

Comprehensive and uncompromising: drive test system analyzes TETRA networks

The new drive test system allows assessment of the coverage and quality of service of TETRA networks. The system consists of the R&S®TSMW universal radio network analyzer and the R&S®ROMES4 drive test software. It handles all aspects of mobile measurement data acquisition and presentation, including in-depth analysis. This is one of the prerequisites for top operational reliability and availability of these networks for professional applications.

Extremely high availability is a must

TETRA communications networks for government authorities and industry must provide operational reliability and availability at all times. Suitable T&M equipment is therefore very important in the planning and setup phase as well as during subsequent operation, and also is a key element for preventing problems. Drive tests provide information about the actual conditions prevailing in the network and especially on the air interface. There are three categories of tests that overlap to some extent and are best combined as part of a measurement campaign:

- Coverage measurements
- Quality of service measurements
- Troubleshooting measurements

See page 13 for a description of how the R&S®TSMW universal radio network analyzer and the R&S®ROMES4 drive test software help in LTE systems to assess where it will pay off to invest in additional network equipment.



Fig. 1 The R&S®TSMW universal radio network analyzer and the R&S®ROMES4 drive test software are an unbeatable pair for analysis and optimization work on TETRA networks — both during network setup and also for ensuring troublefree operation over the long term.

Ensuring radio coverage

Coverage measurements provide exact, reproducible verification of the TETRA mobile radio coverage in a region or a country. Drive tests are performed to record the transmitted power for all cells along the drive, as well as qualitative properties of the TETRA signals and parameters of the radio channel. These measurements are passive and do not have any influence on the network. They provide valuable data for the following applications:

- Comparison of actual radio coverage with planned radio network and infrastructure specifications
- Frequency coordination with adjacent networks
- Investigation of signal-to-noise ratios and multipath propagation

Coverage measurements are frequently performed during network setup. However, they are also useful in the long term for ongoing network optimization in order to ensure sustainable, high-quality radio coverage in the area.

Rohde&Schwarz has developed compact and extremely powerful T&M equipment for such applications: The R&S®TSMW universal radio network analyzer (Fig. 1) works with the R&S®TSMW-K26 TETRA option and the R&S®ROMES4 drive test software to determine all relevant parameters — with unmatched accuracy and speed. During coverage measurements, the R&S®TSMW uses its two 20 MHz wide frontends to scan one or two TETRA bands, each containing up to 600 adjacent channels, several times per second. Besides the signal power for each cell that is detected, the following additional parameters are determined:

- Frequency, carrier and main carrier
- Mobile country code (MCC), mobile network code (MNC) and location area (LA)
- Channel power and received signal power (including correction of transducer factors and cable losses)
- Signal-to-noise ratio (SNR)
- Timeslot number (TN), TDMA frame number (FN), TDMA multiframe number (MFN)
- Various bit error rates (BER)
- Frequency errors and phase errors
- Delay spread
- Inband spectrum
- Constellation diagram (QPSK)
- Channel impulse response (CIR) for multipath propagation
- Co-channel interference

In addition, the drive test system determines the system information for all cells by demodulating the non-crypted elements of the protocol data units (PDU).

After the drive test, the network coverage can be analyzed during the postprocessing phase using the R&S®ROMES4N15 network performance analyzer software option (coverage plug-in) to obtain coverage statistics. The network coverage analyzer aggregates the data of multiple measurement campaigns and allows convenient analysis of coverage and interference within the network, or from neighboring networks (Fig. 2). For comparison purposes, the TETRA network's planning data plots can be overlaid on the map. The software can automatically generate reports for all the analyses in Excel, HTML or PDF format.

