Indicator and the Rank Indicator are also displayed in the "LTE Mobile Statistics" page.

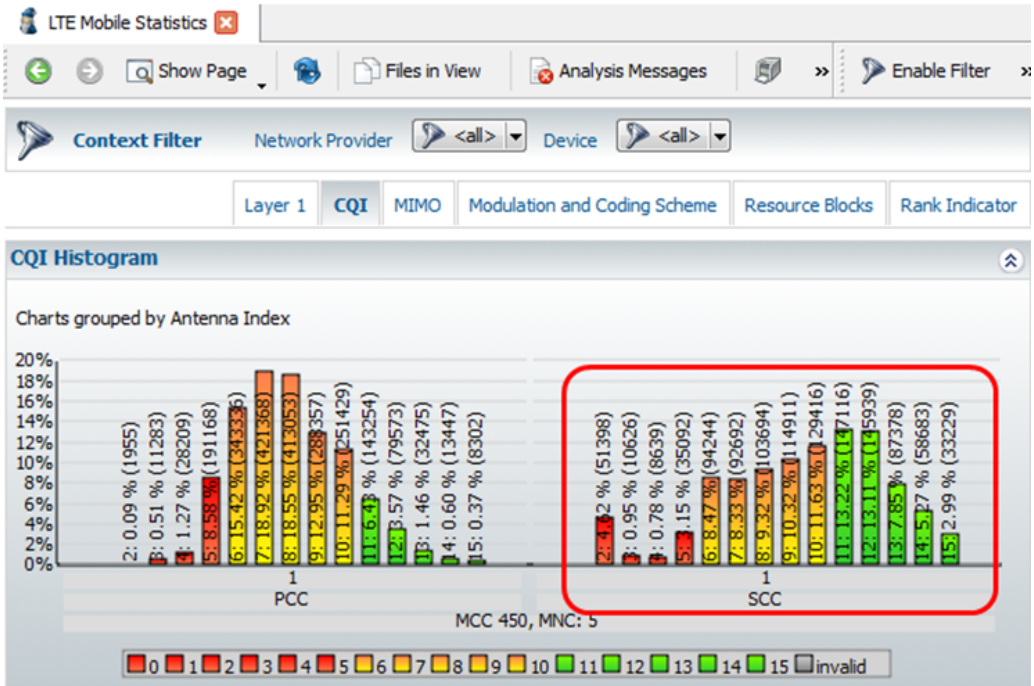


Figure 12-285: CQI statistics for PCC and SCC

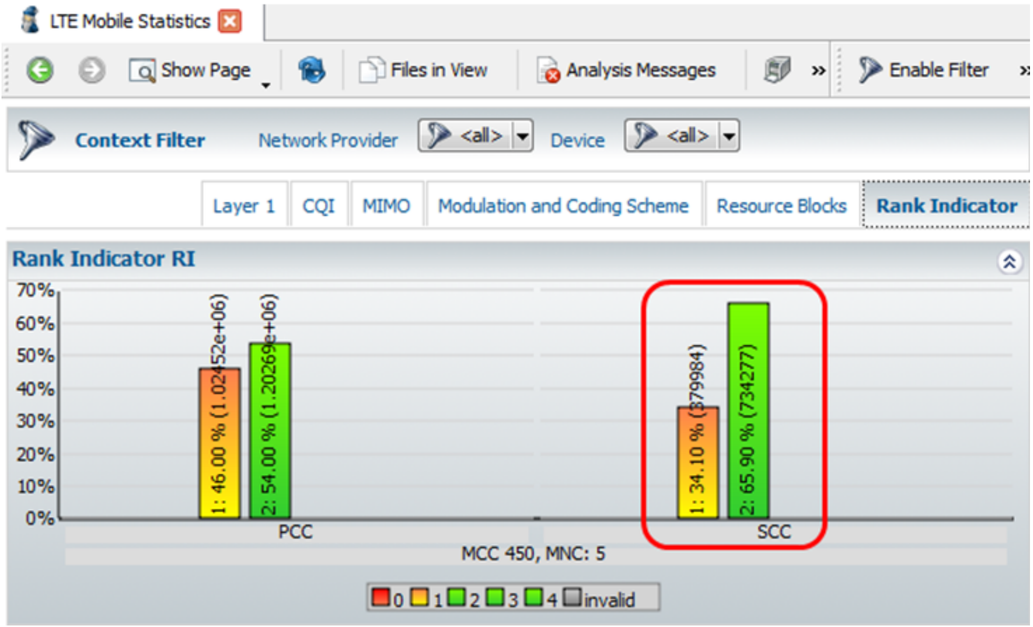


Figure 12-286: RI statistics for PCC and SCC

The statistics of usage of DL MCS per PCC and SCC is displayed. The bar charts show the distribution of the modulation schemes QPSK/16QAM/64QAM/256QAM.

If 64QAM is not allowed, UL modulation schemes 21 to 30 are operated with 16QAM and aggregated in that way.

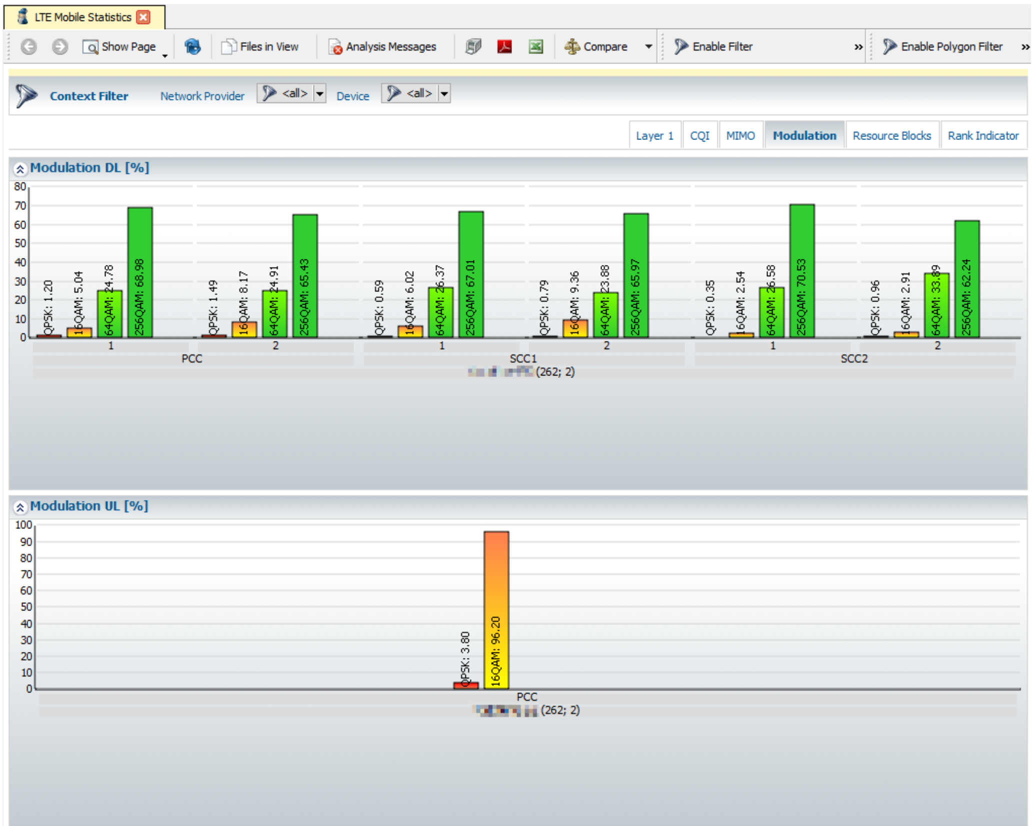


Figure 12-287: DL/UL statistics per modulation scheme

The following figure displays the RB usage.

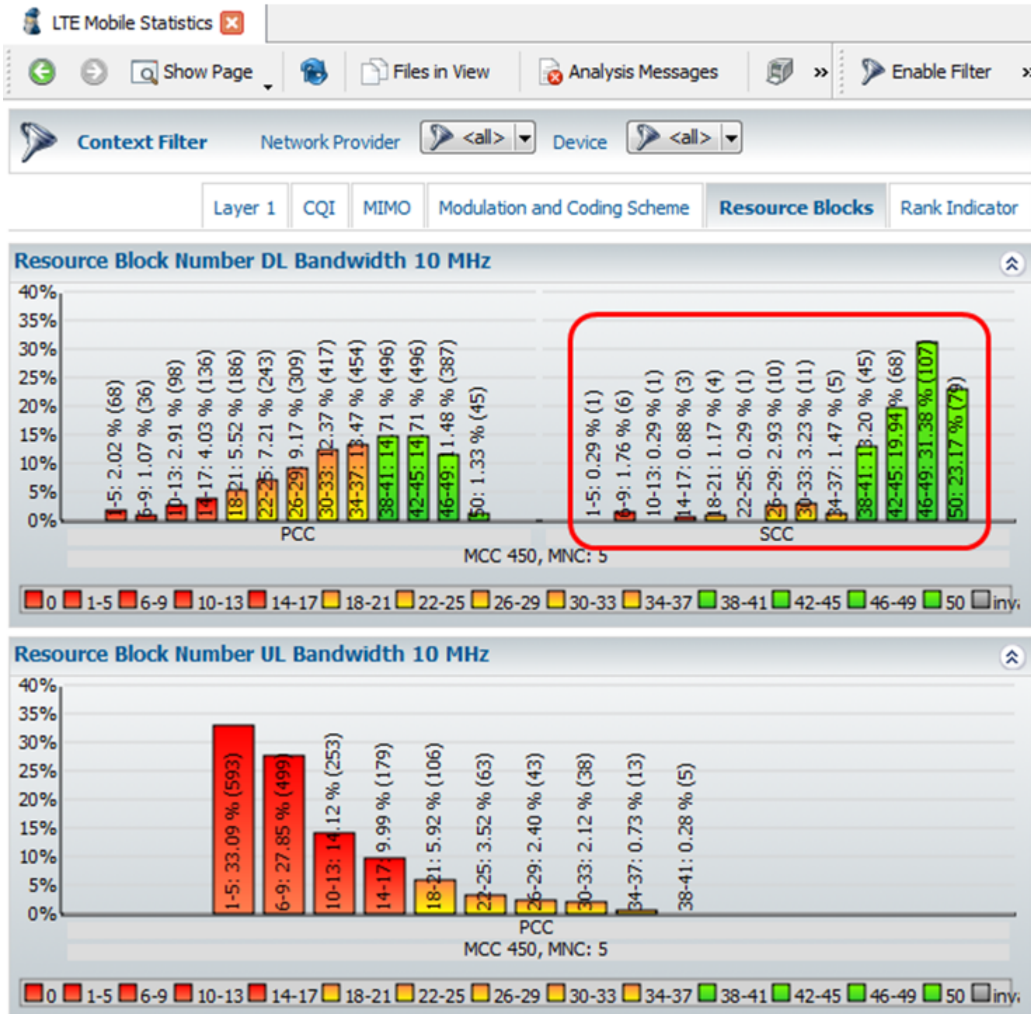


Figure 12-288: Statistics of number of allocated RBs in DL and UL

12.27 NB-IoT measurements aggregation

R&S ROMES4 NPA supports aggregation of the R&S ROMES4 scanner measurements for NB-IoT. The collected measurements include the cell data (MCC, MNC, CI). The cell data is used for identification of measurement results, that is, for NRSRP, NRSRQ and NSINR measurements.

The following figure shows available options for the NB-IoT statistics and analysis. Apart from the NB-IoT coverage rasters and statistics, supported are some mobile statistics.

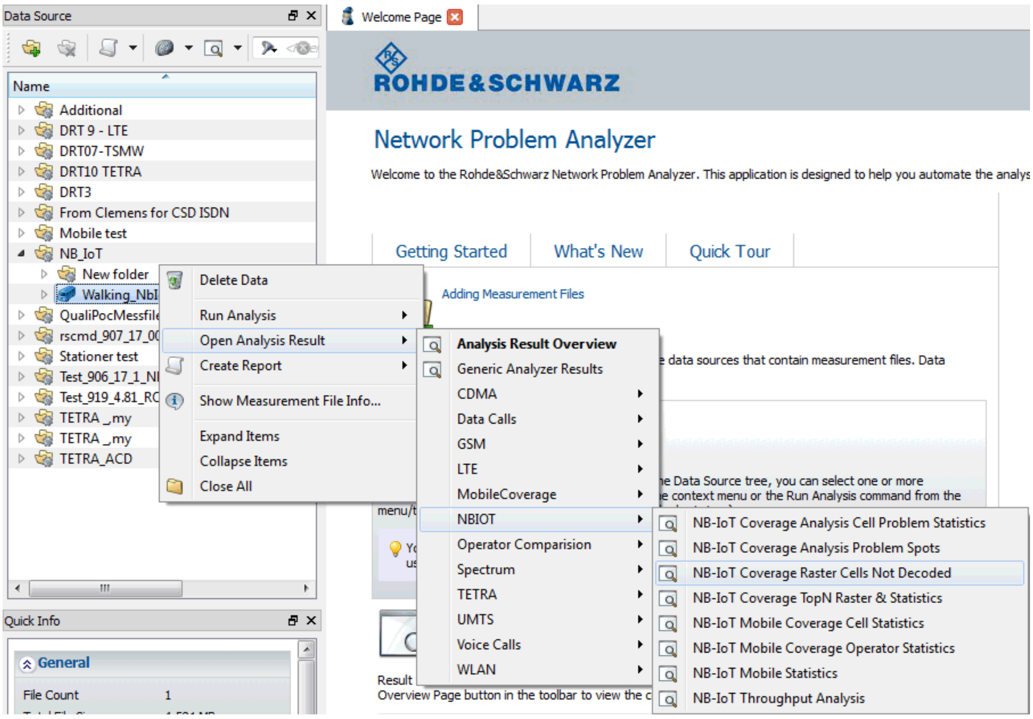


Figure 12-289: NB-IoT statistics and analysis options

Dependent on which statistic type is selected, the "NB-IoT" page shows the related icons to open the wanted statistics page.

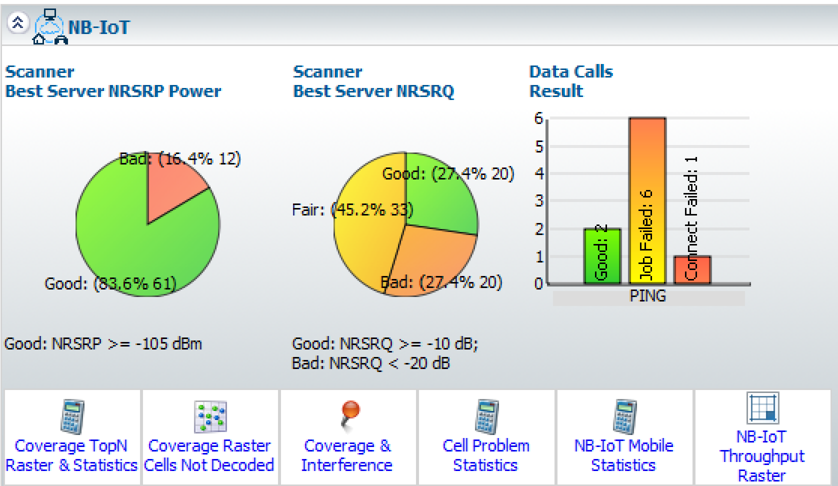


Figure 12-290: NB-IoT analysis results

The NB-IoT analysis is based on the generic scanner evaluations common for 3GPP RATs and based on:

- Coverage analysis
- Interference analysis
- Network analysis

- Pollution analysis

The individual configuration of these analysis types is done in "Coverage Analysis Data Processor" > "NB-IoT Analysis".

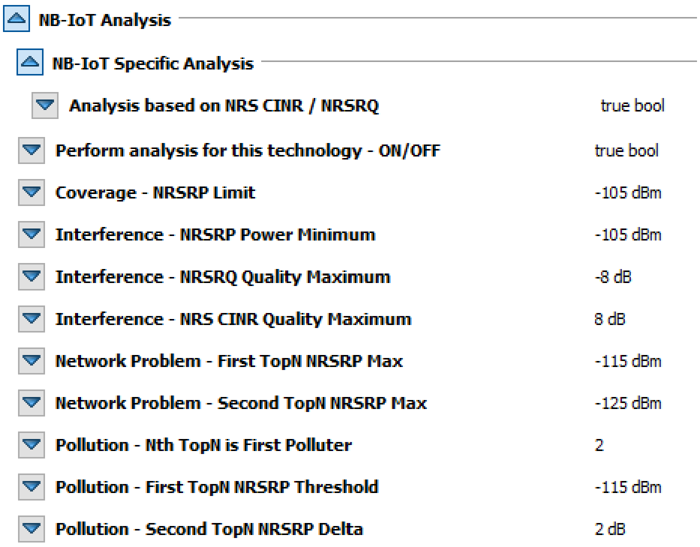


Figure 12-291: Configuration of NB-IoT analysis

12.27.1 NB-IoT cell list

The R&S ROMES4 NPA supports import of the BTS database lists in the ATD format showing NB-IoT in the column SYS_TYPE. The cell tree shows the BTS details in a same way as for the other RATs.

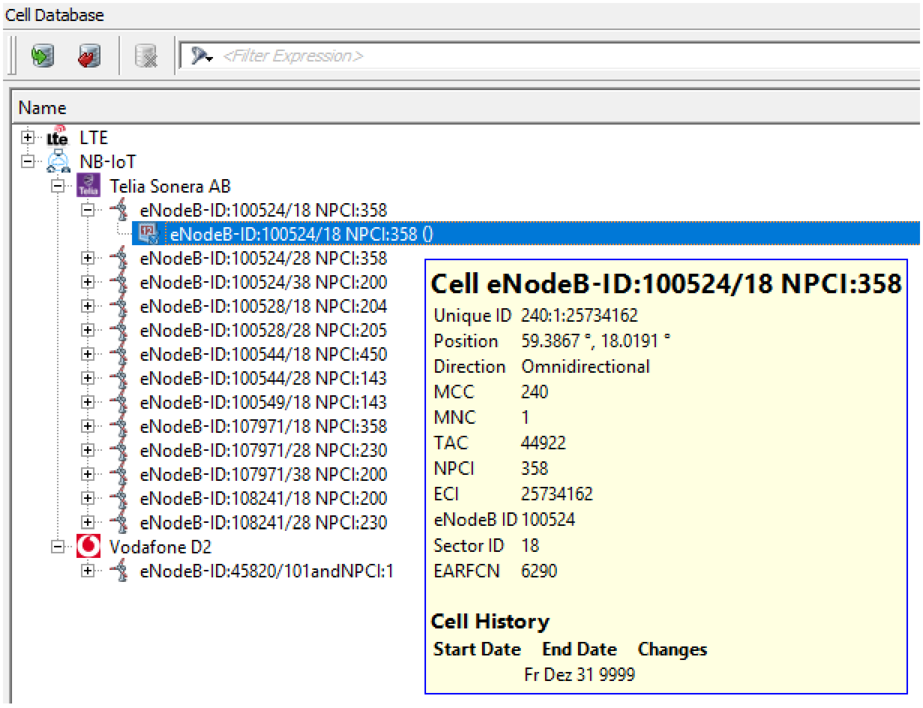


Figure 12-292: NB-IoT cells list

12.27.2 NB-IoT coverage topn raster and statistics

If the NB-IoT Coverage TopN Raster & Statistics is configured, the "Coverage TopN Raster & Statistics" icon is available in the "NB-IoT" page. Click the icon to open the "NB-IoT Coverage TopN Raster & Statistics" page and see the results of the measurement file processing.

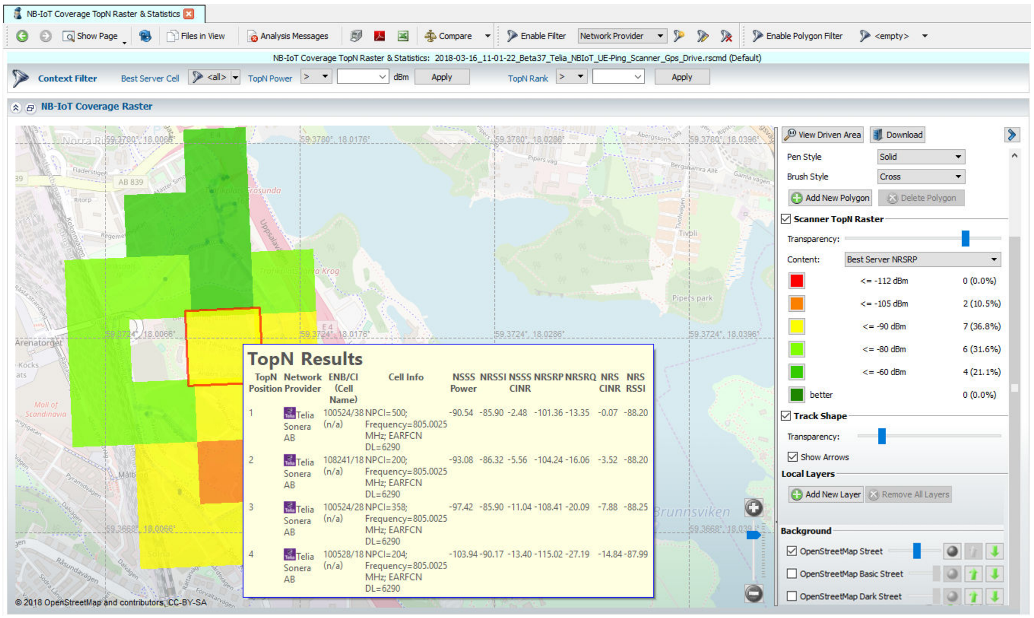


Figure 12-293: NB-IoT coverage raster - best server

The NB-IoT Coverage Raster map and the Cell Statistics table adapt automatically to the NPCI filter selection of the user and fill the data accordingly, as shown in the following two associated figures. For details of NPCI filtering, see Chapter 4.5.3.6, "Filter definition dialog - general handling", on page 94.

