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R&S®CMU200 Universal Radio Communication Tester

Testing Applications in Mobile Radio Communications

ROHDE&SCHWARZ

R&S®CMU200 goes Internet: testing data applications

The highly successful R&S®CMU200 universal radio communication tester, which was originally designed as a pure RF tester for the various mobile radio standards used around the world, now enables additional user groups to test voice and video telephony as well as applications based on the Internet protocol (IP), such as web browser or file transfer.

Because of the increased transmission rates and enormous computing power of modern mobile phones, developers and manufacturers are faced with new test requirements due to the wealth of new applications.

By means of a wide range of tests, the R&S®CMU200 supports applications based on circuit-switched connections, such as short message service (SMS), traditional voice transmission, or modern video telephony. The same applies to IP-data-based applications on the basis of packet-switched connections.

Appealing compact solution

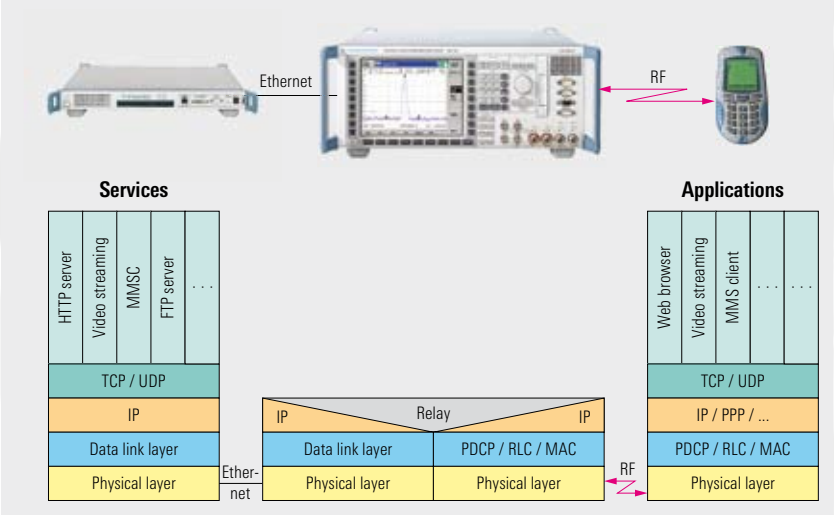
Both developing and providing data applications for mobile radio present a multitude of new challenges. Most applications in data communications are based on the Internet protocol (IP), which in turn is based on the client-server principle. This means that a client uses a mobile phone to request services that are provided by a server in the communications network. The software for these applications is usually developed on PCs; after its implementation and extensive computer simulations, the software is ported to the mobile phone. To perform further tests on the mobile phone itself, a public mobile radio network or the simulation of such a network is required.

Up to now, radio networks could usually be simulated only with the aid of complex setups. This is remedied by the R&S®CMU200, which is a very interesting alternative for such tasks. Due to the extensive possible settings it offers, tests can also be performed on frequency bands, for example, that are not necessarily part of an available public radio network.

Before communications services can be launched on the market, network operators must subject them to interoperability tests to ensure that they operate smoothly. With the multimedia message service (MMS), for example, the correct exchange of messages with the server implementation in the network or between mobile phones from different manufacturers is checked. Moreover, making objective comparisons under user-definable and randomly reproducible operating and test conditions is another pivotal function this target group needs.

Test setup

Application test setups basically consist of a mobile phone, the R&S®CMU200, and a PC. The mobile radio tester, which is connected to the mobile phone via the radio interface, simulates the mobile radio network. Via an Ethernet connection, it accesses the IP-based computer world, which can be either a local area network (LAN), the Internet or, at its simplest, a controller, where the servers providing the communications services can be accessed. The user usually accesses these services from the mobile phone via mobile originated calls. The R&S®CMU200 bridges the gap between wired data communications and radiocommunications across various protocol layers.

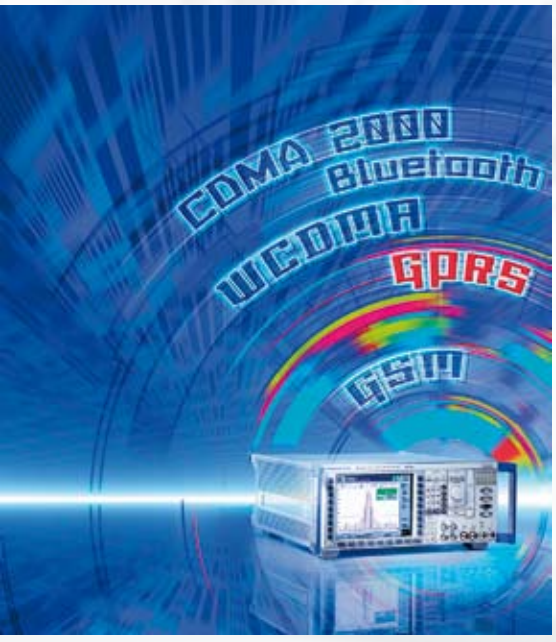


Versatile test scenarios

Go / NoGo tests start an application on the mobile phone and test the operation from the user's viewpoint. These tests differ from RF measurements performed with the R&S®CMU200 by covering the entire operating system of a phone and subjecting it to the appropriate stress. After an application passes this basic test, performance measurements are usually carried out; their aim is to analyze the achievable data transmission rates in the downlink and the uplink.

Network operators often require proof that minimum data rates are achieved under specific conditions. The R&S®CMU200 allows such confirmation.

Another noteworthy criterion that helps determine the practical value of mobile phones is their operating time with rechargeable batteries. To minimize a phone's power consumption, you need to measure the consumption while an application is active so that you can find out more about possible optimization procedures. If required, the mobile radio tester simultaneously records detailed information about the processed protocol layers in a log file, which is then available for future evaluation and analysis.



