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A wealth of T&M solutions for network specialists

Every new mobile radio technology calls for specialized high-performance T&M solutions. Rohde & Schwarz keeps its eye on these dynamic advancements right from the start and offers a comprehensive portfolio of T&M solutions for manufacturers and network operators.

Solutions for any task

At the end of 2005, more than two billion mobile radio subscribers worldwide had at least one mobile phone. They use their phones not only for calls and SMS but, increasingly, also for broadband data services such as multimedia messaging service (MMS) or Internet via terminal. Mobile phone owners in Asia, America and Europe still differ widely in their day-to-day use of wireless data services. In Japan or Korea, for example, friends enjoy linking together for Internet gaming. Today, it no longer matters where a user lives – the main thing is that the mobile radio network works.

As a result, up to 30% of network capacity at many operators is already being taken up by Internet or MMS and SMS use. In Europe, for example, network

operators handle up to a billion SMSs per month.

This is an enormous challenge for network specialists at mobile radio providers. They must ensure that customers are satisfied with the quality of voice and data transmission at all times. The hardware and software solutions in the base stations and backbone must operate flawlessly 24 hours a day.

To meet these demanding challenges, network operators turn to the experts from Rohde & Schwarz. Our company has been providing comprehensive T&M solutions in this market since digital mobile radio was introduced in Europe more than 15 years ago. Network operators rely on Rohde & Schwarz measuring instruments at all phases, first to calibrate tools during network planning and later to perform measurements on net-

work base stations. When they need to optimize their base stations, they call on the experts from Rohde & Schwarz to provide them with T&M equipment and customized applications.

Rohde & Schwarz furnishes network operators and network equipment suppliers worldwide with T&M solutions for the GSM / GPRS / EDGE, WCDMA 3GPP and CDMA2000® standards. We also offer a complete T&M portfolio for setting up and operating mobile radio networks using WCDMA HSDPA. Network specialists can depend on us for T&M solutions in all areas (FIG 1):

- ◆ System testing at test laboratories
- ◆ Terminal testing at test laboratories
- ◆ Installation, operation and servicing of base stations
- ◆ Radio network planning and optimization

System-testing solutions for test laboratories

Network operator laboratories must have at hand all system components they need for performing tests on new modules and software versions without affecting the existing network. The rapid evolution of standards calls for flexible measuring instruments. A good example is the compact Universal Radio Communication Tester R&S®CMU 300, which has been specially designed for system, regression and approval testing on base stations (FIG 2). This tester includes an analyzer and a generator which it uses to perform transmitter and receiver measurements for the GSM, GPRS, EDGE and UMTS standards.

Its new realtime analyzer functions make it ideal for monitoring the new high-speed control and broadcast channels in the HSDPA standard (introduced

in 3GPP release 5), as well as for monitoring the data throughput of a cell, specific to individual subscribers.

When combined with an RNC (radio network controller) simulator such as offered by Nethawk, the R&S®CMU 300 is ideal for high-level field service.

You can also use power meters and combined spectrum/signal analyzers to perform tests on transmitter units. Rohde & Schwarz offers solutions ranging from power sensors and the Handheld Spectrum Analyzer R&S®FSH 3 (FIG 5) to the portable (with optional battery pack) R&S®FSP spectrum/signal analyzer (FIG 5), whose excellent price/performance ratio makes it the industry benchmark in the mid-range class. Standard measurement routines such as channel-power measurement at the press of a button paired with the capability to demodulate both UMTS and

FIG 1 Rohde & Schwarz offers a comprehensive T&M portfolio for network operators and suppliers.

Area	Radiocommunications testers	Signal analyzers	Signal generators	Drive test systems
System testing at test laboratories	Base station tests: R&S®CMU 300	R&S®NRT / NRP R&S®FSH R&S®FSL / R&S®FSP R&S®FSQ R&S®TSMU	R&S®SMU 200A / R&S®SMJ 100A R&S®SML R&S®SMR	Monitoring: R&S®ROMES with R&S®TSMU
Terminal testing at test laboratories	Mobile phone / protocol tests: R&S®CMU 200 R&S®CRTU Power supply: R&S®NGMO	R&S®FSP	R&S®SMU 200A / SMJ 100A	Monitoring: R&S®ROMES with R&S®TSMU and test mobile phone
Installation, operation and servicing of base stations	Base station tests: R&S®CMU 300	R&S®NRT / R&S®NRP R&S®FSH R&S®FSL / R&S®FSP		Function tests: R&S®ROMES with R&S®TSMU and test mobile phone
Radio network planning and optimization	Mobile phone tests: R&S®CMU 200	R&S®ESPI R&S®TSMU R&S®FSP R&S®FSH	R&S®SMU 200A / R&S®SMJ 100A Power amplifiers	R&S®ROMES with R&S®TSMU and various test mobile phones as well as applications (speech quality, QoS, and many more)



FIG 2 The R&S®CMU200 (top) tests all mobile radio phones while the R&S®CMU300 (bottom) specializes in base stations.