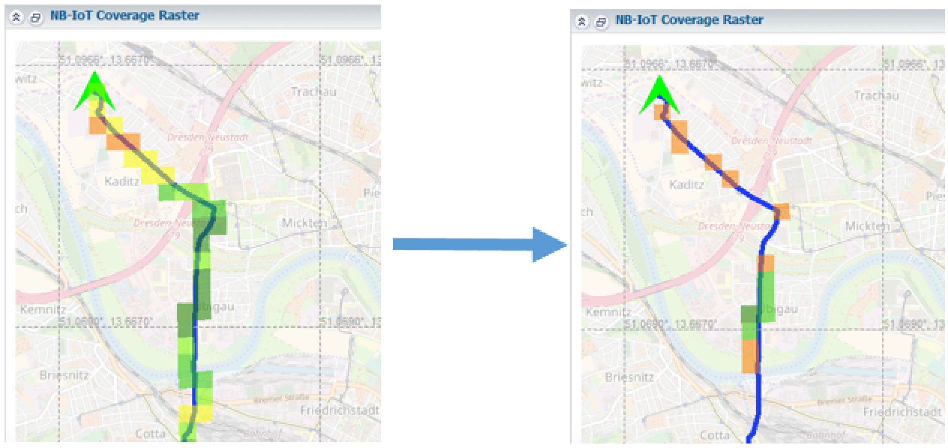


Figure 12-294: NB-IoT coverage map adapts to the NPCI selection

The map with the scanner raster shows the BTS symbols and server lines.

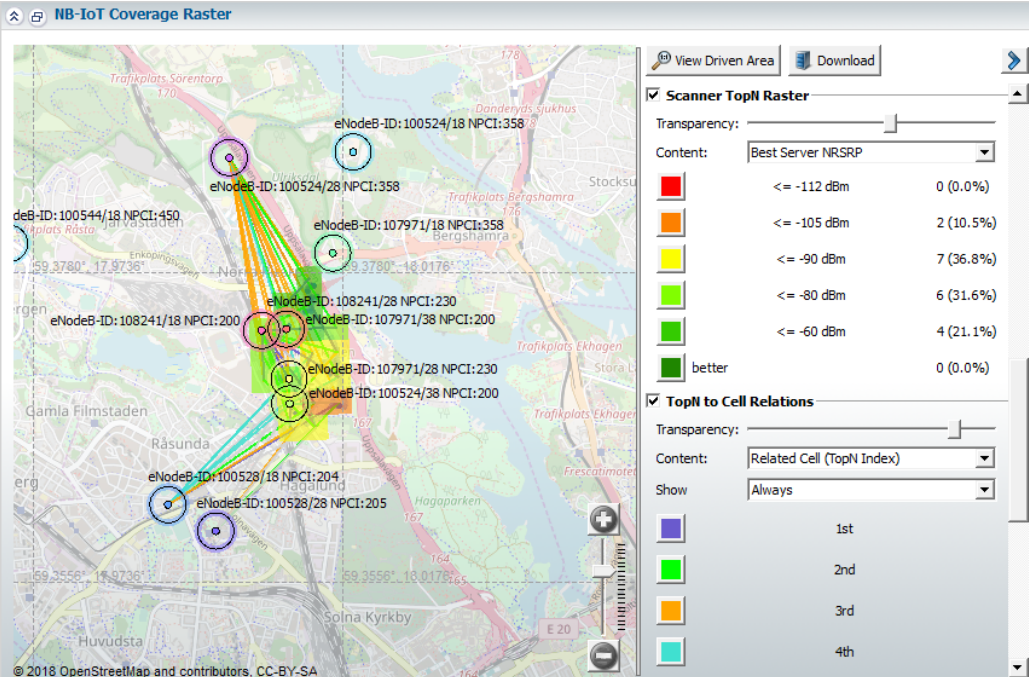
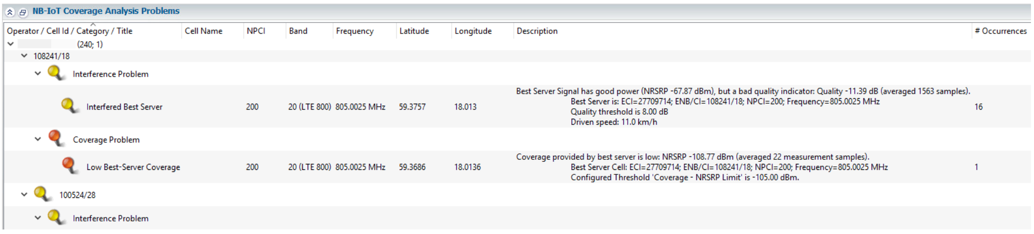


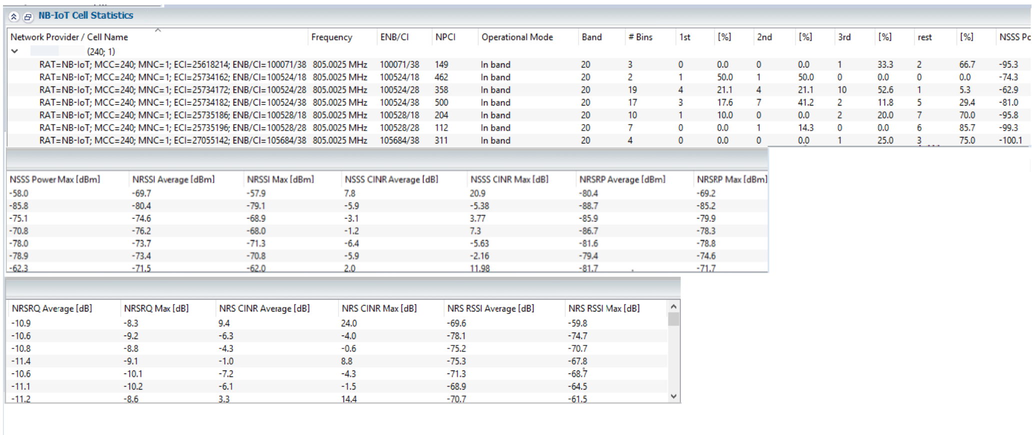
Figure 12-295: NB-IoT coverage raster - related cells



NB-IoT Coverage Analysis Problems

Operator / Cell Id / Category / Title	Cell Name	NPCI	Band	Frequency	Latitude	Longitude	Description	# Occurrences
(240; 1)								
108241/18								
Interference Problem								
Interfered Best Server		200	20 (LTE 800)	805.0025 MHz	59.3757	18.013	Best Server Signal has good power (NRSRP -67.87 dBm), but a bad quality indicator: Quality -11.39 dB (averaged 1563 samples). Best Server is: ECI=27709714; ENB/CI=108241/18; NPCI=200; Frequency=805.0025 MHz Quality threshold is 8.00 dB Driven speed: 11.0 km/h	16
Coverage Problem								
Low Best-Server Coverage		200	20 (LTE 800)	805.0025 MHz	59.3686	18.0136	Coverage provided by best server is low: NRSRP -108.77 dBm (averaged 22 measurement samples). Best Server Cell: ECI=27709714; ENB/CI=108241/18; NPCI=200; Frequency=805.0025 MHz Configured Threshold 'Coverage - NRSRP Limit' is -105.00 dBm.	1
100524/28								
Interference Problem								

Figure 12-296: Results of the coverage problems analysis



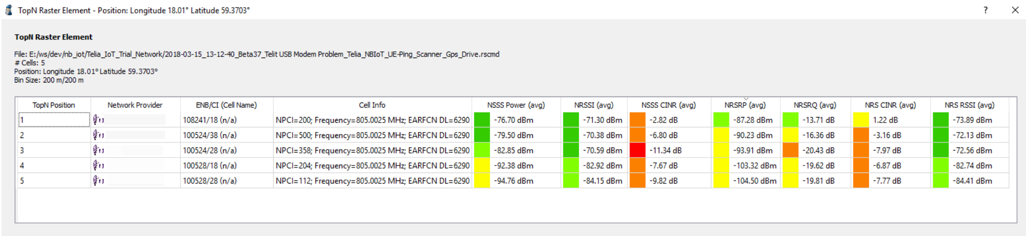
NB-IoT Cell Statistics

Network Provider / Cell Name	Frequency	ENB/CI	NPCI	Operational Mode	Band	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	NSSS Pc
(240; 1)															
RAT=NB-IoT; MCC=240; MNC=1; ECI=25618214; ENB/CI=100071/38	805.0025 MHz	100071/38	149	In band	20	3	0	0.0	0	0.0	1	33.3	2	66.7	-95.3
RAT=NB-IoT; MCC=240; MNC=1; ECI=25734162; ENB/CI=100524/18	805.0025 MHz	100524/18	462	In band	20	2	1	50.0	1	50.0	0	0.0	0	0.0	-74.3
RAT=NB-IoT; MCC=240; MNC=1; ECI=25734172; ENB/CI=100524/28	805.0025 MHz	100524/28	358	In band	20	19	4	21.1	4	21.1	10	52.6	1	5.3	-62.9
RAT=NB-IoT; MCC=240; MNC=1; ECI=25734182; ENB/CI=100524/38	805.0025 MHz	100524/38	500	In band	20	17	3	17.6	7	41.2	2	11.8	5	29.4	-81.0
RAT=NB-IoT; MCC=240; MNC=1; ECI=25735186; ENB/CI=100528/18	805.0025 MHz	100528/18	204	In band	20	10	1	10.0	0	0.0	2	20.0	7	70.0	-95.8
RAT=NB-IoT; MCC=240; MNC=1; ECI=25735196; ENB/CI=100528/28	805.0025 MHz	100528/28	112	In band	20	7	0	0.0	1	14.3	0	0.0	6	85.7	-99.3
RAT=NB-IoT; MCC=240; MNC=1; ECI=27055142; ENB/CI=105684/38	805.0025 MHz	105684/38	311	In band	20	4	0	0.0	0	0.0	1	25.0	3	75.0	-100.1

NSSS Power Max [dBm]	NRSSI Average [dBm]	NRSSI Max [dBm]	NSSS CINR Average [dB]	NSSS CINR Max [dB]	NRSRP Average [dBm]	NRSRP Max [dBm]
-58.0	-69.7	-57.9	7.8	20.9	-80.4	-69.2
-85.8	-80.4	-79.1	-5.9	-5.38	-88.7	-85.2
-75.1	-74.6	-68.9	-3.1	3.77	-85.9	-79.9
-70.8	-76.2	-68.0	-1.2	7.3	-86.7	-78.3
-78.0	-73.7	-71.3	-6.4	-5.63	-81.6	-78.8
-78.9	-73.4	-70.8	-5.9	-2.16	-79.4	-74.6
-62.3	-71.5	-62.0	2.0	11.98	-81.7	-71.7

NRSRQ Average [dB]	NRSRQ Max [dB]	NRS CINR Average [dB]	NRS CINR Max [dB]	NRS RSSI Average [dB]	NRS RSSI Max [dB]
-10.9	-8.3	9.4	24.0	-69.6	-59.8
-10.6	-9.2	-6.3	-4.0	-78.1	-74.7
-10.8	-8.8	-4.3	-0.6	-75.2	-70.7
-11.4	-9.1	-1.0	8.8	-75.3	-67.8
-10.6	-10.1	-7.2	-4.3	-71.3	-68.7
-11.1	-10.2	-6.1	-1.5	-68.9	-64.5
-11.2	-8.6	3.3	14.4	-70.7	-61.5

Figure 12-297: NB-IoT cell statistic



TopN Raster Element - Position: Longitude 18.01° Latitude 59.3703°

TopN Raster Element

File: E:/ws/dev/nb_iot/Telia_IoT_Trial_Network/2018-03-15_13-12-40_Beta37_Telit USB Modem Problem_Telia_NBIoT_UE-Ping_Scanner_Gps_Drive.rscmd
Cells: 5
Position: Longitude 18.01° Latitude 59.3703°
Bin Size: 200 m/200 m

TopN Position	Network Provider	ENB/CI (Cell Name)	Cell Info	NSSS Power (avg)	NRSSI (avg)	NSSS CINR (avg)	NRSRP (avg)	NRSRQ (avg)	NRS CINR (avg)	NRS RSSI (avg)
1		108241/18 (n/a)	NPCI=200; Frequency=805.0025 MHz; EARFCN DL=6290	-76.70 dBm	-71.30 dBm	-2.82 dB	-87.28 dBm	-13.71 dB	1.22 dB	-73.89 dBm
2		100524/38 (n/a)	NPCI=500; Frequency=805.0025 MHz; EARFCN DL=6290	-79.50 dBm	-70.38 dBm	-6.80 dB	-90.23 dBm	-16.36 dB	-3.16 dB	-72.13 dBm
3		100524/28 (n/a)	NPCI=358; Frequency=805.0025 MHz; EARFCN DL=6290	-82.85 dBm	-70.59 dBm	-11.34 dB	-93.91 dBm	-20.43 dB	-7.97 dB	-72.56 dBm
4		100528/18 (n/a)	NPCI=204; Frequency=805.0025 MHz; EARFCN DL=6290	-92.38 dBm	-82.92 dBm	-7.67 dB	-103.32 dBm	-19.62 dB	-6.87 dB	-82.74 dBm
5		100528/28 (n/a)	NPCI=112; Frequency=805.0025 MHz; EARFCN DL=6290	-94.76 dBm	-84.15 dBm	-9.82 dB	-104.50 dBm	-19.81 dB	-7.77 dB	-84.41 dBm

Figure 12-298: Top N Raster Element table

12.27.2.1 Labeling for NB-IoT scanner results

The 'Labeling for NB-IoT scanner results' feature lets you choose extra information which can be displayed next to the raster bins on the map for NB-IoT scanner results.

In the legend configuration field, within the "Scanner TopN Raster" area, there is the "Labels" combo box which offers variety of information that can be displayed next to the raster bins on the map.

The following figure shows the Top1 power of bins along the driven area.

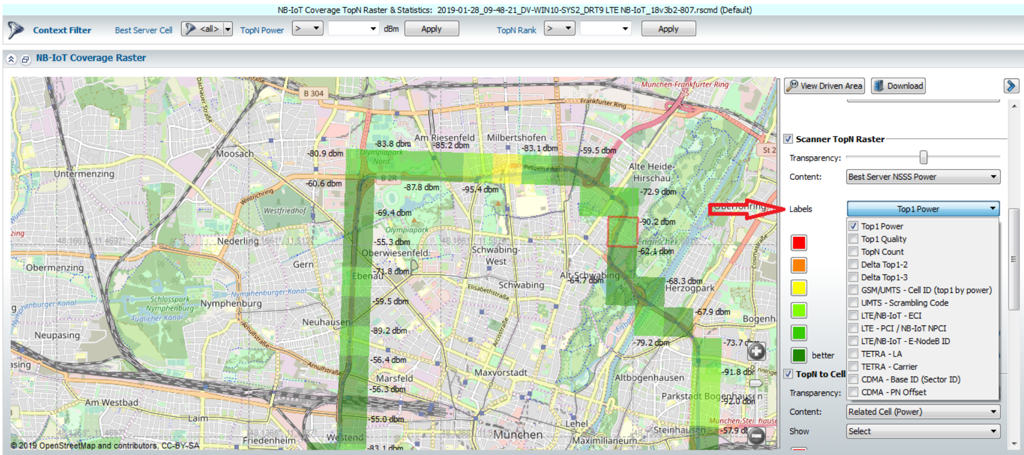
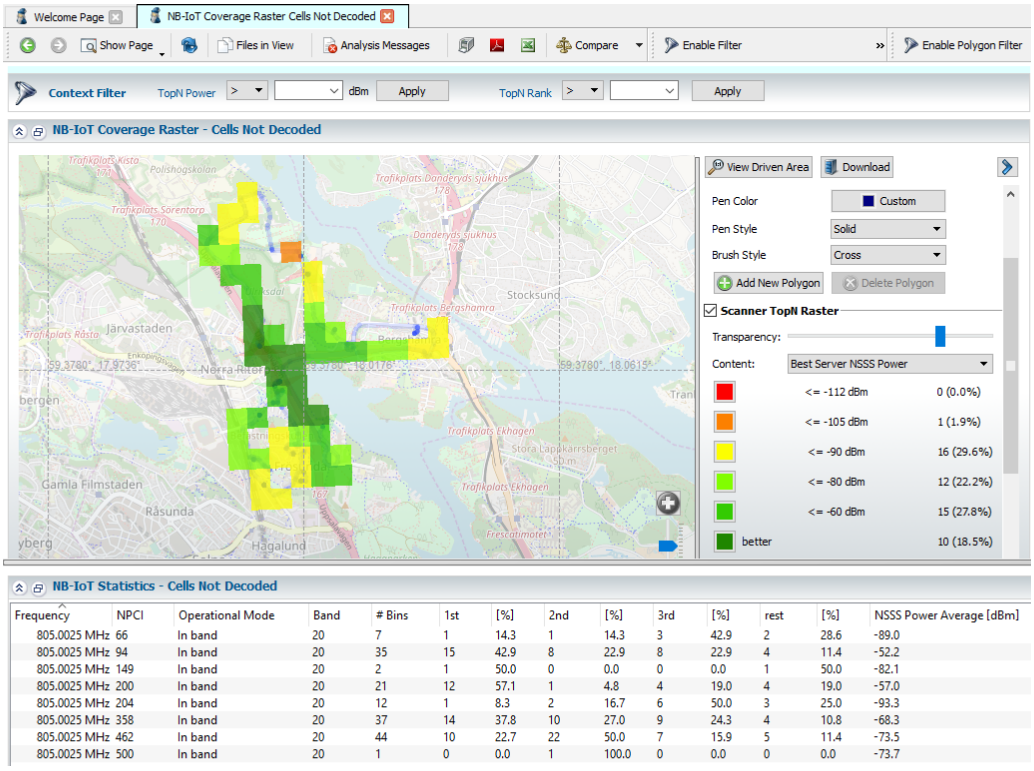


Figure 12-299: Extra information next to the bins on the map - Top1 power

12.27.3 NB-IoT coverage raster - cells not decoded

The NB-IoT statistics and analysis function show the measurement values of the cells for which the cell information was not decoded in separate page. The page is named "NB-IoT Coverage Raster Cells Not Decoded".



Frequency	NPCI	Operational Mode	Band	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]	NSSS Power Average [dBm]
805.0025 MHz	66	In band	20	7	1	14.3	1	14.3	3	42.9	2	28.6	-89.0
805.0025 MHz	94	In band	20	35	15	42.9	8	22.9	8	22.9	4	11.4	-52.2
805.0025 MHz	149	In band	20	2	1	50.0	0	0.0	0	0.0	1	50.0	-82.1
805.0025 MHz	200	In band	20	21	12	57.1	1	4.8	4	19.0	4	19.0	-57.0
805.0025 MHz	204	In band	20	12	1	8.3	2	16.7	6	50.0	3	25.0	-93.3
805.0025 MHz	358	In band	20	37	14	37.8	10	27.0	9	24.3	4	10.8	-68.3
805.0025 MHz	462	In band	20	44	10	22.7	22	50.0	7	15.9	5	11.4	-73.5
805.0025 MHz	500	In band	20	1	0	0.0	1	100.0	0	0.0	0	0.0	-73.7

Figure 12-300: Coverage raster of not decoded cells

12.27.4 NB-IoT mobile statistic and analysis

The NB-IoT mobile statistic and analysis includes the statistics and analysis of the following performances.

- CE Level / eDRX / PSM
- NPRACH Tx Power and repetitions
- NPUSCH Tx Power vs. repetitions
- NRSRP
- NRSRQ
- NSINR
- Modulation
- QPing/NPing RTT
- DQA UDP jobs
- DQA FTP DL/UL jobs
- DQA FTP and UDP jobs aggregation
- Throughput

The map page with the mobile raster, in a similar way as the page with scanner raster, shows the BTS symbols and lines.