Interaction tests analyze how different, simultaneously active applications on a mobile phone affect each other. These tests analyze, for example, what will happen if an SMS arrives while a video is being downloaded and the calendar function is outputting an alarm.

Interoperability tests check whether mobile phones function smoothly within a network, for example when interacting with the network operator's MMS server, or when two phones from different manufacturers interact with each other. In the simplest case, just one phone is used in the echo mode to perform a combined transmission/reception test.

For this test, an MMS is generated on the mobile phone and then sent back to the same phone if the originating phone number is entered at transmittal. Before a new mobile phone reaches the market, it must undergo a number of tests to ensure that is customer-ready. In the EMC test, for example, the telephone must operate reliably in the lab during simultaneous transmission and reception of data and remain largely unaffected by strong electromagnetic fields.

When the R&S®CMU200 is combined with the R&S®ABFS fading simulator, the operation of a mobile telephone under various fading scenarios such as in an automobile at various speeds and reception conditions can be simulated. Thus, the reliability of data exchange can be tested and evaluated.

In contrast to a practical test in a public mobile radio network, the R&S®CMU200 makes it possible to individually define all radio parameters as, for example, field strength or channel coding, and to repeat them as often as desired at any time. The performance of different mobile phones or implementations can thus be objectively evaluated and compared in benchmark tests.

TCP/IP services

The clients on the mobile phone require suitable servers at the controller end as a counterpart for application tests. The R&S®CMU200 application testing options allow IP-based data applications to be tested on a mobile phone; in addition, they include several TCP/IP servers, for example an HTTP server, which allows you to start a web browser on a mobile phone.

Rohde&Schwarz offers additional products for developing and certifying a number of mobile-phone-specific applications such as MMS or push-to-talk over cellular (PoC). The MMS center (MMSC), a standard-conforming server, allows the base functions, i.e. transmitting and receiving multimedia messages on mobile phones, to be tested. The R&S®CA-AA02 and/or R&S®CA-AC02 options from Rohde&Schwarz verify if a PoC-capable mobile phone performs in accordance with the standard.

Future prospects

Application tests are becoming more and more important in mobile radio. Rohde&Schwarz is meeting this trend by continuously developing new solutions in this field. The licensing authorities have responded to changes in the way mobile communications are used: By developing test scenarios with exact specifications, they define appropriate tests at the application level that will ensure that mobile radio networks will also operate smoothly in the future.

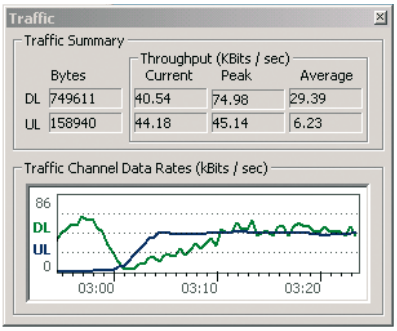
Versatile application tests in (E)GPRS mobile radio

The R&S®CMU-K92 software option allows you to test applications for 2.5G mobile phones. For example, you can now test the transmission or reception of multimedia message services (MMS), Internet browsing, or video streaming within a simulated (E)GPRS network environment. In addition to measuring the known RF parameters of power, spectrum or modulation, you can now also perform such tasks as displaying data throughput or analyzing protocols.

(E)GPRS application tests with the R&S®CMU200

Owing to significant protocol stack extensions, the R&S®CMU200 also allows you to test applications via GPRS and EGPRS(EDGE) mobile phones simply by activating a new software option. The R&S®CMU-K92 software option makes it possible to test almost any IP-based applications in packet-oriented mode via an IP gateway.
You can simply test proper functioning, but also check whether different applications that are simultaneously activated on a mobile phone run smoothly.

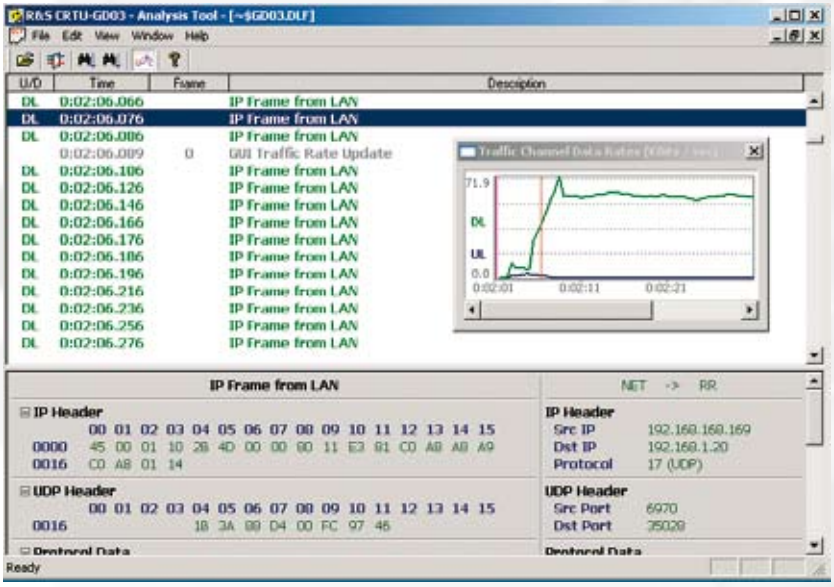
GPRS and EGPRS, the offshoots of the GSM standard, achieve data transmission rates of up to 171.2 kbit/s and 473.6 kbit/s respectively, thus allowing a multitude of applications to be carried out, some of them even with realtime requirements. In addition to displaying the current data throughput of the IP packets exchanged between mobile phone and server, the R&S®CMU200 also records various transmission protocols. Design engineers are thus able to thoroughly analyze not only the IP protocol, but also a number of other radio-specific protocols such as radio link control (RLC) or medium access control (MAC). Regardless of these activities, it is still possible to measure and analyze the RF signals transmitted by GPRS or EGPRS mobile phones on the R&S®CMU200 with respect to power, spectrum, or modulation. Unlike the previous transmitter test, the measurement is now performed as part of the application data transmission and no longer on the basis of pseudo-random binary sequences (PRBS). If two R&S®CMU200 testers are available, the application tests can be expanded to accommodate data end-to-end tests, for example for checking the exchange of an MMS message between two mobile phones. If only one R&S®CMU200 is available, the transmission and slightly delayed reception of an MMS message with one mobile phone can also be implemented using the loopback setting in the MMSC.