FIG 3 The R&S®CRTU-W/-M platform for protocol tests.



FIG 4 The Vector Signal Generator R&S®SMU200A (top) and the high-end R&S®FSQ signal analyzer set up for measurements on a power amplifier.

▶ GSM signals make the two analyzers ideal for numerous measurement tasks involving the base station transmitter.

The future-proof high-end R&S®FSQ signal analyzer (FIG 5) with a demodulation bandwidth of up to 120 MHz for all conventional modulation modes (e.g. for the WiMAX standard) is ideal for high-end applications that push the limits of dynamic range and noise characteristics.

Vector signal generators of type R&S®SMU200A or R&S®SMJ100A are used for testing receive modules (FIGS 4 and 6). They can generate any type of standard-compliant digitally modulated signals, and you can superimpose fading, noise and other baseband errors on the signals as needed. You can easily create reference measurement channels (RMC) in accordance with specifications as well as modulated interferers using the integrated baseband generator and the intuitive operating concept.

If you need to generate unmodulated signals, e.g. for RF fading simulators or also as interferers, you can use the Signal Generator R&S®SML, which offers an outstanding price/performance ratio. The high-end R&S®FSQ signal analyzer and the Vector Signal Generator R&S®SMU200A paired with the user-friendly application software for the R&S®FSMU-W enable you to perform tests in accordance with the TS25.141 specification.

Terminal-testing solutions for test laboratories

Rohde & Schwarz offers RF and protocol T&M solutions for tests necessary during servicing, as well as for regression, compatibility and interoperability tests. The R&S®CMU200 test platform (FIG 2) and the R&S®CRTU protocol tester (FIG 3) cover all major standards ranging from GSM, GPRS and CDMA2000® to UMTS,

HSDPA and even HSUPA. These test solutions can generate message logs as well as perform RF, handover, acoustic, and data application tests.

The Vector Signal Generators R&S®SMU200A and R&S®SMJ100A are especially useful in cell selection tests. They can generate additional passive signals for the DUT that, however, are digitally modulated in realtime and possess variable noise components.

If you need to perform precise power consumption measurements under a wide variety of conditions at high resolution and speed, the solution is the Dual-Channel Analyzer / Power Supply R&S®NGM02 (FIG 7). It is ideal for tasks such as determining operating time and performing battery tests on mobile phones. You can also use it to optimize application software such as Java applets, since every access of the SIM card increases the current, thus reducing operating time.



T&M solutions for base station installation, operation and servicing

The most vulnerable part of a base station is the antenna system on the mast, including its dipole, RF cable and amplifier. The system must withstand humidity, wide temperature fluctuations and electrostatic discharges, which clearly explains why approx. 75 % of all measurements in the field focus on determining the transmit and receive characteristics of antenna systems.

Since the introduction of cross-polarized antennas, the matching measurements commonly used to obtain information about an antenna system's operating state have become less significant. Today, decoupling and cable fault measurements are also required. The Handheld Spectrum Analyzer R&S®FSH (FIG 8) has been specially designed for this purpose. No matter whether an antenna system is equipped with or without a mast amplifier, the R&S®FSH can very

accurately measure and document the return loss, cable faults and decoupling. In addition, the analyzer can measure the spectrum, which provides valuable information about any interferers in the uplink or downlink.

The compact R&S®FSH with its new code domain power measurement function and its favorable price/performance ratio can handle almost any measurement task in field service. In addition, new instruments purchased as of late 2005 can also be equipped with the new R&S®FSH-K4 option, which analyzes the power and modulation quality of the major downlink channels (CPICH, P-CCPCH and SCH).

The newest R&S®FSL spectrum analyzer – which can also be battery-operated and features RF characteristics unique in its class – is making a name for itself in field service. It is used to locate noise sources (e.g. defective mast amplifiers) and any type of interference signal.