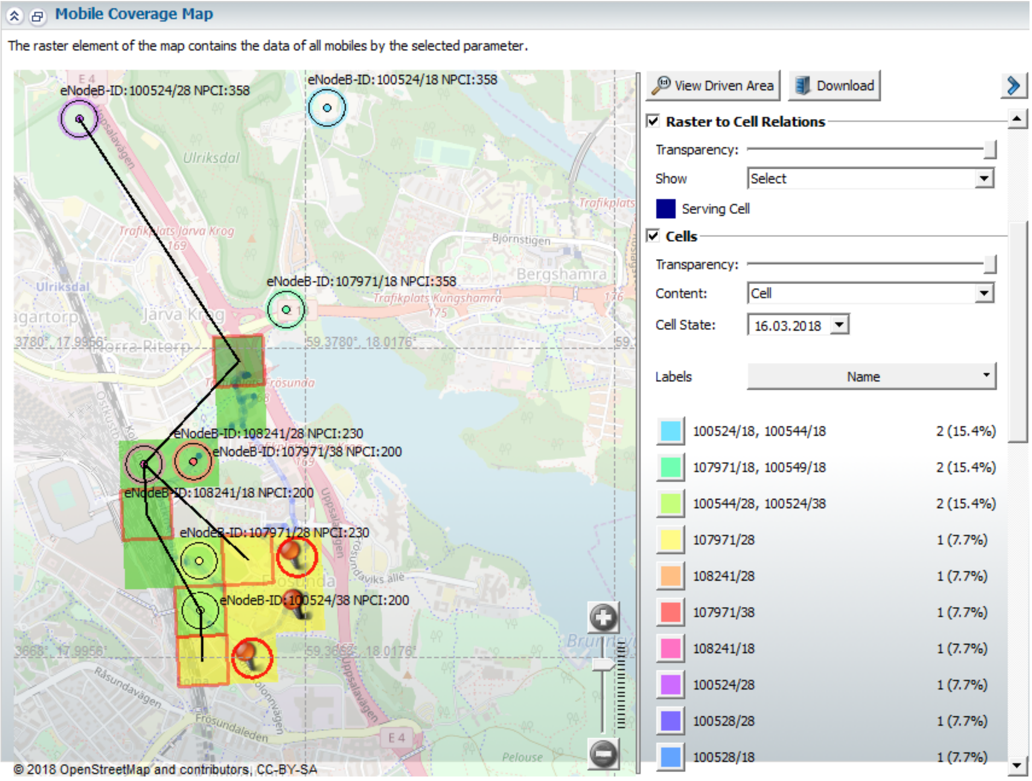


Figure 12-301: Map page with mobile raster

Furthermore, the analysis creates a throughput raster with power and quality in the same way as done for LTE, UMTS and GSM.

The "NB-IoT Mobile Statistics" page shows tabs for the previously listed statistics.

12.27.4.1 CE level / edrx / PSM

The used eDRX configuration is read from the EMM_Attach_Accept message and displayed on the result "NB-IoT Mobile Statistics" page within the "CE Level / eDRX / PSM" tab.

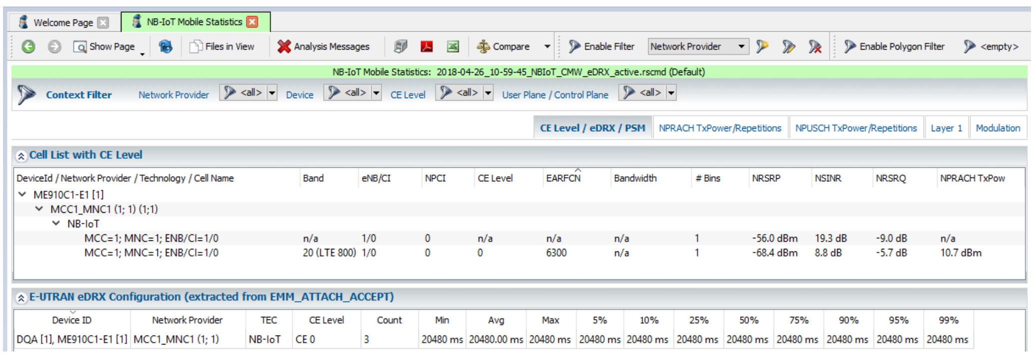
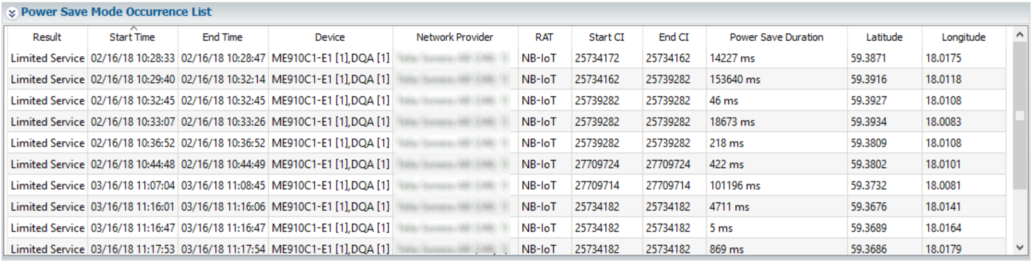


Figure 12-302: NB-IoT Mobile Statistics - CE level / eDRX / PSM tab

It normally occurs that some measurements do not show a CE level. It is indicated as "n/a" in the "CE Level" column.

PSM occurrence is aggregated to a list showing, for example, device type and power save duration.



Power Save Mode Occurrence List

Result	Start Time	End Time	Device	Network Provider	RAT	Start CI	End CI	Power Save Duration	Latitude	Longitude
Limited Service	02/16/18 10:28:33	02/16/18 10:28:47	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	25734172	25734162	14227 ms	59.3871	18.0175
Limited Service	02/16/18 10:29:40	02/16/18 10:32:14	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	25734162	25739282	153640 ms	59.3916	18.0118
Limited Service	02/16/18 10:32:45	02/16/18 10:32:45	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	25739282	25739282	46 ms	59.3927	18.0108
Limited Service	02/16/18 10:33:07	02/16/18 10:33:26	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	25739282	25739282	18673 ms	59.3934	18.0083
Limited Service	02/16/18 10:36:52	02/16/18 10:36:52	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	25739282	25739282	218 ms	59.3809	18.0108
Limited Service	02/16/18 10:44:48	02/16/18 10:44:49	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	27709724	27709724	422 ms	59.3802	18.0101
Limited Service	03/16/18 11:07:04	03/16/18 11:08:45	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	27709714	27709714	101196 ms	59.3732	18.0081
Limited Service	03/16/18 11:16:01	03/16/18 11:16:06	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	25734182	25734182	4711 ms	59.3676	18.0141
Limited Service	03/16/18 11:16:47	03/16/18 11:16:47	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	25734182	25734182	5 ms	59.3689	18.0164
Limited Service	03/16/18 11:17:53	03/16/18 11:17:54	ME910C1-E1 [1],DQA [1]	[illegible]	NB-IoT	25734182	25734182	869 ms	59.3686	18.0179

Figure 12-303: NB-IoT PSM statistics

12.27.4.2 NPRACH

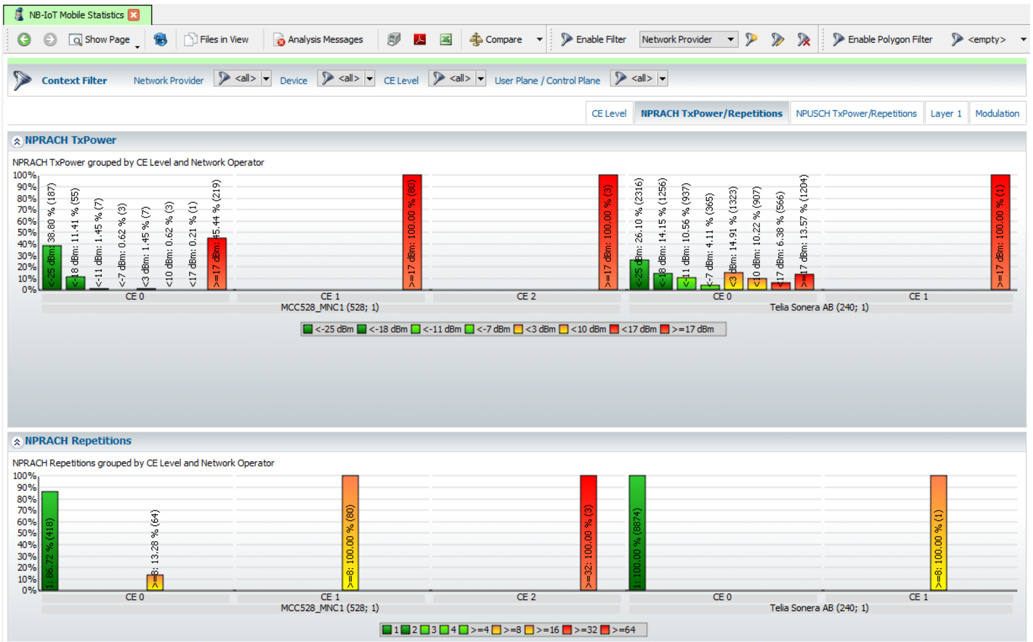


Figure 12-304: NB-IoT mobile statistics - NPRACH Tx power and repetitions

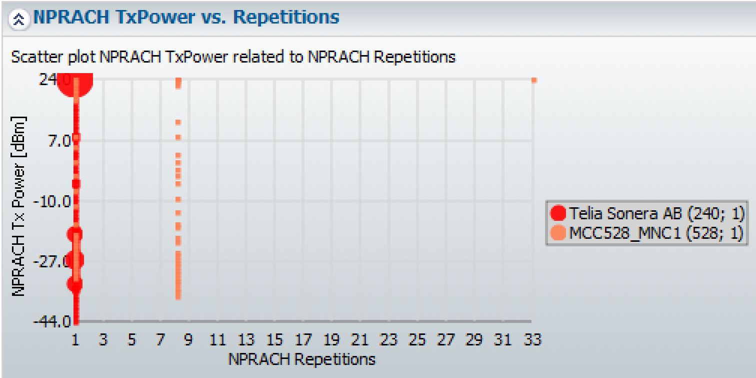


Figure 12-305: NB-IoT mobile statistics - NPRACH Tx power vs. repetitions

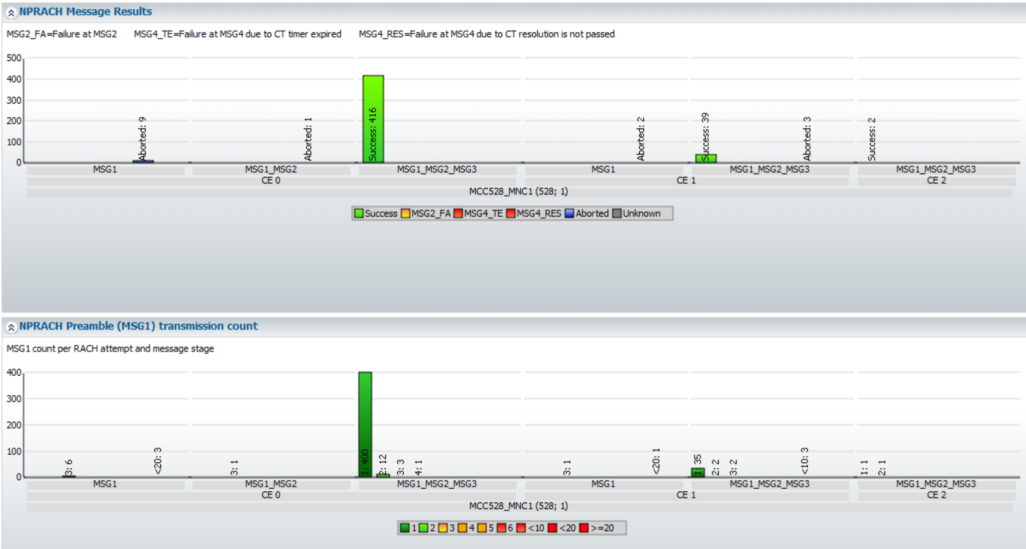


Figure 12-306: NB-IoT mobile statistics - NPRACH messages

12.27.4.3 NPUSCH

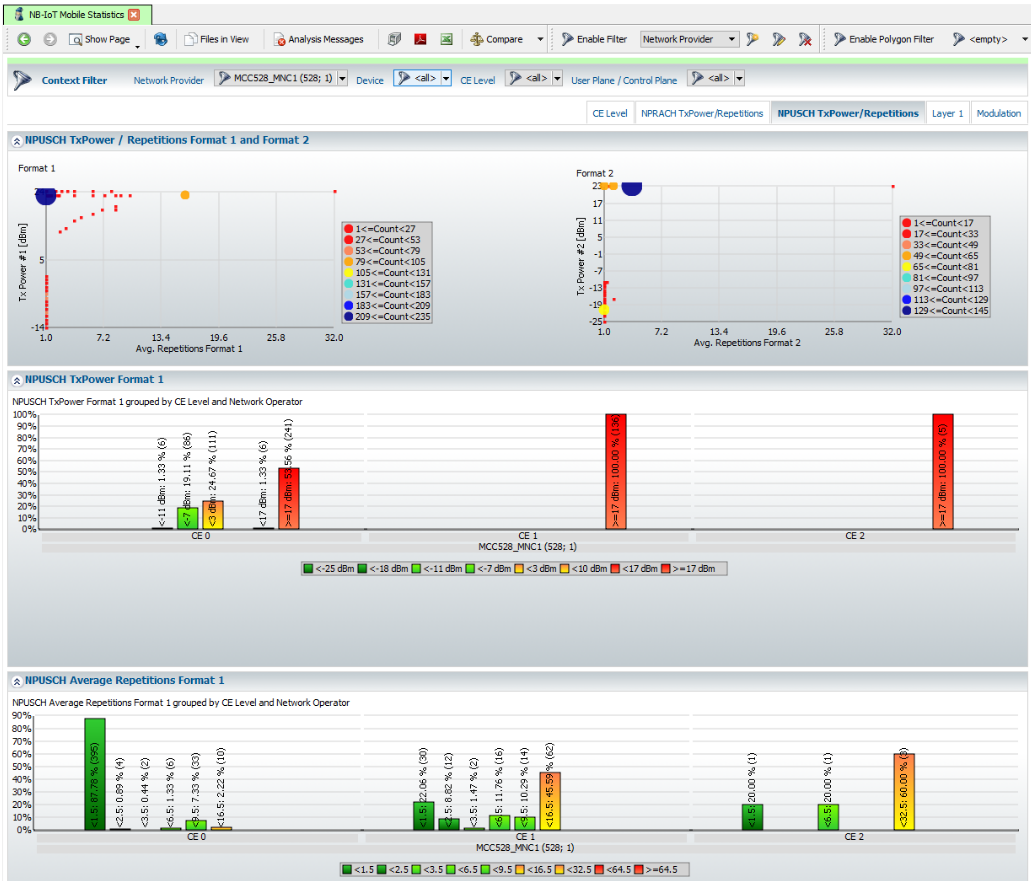


Figure 12-307: NB-IoT mobile statistics - NPUSCH Tx power and repetition formats

Figure 12-308: NB-IoT mobile statistics - NPUSCH Tx power format

12.27.4.4 Layer1: NRSRP, NRSRQ, NSINR

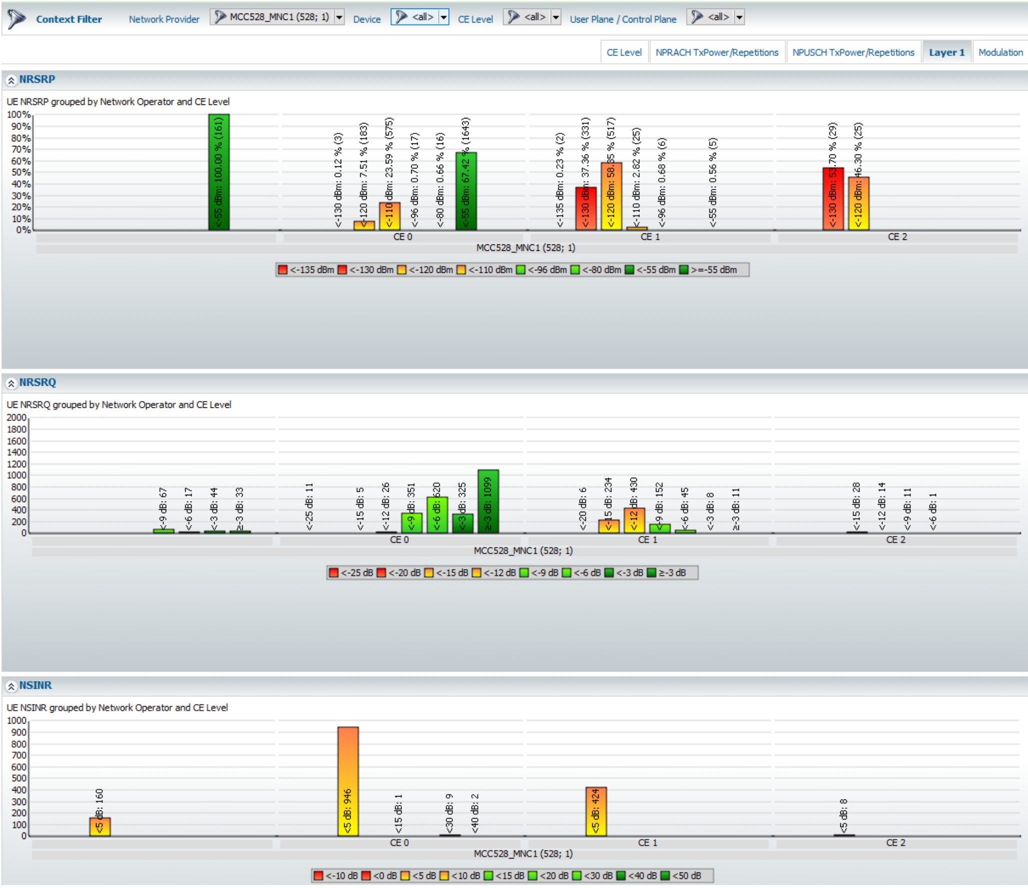


Figure 12-309: NB-IoT mobile statistics - NRSRP, NRSRQ, NSINR level statistics

The following figures show the NB-IoT statistics per operator related to CDF of NRSRP, NRSRQ and NSINR which are the indicators of a cell coverage and interference.

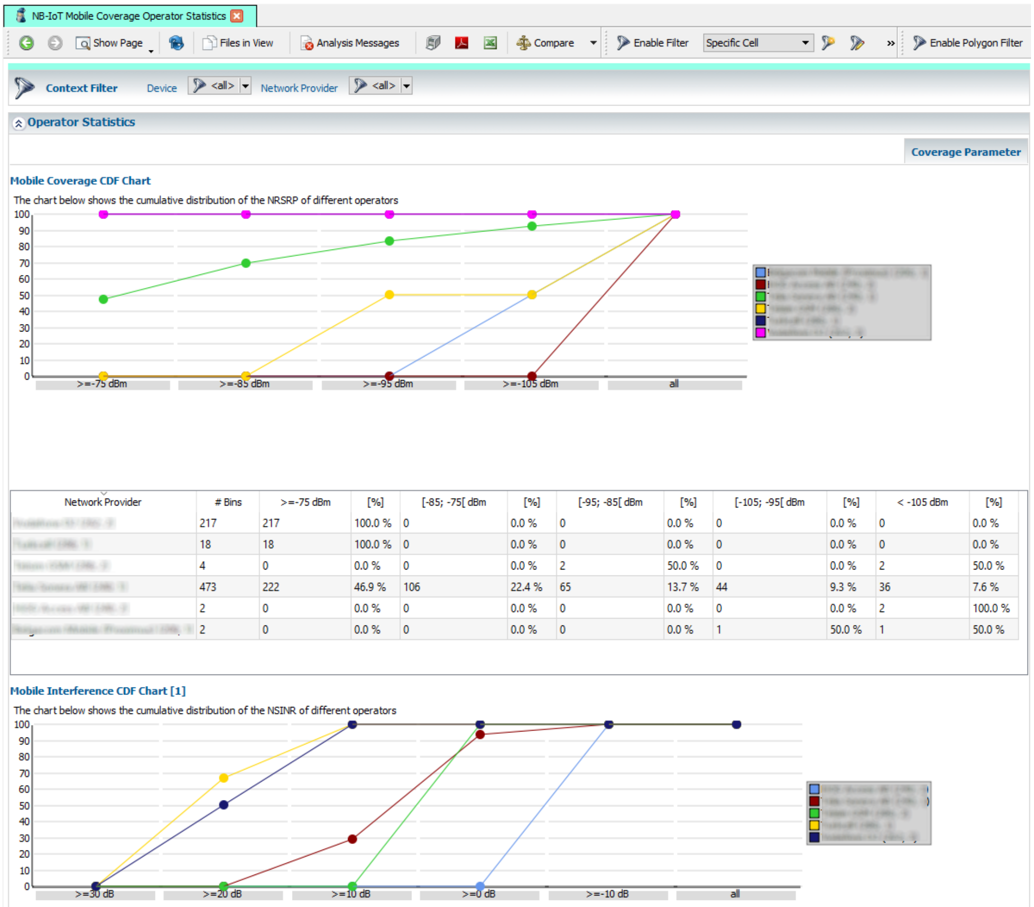


Figure 12-310: CDF of NRSRP and NSINR

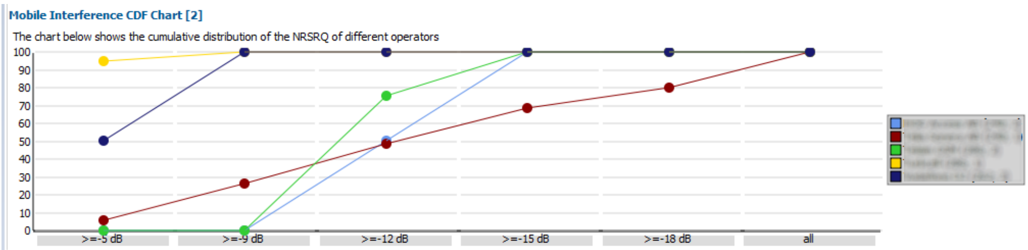


Figure 12-311: CDF of NRSRQ

12.27.4.5 Modulation

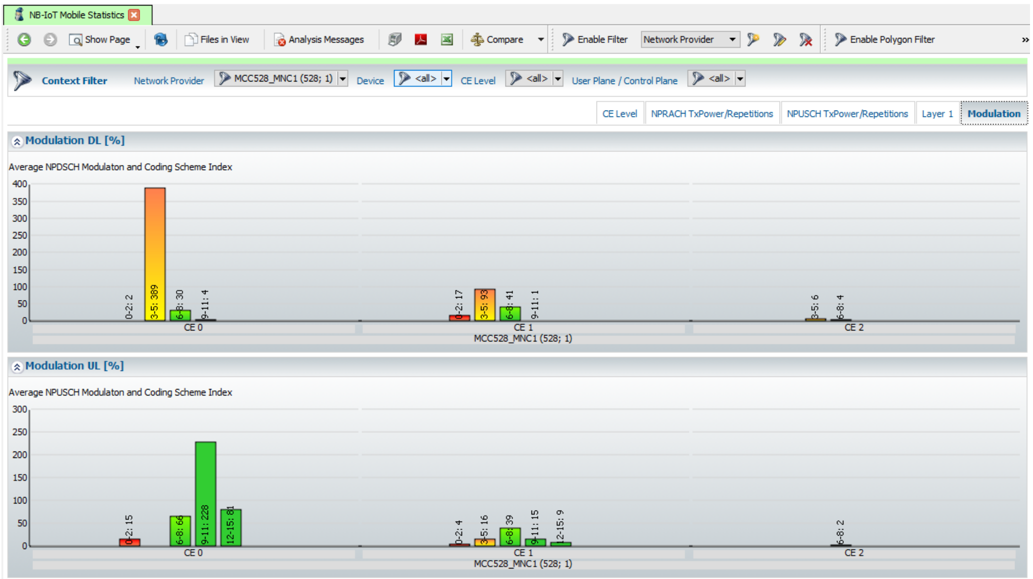


Figure 12-312: NB-IoT mobile statistics - used MCS statistics

12.27.4.6 QPing/NPing RTT

Some IoT module vendors offer possibility to control the internal IP stack to execute data transaction tests. This is an alternative approach to the traditional Dial-Up modem connection that terminates the IP connection on the external controller PC.