Throughput of IP data exchanged between mobile phone and radio network in uplink (UL) and downlink (DL).

Automation

To reduce staff costs, repetitive test routines such as benchmark tests can be automated. By using a control program, all settings required for automation can be automatically made via standardized interfaces. Measurement results, e.g. data throughput, are recorded.



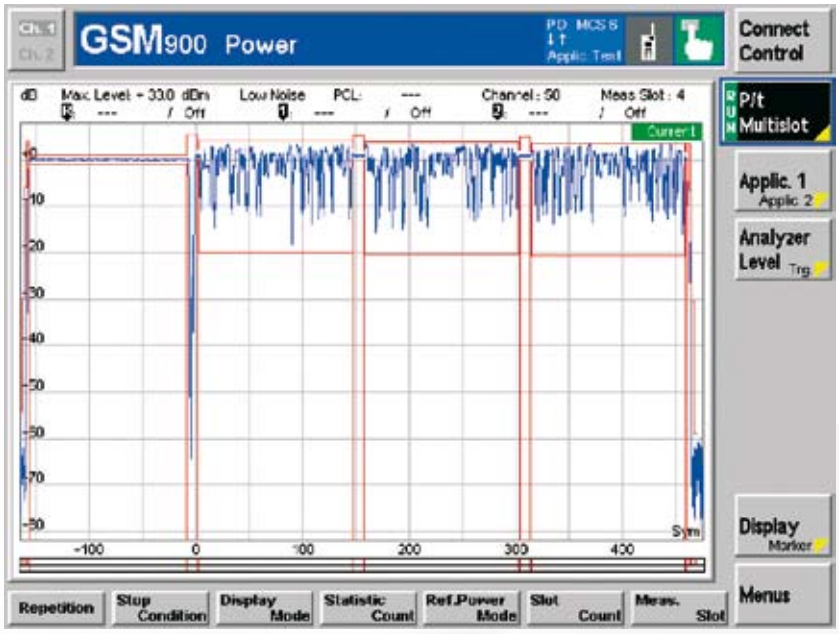
Recording of all exchanged IP data packets with time stamp and display of the data transmission rate achieved.

Powerful aid in the development lab

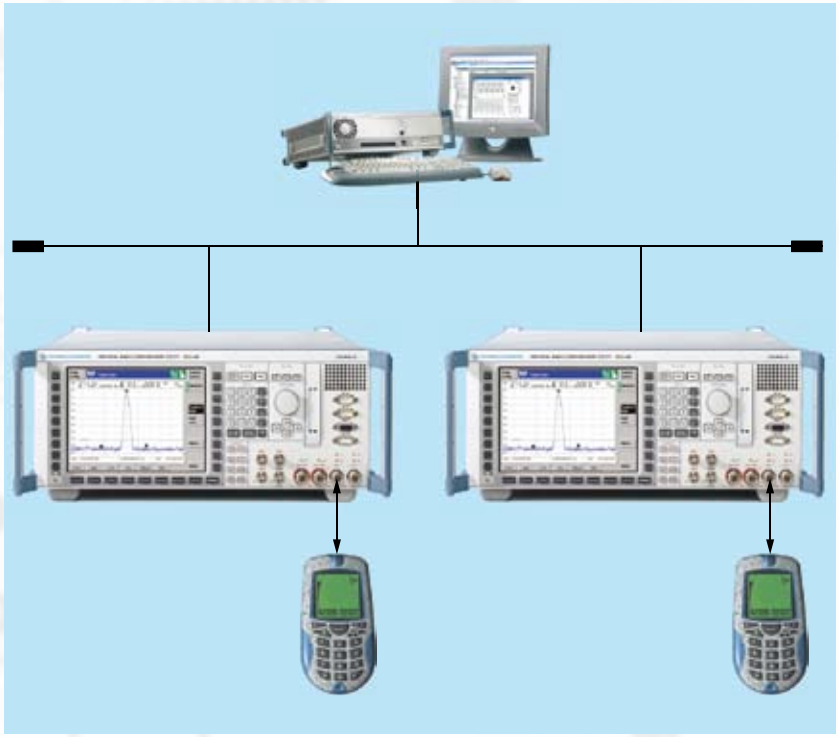
The R&S®CMU-K92 software option for the R&S®CMU200 allows application design engineers to test their work in the lab on mobile phones in a simulated radio network. In this case, the main focus is on proving that the application runs smoothly on the mobile phone under normal operating and radio conditions. For these applications, which can be divided into mobile-originated and mobile-terminated applications, this represents the first realistic test after completion of the simulation tests on the development computer. When testing mobile-originated applications, data communication is initiated on the mobile phone, for example by calling up an integrated browser with subsequent access to the data of a web server connected via the Ethernet interface of the R&S®CMU200. An example of a test of a mobile-terminated application is an SMS transmission, either from a computer connected to the tester or directly from the tester to the mobile phone.