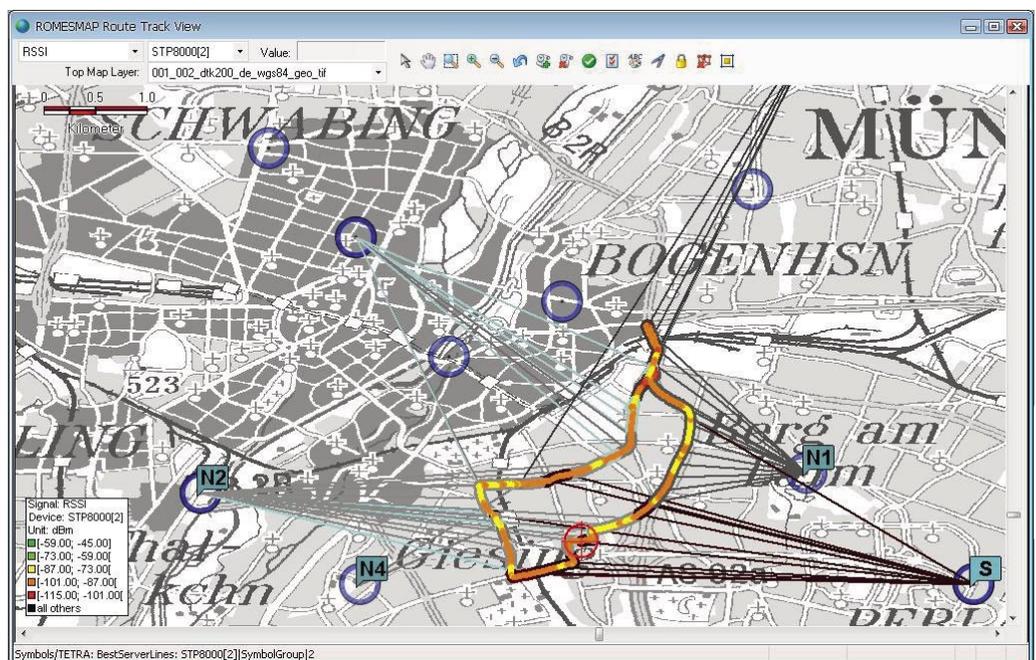


Fig. 2 Map display and TETRA terminal behavior.

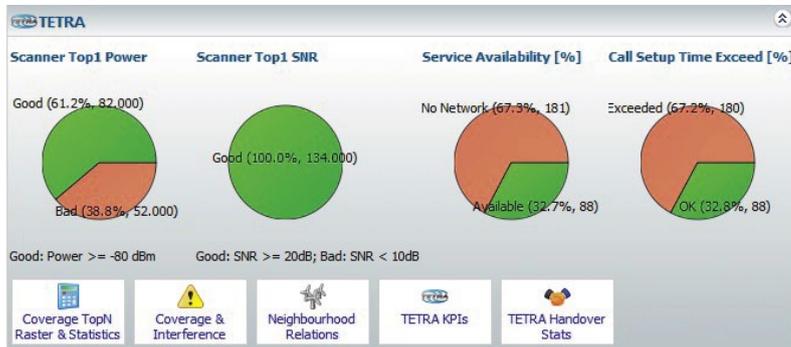


Fig. 3 Analysis of quality of service.

Quality of service measurements for dependable network quality

Quality of service from the user's perspective is measured based on specifications in order to enable reproducible comparisons in area and time. Unlike coverage measurements, quality of service measurements are active, meaning they participate in TETRA network operation to obtain the required data. The European Telecommunications Standards Institute (ETSI) specified most of these measurements. However, there are often other parameters that need to be measured which the infrastructure provider or user must verify on an individual basis.

Quality of service measurements (Fig. 3) assess a number of trigger points during productive operation and use this data to compute certain quality of service parameters. These parameters are then compared with the agreed service level for a given network. These measurements help in the following cases:

- Verification of agreed specifications for the network
- Evaluation of network quality (also from user's perspective)
- Identification of spots where disruptions frequently occur

Since these measurements reflect the actual user perception in TETRA networks, they cover intrinsic network properties and end-to-end quality parameters during network operation for group calls and individual calls as well as the short data service (SDS). During the automatic measurements as part of the drive tests, however, certain quality of service measurements cannot be conducted reasonably (such as emergency and assistance calls, tactical status messages and alarms) since they could have unacceptable consequences in an operational network.

TETRA terminals that are controlled by the R&S®ROMES4 software are used exclusively for quality of service measurements. The terminals assess a large amount of signaling information as well as the voice quality in line with ITU P.862.

As in coverage measurements, the results of the quality of service measurements undergo postprocessing. In this case, the network performance analyzer software (NPA,

R&S®ROMES4N11 option) is used to determine the quality of service (QoS) parameters. Users can customize numerous possible settings that go beyond the selected standard to perform individual evaluation of the service level for all time points and in all regions.

Troubleshooting

Any interference occurring in the network must be detected and corrected as quickly as possible. Problems may have diverse reasons, but the main trouble sources in TETRA are:

- Interference in a TETRA network due to insufficient planning or overreach
- Shadow effects and multipath propagation
- Interference caused by other networks
- Interference caused by external emissions
- Interference caused by faulty network components (e.g. repeaters, terminals, base station amplifier output stages)
- Problems in the core network (not covered here)

Rohde&Schwarz is well positioned to analyze interference in TETRA networks due to the company's extensive experience with GSM technology which has similar signal characteristics. Detecting and analyzing the causes of interference in a fast and pinpoint manner requires the ability to combine the measurement data from the scanner and terminal.