R&S ROMES4 supports the use of Quectel and U-blox modules internal IP stack for Ping job testing using their specific AT commands QPing and NPing.

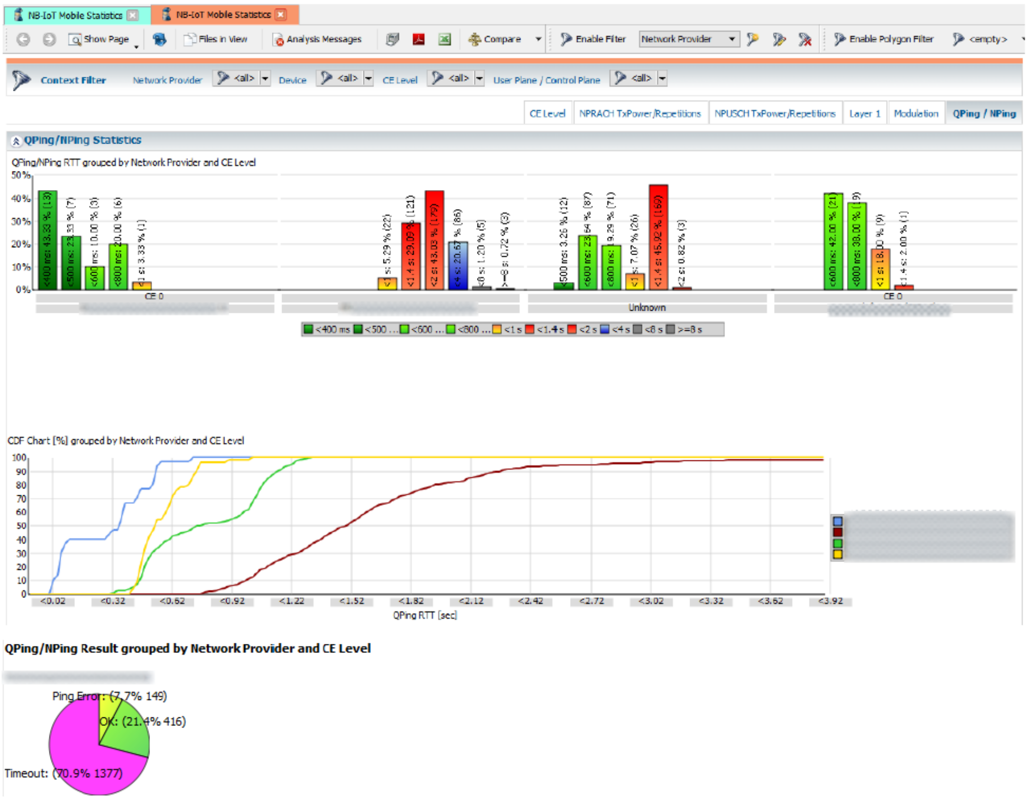


Figure 12-313: NB-IoT mobile statistics - QPing/NPing statistics

12.27.4.7 DQA UDP

The "NB-IoT Mobile Statistics" > "UDP" tab shows the DQA UDP jobs results per network operator and CE level.

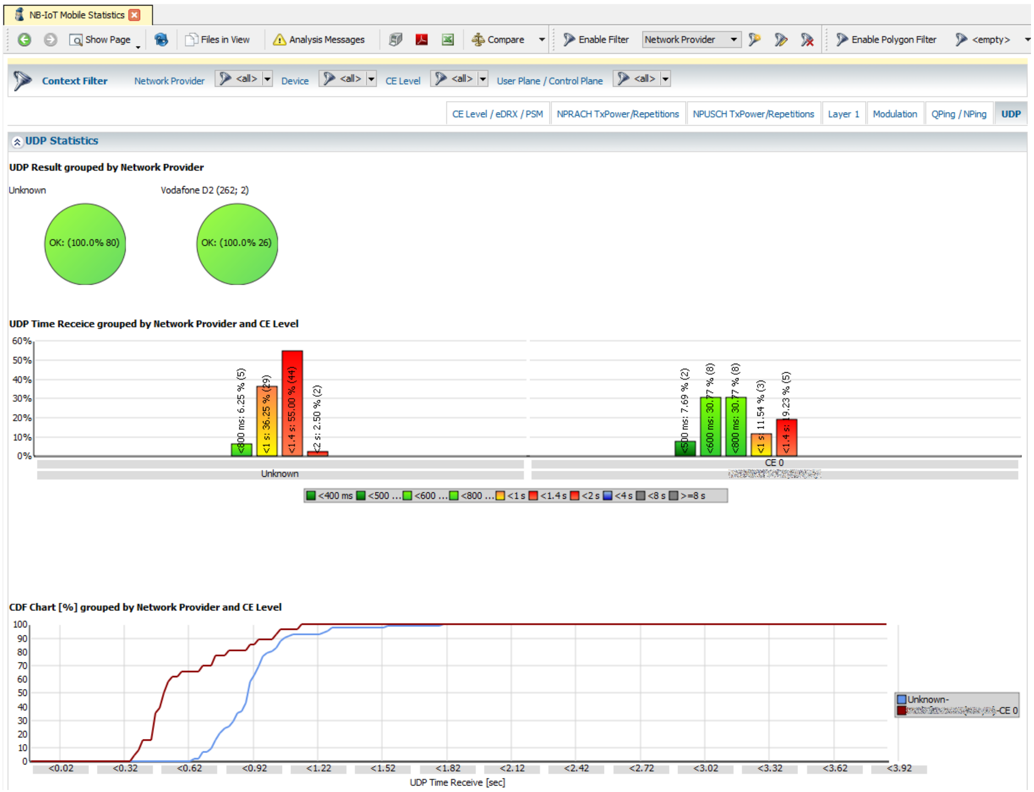
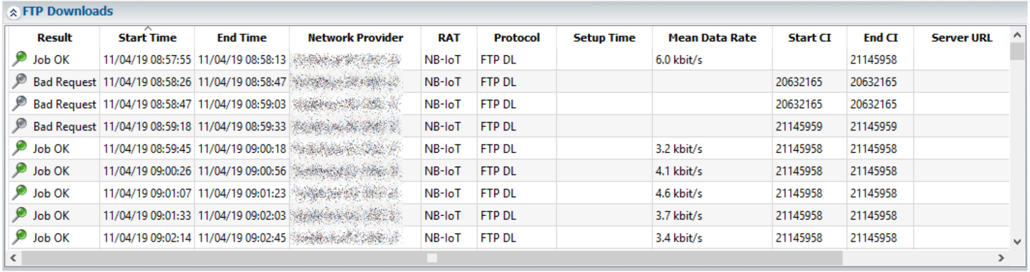


Figure 12-314: NB-IoT UDP job statistics - CDF

Figure 12-315: NB-IoT UDP job statistics - time send and CDF chart

12.27.4.8 DQA FTP jobs statistics

The DQA NB-IoT FTP DL/UL jobs analysis is supported.



FTP Downloads

Result	Start Time	End Time	Network Provider	RAT	Protocol	Setup Time	Mean Data Rate	Start CI	End CI	Server URL
Job OK	11/04/19 08:57:55	11/04/19 08:58:13	[illegible]	NB-IoT	FTP DL		6.0 kbit/s		21145958	
Bad Request	11/04/19 08:58:26	11/04/19 08:58:47	[illegible]	NB-IoT	FTP DL			20632165	20632165	
Bad Request	11/04/19 08:58:47	11/04/19 08:59:03	[illegible]	NB-IoT	FTP DL			20632165	20632165	
Bad Request	11/04/19 08:59:18	11/04/19 08:59:33	[illegible]	NB-IoT	FTP DL			21145959	21145959	
Job OK	11/04/19 08:59:45	11/04/19 09:00:18	[illegible]	NB-IoT	FTP DL		3.2 kbit/s	21145958	21145958	
Job OK	11/04/19 09:00:26	11/04/19 09:00:56	[illegible]	NB-IoT	FTP DL		4.1 kbit/s	21145958	21145958	
Job OK	11/04/19 09:01:07	11/04/19 09:01:23	[illegible]	NB-IoT	FTP DL		4.6 kbit/s	21145958	21145958	
Job OK	11/04/19 09:01:33	11/04/19 09:02:03	[illegible]	NB-IoT	FTP DL		3.7 kbit/s	21145958	21145958	
Job OK	11/04/19 09:02:14	11/04/19 09:02:45	[illegible]	NB-IoT	FTP DL		3.4 kbit/s	21145958	21145958	

Figure 12-316: NB-IoT FTP DL jobs statistics

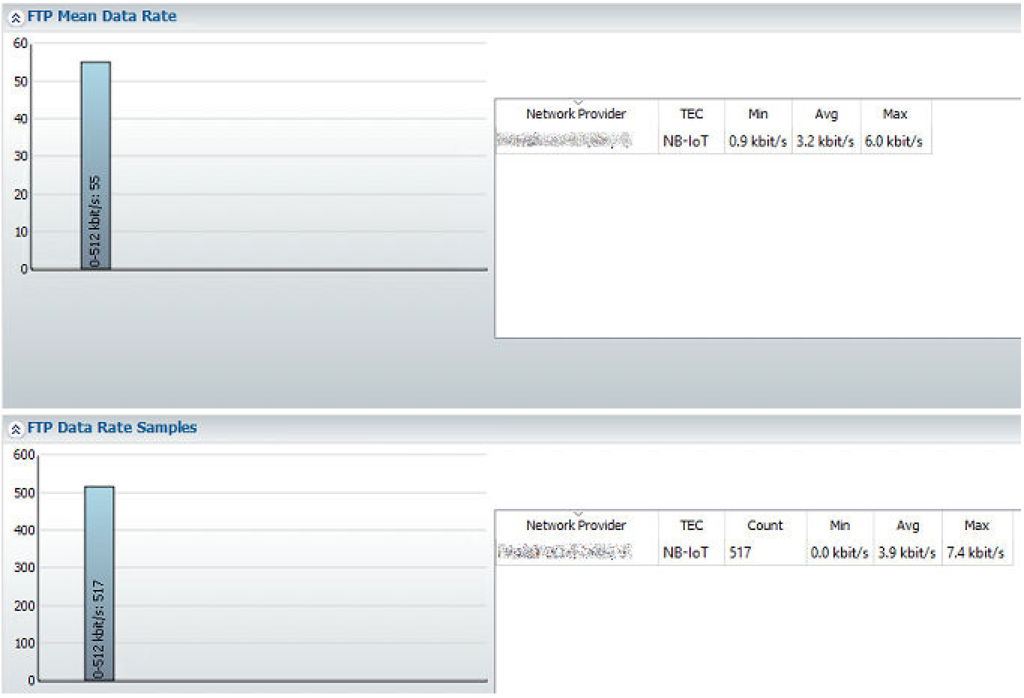
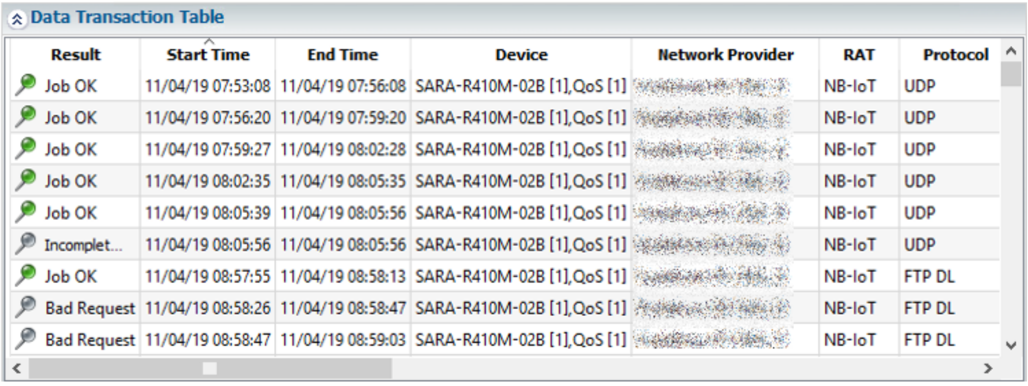


Figure 12-317: NB-IoT FTP job data rate statistics

12.27.4.9 Aggregation of DQA NB-IoT jobs FTP and UDP

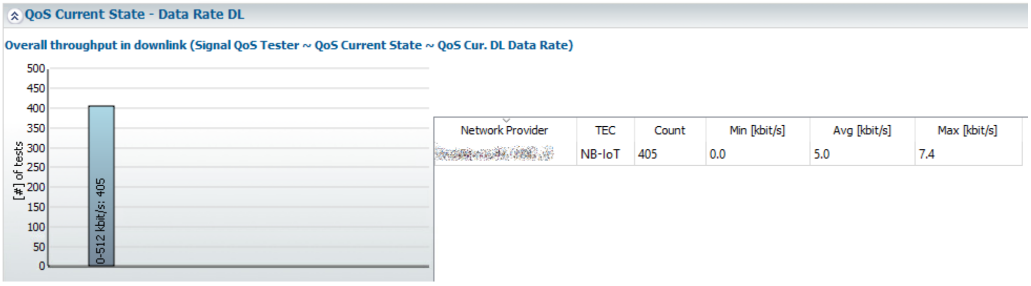
The R&S ROMES4 measurements of the NB-IoT jobs FTP DL/UL and UDP can be aggregated and presented on the existing resulting pages for these jobs in R&S ROMES4 NPA.



Data Transaction Table

Result	Start Time	End Time	Device	Network Provider	RAT	Protocol
Job OK	11/04/19 07:53:08	11/04/19 07:56:08	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	UDP
Job OK	11/04/19 07:56:20	11/04/19 07:59:20	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	UDP
Job OK	11/04/19 07:59:27	11/04/19 08:02:28	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	UDP
Job OK	11/04/19 08:02:35	11/04/19 08:05:35	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	UDP
Job OK	11/04/19 08:05:39	11/04/19 08:05:56	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	UDP
Incomplet...	11/04/19 08:05:56	11/04/19 08:05:56	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	UDP
Job OK	11/04/19 08:57:55	11/04/19 08:58:13	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	FTP DL
Bad Request	11/04/19 08:58:26	11/04/19 08:58:47	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	FTP DL
Bad Request	11/04/19 08:58:47	11/04/19 08:59:03	SARA-R410M-02B [1],QoS [1]	[illegible]	NB-IoT	FTP DL

Figure 12-318: Aggregated NB-IoT FTP and UDP jobs in DQA Transaction Table



Network Provider	TEC	Count	Min [kbit/s]	Avg [kbit/s]	Max [kbit/s]
[illegible]	NB-IoT	405	0.0	5.0	7.4

Figure 12-319: NB-IoT FTP and UDP jobs data rate statistics

12.27.4.10 Throughput

The NB-IoT throughput analysis is supported.

The throughput raster map shows aggregated measurement data from the Cat-NB UE using geographic bins.

The ping RTT value for the selected bin is shown on the result "NB-IoT Throughput Analysis" page based on configured value in "Labels".

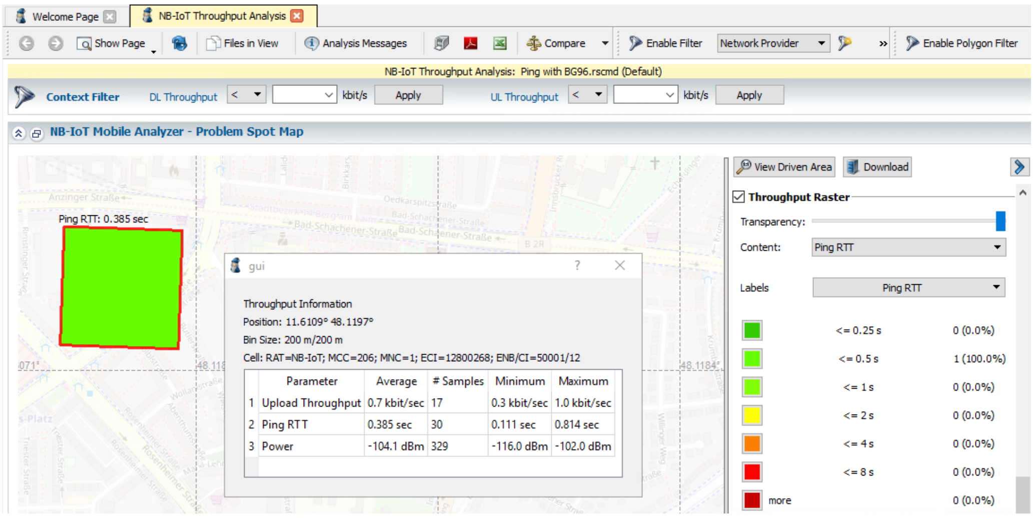


Figure 12-320: NB-IoT mobile statistics - ping RTT on the map

The pop-up window "gui" shows the analysis results per bin and raster color.

12.28 LTE-M measurements aggregation

R&S ROMES4 NPA supports narrowband aggregation of the R&S ROMES4 scanner measurements for LTE-M. The collected measurements include a cell data (eNB Id, CI, EARFCN). The cell data is used for identification of measurement results, that is, for BR-RSRP, BR-RSRQ and BR-SINR measurements.

The following figure shows available options for the LTE-M statistics and analysis.

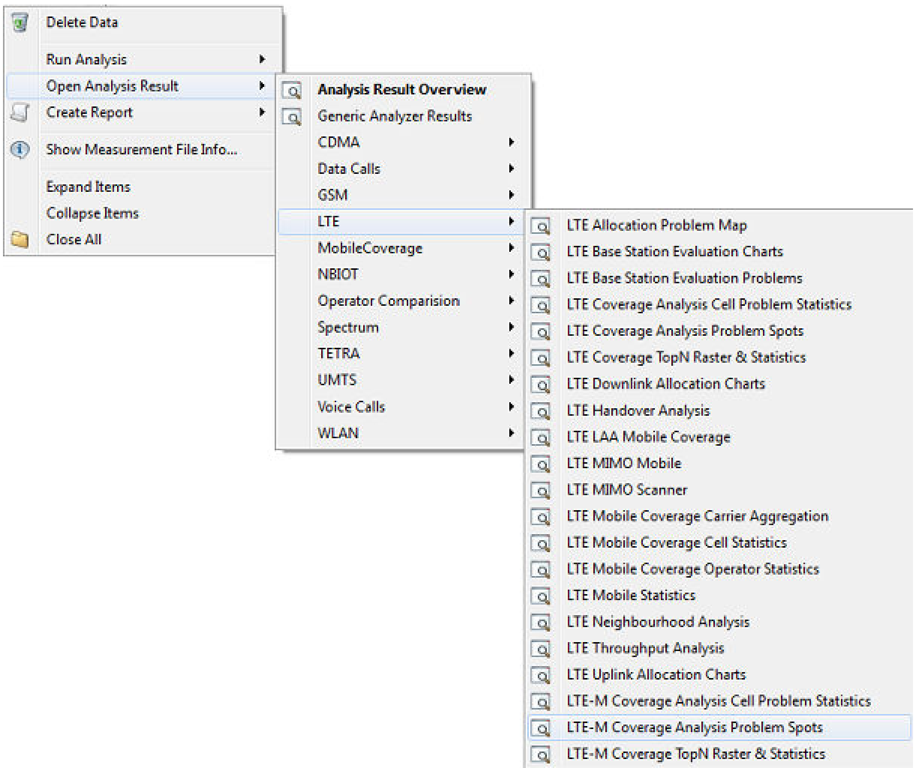


Figure 12-321: LTE-M statistics and analysis options

The measurement results of the LTE-M scanner are aggregated by narrowband. The results are accessed on the overview page in the LTE section.