Future prospects

The R&S®CMU-K92 option is the platform for further application tests. It is required in order to run validated MMS test cases or to test complex applications such as push-to-talk over cellular (PoC). In the forthcoming configurations, data applications can also be tested while voice transmission is in progress. If feasible with the mobile phone, both applications (circuit-switched/ packet-switched) can then be operated and tested simultaneously in the dual transfer mode.



The R&S®CMU 200 can also measure spectra, power, and modulations. Here is an example of a power measurement during a file transfer with four slots in the uplink and triggering in response to combined GMSK/8PSK modulation.



A test setup for an end-to-end test between two mobile phones for testing for problem-free MMS exchange between mobile phones from different manufacturers, for example.

WCDMA/HSDPA/HSUPA: data applications and video telephony test

The R&S®CMU-K96 option makes it possible to test data applications on WCDMA/HSDPA/HSUPA mobile phones.

Settings and measurement results

The configuration of the RF parameters of a WCDMA radio network can be dynamically adjusted on the R&S®CMU200 during application testing. Changing the channel numbers triggers an intracell handover, for example, which is required if co-channel interference considerably impairs the signal quality in radio networks. Since a reduced transmit level increases the bit error probability at the receiver end, an application function on a mobile phone can also be tested under adverse receive conditions. If the application test is performed in compressed mode, the mobile phone is subjected to additional stress, which allows you to check the quality of the UE report transmitted from the mobile phone to the tester. While an application is running on the mobile phone, the known transmitter measurements such as power, code domain power, spectrum, and modulation can still be performed. The block error ratio (BLER) determined by the R&S®CMU200 is used to evaluate the receiver in the mobile phone.

For simple tests, the R&S®CMU200 internally provides services for PING and file transfer protocol (FTP) data transfer. Using this simple test configuration, data transmissions of files can be tested even in the megabit range.

HSDPA/HSUPA

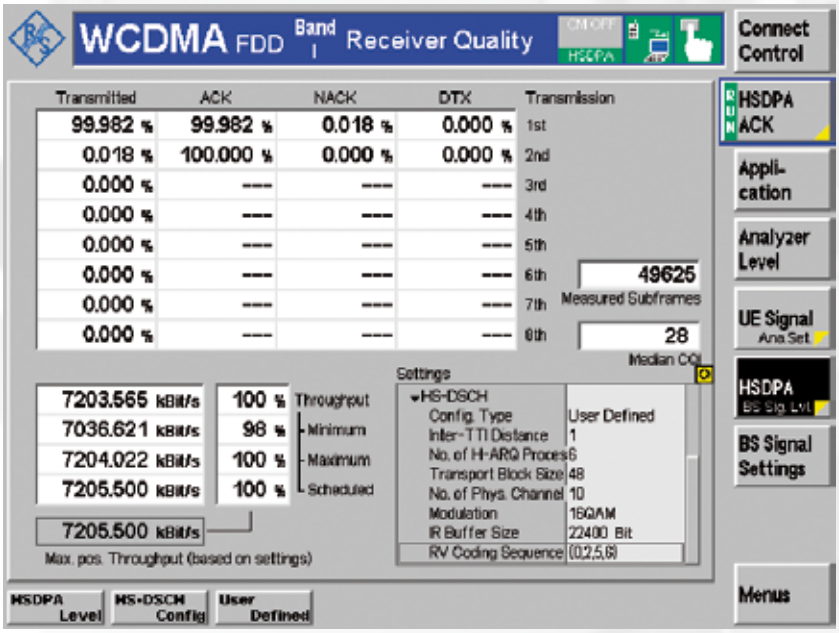
The data transmission rates in tests of WCDMA mobile phones extend into the megabit range in the downlink (high speed downlink packet access, HSDPA) and uplink (high speed uplink packet access, HSUPA). As always, all relevant RF parameters can be measured and applications can also be tested in these two cases. Of particular interest are data throughput measurements, which are performed with regard to the physical layer or the radio link control (RLC) protocol. With the RLC protocol, the data throughput versus time, as well as statistics concerning the transmitted protocol data units (PDU) and service data units (SDU) are displayed. This provides the user with an informative evaluation of data transmission in the downlink and uplink at a glance.

Remote control and automation

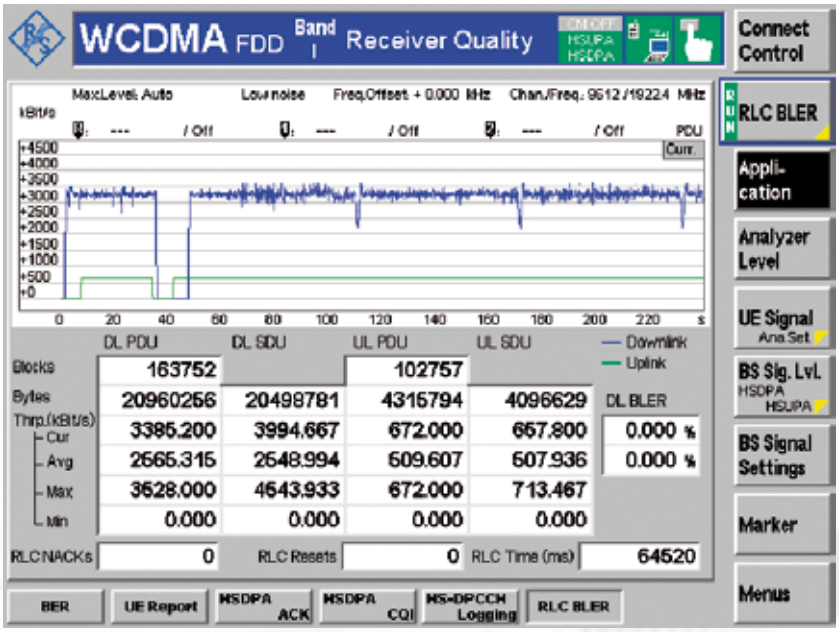
To remote-control the R&S®CMU200 during application tests, an IEC/IEEE bus interface is available; it can be used, for example, to automatically obtain measurement results and measurement values – a prerequisite for program-controlled sequences. Such automatically running tests can be repeated at any time and as often as necessary without staff intervention, thus helping to increase the system's efficiency.

