Universal Radio Communication Tester R&S® CMU 200

Testing Applications in Mobile Radio Communications
CMU goes Internet: Testing data applications for WCDMA

The highly successful Universal Radio Communication Tester R&S®CMU200, 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 video telephony and data applications.

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®CMU 200 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.

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 consump-
tion 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 loop-back 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®CMU 200 is combined with the Fading Simulator R&S® ABFS, 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.

**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.

**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®CMU-K96 WCDMA application testing option allows IP-based data applications to be tested on a mobile phone; in addition, it includes several TCP/IP servers, for example an HTTP server, which allows you to start a web browser on a mobile phone. Another server is the MMS center (MMSC) with basic functionality, which can be used to test the transmission and reception of multimedia messages on a mobile phone.
Versatile application tests in (E)GPRS mobile radio

The software option R&S® CMU-K92 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 now also allows you to test applications via GPRS and EGPRS(EDGE) mobile phones simply by activating a new software option. In addition to the application test for CDMA2000®, this is yet another standard ideally supported by the R&S® CMU200, proving its flexible, future-proof concept. The new 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 loop-back setting in the MMSC.

Powerful aid in the development lab

The new software option R&S® CMU-K92 for the R&S® CMU200 for the first time 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**

Option R&S®CMU-K92 is the platform for further application tests. This option is required in order to run the 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.
WCDMA: data applications and video telephony test

Settings and measurement results

To configure the WCDMA radio network for application tests, the R&S®CMU200 parameter settings known from the RF measurements can be used and dynamically adjusted during testing. Changing the channel numbers triggers an intracell handover, for example. 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 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.

In combination with an additional fading simulator such as the R&S®ABFS, the function of an application can be simulated at different speeds in vehicles and in varying environments.

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 (FIG3). This powerful tool permits in-depth analyses, including transport layer analyses.
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 from the radio tester and displayed by the phone as would-be video and audio signals of a called station.

Future prospects

The application test is the latest addition to radiocommunications testing and 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 next steps to be taken include the expansion to high speed downlink packet access (HSDPA) and, once a uniform worldwide standard has been specified, to test cases for push to talk over cellular (PoC).
Testing CDMA2000® data applications

Standard CDMA2000® mobile radio networks have already been in commercial use since 2000 in many Asian countries (e.g. Japan and South Korea), the Americas (e.g. the USA and Canada), as well as in Eastern Europe. With the options R&S®CMU-B87 and R&S®CMU-K87 the R&S®CMU200 now offers extensive test capabilities for data applications for this important global 3G standard.

Extensive test capabilities

The CDMA2000® 1x 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), which is now in commercial use, allows data rates of up to 307.2 kbit/s in a 1.25 MHz frequency channel. Once further optimization stages have been completed, Revision A (also known as 1xEV-DO) will allow 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 3G 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. For example, the TIA/EIA standard TIA-898 specifies data rate measurements for FTP 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 (foreign agent care-of address) in the foreign network and functions as the terminal point of the tunnel departing from the home agent.

The IP addresses for the mobile phone’s foreign agent and home agent can be defined on the R&S®CMU200, thus allowing data packets to be exchanged between the foreign agent and the mobile phone.

CDMA2000® is a registered trademark of the Telecommunications Industry Association (TIA-USA).
**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.
MMS tests on (E)GPRS and WCDMA multimedia mobile phones with the R&S®CMU 200 and R&S®CRTU

MMS – a new challenge in mobile radio networks

GPRS, EGPRS and UMTS are 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 message service (MMS), which transmits a combination of text and multimedia files.

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 having to revert to conversion aids for the different types of mobile phones that network operators provide 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.

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.

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 R&S®CRTU 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.

Fit for the future with solutions from Rohde & Schwarz

The R&S®CRTU-ATE application test environment software platform from Rohde & Schwarz is a flexible MMS test solution. The R&S®CRTU-ATE software platform contains all components required for MMS tests. It is modular in design so that it can be expanded to meet future requirements. The supplied test cases only include tests at the application level and are independent of the mobile radio standard.
The core of the MMS center consists of a parser and a viewer. The parser splits the multimedia message into separate contents; comparing them with the reference content indicates whether a mobile phone functions correctly. The supplied viewer can display pictures or videos and help find out why a display is not correct.

Summary

With its R&S®CRTU-ATE MMS test solution, Rohde & Schwarz has expanded its portfolio by a key component for developing, verifying and certifying multimedia mobile phones. The next step will be to provide test solutions for PoC and the Instant Messaging and Presence Service (IMPS).