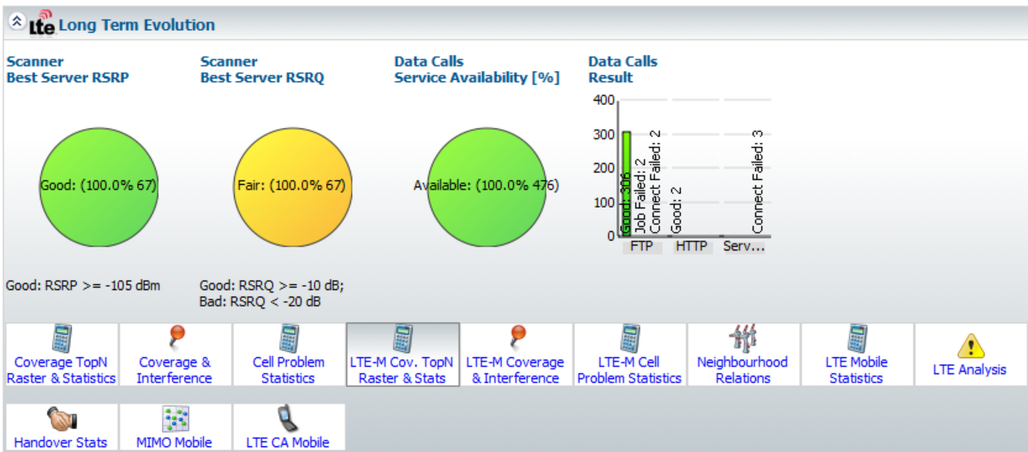


Figure 12-322: LTE-M analysis results of the selected option Cov. TopN Raster and Statistics

The following supported LTE-M analyses are based on the generic scanner evaluations common for 3GPP RATs:

- Coverage and interference analysis
- Network analysis

The individual configuration of analysis for high delta between best and worst narrowband is done in "Coverage Analysis Data Processor" > "LTE-M Analysis".

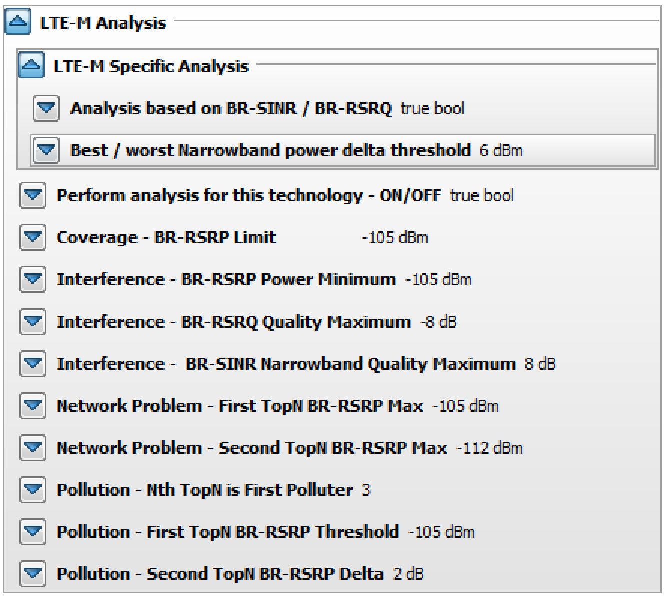
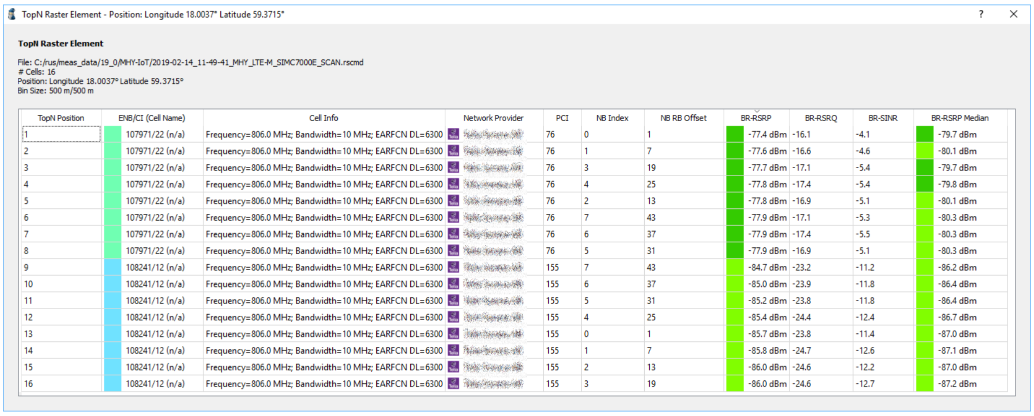


Figure 12-323: Configuration of LTE-M analysis

12.28.1 LTE-M mobile statistic and analysis

The measurements for the narrowband are identified by NB Index. The NB RB Offset is displayed.


TopN Raster Element - Position: Longitude 18.0037° Latitude 59.3715°

TopN Raster Element

File: C:/rus/meas_data/19_0/MHY-IoT/2019-02-14_11-49-41_MHY_LTE-M_SIMC7000E_SCAN.rscmd
Cells: 16
Position: Longitude 18.0037° Latitude 59.3715°
Bin Size: 500 m/500 m

TopN Position	ENB/CI (Cell Name)	Cell Info	Network Provider	PCI	NB Index	NB RB Offset	BR-RSRP	BR-RSRQ	BR-SINR	BR-RSRP Median
1	107971/22 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	76	0	1	-77.4 dBm	-16.1	-4.1	-79.7 dBm
2	107971/22 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	76	1	7	-77.6 dBm	-16.6	-4.6	-80.1 dBm
3	107971/22 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	76	3	19	-77.7 dBm	-17.1	-5.4	-79.7 dBm
4	107971/22 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	76	4	25	-77.8 dBm	-17.4	-5.4	-79.8 dBm
5	107971/22 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	76	2	13	-77.8 dBm	-16.9	-5.1	-80.1 dBm
6	107971/22 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	76	7	43	-77.9 dBm	-17.1	-5.3	-80.3 dBm
7	107971/22 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	76	6	37	-77.9 dBm	-17.4	-5.5	-80.3 dBm
8	107971/22 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	76	5	31	-77.9 dBm	-16.9	-5.1	-80.3 dBm
9	108241/12 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	155	7	43	-84.7 dBm	-23.2	-11.2	-86.2 dBm
10	108241/12 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	155	6	37	-85.0 dBm	-23.9	-11.8	-86.4 dBm
11	108241/12 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	155	5	31	-85.2 dBm	-23.8	-11.8	-86.4 dBm
12	108241/12 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	155	4	25	-85.4 dBm	-24.4	-12.4	-86.7 dBm
13	108241/12 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	155	0	1	-85.7 dBm	-23.8	-11.4	-87.0 dBm
14	108241/12 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	155	1	7	-85.8 dBm	-24.7	-12.6	-87.1 dBm
15	108241/12 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	155	2	13	-86.0 dBm	-24.6	-12.2	-87.0 dBm
16	108241/12 (n/a)	Frequency=806.0 MHz; Bandwidth=10 MHz; EARFCN DL=6300	[illegible]	155	3	19	-86.0 dBm	-24.6	-12.7	-87.2 dBm

Figure 12-324: LTE-M topN raster element

The detected interference problems are shown in the following problem spot analysis pages.

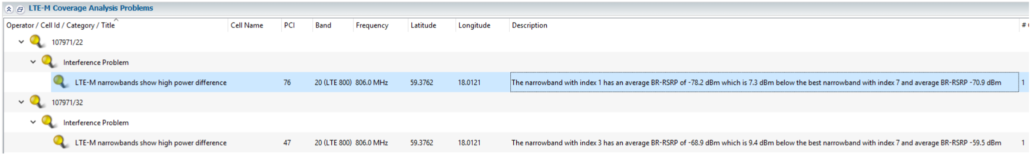


Figure 12-325: LTE-M coverage analysis result

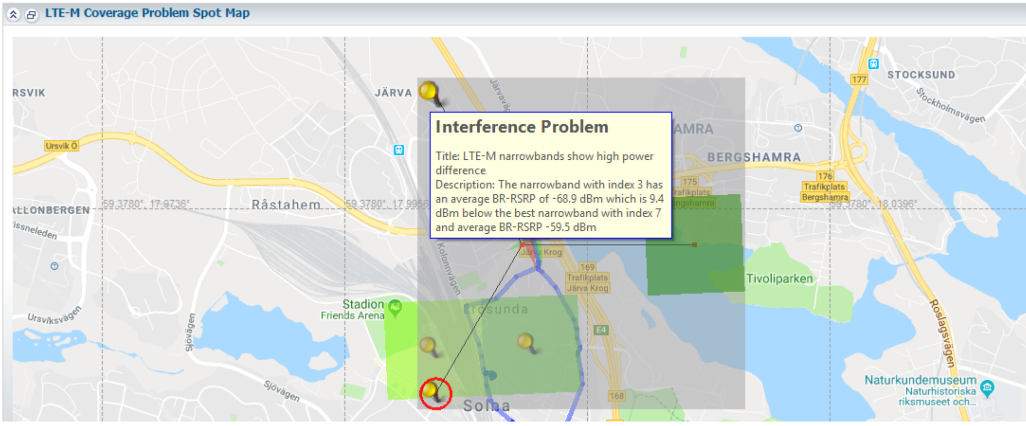


Figure 12-326: LTE-M coverage problem spot map

12.28.1.1 Aggregation of LTE-M attach and detach messages

R&S ROMES4 NPA aggregates the ATTACH and DETACH messages and shows the associated KPIs of ATTACH/DETACH success rates. To see the results, click "LTE Mobile Statistics" > "Attach" /"Detach".

The feature benefit is a good overview of the procedures success rates and timings.

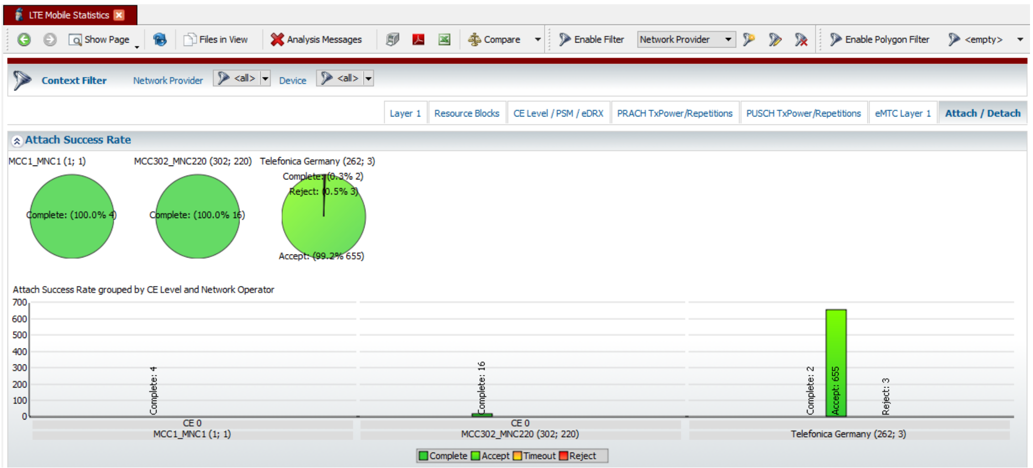


Figure 12-327: Attach success rate

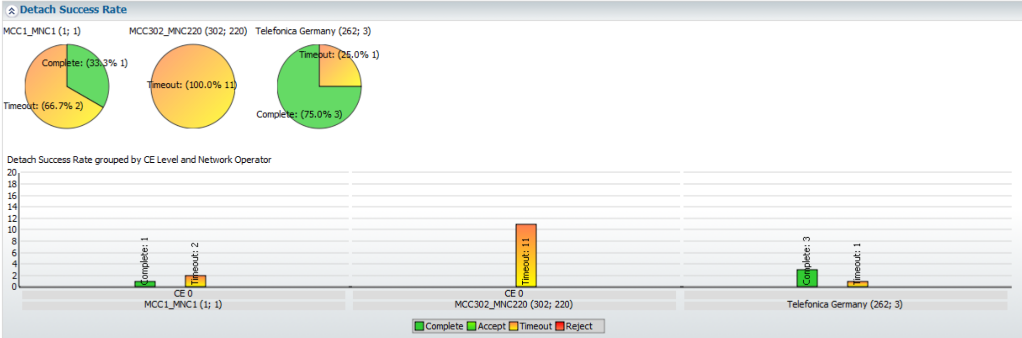


Figure 12-328: Detach success rate

Figure 12-329: Attach procedure time distribution

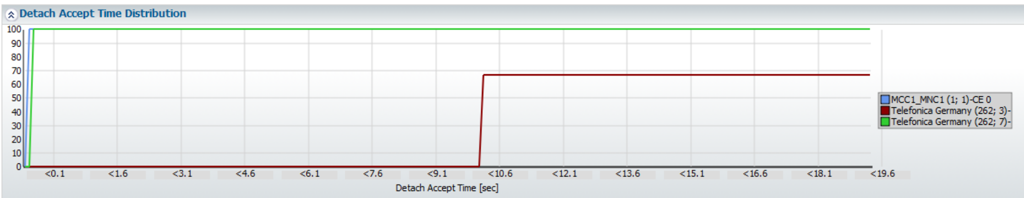


Figure 12-330: Detach accept time distribution

12.28.1.2 Aggregation of LTE-M paging messages

The aggregation of LTE-M PCCH paging provides a quick overview of PCCH paging and subsequent RRC Connection Setup success rates and timings.

The analysis of LTE EMM PCCH paging messages is based on TMSI of a device.

The actual TMSI is derived fromLTE EMM Attach and Tracking Area Update and from RRC Connection Request.

LTE RRC Connection Request messages with establishmentCause mt_Access are regarded to be triggered by the paging the actual TMSI of a device.

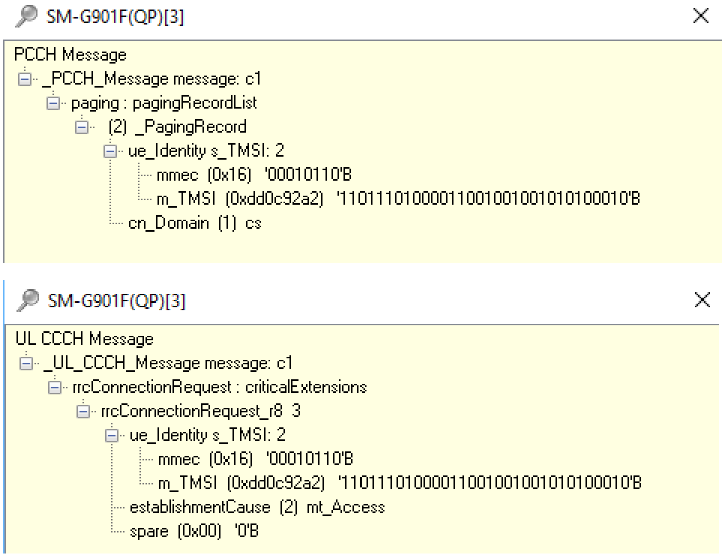


Figure 12-331: Paging message and response of UE

The following messages are used for calculation of the time delta since the paging.

- RRC Connection Setup
- RRC Connection Setup Complete

Paging success is determined by an RRC Connection Request with the establishment-Cause mt_Access after the paging to our TMSI.

Paging is counted as 'timeout' and unsuccessful if the following is detected:

- RRC Connection Request is not received within the configured time interval after the paging
- RRC Connection Request is received with the Establishment Cause other than mt_Access, for example the establishmentCause mo_Data

The KPI RRC Connection Setup success is derived by the RRC Connection Setup Complete message. If this message is not received within the configured time interval, the result is counted as ‘timeout’.

Paging success

The results for paging are presented within the "LTE-Mobile Statistics" > "Paging" tab.

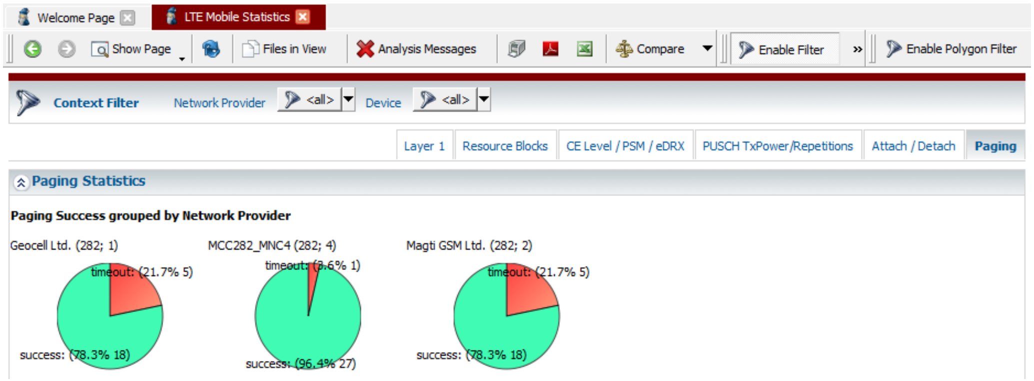


Figure 12-332: Paging success rate

RRC connection request timing

The following figures show paging to RRC Connection Request time with CE level applicable.

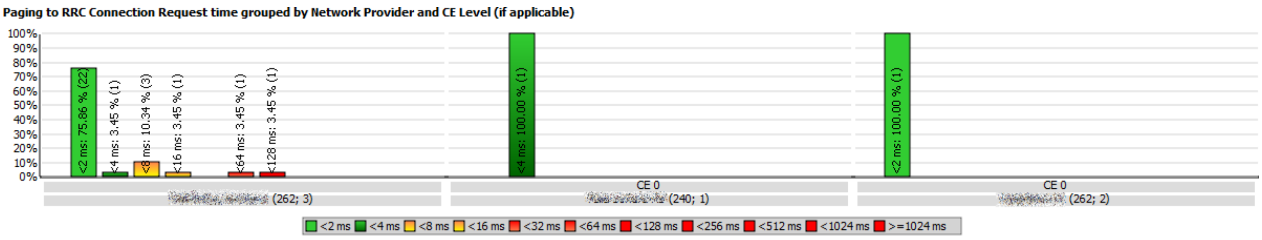
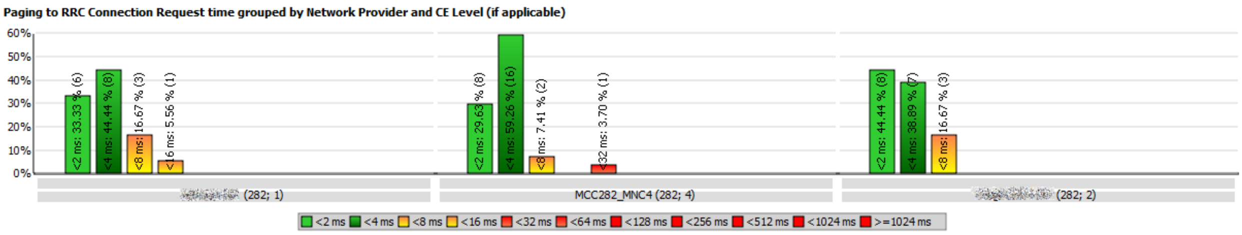


