Guideline for Scanner-based Drive Tests Application Note

Products:

- | R&S[®]TSML
- | R&S[®]TSMU
- | R&S[®]TSMQ

This guideline gives the customers of Rohde & Schwarz an insight into using Drive Test Scanners compared with test mobiles. It shows the main benefits and features of scanners, and emphasizes the advantages of the Rohde & Schwarz Drive Test Scanners TSML, TSMU and TSMQ.



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1 Rohde & Schwarz

Rohde & Schwarz can look back on 75 years of successful driving innovations and the company's core competence is RF Test & Measurement. Over the last two decades Rohde & Schwarz has gained extensive experience in providing solutions for Network Optimisation. The key component hereby is the Network Scanner. Rohde & Schwarz provides a complete Drive Test Scanner family TSMx, consisting of TSML, TSMU, TSMQ and TSMW. The R&S Drive Test Software ROMES was established 20 years ago.

The Drive Test solutions of R&S encompass a full product portfolio for comprehensive GSM/GPRS/EDGE, WCDMA/HSDPA/HSUPA, IS95/CDMA2000/EVDO, DVB-T/DVB-H, WiMAX and LTE testing. Solutions range from scanner / mobile configurations up to full-equipped backpacks, suitcases and drive-test vehicles.



2 At a glance: Why do I need a Scanner?

As measurement devices, Network Scanners are rigorously designed for the challenges in network optimisation and trouble shooting. They include a high-end RF front-end and sophisticated algorithms to quickly and accurately scan the air interface and reliably detect all base stations and their signal components. In contrast to mobile phones, they do not face the limitations of a consumer product in precision, processing power and size.

In trouble shooting scenarios, Network Scanners come into play when a mobile phone for example cannot register to the network, drops the call or faces degradations in its voice or data quality. The Network Scanner can provide network information in situations which are beyond the capabilities of a mobile phone. Network Scanner at a glance:

- Scanners can reach 50x higher measurement speed than test mobiles can deliver
- The measurements are independent from the network and the operator
- Spectrum analysis function and Channel Impulse Response (CIR) provide additional information
- Useful as a reference for mobiles due to the chipset independent front-end
- Higher level and timing accuracy compared to mobile based measurements
- Higher sensitivity and dynamic range than test mobiles
- Use of only one unit for multiple networks and technologies
- No costs and no capacity will be allocated
- Scanner offer different and new applications e.g.:
- Base Station Localization
- Roaming tests
- Neighbourhood Analysis
- Detection of RF problems in base stations like faulty clock, missing synchronization or intermodulation)

3 Always important – scan speed

Test mobiles can usually deliver many important signals but the RF performance and update rate is very limited. For example, a GSM test mobile is able to deliver 2 measurements per second, Assuming that the drive test is done with a car, the velocity can be expected to be 50 km/h (14 m/s). This would result in one measurement every 280 meters and this is not sufficient in most cases, e.g. measurement based frequency planning or hand-over failures.

Network Scanners can provide a significantly higher measurement rate. Rohde & Schwarz's TSMQ for example provides scanning rates of up to 100 channels/sec for GSM and 50 measurements/sec for WCDMA, included BCH (Broadcast Channel System Information) demodulation.

The advantages of having high-speed measurements are:

- Better statistics, clearer picture of overall situation (e.g. Binning with Post Processing Tools)
- Lower chance of missing important problems or situations
- Higher measurement resolution especially during the hand-over (e.g. at tunnels)
- More channels / networks can be measured at the same time
- Measurements not influenced by mobile behaviour (e.g. during handovers etc.)

The Rohde & Schwarz Scanner benefit reaches from highest speed to independent performance to the radio conditions or driving speed to full decoding.