In principle, detection of interference in the field is handled in a similar manner to coverage and quality of service measurements with a vehicle, PC, software, radio network analyzer and terminals. Analysis is performed using the R&S®ROMES4N17 software option (handover and neighborhood analysis) for the network performance analyzer. It shows all the locations designated as "problem spots" based on adjustable criteria. These locations are divided into different categories (Fig. 4):

- Coverage problems
- Interference problems
- Handover problems
- Network problems
- SDS problems

Handover analysis (Fig. 5) and neighborhood analysis are very powerful modules. They provide all relevant information about each individual handover or the neighborhoods along with possible causes of any problems that were identified.

The scanner and terminal signaling information is used to determine all sources of interference. This information is provided with as much detail as possible for each of the problem spots. Most problems can be identified with the information obtained by the drive test system, meaning that final, intensive and specific measurements in the field are often not required.

Special measurements

As an option for coverage measurements, the R&S®TSMW can also estimate the [position of TETRA base stations](#) (Fig. 6). The analyzer saves all the cells it finds in a database. As an addition to the drive tests, the Rohde&Schwarz R&S®DDF0xA and R&S®DDF0xE direction finders can be used to determine the position of base stations and terminals.

In principle, [measurement of TETRA cells assigned to airborne operation](#) is similar to measurements made using a vehicle. However, it is somewhat more difficult to integrate the measuring system into the aircraft and to select and mount the necessary antennas. The flight path and altitude are recorded using GPS.

The [TETRA enhanced data service \(TEDS\)](#) can be tested using a scanner and the R&S®TSMW-K26Q option. Suitable terminals are not yet available for quality of service measurements within R&S®ROMES4. This option extends the scanner's parameters to include TEDS-specific parts such as:

- Modulation type
- Code rate
- Burst, header and pilot modulation error rate
- Data message erasure rate
- SICH, AACH and data error rate
- Expansion of the constellation diagram

LTE is already available as a broadband expansion for TETRA. It will further boost the requirements for quality and operational reliability in these networks. Rohde&Schwarz is already a leader in the field of drive test systems for commercial LTE networks. These strengths can be ideally exploited in [combined TETRA and LTE drive tests](#). The R&S®TSMW measures TETRA on the first RF channel and LTE independently on the second RF channel. Terminals that implement the respective mobile radio standards are used for the quality of service measurements.

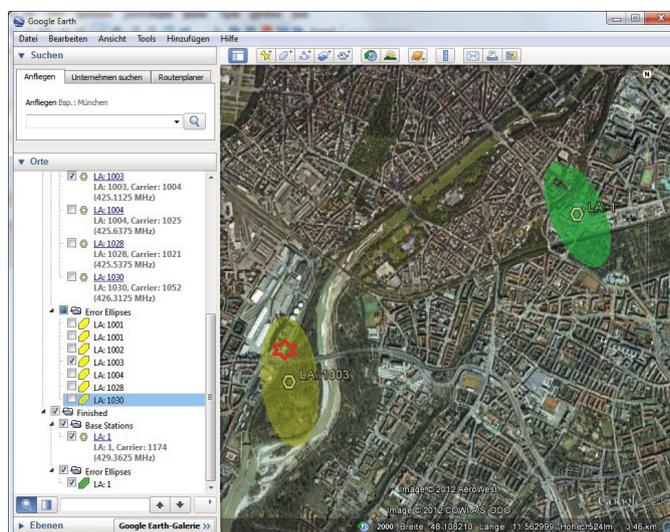


Fig. 6 Estimation of the position of TETRA base stations.

[Direct mode operation \(DMO\) and indoor measurements](#) have been hot topics for TETRA users in recent times. The R&S®TSMW-K26D DMO option will be available for the R&S®TSMW in September 2012. It is supported by R&S®ROMES.

The R&S®TSMW-K27 option enables [spectrum analysis](#) in parallel to the scanner measurements. This is particularly relevant on the TETRA uplink and downlink bands. A waterfall display of the spectrum is especially helpful for visually identifying interference.

Summary

The R&S®TSMW universal radio network analyzer and the R&S®ROMES4 drive test software are an unbeatable pair for analysis and optimization work on public and private TETRA networks — both during network setup and also for ensuring troublefree operation over the long term. In the future, too, Rohde&Schwarz measuring systems will retain their cutting-edge position in drive testing for terrestrial trunked radio, providing a comprehensive, integrated solution for all types of network problems at any time.

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