Protocol analysis

After the software has been ported to the mobile phone, users often want to record protocols to optimize internal processes or to perform an error analysis that may be necessary. The R&S®CMU-Z46 WCDMA message analyzer and recorder option allows all universal terrestrial radio access network (UTRAN) protocol layers to be recorded, which can then be used for more detailed analysis. This powerful tool permits in-depth analyses, including transport layer analyses.



In the ACK/NACK menu, the tester displays the data throughput, the CQI median value and the percentages of the ACK, NACK, and DTX values: ACK (DUT has acknowledged), NACK (DUT has not acknowledged and may request a repeat transmission), DTX = discontinuous transmissions (DUT was expected to respond but did not).

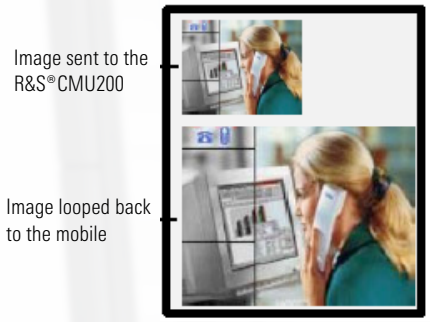


Example of Receiver Quality/RLC BLER measurement during an HSDPA/HSUPA data end-to-end connection.

Video telephony

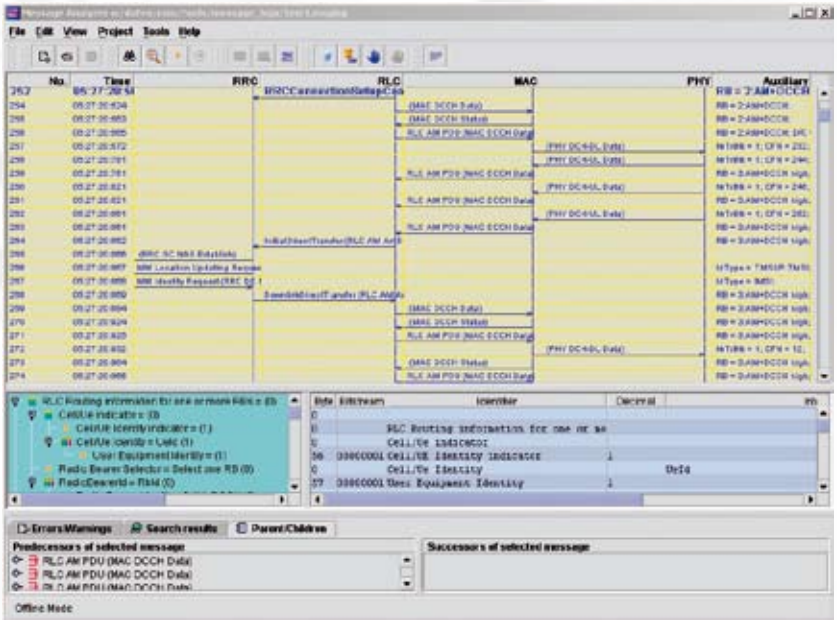
In all likelihood, video telephony is the most spectacular new WCDMA application. It is unique in that it is circuit-switched, and not IP-based like the previously described applications. The WCDMA firmware checks this functionality without requiring optional extensions. The test is performed in echo mode, where the transmission and reception of video and audio signals can be checked with just one mobile phone. The video telephony signals transmitted by the phone to the R&S®CMU200 are looped back by the radio tester and displayed by the phone as would-be video and audio signals of a called station.

Video telephony test in a loop-back



Future prospects

The application test is sure to gain increasing importance over the next few years. Rohde&Schwarz will continue to enhance the functional scope of the R&S®CMU200's current test functions to match market requirements.



The R&S®CMU-Z46 WCDMA message analyzer and recorder option records all UTRAN protocol layers affected by communications between the R&S®CMU200 and the mobile phone. The top half of the screen shows a list of all recorded protocol layers. The individual layers can be selected and their contents analyzed in detail (bottom half of screen).

Testing CDMA2000® data applications

With the R&S®CMU-B87 option (interface for data testing) and R&S®CMU-K87 option (application testing), the R&S®CMU200 offers comprehensive test capabilities for CDMA2000® 1xRTT and 1xEV-DO packet data application testing.

Extensive test capabilities

The CDMA2000® 1xRTT mobile radio standard, which was developed by the 3GPP2 standardization body, is officially recognized by the ITU as an IMT-2000 standard for the third mobile radio generation (3G). Revision 0 (or A), allows data rates of up to 307.2 kbit/s in a 1.25 MHz frequency channel. The 3GPP2 1xEV-DO standard, which was developed for pure data applications, will be used to an increasing extent in the future. The latest version of this standard (1xEV-DO Rel. A) allows a maximum data rate of 3.1 Mbit/s in the forward link (base station to mobile station) and 1.8 Mbit/s in the reverse link (mobile station to base station).