In contrast, measurement tasks on base station transmitters that involve the complete analysis of all code channels have become significantly less common in practice and call for an analyzer with additional decoding capabilities. The perfect tool for these tasks is the mid-range R&S®FSP spectrum/signal analyzer, which can measure modulation quality and code domain power in battery operation.

Users who provide high-level service are also increasingly turning to the Universal Radio Communication Tester R&S®CMU300, combined with an external RNC simulator or Node B configurator such as Nethawk.

Hands-on experience has revealed that the various measuring instruments are used quite differently in the field:

FIG 5 The full range of analyzers from Rohde & Schwarz covers virtually every requirement for performance level, frequency range and functionality. Left to right: R&S®FSQ (top), R&S®FSU, R&S®FSP, R&S®FSH3.



FIG 6 The multipurpose Vector Signal Generator R&S®SMJ100A is redefining the medium range.



FIG 7 The intelligent Dual-Channel Analyzer / Power Supply R&S®NGM02 offers a variety of functions, making it a must for network specialists.



FIG 8 The R&S®FSH3, the do-it-all solution for measurements required during installation and on-site maintenance, used for measuring a mobile radio antenna.

- ▶ ◆ 85 % Handheld Spectrum Analyzer R&S®FSH, especially for antenna and TX tests
- ◆ 10 % battery-powered mid-range R&S®FSL / R&S®FSP spectrum/signal analyzers
- ◆ 5 % Universal Radio Communication Tester R&S®CMU 300

Using different units for different tasks makes T&M budget planning easy and efficient.

Mobile radio from A to Z – a long tradition at Rohde & Schwarz

Rohde & Schwarz entered the field of digital communications T&M in 1990 when it introduced the first base station tester for mobile radio. It has been a leading player ever since. Customers in the US, Asia and Europe turn to Rohde & Schwarz for T&M solutions covering established cellular technologies such as GSM / GPRS / EDGE, WCDMA FDD (UMTS), HSDPA and CDMA2000®. In addition to coverage measurement solutions for WCDMA HSDPA – scheduled for launch in summer 2006 – Rohde & Schwarz already offers a comprehensive T&M portfolio for signal generation, signal analysis, radiocommunications tests and protocol tests. The T&M solutions for 1xEV-DO are being expanded so that they will also be available for Release A in fall 2006.

Users working on broadband wireless solutions such as WiMAX (IEEE 802.16-2004, IEEE 802.16b) and WiBro also rely on T&M equipment and applications from Rohde & Schwarz. Moreover, Rohde & Schwarz provides measuring equipment to the terminal and base station design engineers as well as network operators who will turn DVB-H into a market force as a mobile broadcast technology together with its corresponding applications.

T&M solutions for radio network planning and optimization

The rapidly growing number of subscribers calls for ever denser radio networks. To optimize radio network planning and simulation, calculations are more and more often based on real measurement data. Radio network planners know that planning tools can only be as good as the quality of the data available for complex calculations.

Continuous wave (CW) measurements are used to calibrate planning tools. During these measurements, the Vector Signal Generator R&S®SMJ 100 A, R&S®SMU 200 A or Signal Generator R&S®SML generates partly unmodulated signals that are applied to the antenna systems via a measurement amplifier. Highly precise and fast test receivers such as the Radio Network Analyzer R&S®TSMU (FIG 9) or the precompliance Test Receiver R&S®ESPI – together with Coverage Measurement Software R&S®ROMES – measure these signals and provide realistic information about the path loss in the relevant frequency range.

Since the R&S®TSMU is continuously being enhanced, it can decode and measure downlink control channels at unrivaled speed without having to register on the network. This function is the main precondition for fast neighborhood analysis when optimizing handover procedures. This measurement data enables you to proactively analyze interference in critical areas even in the planning phase.

The R&S®TSMU, which is configured as a GSM scanner, supplies a variety of parameters together with Coverage Measurement Software R&S®ROMES and a GPS receiver: position data, channel number (GSM), level, cell identity, network and country code – all 10 to 20 times faster than with conventional test mobile phones.

In addition, you can use the R&S®TSMU to analyze co-channel or adjacent-channel interferers in realtime during the drive test by implementing the latest version of Coverage Measurement Software R&S®ROMES, a GSM test mobile phone and a list of base stations.