4 Why is the Rohde & Schwarz Scanner that fast?

WCDMA can be used as a reference for a more appropriate explanation. Here the scanner can work in different operation modes. The high speed mode focuses on maximum speed and the high dynamic mode focuses on maximum dynamic with lower scan speed. In the former, one scanner needs just 1 slot for the necessary measurements. Due to the mobile's nature it uses at least 15 slots to synchronize to the P-SCH and S-SCH (Primary and Secondary Synchronization Channel).



Figure 1 WCDMA Frame structure

5 Even more important – high accuracy, sensitivity, dynamic range and detection performance

Compared to test mobiles, Drive Test Scanners can deliver a higher RF level accuracy and sensitivity. A GSM test mobile for instance usually has an accuracy of ± 6 dB in the dynamic range of -110 dBm ... -48 dBm (according to the standard).

As a comparison, Rohde & Schwarz Network Scanners deliver an accuracy of \pm 1 dB. The sensitivity depends on the technology and its measurement mode. For GSM –118 dBm, for WCDMA up to -122 dBm and for CDMA2000/ 1xEVDO -131 dBm can be reached.

- The advantages of having highest accuracy and sensitivity are:
- More accurate measurements representing the real signal
- Detection of more signals / neighbour cells, even on low signal levels
- Comparable measurements, better reference

In contrast to a mobile phones, the Network Scanner can use the PPS clock of the GPS system for synchronization. This timing reference allows the detection of unwanted frequency and timing drifts in a network, which can lead to call-drops during handover for example. A mobile phone lacks this capability as it will always synchronize to frequency and timing of the network.

A very high count of internal rake receivers with 2500 rakes provides the best performance in fading and multi-path scenarios. R&S scanners are therefore ideal for mobile drive tests.

Additionally, the scanner's front-end and its detection algorithms allow the reliable detection of base stations in the presence of other signals, even when a mobile can no longer detect this base station. The Rohde & Schwarz Network Scanners can successfully detect a GSM base station signal with its unique Cell Identity (CI) for a C /I \geq 2.5 dB. A re-detection can be done at a C/I \geq -11dB. This allows the scanner to distinguish the signals exactly from the different base stations which add up in one GSM channel and to detect the corresponding interferences. Compared to the above C/I values of the scanner, a mobile phone can typically just detect a base station signal for a C/I \geq 9dB successfully. BTS signals causing co-channel interferences can therefore hardly be detected with a trace mobile, regardless if this mobile is in network or in scanner mode.

6 The benefit in being network independent

Test Mobiles are only able to measure channels which are announced by the network via the BTS neighbourhood list. The channels are defined in the System Information or they are transmitted during a dedicated session. For instance neighbour cells are provided by the network and the test mobile will not detect any other cells which may be present.

In comparison Network Scanners can see everything which is on the air-interface. They can deliver all TopN signals independent of the network, allowing new cells or signals to be discovered. This happens primarily during a network roll-out, when new base stations are established but have not been correctly added to the network signalling. Having a dedicated tool to find new, not registered cells speeds up the network roll-out.

The advantages of being independent to the network are:

- There are no influences by the network infrastructure or mobiles
- Independent of the network's measurement report
- Enables checking of hidden/missing neighbour cells
- Interferences / Pilot Pollution can be detected

Furthermore, the Rohde & Schwarz Network Scanners are being independent with the R&S developed front-end. Due to its broadband scanners they are independent of the frequency band and cover multiple technologies. Subsequently unknown cells in the target network, unknown cells in other technologies and even unknown cells in other bands can be found. Particularly external interferences can have their origins in other sources such as broadcast transmitters where harmonics still have enough power to interfere. In addition the R&S scanner provides scanning of all 512 WCDMA scrambling codes and requires no scrambling code list. All codes are detected and decoded automatically (BCH decoding included on each).

7 The benefit in being chipset independent

The architecture of the Rohde & Schwarz Network Scanners is completely different to that of a mobile phone. It is based on a broad-band RF front-end and a baseband processing system independent from any mobile phone chipset. Using different test mobile brands with different chipsets in one drive test solution would show that not all different chipsets provide equal results. The scanner can be used as reference to the mobiles and to the network. All measurements with a scanner will remain unchanged, even if the test mobile is changing. This is very important, especially when considering the short life cycles of mobile phones.