Figure 12-333: Paging to RRC Connection Request time



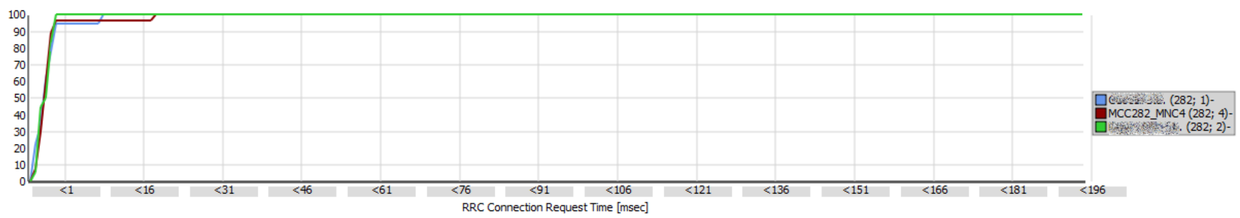


Figure 12-334: Paging to RRC Connection Request time and timing above 1s

RRC connection setup timing

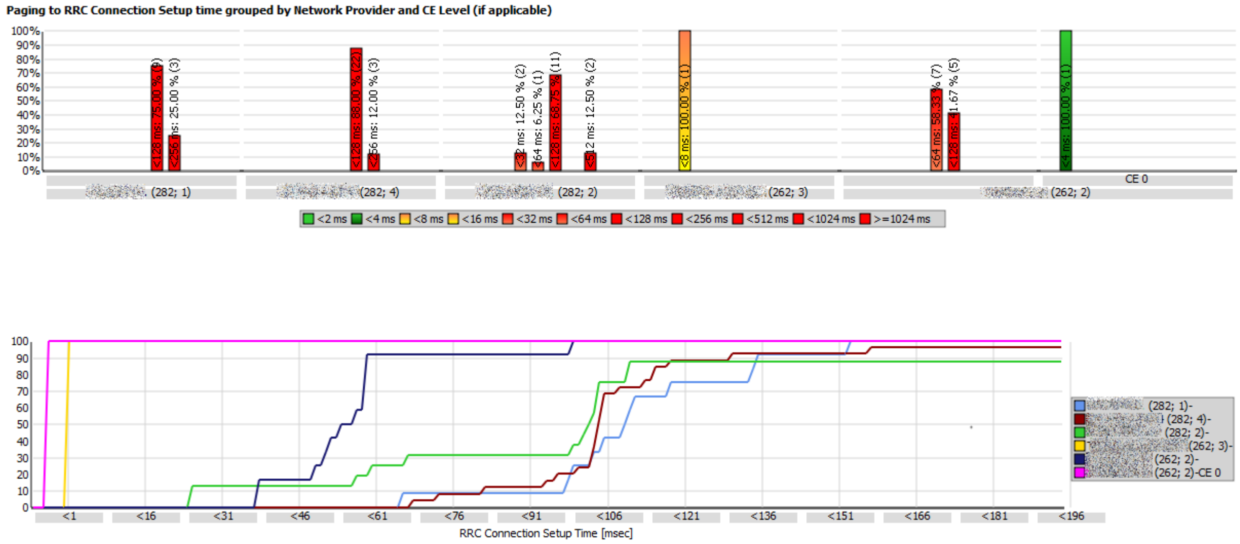


Figure 12-335: Paging to RRC Connection Request time and timing above 1s

RRC connection setup complete timing and RRC connection request causes

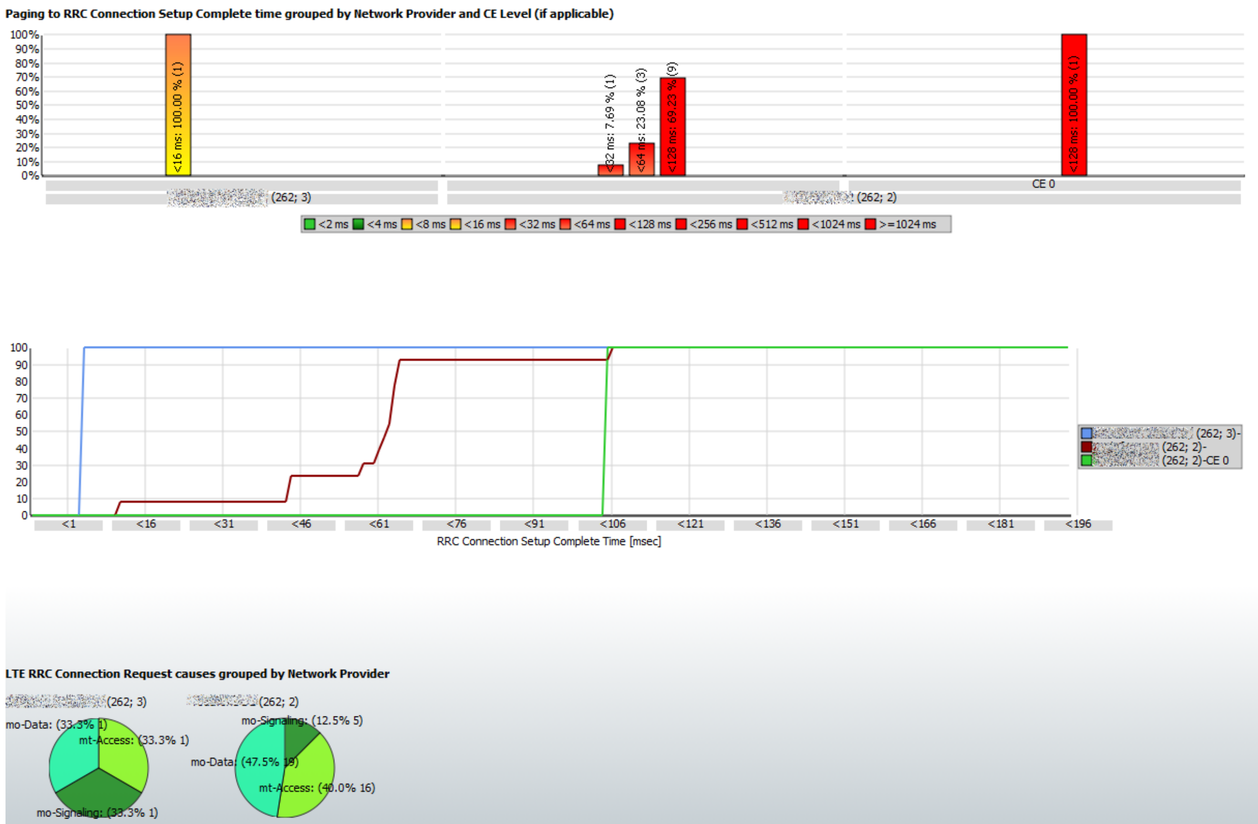


Figure 12-336: Paging to RRC Connection Setup Complete time and the cause

12.29 NB-IoT and LTE-M statistics and operator comparison

The feature serves in providing NB-IoT and LTE-M statistics and the operator comparison for the following views:

- Coverage cell statistics scanner based
- Operator comparison scanner based

NB-IoT Cell Statistics

Network Provider / Cell Name	Frequency	ENB/CI	NPCI	Operational Mode	Band	# Bins	1st	[%]	2nd	[%]	3rd	[%]	rest	[%]
(262; 2)														
RAT=NB-IoT; MCC=262; MNC=2; ECI=20485221; ENB/CI=80020/101	805.0025 MHz	80020/101	110	In band	20	33	8	24.2	9	27.3	10	30.3	6	18.2
RAT=NB-IoT; MCC=262; MNC=2; ECI=20485223; ENB/CI=80020/103	805.0025 MHz	80020/103	109	In band	20	14	12	85.7	2	14.3	0	0.0	0	0.0
RAT=NB-IoT; MCC=262; MNC=2; ECI=20632165; ENB/CI=80594/101	805.0025 MHz	80594/101	238	In band	20	4	0	0.0	0	0.0	0	0.0	4	100.0
RAT=NB-IoT; MCC=262; MNC=2; ECI=20632677; ENB/CI=80596/101	805.0025 MHz	80596/101	440	In band	20	18	4	22.2	13	72.2	1	5.6	0	0.0
RAT=NB-IoT; MCC=262; MNC=2; ECI=20632678; ENB/CI=80596/102	805.0025 MHz	80596/102	439	In band	20	21	10	47.6	4	19.0	1	4.8	6	28.6
RAT=NB-IoT; MCC=262; MNC=2; ECI=20632679; ENB/CI=80596/103	805.0025 MHz	80596/103	438	In band	20	31	14	45.2	4	12.9	2	6.5	11	35.5
RAT=NB-IoT; MCC=262; MNC=2; ECI=20687718; ENB/CI=80811/102	805.0025 MHz	80811/102	84	In band	20	23	13	56.5	0	0.0	3	13.0	7	30.4
RAT=NB-IoT; MCC=262; MNC=2; ECI=20687719; ENB/CI=80811/103	805.0025 MHz	80811/103	85	In band	20	7	0	0.0	4	57.1	2	28.6	1	14.3
RAT=NB-IoT; MCC=262; MNC=2; ECI=20742502; ENB/CI=81025/102	805.0025 MHz	81025/102	384	In band	20	13	6	46.2	2	15.4	0	0.0	5	38.5
RAT=NB-IoT; MCC=262; MNC=2; ECI=20742503; ENB/CI=81025/103	805.0025 MHz	81025/103	386	In band	20	22	4	18.2	4	18.2	5	22.7	9	40.9
RAT=NB-IoT; MCC=262; MNC=2; ECI=20746853; ENB/CI=81042/101	805.0025 MHz	81042/101	150	In band	20	31	9	29.0	6	19.4	5	16.1	11	35.5
RAT=NB-IoT; MCC=262; MNC=2; ECI=20746854; ENB/CI=81042/102	805.0025 MHz	81042/102	151	In band	20	31	8	25.8	17	54.8	1	3.2	5	16.1
RAT=NB-IoT; MCC=262; MNC=2; ECI=20751461; ENB/CI=81060/101	805.0025 MHz	81060/101	127	In band	20	18	1	5.6	7	38.9	1	5.6	9	50.0
RAT=NB-IoT; MCC=262; MNC=2; ECI=20751462; ENB/CI=81060/102	805.0025 MHz	81060/102	126	In band	20	32	1	3.1	6	18.8	10	31.2	15	46.9
RAT=NB-IoT; MCC=262; MNC=2; ECI=20832101; ENB/CI=81375/101	805.0025 MHz	81375/101	118	In band	20	13	6	46.2	1	7.7	3	23.1	3	23.1
RAT=NB-IoT; MCC=262; MNC=2; ECI=20910949; ENB/CI=81683/101	805.0025 MHz	81683/101	248	In band	20	23	6	26.1	3	13.0	7	30.4	7	30.4
RAT=NB-IoT; MCC=262; MNC=2; ECI=20980069; ENB/CI=81953/101	805.0025 MHz	81953/101	117	In band	20	25	4	16.0	6	24.0	5	20.0	10	40.0
RAT=NB-IoT; MCC=262; MNC=2; ECI=20980070; ENB/CI=81953/102	805.0025 MHz	81953/102	118	In band	20	29	3	10.3	13	44.8	10	34.5	3	10.3
RAT=NB-IoT; MCC=262; MNC=2; ECI=20980071; ENB/CI=81953/103	805.0025 MHz	81953/103	119	In band	20	16	6	37.5	1	6.2	4	25.0	5	31.2
RAT=NB-IoT; MCC=262; MNC=2; ECI=20982117; ENB/CI=81961/101	805.0025 MHz	81961/101	140	In band	20	12	0	0.0	6	50.0	2	16.7	4	33.3
RAT=NB-IoT; MCC=262; MNC=2; ECI=20985445; ENB/CI=81974/101	805.0025 MHz	81974/101	445	In band	20	34	10	29.4	7	20.6	6	17.6	11	32.4
RAT=NB-IoT; MCC=262; MNC=2; ECI=20985446; ENB/CI=81974/102	805.0025 MHz	81974/102	444	In band	20	40	13	32.5	12	30.0	1	2.5	14	35.0
RAT=NB-IoT; MCC=262; MNC=2; ECI=20985447; ENB/CI=81974/103	805.0025 MHz	81974/103	446	In band	20	15	1	6.7	5	33.3	7	46.7	2	13.3
RAT=NB-IoT; MCC=262; MNC=2; ECI=20985957; ENB/CI=81976/101	805.0025 MHz	81976/101	375	In band	20	21	9	42.9	6	28.6	3	14.3	3	14.3
RAT=NB-IoT; MCC=262; MNC=2; ECI=20985959; ENB/CI=81976/103	805.0025 MHz	81976/103	376	In band	20	15	4	26.7	7	46.7	3	20.0	1	6.7
RAT=NB-IoT; MCC=262; MNC=2; ECI=20986213; ENB/CI=81977/101	805.0025 MHz	81977/101	262	In band	20	32	12	37.5	9	28.1	5	15.6	6	18.8
RAT=NB-IoT; MCC=262; MNC=2; ECI=20986214; ENB/CI=81977/102	805.0025 MHz	81977/102	261	In band	20	23	1	4.3	3	13.0	12	52.2	7	30.4
RAT=NB-IoT; MCC=262; MNC=2; ECI=21055589; ENB/CI=82248/101	805.0025 MHz	82248/101	282	In band	20	13	4	30.8	7	53.8	2	15.4	0	0.0
RAT=NB-IoT; MCC=262; MNC=2; ECI=21055591; ENB/CI=82248/103	805.0025 MHz	82248/103	283	In band	20	15	5	33.3	4	26.7	4	26.7	2	13.3
RAT=NB-IoT; MCC=262; MNC=2; ECI=21060197; ENB/CI=82266/101	805.0025 MHz	82266/101	465	In band	20	55	37	67.3	5	9.1	1	1.8	12	21.8
RAT=NB-IoT; MCC=262; MNC=2; ECI=21060198; ENB/CI=82266/102	805.0025 MHz	82266/102	466	In band	20	20	0	0.0	10	50.0	0	0.0	10	50.0
RAT=NB-IoT; MCC=262; MNC=2; ECI=21080677; ENB/CI=82346/101	805.0025 MHz	82346/101	106	In band	20	20	4	20.0	9	45.0	4	20.0	3	15.0

Figure 12-337: Coverage cell statistics scanner based for NB-IoT

LTE-M Cell Statistics

Network Provider / Cell Name	add. PLMNs	EARFCN	Frequency	Bandwidth	ENB/CI	PhyCI	NB Index	NB RB Offset	#Tx Antennas	# Bins	1st
(310; 410)											
RAT=LTE; MCC=310; MNC=410; ECI=84516623; ENB/CI=330143/15	313/100	5780	739.0 MHz	10	330143/15	162	0	1	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516623; ENB/CI=330143/15	313/100	5780	739.0 MHz	10	330143/15	162	1	7	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516623; ENB/CI=330143/15	313/100	5780	739.0 MHz	10	330143/15	162	2	13	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516623; ENB/CI=330143/15	313/100	5780	739.0 MHz	10	330143/15	162	3	19	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516623; ENB/CI=330143/15	313/100	5780	739.0 MHz	10	330143/15	162	4	25	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516623; ENB/CI=330143/15	313/100	5780	739.0 MHz	10	330143/15	162	5	31	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516623; ENB/CI=330143/15	313/100	5780	739.0 MHz	10	330143/15	162	6	37	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516623; ENB/CI=330143/15	313/100	5780	739.0 MHz	10	330143/15	162	7	43	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516624; ENB/CI=330143/16	313/100	5780	739.0 MHz	10	330143/16	163	0	1	2	37	1
RAT=LTE; MCC=310; MNC=410; ECI=84516624; ENB/CI=330143/16	313/100	5780	739.0 MHz	10	330143/16	163	1	7	2	37	0
RAT=LTE; MCC=310; MNC=410; ECI=84516624; ENB/CI=330143/16	313/100	5780	739.0 MHz	10	330143/16	163	2	13	2	37	2
RAT=LTE; MCC=310; MNC=410; ECI=84516624; ENB/CI=330143/16	313/100	5780	739.0 MHz	10	330143/16	163	3	19	2	37	1
RAT=LTE; MCC=310; MNC=410; ECI=84516624; ENB/CI=330143/16	313/100	5780	739.0 MHz	10	330143/16	163	4	25	2	37	1
RAT=LTE; MCC=310; MNC=410; ECI=84516624; ENB/CI=330143/16	313/100	5780	739.0 MHz	10	330143/16	163	5	31	2	37	0
RAT=LTE; MCC=310; MNC=410; ECI=84516624; ENB/CI=330143/16	313/100	5780	739.0 MHz	10	330143/16	163	6	37	2	37	3
RAT=LTE; MCC=310; MNC=410; ECI=84516624; ENB/CI=330143/16	313/100	5780	739.0 MHz	10	330143/16	163	7	43	2	37	2
RAT=LTE; MCC=310; MNC=410; ECI=84516625; ENB/CI=330143/17	313/100	5780	739.0 MHz	10	330143/17	164	0	1	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516625; ENB/CI=330143/17	313/100	5780	739.0 MHz	10	330143/17	164	1	7	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516625; ENB/CI=330143/17	313/100	5780	739.0 MHz	10	330143/17	164	2	13	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516625; ENB/CI=330143/17	313/100	5780	739.0 MHz	10	330143/17	164	3	19	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516625; ENB/CI=330143/17	313/100	5780	739.0 MHz	10	330143/17	164	4	25	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516625; ENB/CI=330143/17	313/100	5780	739.0 MHz	10	330143/17	164	5	31	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516625; ENB/CI=330143/17	313/100	5780	739.0 MHz	10	330143/17	164	6	37	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516625; ENB/CI=330143/17	313/100	5780	739.0 MHz	10	330143/17	164	7	43	2	14	0
RAT=LTE; MCC=310; MNC=410; ECI=84516881; ENB/CI=330144/17	313/100	5780	739.0 MHz	10	330144/17	5	0	1	2	88	3
RAT=LTE; MCC=310; MNC=410; ECI=84516881; ENB/CI=330144/17	313/100	5780	739.0 MHz	10	330144/17	5	1	7	2	88	0
RAT=LTE; MCC=310; MNC=410; ECI=84516881; ENB/CI=330144/17	313/100	5780	739.0 MHz	10	330144/17	5	2	13	2	88	0
RAT=LTE; MCC=310; MNC=410; ECI=84516881; ENB/CI=330144/17	313/100	5780	739.0 MHz	10	330144/17	5	3	19	2	88	0
RAT=LTE; MCC=310; MNC=410; ECI=84516881; ENB/CI=330144/17	313/100	5780	739.0 MHz	10	330144/17	5	4	25	2	88	1
RAT=LTE; MCC=310; MNC=410; ECI=84516881; ENB/CI=330144/17	313/100	5780	739.0 MHz	10	330144/17	5	5	31	2	88	2
RAT=LTE; MCC=310; MNC=410; ECI=84516881; ENB/CI=330144/17	313/100	5780	739.0 MHz	10	330144/17	5	6	37	2	88	3
RAT=LTE; MCC=310; MNC=410; ECI=84516881; ENB/CI=330144/17	313/100	5780	739.0 MHz	10	330144/17	5	7	43	2	88	3

Figure 12-338: Coverage cell statistics scanner based for LTE-M

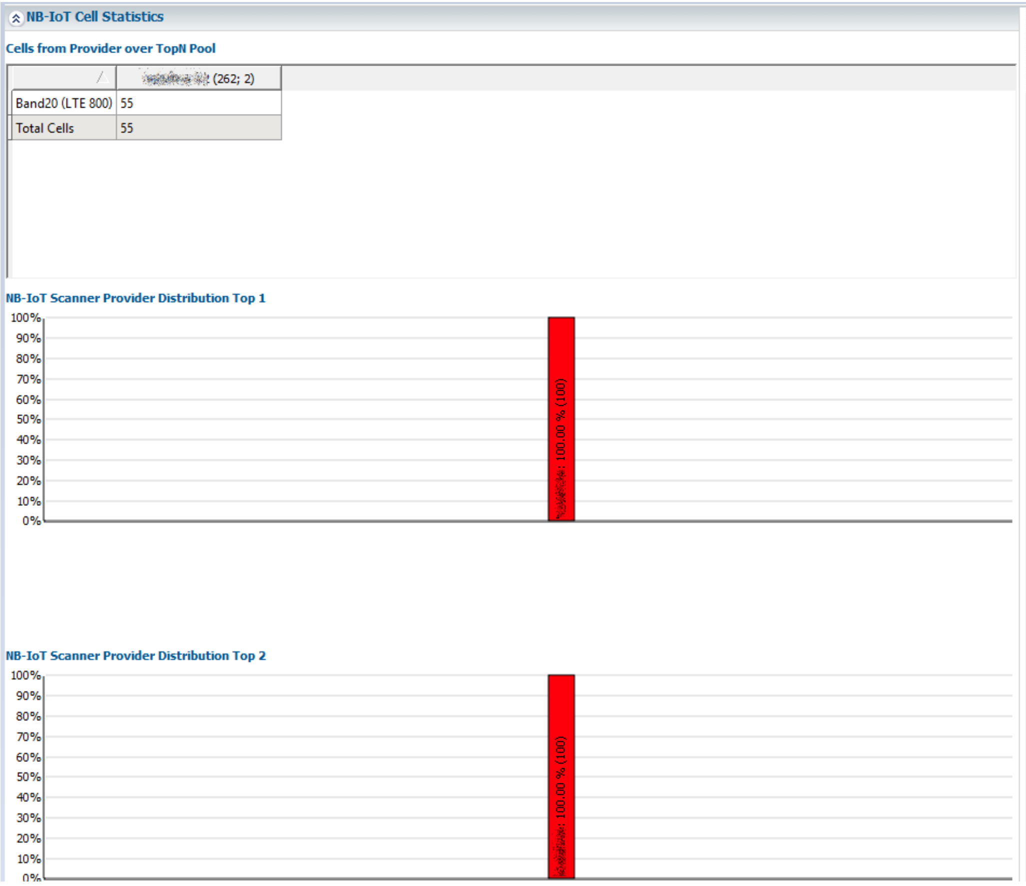


Figure 12-339: Operator comparison - scanner based for NB-IoT

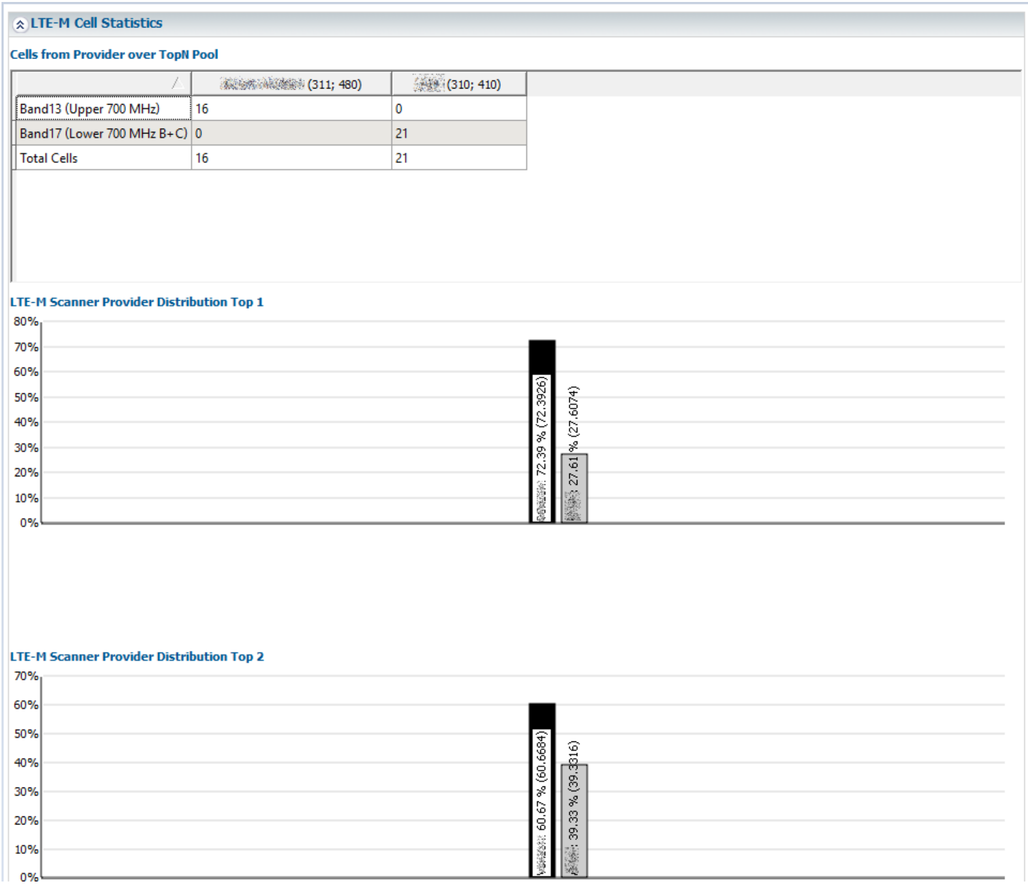


Figure 12-340: Operator comparison - scanner based for LTE-M

13 UE emulation

The UE Emulation feature is an addendum to the scanner coverage analysis.