In these networks, data links based on the Internet protocol are playing a more and more significant role. This calls for new test procedures designed to verify the functionality of IP-based links. The TIA/EIA standard, for example, specifies different test scenarios for packet-oriented data links.

Service Option 33

In its Service Option 33, the TIA/EIA standard IS-707-A-1 specifies IP-based data links for the CDMA2000® standard. The R&S®CMU200 provides all parameters required for this service option, ranging from traffic channel configuration (data rates of up to 153.6 kbit/s can be set for the supplemental channel (SCH) both for the forward and the reverse link) through to the parameters for mobile IP and authentication.

PPP authentication

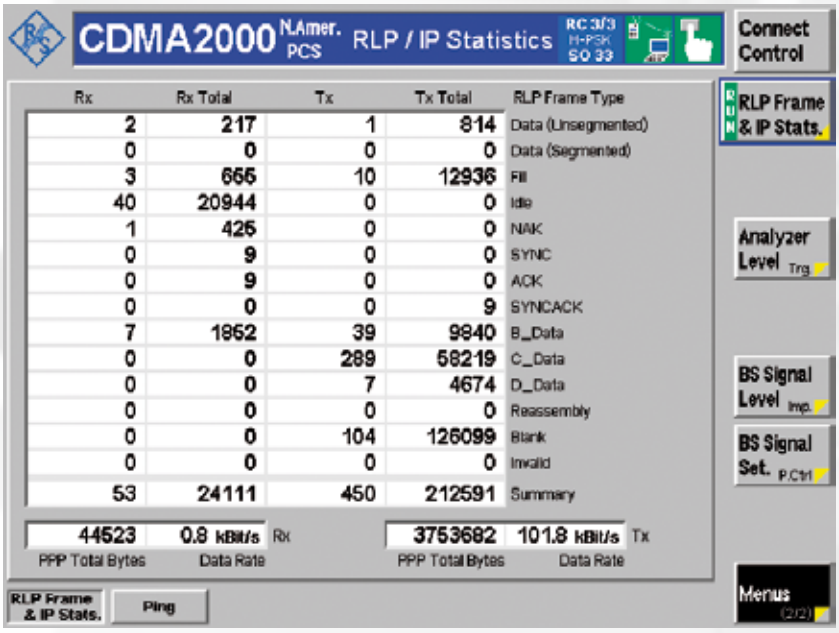
For setting up a point-to-point protocol (PPP) link, the R&S®CMU200 can be configured to request PPP authentication from the mobile phone.

The R&S®CMU200 supports two methods of authentication: CHAP (challenge handshake authentication protocol) and PAP (password authentication protocol). On receiving the authentication request, the mobile phone returns the user name and the password entered for the link setup. The tester checks whether the user name and password are valid. For the CHAP protocol, periodically repeating authentication can be configured. For mobile IP links, the mobile IP standard stipulates that authentication be deactivated.

Mobile IP

Mobile IP is an addition to the conventional Internet protocol. It makes the movements of a mobile computer (mobile node, i.e. in this case a mobile phone) transparent for data applications and the higher protocol layers.

A mobile IP environment involves two new network elements – the home agent and the foreign agent. The home agent is located in the mobile phone's home network; it knows the mobile phone's current location and "tunnels" data packets directed to the mobile phone's home address to the mobile phone's current location. The foreign agent assigns the mobile phone a temporary address in the foreign network (foreign agent care-of address) and functions as the terminal point of the tunnel departing from the home agent.



Statistical evaluation of data transfer between the R&S®CMU200 and the mobile phone during the application test. After the RLP (radio link protocol type 3) and IP data packets are exchanged, the transmitted and received packets are evaluated using different criteria.

By using the R&S®CMU 200, internal single-box solutions can be implemented, as can mobile IP test scenarios, which require a separate home and foreign agent.

PPP link status

During periods in which the mobile phone is not transmitting or receiving data, it switches to an idle state referred to as dormant mode. In this mode, the PPP link is maintained, but no traffic channel connections are set up in the CDMA2000® network. The R&S®CMU200 indicates the various PPP states the mobile phone can assume:

Registered mobile phone is registered, no PPP link is established

PPP Connected PPP link is established, traffic channel connections are set up, mobile phone transmits/receives data

PPP Dormant PPP link is established, no traffic channel connections are set up, mobile phone does not transmit/receive data