Additionally the most test mobiles are working on a limited number of bands. This results in country specific models due to the high variety of worldwide frequency bands. The R&S Network Scanners can be applied all over the world. If new bands are released for new technologies e.g. UMT900 the R&S scanners can be already used for this without any updates or changes.

Beneficial is furthermore the proper separation of different signals on same channel. In GSM for instance the R&S Scanners are able to detect different signal sources (base stations) on the same resource (channel). So easily co-interferences can be detected.

8 Scanners are passive

A Drive Test Scanner operates completely passively, i.e. non-intrusive and has no interactions with the network. It does not allocate any resources which can be used by customer traffic. No SIM cards are required. Performing a benchmark of several different networks or operators can be done without any costs.

The advantages of being passive are:

- There is no organizational effort for SIM cards, internal cost for administration, etc.
- Scanner measurements do not influence the network
- Scanner measurements are not recognized by the network
- Competitor and foreign networks can be scanned easily
- At borderlines all networks can be monitored without roaming SIM cards

With TSMQ Rohde & Schwarz provides a multi-technology Network Scanner, which can be used for several networks or operators at the same time without any SIM cards.

9 Spectrum Scan of the entire frequency spectrum

All R&S scanners are able to perform a spectrum scan in a user defined frequency. Multiple frequency ranges (sweeps) can be defined and distributed over the whole area between 80 MHz and 3 GHz (80 MHz to 6 GHz for TSML-CW).

All test mobiles and most Network Scanners are optimized to one or a few certain bands and so-called external interferences can never be detected with this limitation.



The advantages of a built-in RF Spectrum Scan are:

- Detection of in-band and external interferences
- Interference hunting
- Uplink frequency scanning
- No separate device required
- General radio conditions can be checked easily
- Extremely fast
- Low additional costs

The Rohde & Schwarz Network Scanners are able to perform cellular measurements in parallel to the Spectrum Scan function.

10 Scanners offer totally different and new applications

Due to all the above-mentioned features and functions of a Network Scanner, new applications are now possible:

- Automatic missing neighbours detection
- In-band interferences / out-of-band interferences
- GSM interferer detection and identification
- Propagation model calibration and tuning
- For regulators: easier check and comparison of all networks
- Easy check of competitor and foreign networks
- BTS geographical position estimation



11 Form factor and parallel operation matters

The Rohde & Schwarz Network Scanner family TSMx has a remarkable size to function ratio. So many functions and features have never been in such a small case with only 8 Watt power consumption. This aspect and the light weight means that it is most advantageous for mobile measurements, especially for indoor tests. All the equipment fits easily into a backpack which allows it to be carried around easily. For TSMU and TSMQ, the hardware is software-defined and can overtake a new technology by just updating the software. With this the R&S Scanners are future-proofed and offer a longer life cycle than any test mobile or other scanner.

12 Ordering Information

| TSML-G | Scanner for GSM | 1153.6000.13 |
|-----------|------------------------------|--------------|
| TSML-W | Scanner for WCDMA | 1153.6000.11 |
| TSML-C | Scanner for CDMA2000 1x EVDO | 1153.6000.12 |
| TSML-CW | CW Power Measurement | 1153.6000.15 |
| TSMU | Universal scanner | 1153.6000.02 |
| TSMQ | Parallel universal scanner | 1153.6000.50 |
| | | |
| ROMES | Drive Test Software | 1117.6885.04 |
| ROMES4T1Q | Scanner Driver | 1117.6885.40 |

About Rohde & Schwarz

Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

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Certified Quality System ISO 9001 DQS REG. NO 1954 QM

Certified Environmental System ISO 14001 DQS REG. NO 1954 UM

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