The R&S ROMES4 option for UE emulation is needed during a measurement in the NPA processing to perform these calculations.

The calculation of the selection criteria uses the cell parameters decoded from:

- GSM message System Information type 3
- UMTS message System Information Block type 3
- LTE message System Information Block type 1

The calculated results are shown in the cell statistics and the TopN within the geografical raster. The raster configuration allows to choose the selection criteria as best server painter.

13.1 GSM UE emulation

The selection criteria C1 and C2 are calculated by using the measured RxLev and the cell parameters given in the following table.

Table 13-1: GSM UE emulation

Parameter	Value Range (dBm)	Description
C1	-100 to 100	Selection criterion C1 considers RXLEV ACCESS MIN, MS TXPWR MAX CCH and POWER_OFFSET
C2	-100 to 100	Selection criterion C2 additionally considers PENALTY_TIME, TEMPORARY_OFFSET and CELL_RESELECT_OFFSET

13.2 UMTS UE emulation

The selection criteria Cue and Cue Lev are calculated by using the measured EcN0 and RSCP and the cell parameters given in the following table depending on cellSelectQualityMeasure showing cpich_Ec_N0.

Table 13-2: UMTS UE emulation with cpich_Ec_N0

Parameter	Value Range (dBm)	Description
Cue	-100 to +100	Selection criterion Cue considers EcN0 and QualMin
Cue Lev	-100 to +100	Selection criterion C2 additionally considers RSCP, RxLevMin, maxAllowedUL_TX_Power

Otherwise, the selection criteria Cue and Cue Lev are calculated as given in the following table.

Table 13-3: UMTS UE emulation without cpich_Ec_N0

Parameter	Value Range (dBm)	Description
Cue	-100 to +100	Selection criterion Cue considers RSRQ, RxLevMin, maxAllowedUL_TX_Power
Cue Lev	n/a	not calculated

13.3 LTE UE emulation

The selection criteria Cue and Cue Qual are calculated by using the measured RSRP and RSRQ, respectively and the cell parameters given in the following table.

Table 13-4: GSM UE emulation

Parameter	Value Range (dBm)	Description
Cue	-100 to +100	Selection criterion Cue considers RSRQ, RxLevMin, RxLevMinOffset, p_MAX
CueQual	-100 to +100	Selection criterion C2 additionally considers RSRQ, QualMin, QualMinOffset

14 R&S ROMES4 NPA version history

14.1 R&S ROMES4 NPA version 23.1

14.1.1 Offline maps for R&S MapsStudio available in GLORIS

R&S ROMES4 contains R&S MapsStudio which is an locally installed OpenStreeMap server. The offline maps for R&S MapsStudio can be downoaded from GLORIS, instead of requesting them from R&S personal.

14.2 R&S ROMES4 NPA version 23.0

14.2.1 Additional OSM map server on local machine

R&S ROMES4 contains R&S Maps Studio which is an locally installed OpenStreeMap server. Thereby the R&S ROMES4NPA offers the following map layers:

- OpenStreetMap Basic Street

- OpenStreetMap Dark Street

- OpenStreetMap Light Street

- OpenStreetMap Simple Street

The two entries are introduced in the "Help" menu of the R&S ROMES4 NPA menu bar. These entries facilitate access to the RS Maps Studio 2.0 server configuration and the associated manual, see Chapter 11.2.6.4, "RS Maps Studio 2.0", on page 213.

14.3 R&S ROMES4 NPA version 22.3

14.3.1 GUI

The R&S ROMES4 and R&S ROMES4 NPA apply the company's Open Streetmap servers named RSMapsStudio for background map layers starting from the version 22.3, see Chapter 6.3.3, "Background layer", on page 171.

14.4 R&S ROMES4 NPA version 22.2

14.4.1 Analysis modules

The two measurement files containing different cell reselection offsets for the same cell can be viewed separate, but not combined. For combined view, the processing with the new "No CRO evaluation" function helps as the usage of offsets is omitted. However, omitted is the CRO in the cell information and the C2 calculation. For more, see Figure 12-142.

14.4.2 GUI

The "GSM Specific Analysis" function of the "Coverage Analysis Data Processor" > "GSM Analysis" has the configuration switch to deactivate consideration of the cell reselection offset, see Figure 12-137.

14.5 R&S ROMES4 NPA Version 22.1

There are no new features added in R&S ROMES4 NPA v22.1.

14.6 Version 22.0

14.6.1 GUI

There is the possibility to activate the labels of the mobile raster data layer in the "Mobile Coverage Map" page, see Figure 12-13.

14.7 Version 21.3

14.7.1 GUI

The number of colors for cells on maps is increased. This improvement applies to all R&S ROMES4 NPA map views with a cell layer. The available colors refer to the R&S style guide. For the example of available colors, see Figure 5-19.

14.8 Version 21.2

There are no new features added in R&S ROMES4 NPA v21.2.

14.9 Version 21.1

14.9.1 Analysis modules

The following analysis modules and changes are added in this version:

- The R&S ROMES4 NPA supports the TETRA scanner based UE comparison, see Chapter 12.7, "TETRA scanner results based UE comparison", on page 278. A new TETRA Scanner and Mobile Combined Analysis analyzer is introduced to perform the UE comparisons and detect possible problems.

14.10 Version 21.0

There were no features added in R&S ROMES4 NPA v21.0.

14.11 Version 20.3

There were no features added in R&S ROMES4 NPA v20.3.

14.12 Version 20.2

14.12.1 Analysis modules

- R&S ROMES4 NPA supports analysis of the OOKLA ® tests obtained from the QualiPoc measurements, see Chapter 4.9.2, "Support of QualiPoc OOKLA ® tests", on page 119. The "Analysis Result Overview" and the "Data Transcation KPIs" pages show the results of the tests, see also Figure 12-95.
- Range of TETRA speech quality MOS categories Fair, Good and Excelent is extended and their threshold values for display is configurable, see Figure 5-7 and Table 12-3.

14.13 Version 20.1

14.13.1 Analysis modules

The following analysis modules and changes are added in this version:

- The LTE Cell Statistics list shows the broadcasted capabilities of LTE-M, NB-IoT and 5G-NR, if these are available, see Chapter 12.16.7, "LTE scanner", on page 363.
- Points of interest (POI) can be displayed in a map layer, see Chapter 6.3.2, "Points of interest", on page 168. The option lets you load you own POI into R&S ROMES4 NPA map and check if the area was measured or not.

14.14 Version 20.0

14.14.1 Analysis modules

The following analysis modules and changes are added in this version:

- LTE MIMO scanner raster analysis contains the Condition Number (CN) results of MIMO 4x2 and MIMO 4x4 mode, see Figure 12-251.The improved MIMO modes comparision of a cell is the benefit of this feature.
- R&S ROMES4 NPA supports aggregation of the DQA NB-IoT jobs FTP and UDP. Such an aggregation provides immediate overview of the jobs results, see Chapter 12.27.4.9, "Aggregation of DQA NB-IoT jobs FTP and UDP", on page 474
- R&S ROMES4 NPA suports WIBU codemeter for license validation, see also Chapter A.2.2.1, "WIBU codemeter", on page 509.

14.15 Version 19.3

14.15.1 Analysis modules

The following analysis modules and changes are added in this version:

- Conversion of the R&S ROMES4 MF, SQC and SQZ measurement files older then version 18.0 is not supported. The error message is displayed to indicate this in the "Command Report", see Figure 4-4.

14.15.2 GUI

- Units of the measured values are not written besides the values anymore. Instead, they are written in the header of the R&S ROMES4 NPA tables which provides better visibility.
- Harmonization of TETRA mobile raster - the UE measurement values are presented as small bin-quadrants with rounded edges in the maps. In this way, it is easy to read the scanner values, see Figure 12-27.
- The GSM statistic tables have added letter P besides the ARFCN value in the column "BCCH ARFCN" if the measured frequency belongs to the frequencies assigned to PCS-GSM (GSM 1900), see Figure 12-131.

14.16 Version 19.2

14.16.1 Analysis modules

The following analysis modules and changes are added in this version:

- R&S ROMES4 NPA supports activation /deactivation Fle Meta Data section in the PDF report, see Figure 5-14.
- The LTE scanner coverage problem analysis offers the option to combine the carriers per operator for analysis instead of analyzing the single carrier coverage problem, see Chapter 12.16.8, "LTE operator based coverage analysis", on page 365.
- Added is a result overview page customized for TETRA results. You can choose whether to use the general overview page or the TETRA overview page, see Chapter 5.2.2.1, "Customizing the TETRA overview page", on page 141.
- TETRA handover analyzer shows the problem sport for consecutive Layer3 messages which provides better investigation of configuration problems, see Chapter 12.19.4.1, "Problem spot at TETRA handover analyzer for consecutive layer3 messages", on page 402.

14.17 Version 19.1

14.17.1 Analysis modules

The following analysis modules and changes are added in this version:

- TETRA cell database import supports the ATD/TXT file format with LAC as the neighbor definition only, without channel number. This feature simplifies the neighbor cells definition, see Figure 4-10.
- Geographic presentation of failed DQA sessions and jobs is supported by the "Data Job Problems" function. The result page of the function shows dropped PS

call pins on throughput problem map, see Figure 12-102. For the function, see Figure 4-70.

- Some improvements in TETRA scanner analyses are introduced. These include the investigation of values from single (own) provider, differentiation between problem spots and their filtering and an overview of interference problems per provider, see Chapter 12.16.9.14, "TETRA scanner analysis at the border", on page 380.
- R&S ROMES4 NPA displays the jitter as the additional KPI for void call quality in the "VoLTE and VoWiFi Telephony KPIs" page, see Figure 12-43.
- Maximum zoom level of the maps is configurable, see Max Zoom Level. In this way the created reports are more user friendly and the result pages in case of small driven area show enough information.
- Operator comparison scanner based and the coverage cell statistics scanner based support for NB-IoT and LTE-M is introduced, see Chapter 12.29, "NB-IoT and LTE-M statistics and operator comparison", on page 484.

14.17.2 GUI

- Mobile and scanner raster bins differ from each other to avoid the overlapping when the mobile and scanner layers are simultaneously displayed, see Chapter 5.2.4, "Rasterization of mobile and scanner layer outputs", on page 149.

14.18 Version 19.0

14.18.1 Analysis modules

The following analysis modules and changes are added in this version:

- TETRA configuration feature has added the option to print maps on PDF measurement reports in landscape orientation, see Figure 5-7. The option makes it possible to create PDF reports without viewing the result in the R&S ROMES4 NPA GUI. For "how to", see Chapter 5.2.2.2, "Overview report on larger areas", on page 143
- R&S ROMES4 NPA supports the LTE-M scanner measurement results aggregation by narrowband, see Chapter 12.28, "LTE-M measurements aggregation", on page 476. The benefit is quick overview of the measurement results.
- R&S ROMES4 NPA supports LTE-M attach and detach measurements and display of the success rate of these proceduresand timings in the "LTE Mobile Statistics" page, see Chapter 12.28.1.1, "Aggregation of LTE-M attach and detach messages", on page 479.
- R&S ROMES4 NPA supports LTE-M paging measurements and display of the paging and subsequent RRC connection setup success rates and timings in the "LTE Mobile Statistics" page, see Chapter 12.28.1.2, "Aggregation of LTE-M paging messages", on page 480.

14.18.2 GUI

- Extra information could be displayed next to the raster bins on the map for NB-IoT scanner raster. The "Label" combo box is added in the legend configuration field, see Chapter 12.27.2.1, "Labeling for NB-IoT scanner results", on page 463.

14.19 Version 18.3

14.19.1 Analysis modules

The following analysis modules and changes are added in this version:

- R&S ROMES4 NPA generates the end call status statistics which includes the statistics of cancelled calls, see Figure 12-5.
- Duration thresholds for handover are changeable allowing to get the handover rate within defined time window, see Figure 5-4 and Figure 12-200 and the accompanying text.
- Call restoration procedure is added to TETRA handover analyzer, see Chapter 12.19.8.1, "Call restoration", on page 409.
- R&S ROMES4 NPA supports the EUTRAN timers T3324 and T3412 extended for LTE_M_DRX, see Figure 12-281.
- R&S ROMES4 NPA supports aggregation of DQA AT UDP jobs, see Chapter 12.27.4.7, "DQA UDP", on page 472. The aggregation speeds the overview of the UDP test results up.

14.19.2 GUI

- R&S ROMES4 NPA provides additional charts and statistics for overall data rates and the session results, see Figure 12-110, Figure 12-111 and Figure 12-112.

14.20 Version 18.2

14.20.1 Analysis modules

The following analysis modules and changes are added in this version:

- Ping test results and the associated DQA KPIs are available for all devices and split by device, see Chapter 12.9.1.5, "Ping", on page 303.
- MOC and MTC calls can be filtered and shown in the call list. This is based on support of filtering of all types of call, see Figure 12-2.

- R&S ROMES4 NPA LTE MIMO analyzer supports Tx antenna counting from the info contained in MIB, see Figure 12-247.
- DQA analyzer of the R&S ROMES4 NPA is extended to support the problem table and some pie charts for the Ping job tests, see Chapter 12.9.1.5, "Ping", on page 303.
- Problem of bins not containing all configured GSM channels in the measurement is reported in the Errors during analysis, instead of former reporting in problem spots table. See "GSM coverage problem report related to test measurement rate" on page 70.
- LTE Mobile statistic analysis aggregates the LTE-M statistics similar to NB-IoT statistics aggregation, see Chapter 12.26.2, "LTE-M mobile statistics", on page 451.
- R&S ROMES4 NPA supports NB-IoT mobile statistics and analysis defined as "Phase 2", that is the statistics related to ping RTT, CE level, eDRX and PSM. See Chapter 12.27.4.1, "CE level / edrx / PSM", on page 465 and Chapter 12.27.4.10, "Throughput", on page 475.
- R&S ROMES4 NPA LTE MIMO analyzer supports visualizing the mobile and scanner rank indicator values for 2x2, 4x2 and 4x4 MIMO modes, see Chapter 12.24.1, "LTE MIMO analyzer", on page 431 and Chapter 12.24.1, "LTE MIMO analyzer", on page 431.

14.20.2 GUI

- UMTS "TopN Raster Element" table shows a cell's carrier frequency in MHz, see Figure 6-24.
- The "Memory Usage" entry is added to the "Help" menu, see Chapter 11.2.6.10, "Memory usage", on page 214. The entry makes possible to see the memory usage of the GUI process and additional information regarding the occupied space. The option to install an alarm which sends a notification once a certain threshold is reached is included.
- Immediate display of errors is not supported any more. Existing errors are indicated within "Analysis Messages", see Figure 11-10.

14.21 Version 18.1

14.21.1 Analysis modules

The following analysis modules and changes are added in this version:

- Support of QualiPoc WhatsApp tests, see Chapter 4.9, "Support of QualiPoc tests", on page 116.
- Support of recording the LTE throughput value for mobiles with Samsung chipset at MCA plugin, refer to Figure 12-134 and the associated description.

- Support of import of the BTS lists in the ATD format showing NB-IoT in the column SYS_TYPE, see Chapter 12.27, "NB-IoT measurements aggregation", on page 457.
- Mobile Coverage Analyzer Processor is enhanced with the threshold parameter for the overshooting distance, see Figure 12-183.
  This allows to display the problem spots for the larger distances between BTS and UE, see Chapter 12.17.2.2, "Overshooting problem", on page 387.
- R&S ROMES4 NPA supports the SMS tests at the "DQA App Test" result page, see Chapter 4.9, "Support of QualiPoc tests", on page 116.
- LTE Data Processor offers the option to activate LTE mobile statistics aggregation in mobile's idle state, that is, independently on whether the FTP/HTTP jobs are going on, see Figure 12-275.
- R&S ROMES4 NPA provides the additional NB-IoT coverage raster view of the cells which were not decoded, see Chapter 12.27.3, "NB-IoT coverage raster - cells not decoded", on page 463.

14.21.2 GUI

- Display the BTS NB-IoT symbols on the scanner and mobile map with server lines to measurements, see Figure 12-295 and Figure 12-301.
- Speech quality on sample basis KPI shows the usage of EVS codec, see Figure 12-9l
  Display of the statistics on the distribution of codecs and bit rates used during voice calls is enhanced by showing the EVS codec statistics in addition to the existing AMR and WBAMR codecs, see Figure 12-11.

14.22 Version 18.0

14.22.1 Analysis modules

The following analysis modules and changes are added in this version:

- Table providing a quick overview of the R&S ROMES4 NPA analysis capabilities, see Table 1-1.
- R&S ROMES4 NPA supports the analysis of the Facebook and Dropbox tests obtained from QualiPoc measurements. The analysis pages show results per test and statistics over all tests, see Chapter 4.9.3, "Support of QualiPoc Facebook/ Dropbox test", on page 122.
- R&S ROMES4 NPA supports LTE UL carrier aggregation analysis, using mobile measurement data, see Chapter 12.25.2, "UL carrier aggregation analysis", on page 448.
- R&S ROMES4 NPA supports the aggregation of NB-IoT scanner results bay full cell identification, see Chapter 12.27.2, "NB-IoT coverage topn raster and statistics", on page 460.

- R&S ROMES4 NPA supports the NB-IoT mobile statistic and analysis, see Chapter 12.27.4, "NB-IoT mobile statistic and analysis", on page 464.

14.23 Version 17.3

14.23.1 Analysis modules

The following analysis modules and changes are added in this version:

- The meta data information is included in the "File Meta Data" table of an exported result page, see Figure 11-11.
- Open Source Agreement document can be viewed in the R&S ROMES4 NPA, see Chapter 11.2.6.9, "Open-source agreement", on page 214.
- Support of QualiPoc OOKLA ® tests in addition to already supported NPTs, see Chapter 4.9.2, "Support of QualiPoc OOKLA ® tests", on page 119.
- Narrowband PCI filtering via the R&S ROMES NPA "Filter Definition" dialog is supported, see Chapter 4.5.3.6, "Filter definition dialog - general handling", on page 94.

14.23.2 GUI

- Added a splash screen showing the R&S ROMES4 NPA SW version and loading progress, see Figure 3-1.
- Added a meta file information in the top of the analysis result pages, see "Note" in Chapter 4.3.3, "Analysis view", on page 65 and Figure 4-18.
- The jobs tested by QP Network Performance Tests are shown clearly in the "Data Transaction Table", see Figure 4-71.
- The NB-IoT Coverage Raster and the Cell Statistics table are adapted automatically to the filter selection of the user and fill the data accordingly, see Figure 12-294.
- The map for LTE mobile coverage is updated with three additional layers for CA and the results of up to five CA component are shown, see Chapter 12.25.1, "DL carrier aggregation analysis", on page 446.