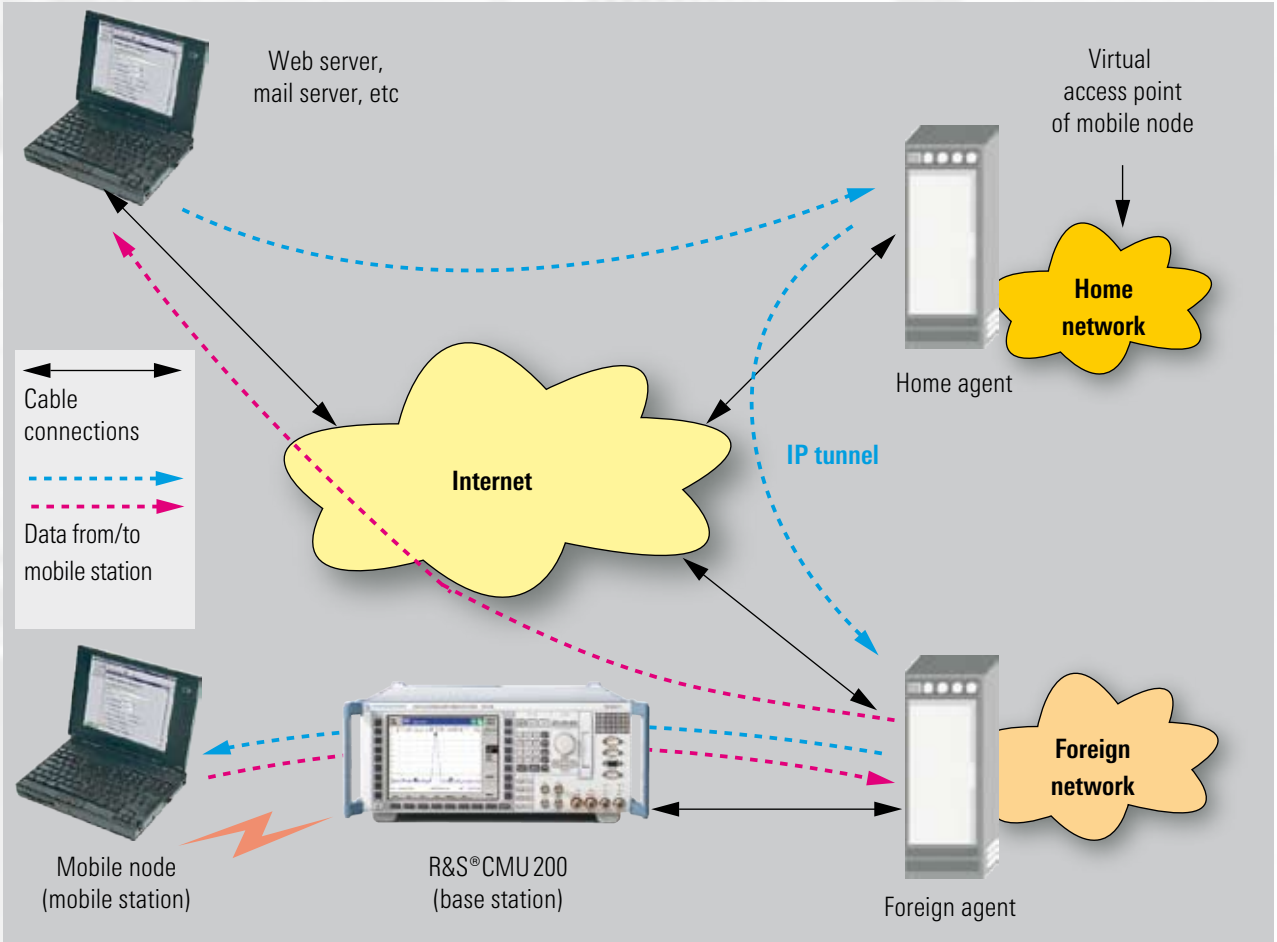
TX/RX RLP frame and IP packet statistics

A statistical evaluation based on counts of the different parameters makes it possible to track the data flow through the base station, i.e. the R&S®CMU200. The following types of data are counted separately for the TX and RX directions:

- RLP frames
- The different RLP frame types (IDLE, FILL, ACK, etc)
- Total PPP bytes
- Total PPP packets
- Total TX/RX data rate

Application scenarios

The R&S®CMU200 allows different test setups to be implemented for different application scenarios. In the simplest case, you can operate the tester in the standalone mode to perform data rate measurements on the mobile phone under test.



Typical test setup for mobile IP link with mobile station and reference to home agent and foreign agent.

Application enabler and validated test cases with the R&S®CMU 200 and R&S®CRTU

Rohde & Schwarz has expanded its portfolio by test solutions for developing, verifying, and certifying mobile-telephone-specific applications such as MMS (multimedia messaging service), PoC (push-to-talk over cellular), or DM (device management).

The modern mobile radio standards are the basis for powerful communications and data transmission networks offering attractive applications such as the transmission of pictures, video clips, or music files to one or more subscribers simultaneously. For this purpose, a mobile phone uses the multimedia messaging service (MMS), which transmits a combination of text and multimedia files.

PoC, the modern version of walkie-talkie communication, is a very promising new voice communications service in mobile radio networks. Voice messages are directly sent to one or more predefined subscribers at a keystroke.

Furthermore, most communications programs as they are known in connection with the Internet are available to mobile users. On the basis of the Internet protocol (IP), these programs can be tested with the aid of the R&S CMU200 application testing solution. In the case of web browsing, the user interface includes an integrated http server for simple functional tests.

MMS – a new challenge in mobile radio networks

Network operators must ensure smooth multimedia file exchange. However, as a prerequisite for an efficient network, all mobile phones have to meet specific minimum requirements for handling the file formats used. For example, because display sizes differ, all mobile phones must be able to display and replay the pictures and video clips transmitted in various sizes and file formats in suitable quality without network operators having to provide conversion aids for the different types of mobile phones in the network. Otherwise, for example, a picture sent in GIF format to a mobile phone that can only process JPEG format would have to be converted in the network. In view of the multitude of disparate mobile phones and file formats, this task would be virtually impossible to handle.

The MMS center is the core of the new solution from Rohde & Schwarz. It allows multimedia messages to be sent and received. The MMSC was specially designed for MMS testing. As the internal MMSC states can be viewed, it offers maximum transparency for troubleshooting.

A parser and a viewer form the core of the MMSC. The parser splits the multimedia message into its individual contents; comparing these contents with the reference contents verifies if a mobile phone operates correctly. The supplied viewer can display pictures or videos and is useful in finding out why a display is not correct.

PoC – go ahead

PoC is based on the IP multimedia subsystem (IMS) standardized by 3GPP. This is a multimedia switching technique describing different IP-based multimedia applications. IMS forms the basis for the packet-switched transmission of multimedia data; it manages the setup, control, and release of connections. Special realtime protocols (RTP, RTCP, TBCP) additionally ensure optimum voice transmission via the data network.

