3G Virtual Protocol Test System R&S CRTU-VT

Virtual testing of 3G mobile radio terminals

What is a virtual test?

The new 3G (UMTS) mobile radio standard will enable a wide range of services such as videotelephony and mobile Internet access. These services require high data rates of up to 2 Mbit/s with the simultaneous efficient and flexible use of the available frequency spectrum. The development of 3G mobile radios is presently characterized by technical requirements that are much more complex than for existing GSM/GPRS networks and by the time pressure as regards the market-launch deadline. Therefore, the testing of software components such as protocol stacks begins at very early development stages. Software simulations replace hardware components such as chipsets and RF front-ends. A layer 1 shortcut simulates the complete physical air interface, layer 1. This test method is called virtual testing and is indispensable for the parallel development of hardware and software.

3G Virtual Protocol Test System R&S CRTU-VT

The R&S CRTU-VT is a powerful all-in-one solution for virtual software testing of 3G UE protocol stacks. It is delivered as a pure software product on a CD-ROM and runs on any modern PC.

The supplied signalling conformance test cases defined in the TTCN language constitute a key component of the virtual tester (see box below). The R&S CRTU-VT comprises the following components:

TTCN signalling conformance test cases

The 3G mobile radio standard defines the protocol sequences for the radio access network (specification 3GPP TS 25.xxx) and the associated signalling conformance tests (3GPP TS 34.108, 3GPP TS 34.123). These test cases are binding for 3G network operators and the manufacturers of mobile radio equipment. The tests are first specified in textual form by the T1/SIG working group and then integrated into the test specification language TTCN by the MCC160 task force at ETSI.

At present, more than 650 test cases in the TTCN version 1.40 are available on the 3GPP baseline 2002-03. These tests cover all protocol layers from layer 2 of the 3G radio access networks (RAN) up to the higher layers 3 and 4 in the non-access stratum. Circuit-switched and packet-switched services are tested in the same way.

Rohde & Schwarz contributed substantially to the specification at T1/SIG, the TTCN implementation at ETSI and the subsequent verification on the testers R&S CRTU-VT and R&S CRTU-W. The TTCN test cases verified by Rohde & Schwarz are integrated into the R&S CRTU-VT.
Development of TTCN test cases
Configuration of TTCN test cases
Execution of TTCN test cases (test session)
Analysis of test results

Virtual test sequence

Tools in R&S CRTU-VT

- 3G TTCN test cases
- TTCN editor
- Test case builder
- TTCN compiler
- PICS/PIXIT editor
- Project explorer
- Message analyzer
- Test case analyzer

Integrated TTCN development environment with graphical editor, test case builder and compiler for creating new or modifying the supplied TTCN test cases
R&S reference implementation of the UTRAN protocol stack in line with the 3G specifications including the layer 1 simulation
Powerful software tools for the configuration and execution of signalling test cases as well as for the detailed analysis of test results using the generated log files
Signalling conformance test cases in TTCN according to 3GPP TS 34.123-3

The software tools of the CRTU-VT are identical to those of the “hardware” Protocol Tester R&S CRTU-W and cover the entire development and test process (FIG 1). The R&S CRTU-VT thus has everything the user needs for early conformance testing of 3G UE protocol stacks before integration into the physical layer.

The user connects the software stack to the R&S CRTU-VT via TCP/IP network links. Powerful programming interfaces in the form of class libraries in C++ are provided for this purpose.

A large number of different test cases for protocol procedures such as connection management, mobility management and call setup can be supplied with the R&S CRTU-VT. The TTCN test case and the UTRAN protocol stack simulate the 3G network. The R&S CRTU-VT records the responses of the protocol stack under test, compares them with the protocol behaviour defined in the 3G specifications and checks them for conformance (FIG 2).

**Reduction of development time**

The early use of the R&S CRTU-VT – even if the layer 1 and RF components are not yet available – allows the parallel development and testing of layer 1 and the protocol stack, thus increasing the quality and reliability of 3G mobile phones. The development costs for the integration of protocol software and hardware for 3G mobile radios are reduced since well-tested software components exist. The execution speed of signalling tests can be varied in wide ranges (soft timing). A test case can be run for regression tests, for example, several hundred times faster than in practice but also slowed down or even stopped for troubleshooting in the protocol stack of the terminal equipment.
Development of 3G applications

The testers presently available on the market do not support 3G applications satisfactorily. How is the application affected by a change in the quality of the radio link and the data rate, for example? Does the application exhibit stable behaviour when the radio bearers are reconfigured? These questions can easily and quickly be answered by means of simulations performed with the R&S CRTU-VT.

TTCN editor Leonardo Pro

The user-friendly and powerful TTCN editor Leonardo Pro that has proven its value in the Bluetooth™ Protocol Tester R&S PTW60 is provided for creating and modifying TTCN test cases. This editor (FIG 3) is completely integrated into the TTCN development environment and enables the display of protocol errors in the TTCN source text, for example. This considerably reduces the processing time during test case development.