14.24 Version 17.2

14.24.1 Analysis modules

The following analysis modules and changes are added in this version:

- Support of QualiPoc network performance tests, see Chapter 4.9.1, "Support of QualiPoc network performance tests", on page 117.
- R&S ROMES4 NPA is extended with a fixed position GPS simulator. The simulator adds a fixed position to the analysis in case no GPS position was recorded during measurement, see Chapter 6.1, "Simulated GPS with fixed position", on page 157.
- Smartphone performance values and problems with battery and CPU are the part of the MCA analyzer, see Chapter 12.17.5, "Smartphone performances analysis", on page 390.
- VoLTE / VoWiFi IMS SIP problems are reported as problem spots and shown on the map, see Figure 12-46 and Figure 12-47. The benefit is quicker overview of IMS related problems.
- LTE mobile analysis regards the actual bandwidth and additional carriers, see Chapter 12.15.3.1, "Dependency on actual bandwidth", on page 342. The feature provides analysis of the resource allocation on multiple carriers.
- Changed the default ranges of the mobile SINR value of the throughput raster in LTE Throughput Analysis view, see Figure 12-284. In this way it is achieved better accuracy when evaluating LTE SINR.

14.24.2 GUI

- New colouring of bins scheme in TETRA scanner results are added for
  - Delta for Top1 cells to Top2 cells
  - Delta for Top1 cells to Top3 cells
  - Label for bins of both values

  For details, see Chapter 12.3, "Voice call analyzer (TETRA)", on page 238.
- Better presentation of the data throughput results on the map is provided by introducing throughput rasters separately for GSM, UMTS and LTE, see Figure 12-109.
- TopN Raster Element page has additional columns for UMTS (SC) and LTE (PCI), see Figure 6-24. The feature provides the sortable TopN table.
- LTE Layer 1: changed step sizes of the LTE SINR histogram, see Figure 12-117.

14.25 Version 17.1

14.25.1 Analysis modules

The following analysis modules and changes are added in this version:

- TETRA Ptot and RSSI parameter is replaced by Inband Power and TETRA Power, respectively. The changes are inserted accordingly in TETRA analyzer configuration fields of "Mobile Coverage Analysis Processor" > "TETRA Analysis" and "TETRA Data Processor" > "TETRA Call Analysis".
- TETRA speech quality problem spot analysis can indicate in which direction (DL/UL) a problem occurs, see Figure 12-17.
- Value for unidentified call types at TETRA handover is changed from "n/a" to "idle", see Figure 12-208.
- R&S ROMES4 NPA supports aggregation of Youtube measurements made with QualiPoc mobiles, see Chapter 4.9.6, "Support of streaming YouTube tests", on page 130.
- Workflow of scanner coverage problem spots is enhanced. "Cell Problem Statistic" displays the total amount of problem spots and the count per problem spot category. A problem with its geographical information is shown on the map, see Chapter 5.3.2.2, "Enhancements for coverage problem spots", on page 154.
- Co-channel interference analysis for TETRA shows the interfering cells from other providers, see "Co-channel interference" on page 356.
- Scaling for the data rate histograms is adjusted to actual LTE rates, see Table 12-7.
- R&S ROMES4 NB IoT scanner measurements are aggregated. For unique identification of the measurements (RSRP, RSRQ and SINR) the frequency, physical cell id and the BTS id dedicated by the scanner are used, see Chapter 12.27, "NB-IoT measurements aggregation", on page 457.
- R&S ROMES4 NPA supports DL 256QAM analysis, see Figure 12-287.

14.25.2 GUI

- Title bar of the R&S ROMES NPA GUI contains info about software version, see Figure 3-2.
- New layers are added to TETRA analysis maps. The mobile data raster and scanner TopN raster layers are added to some TETRA analysis maps of the TETRA problem analyzer, for example, see Chapter 12.3, "Voice call analyzer (TETRA)", on page 238.
- For TETRA visualization, the context filter is drop-down combo box, see Chapter 4.5.5, "Context filter", on page 98.
- Column showing the bandwidth is added in the "Neighbourhood Overview" window of inter-/intra-RAT neighbour cells for LTE, see Figure 12-198 and Figure 12-199.

- Bar charts of TETRA KPIs are enhanced by adding the "Info" button. Also the legend is added to all TETRA speech quality charts, see Figure 12-10 and Chapter 12.3.1.2, "Speech quality charts", on page 244, respectively.
- Added DL/UL throughput for LTE in the Throughput Raster Content drop-down menu, see Figure 12-116.

14.26 Version 17.0

14.26.1 Analysis modules

The following analysis modules are added in this version:

- R&S ROMES NPA can handle QualiPoc measurement files, see Chapter 3.2.2, "Handling QualiPoc result files for analysis", on page 35.
- R&S ROMES NPA supports aggregation of voice calls over WiFi, see Chapter 12.5.3, "Aggregation of voice calls over WiFi", on page 273.
- R&S ROMES NPA supports uplink allocation analysis (ULAA), see Chapter 12.24, "LTE cell with MIMO and resource usage analysis", on page 429.

14.26.2 GUI

- "TETRA Coverage Analysis Problem Spots" and "TETRA Coverage TopN Raster& Statistics" problem pages have an additional filter named "TopN Rank", see Figure 12-154.

14.27 Version 4.92

14.27.1 Analysis modules

The following analysis modules are added in this version:

- TETRA handover analysis provides the additional statistics on handover types per provider and per device, see Figure 12-210.
- R&S ROMES NPA supports RAN sharing analysis. It aggregates the additional PLMN IDs contained in the MIB and SIB1 messages of UMTS and LTE, respectively and stores them with the power and quality measurements, see Chapter 12.16.2.2, "RAN sharing - aggregation of additional PLMN IDs", on page 347.
- The LTE data processor configuration page has the option to omit the aggregation of the statistics for Layer1, CQI, MIMO, MCS, RBs and RI, for each separately, during a measurement file processing, see Chapter 12.26.1, "Handling the LTE mobile

statistics", on page 449. Activating the option improves the performances of the R&S ROMES NPA.

- The LTE data processor configuration page allows adding the GeoPosition option to the statistical results, see Chapter 12.26.1, "Handling the LTE mobile statistics", on page 449.
- Additional type of LTE problem spot related to different sector directions reported with the BSE analyzer is introduced, see Chapter 12.24.3, "LTE wideband antenna problem", on page 445.

14.27.2 GUI

- TETRA handover result page contains two additional filters as a quick filters, see Figure 12-207.
- PLMN IDs related to RAN sharing are displayed in UMTS and LTE Cell Statistics tables and in the TopN Raster Element, see the figures in Chapter 12.16.2.2, "RAN sharing - aggregation of additional PLMN IDs", on page 347.

14.28 Version 4.91

14.28.1 Analysis modules

The following analysis modules are added in this version:

- The KPIs related to VoLTE SIP events, which are triggered when the timing thresholds of these events are exceeded, are introduced, see Chapter 12.5.1.1, "VoLTE problem spots", on page 268. These KPIs indicate problem spots and are shown in the "Problem Spots" list or table.
- IP Service Setup Time Statistics aggregates the IP Service Setup Time KPIs of FTP DL/UL, HTTP DL/UL and E-mail jobs performed by smartphones. A smartphone can show separately the IP Setup Time ETSI B TCP/I KPIs only, see Chapter 12.10.1.4, "Setup time for smartphone use", on page 308.
- LTE scanner measurements with four R&S TSMEs are aggregated. The scanner measurements for antenna combinations are shown in the TopN Raster Element table and the BSE Problems table, see Figure 12-148 and Figure 12-235.

14.28.2 GUI

- The "Problem Spots" table can be undocked for better visualization, see Figure 12-47.
- The "Voice Call Table" showing ETSI Telephony KPIs does not report the last incomplete call. Therefore, the table shows the same calls as the R&S ROMES "ETSI QoS View" shows, see Figure 12-3.

14.29 Version 4.90

14.29.1 Analysis modules

The following analysis modules are added in this version:

- R&S ROMES NPA aggregates the R&S ROMES signals for GSM UE timing information and displays them on the "GSM UE Timing" result page, see Chapter 12, "Data processors", on page 222
- Measurement files of R&S ROMES 4.90 and higher versions are aggregated to derive VoLTE KPIs, see Chapter 12.5, "Voice over LTE (VoLTE) analyzer", on page 263. Aggregated VoLTE KPIs are:
  - Telephony Setup Time (VoLTE/CSFB)
  - Telephony Service Non-Availability (VoLTE/CSFB)
- Coverage cell analysis generates the coverage cell statistics lists for all 3GPP RATs, see Coverage cell statistics
- Common Program Settings has a new function, the Overview Configuration that allows to change default thresholds for analysis overview, see Chapter 5.2.1, "Result page configuration", on page 137
- The Mobile Coverage Analysis plugin is extended to support the Carrier Aggregation feature, see Chapter 12.17, "Mobile coverage analyzer", on page 383 and Chapter 12.25, "LTE carrier aggregation analysis", on page 446

14.29.2 GUI

- "GSM UE Timing" result page showing the GSM UE Timing KPIs.
- "Analysis Result Overview" page has the "Coverage Cell Statistics Scanner based" button
- "Analysis Result Overview" html page allows customizing the overview KPI pie charts
- "Voice Call Table with VoLTE KPIs (from KPI Generator...)" contains two additional columns. One column shows the telephony setup time for VoLTE and CSFB and the other the service non-accessibility time for them
- "Overview Result" page contains an additional "LTE CA Mobile" button if the CA related measurements are available in the result file. Clicking the button opens some charts concerning CA analysis, see Chapter 12.25, "LTE carrier aggregation analysis", on page 446

Annex

A Appendix

This part of the documentation contains the sections that do not fit into the other chapters or serve as reference documentation for some topics.

The following subsections are explained here:

- Using Help
- License Options

A.1 Using help

The R&S ROMES4 NPA help window can either be opened by clicking "Show Help Content" in the menu bar or by pressing F1. You see a standard main window application showing up, with a menu bar and toolbar. Below,on the left-hand side are navigation windows called Contents, Index and Bookmarks organized by tabs in a sidebar. On the right, taking up most of the space, is the "Documentation" window.

A.1.1 Navigation windows

In the content pane, the general navigation tree is shown. It holds the Table Of Contents, where all chapters can be opened directly. Also an Index can be shown containing some of the most used keywords in the manual. The bookmarks section finally supports setting your personal bookmarks in the help on pages that you want to visit in the future. These bookmarks are saved when the helper viewer is closed again and are restored the next help is displayed again.

A.1.1.1 Index search

To perform an index search, click the Index tab on the side bar (or press `Alt+I`). In the 'Look For' line edit enter a word; e.g., 'Quick Start'. As you type, words are found and highlighted in a list beneath the line edit. If the highlighted text matches what you are looking for, double click it (or press `Enter`) and the Documentation window displays the relevant page. You rarely have to type in the whole word before the on-line help finds a match.

For some words, there can be more than one possible page that is relevant.

A.1.2 Documentation window

The help is organized like a book, and the documentation window shows the currently selected chapter. It can be used in the same way as a web browser is used: Tabs can be opened for new topics, navigation is done following the links in the pages and using the navigation buttons in the toolbar.

A.1.2.1 Full text search

The on-line help provides a full text search engine besides the keyword-based index search described above. To search for certain words or text, click the "Search" tab in the Documentation window. Then enter the word or text you want to look for and press `Enter` or click "Search" . The search is not case-sensitive, so, for example, Foo, fOo and FOO are all treated as the same.

The following are license samples of common search patterns:

- net -- lists all the documents that contain the word 'net'
- net* -- lists all the documents that contain a word beginning with 'net', for example, 'network-provider'
- voice call -- lists all documents that contain both 'voice' and 'call'
- voice call" -- list all documents that contain the phrase 'voice call'

It is also possible to use the Advanced search to get more flexibility. You can specify some words so that the hits containing these words are excluded from the result, or you can search for an exact phrase. Searching for similar words give results like these:

- net -- lists all the documents with titles that are similar, such as network-provider
- netork -- lists all the documents with titles that are similar, such as network

Options can be combined to improve the search results. The list of documents found is ordered according to the number of occurrences of the searched text which they contain. The document containing the highest number of occurrences appears first in the list. Simply click any document in the list to display it in the "Documentation" window.

A.2 License options

A.2.1 Available NPA options

The R&S ROMES4 Network Problem Analyzer framework offers the basic and additional options to be purchased. Depending on the licenses that are unlocked in the WIBU soft-license or WIBU dongle used to run the application, functions are available or not in the application. Refer to the related sections for more information.

The unlocked licenses are displayed in the "Help" > "About Network Problem Analyzer" dialog. The dialog shows a list of options and their availability.

If you require additional options, contact your local Rohde & Schwarz sales contact.

Table A-1: R&S basic and additional functional options

Type	Description	Required for	Identnr.
R&S ROMES4NPA	ROMES NPA Basic Package	Run the GUI application and start analysis processes. This option also includes the basic KPI extractor for Voice Calls and Data Transactions option	1510.9276.02
R&S ROMES4N11	NPA Plug-in Extended NQA	Get the detailed problem analysis results from the Voice Call Analyzer	1510.9299.11
R&S ROMES4N15	NPA Plug-in Coverage Analysis	Use scanner data to calculate coverage statistics and geographically rasterized data with the Coverage module	1510.9299.15
R&S ROMES4N17	NPA Neighborhood/ Handover Analysis	Use scanner and or mobile data to analyze the current neighborhood configuration and detect possible optimization possibilities in the Neighborhood Analyzer module	1510.9299.17
R&S ROMES4N18	NPA Spectrum Analysis	Use data from the RF power scan measurement module to identify issues in a spectrum that is intended to be re-used and be cleaned of other transmitters with the Spectrum Analysis module	1117.6885.74
R&S ROMES4N19	Base Station Evaluation	This option offers an overview of the task performed at a base station side - changing parameter, swapping hardware or switching on new base stations; refer to Chapter 12.23, "Base station evaluation analysis", on page 423	1510.9299.19

Type	Description	Required for	Identnr.
R&S ROMES4N20	NPA Data Analysis	This option offers a whole set of analysis modules, which include the following functionality: ● Get the data transaction problem analysis based on IP tracer measurements. More information can be found in the description of the IP Analysis modules. ● Get the throughput problem analysis results from the HSDPA and HSUPA modules. ● Use data from FTP transaction in E-GPRS networks to find infrastructure and configuration issues with the E-GPRS module. ● Enhanced FTP Download Analysis for LTE networks as described in LTE Mobile section. The options are available as ROMES4N14	1510.9299.20
R&S ROMES4N21	NPA DL Carrier Aggregation Analyzer	Processing the DL CA measurement results	1521.5360.02
R&S ROMES4N22	NPA VoLTE Analysis	Processing the speech calls in LTE	1521.5377.02
R&S ROMES4N23	NPA UL Carrier Aggregation Analysis	Processing the UL CA measurement results	4900.5306.02
R&S ROMES4N30	NPA Delta Analysis	Processing the delta power difference and delta angle to high power for problem spot analysis	1510.9299.30
R&S ROMES4N31	NPA LTE MIMO Analysis	Processing the LTE MIMO measurement files obtained both from the R&S scanners and the mobile devices to detect existing problems in the network and show LTE network performances.	1510.9299.31

Type	Description	Required for	Identnr.
R&S ROMES4N34	NPA NB-IoT Scanner	Processing the NB-IoT measurement files from scanners to provide cov-erage Top N raster and statistics for NB-IoT.	4900.5206.02
R&S ROMES4N35	NB-IoT QC Mobile	Processing the NB-IoT measurement files from mobile devices to detect existing mobile coverage statistics and problems for NB-IoT.	4900.5264.02

A.2.2 License validation

The R&S ROMES4 Network Problem Analyzer supports the same license concept as R&S ROMES4 does. The applications of both R&S ROMES4 and R&S ROMES$ NPA use the WIBU soft- license bound to the PC or the hard-license stored on the WIBU dongle.

A.2.2.1 WIBU codemeter

R&S ROMES4 NPA supports WIBU codemeter for license validation since version 20.0.

A.3 Frequently asked questions

The following sections try to give answers in the case that problems or questions arise when using the map view.

Question: Why are there question marks over the all map?

If no data is displayed in the geographic view, it can be the case that no internet connection is available, or the internet connection is routed through a proxy. In that case, set the special settings in the "Connection Settings" page in the "Preferences" dialog.

Question: Why is no data shown?

Make sure that at least one background layer is selected in the legend, and that at least one layer is visible containing data. Also check the transparency settings of the layers.

Question: There are no cells even if data is shown?

The cell state of the most recent measurement drive test is displayed in the map view. If the cell data has a validity after that date, there is no data shown. Set the Cell State date in the "Cell Layer" settings to a newer date.

Question: Is any measurement data sent via the internet to the map data providers?

The only data that is sent to the image servers are the coordinates of the visible rectangle. The zoom level and the screen size of the displayed map, together with the type of map that is requested are sent to the image server. None of the processed data from the NPA is transmitted, all painting and processing is done locally.

Question: Where is the data stored that is downloaded?

It is stored in your user settings directory (`Documents` in Windows 10). There is a directory called `My ROMES\Maps`, in which the tile images for the different layers are cached.

OpenStreetMap data is placed separately to match the caching logic of the ROMES Map component in the `My ROMES\Maps\OpenStreetMap\mapdata\maps\earth\openstreetmap` directory.

Glossary: Abbreviations and definitions

A

ACD: Automatic Channel Detection

ARFCN: Absolute Radio Frequency Channel Number

ASCII: American Standard Code for Information Interchange

AT: Application Test

B

BER: Bit Error Rate

BLER: Block Error Rate

BSE: Base Station Evaluation

C

CA: Carrier Aggregation

CC: Component Carrier

CDF: Cumulative Distribution Function

CDMA: Code Devision Multiple Access

CI: Cell Identity

CQI: Channel Quality Indicator

CRC: Cyclic Redundancy Check

CSD: Circuit Switch Data

D

DB: Database

DNS: Domain Name Server

DQA: Data Quality Analyzer

DRX: Discontinuous Reception

DTX: Discontinuous Transmission

E

EDGE: Enhanced Data Rates for GSM Evolution

EGPRS: Enhanced General Packet Radio Service

eMTC: enhanced MTC

ETCS: European Train Control System

EVDO: Evolution Data Only (Optimized)

F

FTP: File Transfer Protocol

G

GCC: Group Call Control

GPRS: General Packet Radio Services

GPS: Global Positioning System

GSM: Global System Mobile

GUI: Graphical User Interface

H

HO: Handover

HSDPA: High Speed Downlink Packet Access

HSPA: High Speed Packet Access

HSUPA: High Speed Uplink Packet Access

HTML: Hypertext Markup Language

HTTP: Hypertext Transfer Protocol

I

IP: Internet Protocol

IRAT: Inter-RAT

ITU-T: International Telecommunication Union Standardization

K

KPI: Key Preformance Indicator

L

LAC: Location Area Code

LTE: Long Term Evolution

M

MAC: Medium Access Control

MCC: Mobile Country Code

MCS: Modulated Coding Scheme (GSM)
or
Modulation and Coding Scheme (UMTS, LTE)

MIB: Master Information Block

MIMO: Multiple Input Multiple Output

MNC: Mobile Network Code

MOC: Mobile Originating Call

MOS: Mean Opinion Score

MS: Mobile Station

MTC: Machine Type Communication, also called LTE-M

N

NB-IoT: Narrowband Internet of Things

NID: Network ID (CDMA2000/EVDO)

NPA: Network Problem Analyzer

NQA: Network Quality Analyzer

O

OSM: OpenStreetMap

P

PCC: Primary Component Carrier

PESC: Perceptual Evaluation of Speech Calls

PESQ: Perceptual Evaluation of Speech Quality, standard for measuring the voice quality of communications networks

POLQA: Perceptual Objective Listening Quality Assessment, ITU-T Rec. P.863

POP3: Post Office Protocol version 3

PRB: Primary Reference Block

PSM: Power Saving Mode

Q

QAM: Quadrature Amplitude Modulation

QI: Quality Indicator, an indication of interference in GSM systems

QPSK: Quadrature Phase Shift Keying

R

RAT: Radio Access Technology

RB: Resource Block

REC: Railway Emergency Call; also stands for an error-free series of frames longer than or equal to 5 frames

RF: Radio Frequency

RRC: Radio Resource Control

RSCP: Received Signal Code Power

RSRP: Reference Signal Received Power

RSSI: Received Signal Strength Indicator

S

SCC: Secondary Component Carrier

SDS: Short Data Service

SFBC: Space Frequency Block Coding

SIB: System Information Block

SID: Sector ID (CDMA2000/EVDO)

SINR: Signal to Interference and Noise Ratio

SMTP: Simple Mail Transfer Protocol

SSID: Service Set Identifier

T

TAC: Tracking Area Code

TBS: Transport Block Size

TCP: Transmission Control Protocol

TETRA: Terrestrial Trunked Radio

U

UARFCN: UMTS Absolute Radio Frequency Channel Number

UE: User Equipment

UI: User Interface

UMTS: Universal Mobile Telecommunication System

UTM: Universal Transverse Mercator, global coordinate system

W

WCDMA: Wideband Code Division Multiple Access

WLAN: Wireless Local Area Network

X

XML: Extensible Markup Language

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W