Radio networks are optimized by using analyzers that determine network quality from the customer's point of view when combined with test mobile phones. The Radio Network Analyzer R&S®TSMU has become the benchmark for many network operators. In addition to the 2G and 3G standards implemented earlier, the R&S®TSMU now also offers CDMA2000®.

Why do you need the R&S®TSMU in addition to the test mobile phone? To yield meaningful results, measurements must be performed at high speeds. The R&S®TSMU performs measurements approx. 30 times faster than a test mobile phone. Furthermore, high sensitivity and dynamic range are critical to



detecting and analyzing possible weak points such as:

- ◆ Interferences (frequency reuse analysis)
- ◆ Interferers
- ◆ Incorrectly adjusted antennas (alignment, tilt)
- ◆ Reversed sectors
- ◆ Problems in parameterization, e.g. during handover
- ◆ HSDPA, ACK/NACK and CQI analysis in relation to the received quality of the radio channel

Coverage Measurement Software R&S®ROMES enables you to perform measurements in several different cellular networks during a drive test, e.g. in HSDPA, 1xEV-Do and GSM networks. Moreover, you can perform them simultaneously if you preconfigure the software for the specific standard needed. R&S®ROMES is the core component in a variety of solutions ranging from a portable system in a backpack for indoor applications and a test-kit system up to the configurable system installed in the test vehicle. Depending on the hard-

FIG 9 The Radio Network Analyzer R&S®TSMU running Coverage Measurement Software R&S®ROMES during network performance analysis.



ware used, the software supports various radio standards such as WLAN, GSM, EDGE, GPRS, UMTS, HSDPA, and CDMA2000®, as well as analog and digital broadcasting standards such as DAB and DVB.

Detecting and analyzing weak points in the network, as well as points to be optimized, is the main focus of the coverage measurement solutions from Rohde & Schwarz. If you need to analyze and process the results further, you can directly upload them to analysis or processing platforms from various manufacturers. By using the export capability, you can output the results as an ASCII file and also import them into customer-specific evaluation solutions and planning tools.

To fully meet customer-specific requirements, Rohde & Schwarz is continuously enhancing Coverage Measurement Software R&S®ROMES by working closely with leading network operators. In GSM, one of the main focal points is interference analysis of broadcast and data channels. Network operators have already been using this measurement solution for several years to improve network quality despite limited frequency resources.

In UMTS, the primary challenges are encountered in neighborhood and handover analysis. Rohde & Schwarz has optimized this analysis by adding the new BCH demodulator measurement function to the R&S®TSMU. Coverage Measurement Software R&S®ROMES automatically compares the base station list with the data of the test mobile phone. The high-performance R&S®TSMU enormously speeds up the measurement due to its several thousand software rake fingers.

R&S®ROMES includes a data quality analyzer (DQA) module for evaluating and analyzing data applications.

The module supports up to five mobile phones in parallel and records their data. It automatically generates statistics of measured services, which are based on set parameters and specifications.

Test mobile phones must be tested and verified at regular intervals. This is an easy job for the Universal Radio Communication Tester R&S®CMU 200, whose high ACLR measurement accuracy enables it to meet the demanding power-control measurement requirements.

Coverage measurement systems from Rohde & Schwarz are especially valued for their ability to detect and analyze irregularities in the network, tasks that cannot be handled by the fixed network monitoring systems in the operation & maintenance center (OMC) or the radio network controller (RNC).

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More information, data sheets and application notes at www.rohde-schwarz.com

Selected application notes

- 1CM60 Optimization of HSDPA networks with the R&S®CMU 300 and R&S®ROMES
- 1CM56 3GPP base station test measurements
- 1EF44 Measurement on 3GPP Base Station Transmitter Signals
- 1EF52 Testing Mobile Radio Antenna Systems with the R&S®FSH 3
- 1MA40 Testing Power Amplifiers for 3G Base Stations
- 1MA48 Generating and Analyzing 3GPP Multicarrier Signals with High Dynamic Range
- 1MA62 Remote Setup for 3G High Dynamic Multicarrier Signals with R&S®SMIQ03 HD and R&S®FSU/FSQ
- 1MA67 Tests on 3GPP WCDMA FDD Node Bs in accordance with Standard TS 25.141
- 1MA82 HSDPA Test and Measurement Requirements
- 1MA84 HSDPA – Challenges for UE Power Amplifier Design