The voice message is converted to a data stream, packed in data packets, and sent to the PoC server of the network operator via radio. The data packets find their way through the data network by means of the Internet protocol (IP). The voice communications service is based on a client-server architecture. The PoC client on the mobile phone uses the services of the PoC server in the network. The PoC server transmits the incoming data stream to one or more receivers and the data stream is received there with only a few seconds delay. One message thus reaches many receivers at a time. To control correct communications, the PoC server additionally takes over signaling and ensures that only one subscriber can transmit data and use the voice channel. It also controls the specified communications groups.

Minimum standard with new test cases

To circumvent such problems, a minimum standard for transmitting multimedia files has been defined. On behalf of the Global Certification Forum (GCF), the Open Mobile Alliance (OMA) specified test cases by means of which it is possible to verify whether mobile phones comply with this minimum standard when reproducing multimedia content. Some of these test cases were adopted by the GCF and the PCS Type Certification Review Board (PTCRB) and have thus become part of the certification for all mobile phones supporting MMS. Unlike signaling test cases, these test cases verify application layers instead of lower protocol layers.

MMS test cases

For reception tests, OMA provides references that also include picture, video, and sound files in different formats and sizes. For test purposes, a multimedia message is sent to the mobile phone; visual or acoustic comparison determines whether the display on, or replay by, the mobile phone complies with the reference content. To facilitate comparing the results on the mobile phone with the reference content, the reference content is displayed on the screen after the message has been sent.

Unlike reception tests, transmission tests can be evaluated automatically. For this purpose, the mobile phone sends a message with multimedia content to the protocol tester. Using a parser, the protocol tester splits the content into separate media files and the SMIL specification, checks whether they comply with the reference, and then indicates whether the mobile phone has passed the test. A manual file comparison using a viewer, i.e. a supplied program that can display pictures and videos and replay music files, is of course also possible.

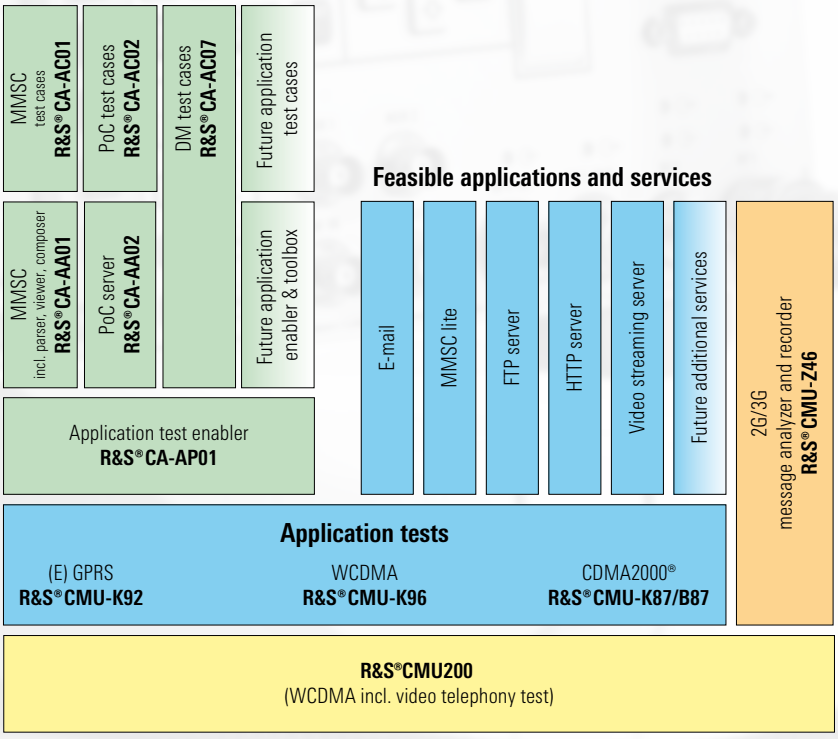
PoC test cases

PoC largely relies on tried-and-tested IP-based protocols, such as the session initiation protocol (SIP), realtime transport protocol (RTP), RTP control protocol (RTCP), and session description protocol (SDP). These protocols were expanded by PoC-specific parameters.

PoC expansions and the interaction of the protocols used can be checked with the test cases classified by the Global Certification Forum (GCF).

DM test cases

Device management (DM) is a standard application for managing software on a mobile phone. Via a web-based application, you can change or update the mobile phone's software, handle debugging issues, or install applications "over the air". In that way, the content on a lost or stolen device can also be easily removed, and sensitive documents do not arrive in the hands of others.



Validated test cases help to ensure and test the standard-compliant implementation of this feature on mobile phones. The test cases are implemented in the open, standardized test language TTCN-3, which allows the tests to be easily simulated and also modified to suit the user's requirements.

Fit for the future with solutions from Rohde & Schwarz

Both servers and the PoC test cases have been implemented as software products running on PCs based on Windows. The link between the mobile phone and the PC is either the R&S®CMU 200 Universal radio communication tester or the corresponding devices of the R&S®CRTU protocol tester family. These devices simulate a mobile radio network and make it possible to call up any IP-based applications of a mobile phone such as PoC. In contrast to public mobile radio networks, you can individually define the radio parameters during such tests and repeat the test any time under reproducible conditions. The supplied test cases only include tests at the application level and are independent of the mobile radio standard.

Future prospects

With the R&S®CRTU-ATE application test environment software platform, the Rohde & Schwarz test solution portfolio in digital mobile radio ranges from the physical layer up to the application layer. Besides the development and availability of new multimedia applications, additional test solutions will follow on this basis.

More information at
www.rohde-schwarz.com
(search term: CMU200)

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