TTCN compiler

The TTCN compiler automatically translates the 3G TTCN test suites into C code. The C code is then compiled and linked to the R&S-specific 3G libraries. The TTCN compiler facilitates the development of test cases by means of a comprehensive syntax check. The ASN.1 BER/PER encoding of messages, which is important for 3G protocols, is also fully supported. A graphical frontend developed by Rohde & Schwarz and named test case builder controls the make/build process of the compiler and makes generating 3G test cases very convenient.
PICS/PIXIT editor

The graphical PICS / PIXIT editor (FIG 4) facilitates generating and editing the PICS / PIXIT parameters that enable test cases to be configured prior to their execution. This tool simplifies the input of parameters, a task that was previously time-consuming and error-prone.

Project explorer

The project explorer (FIG 5) is responsible for the execution of test cases. With this tool, test cases are easily combined to form complete test sessions and the UTRAN protocol stack is correctly configured. During execution the current status of individual test cases can be followed and the project explorer displays the verdict, i.e. the result obtained. The user can start the analysis tools via hyperlinks in the test case reports and analyze the log files.

Message analyzer

The highlight of the R&S CRTU-VT is the message analyzer (FIG 6). It records all messages exchanged between the virtual tester and the protocol stack under test as well as the message flow of the UTRAN protocol stack during the execution of a test case in a central log file. This is followed by detailed analysis of signalling sequences with the user-friendly and powerful message analyzer. The message analyzer fully automatically decodes the messages, displays them in tabular form or as a graphical message sequence chart (MSC) and presents the structure of messages in easily readable form down to the individual bit. Powerful functions such as filtering and searching message elements, the coloured coding of message types and the parent-child view for viewing relationships between messages support the analysis of the complex 3G signalling sequences.
Test case analyzer

In addition to the message analyzer, the test case analyzer visualizes the automatically generated trace files of TTCN test cases. The test case analyzer displays the messages to and from test case PCOs, the timer configuration and constraint matching in tabular form. Hyperlinks allow direct access to the TTCN source text in graphical format. The test case analyzer and the message analyzer have a similar composition and operating concept.

Summary

The R&S CRTU-VT is an excellent support tool for the parallel development of hardware and software. Early testing with a large number of standardized TTCN conformance test cases increases the quality and interoperability of 3G mobile phones. The easy transition from virtual software testing with the R&S CRTU-VT to real testing with the R&S CRTU-W is ensured by a uniform software environment and identical test cases which reduces investment costs, development time and time-to-market.

The R&S CRTU-VT is thus an excellent complement to the 3G test equipment family from Rohde & Schwarz and supports the manufacturers of 3G mobile radios in meeting the enormous technical challenge.

Thomas Moosburger; Dr Thomas Eyring

Abbreviations used

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>3G</td>
<td>3rd Generation</td>
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<tr>
<td>3GPP</td>
<td>3rd Generation Partnership Project</td>
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<tr>
<td>ASN.1</td>
<td>Abstract Syntax Notation</td>
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<td>BER</td>
<td>Binary Encoding Rule (ASN.1)</td>
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<tr>
<td>CC</td>
<td>Call Control (Layer 3)</td>
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<tr>
<td>MAC</td>
<td>Medium Access Control (Layer 2)</td>
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<tr>
<td>MM</td>
<td>Mobility Management (Layer 3)</td>
</tr>
<tr>
<td>MSC</td>
<td>Message Sequence Chart</td>
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<tr>
<td>PCO</td>
<td>Point of Control and Observation (interface of the TTCN test case)</td>
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<tr>
<td>PER</td>
<td>Packed Encoding Rule (ASN.1)</td>
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<tr>
<td>PICS/PIXIT</td>
<td>Protocol Instance Conformance Statement / Protocol Information Extra Implementation for Testing (configuration parameters of TTCN test cases)</td>
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<tr>
<td>RAN</td>
<td>Radio Access Network</td>
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<tr>
<td>RLC</td>
<td>Radio Link Control (Layer 2)</td>
</tr>
<tr>
<td>RRC</td>
<td>Radio Resource Control (Layer 3)</td>
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<tr>
<td>TTCN</td>
<td>Tree and Tabular Combined Notation (formalized language for the definition of test cases)</td>
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<tr>
<td>UE</td>
<td>User Equipment</td>
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<tr>
<td>UMTS</td>
<td>Universal Mobile Telecommunications Standard</td>
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<tr>
<td>UTRAN</td>
<td>UMTS Terrestrial Radio Access Network</td>
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R&S CRTU-G / R&S CMU200/300

Optional IQ and IF interfaces for new applications

Technical concept

With the options CMU-B17 and CRTU-B7, analog IQ and IF interfaces are available for the transmit and receive signal path. The module is connected between the RF section and the digital section. The IQ signals are obtained by conversion of the internal IF signals. The IF frequencies are in the range of 7.68 MHz to 13.85 MHz as required by the application. If the IQ and IF interfaces are not required, the transmit and receive signals can be looped through in the bypass mode without being affected by the interface module and without the specifications of the measuring instruments being modified.

Standards and applications

Currently, the standards GSM / GRPS/EDGE are available for the R&S CMU200 / 300 with software V3.10, and IS136 mobile station tests as well as...