PC-based protocol tester for UMTS LTE

Developments for the new mobile radio standard UMTS long term evolution (LTE) are running at full speed. Rohde & Schwarz supports the industry in this particular challenge with high-grade test equipment. The new product, the LTE virtual tester, is a powerful protocol test environment for generating LTE signaling scenarios.

The development of LTE is in full swing

The new 3GPP mobile radio standard LTE, with data rates up to 150 Mbit/s and low latency times, permits a wide variety of new broadband services. The commercial kickoff of LTE is planned for 2010 in some regions. Both the enormous increase in data rates as compared to UMTS and the significant pressure for a quick market launch are driving factors in the current development of LTE mobile radio devices. As a result, the complex functioning and performance of the higher protocol layers of user equipment (UE) must be verified very early in the development process.

What are virtual tests?

Virtual tests replace as yet unavailable hardware components, such as UE chipsets or RF output stages, with software simulations. The entire physical air interface is simulated with a virtual physical transport layer. The connection between the LTE virtual tester and the UE software is handled via an interface developed by Rohde & Schwarz. This test method permits parallel development of hardware and software and allows UE software problems to be recognized and eliminated during early phases of development — a decisive factor in ensuring the timely launch of a new mobile phone while maintaining high quality standards.

FIG 1 The LTE virtual tester is an excellent addition to the R&S®CMW500 protocol tester, because scenarios generated by it can be reused with the R&S®CMW500.

The LTE virtual tester

As part of the R&S®CMW500 family of products (FIG 1), the LTE virtual tester offers a powerful programming interface as well as advanced tools for effective analysis of UE protocol software, allowing mobile radio equipment manufacturers to verify early on that UE protocol software is being implemented in accordance with standards. Instead of using a connection via the baseband or RF interface, the message elements are exchanged between the LTE virtual tester and the UE via an IP-based interface (FIG 2). The UE protocol software can run either in a PC environment or in an environment that is embedded on the target hardware. If the target hardware does not have an IP interface for data exchange, a software adapter can be used to make the connection via USB or PCMIA (FIG 3).

FIG 2 The message elements are exchanged between the LTE virtual tester and the UE via an IP-based interface.

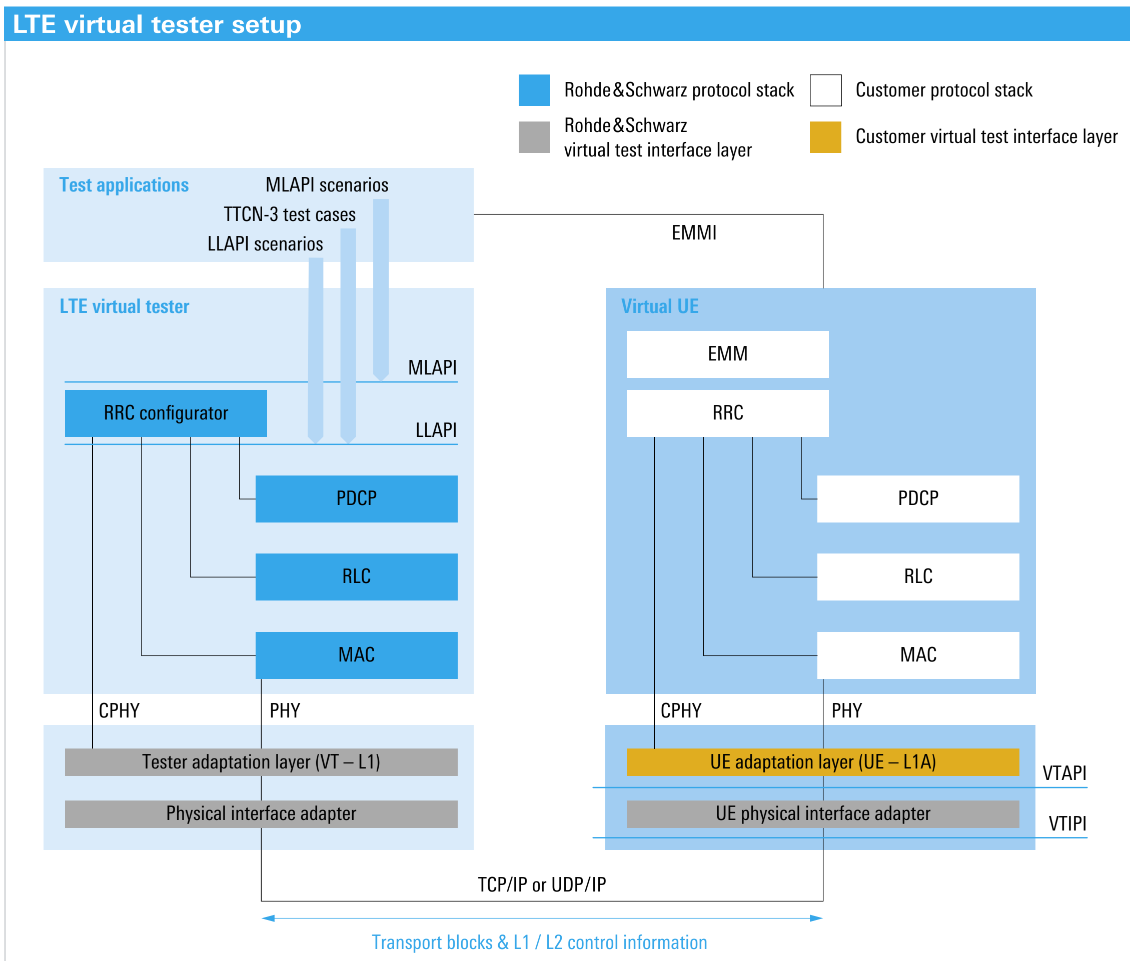
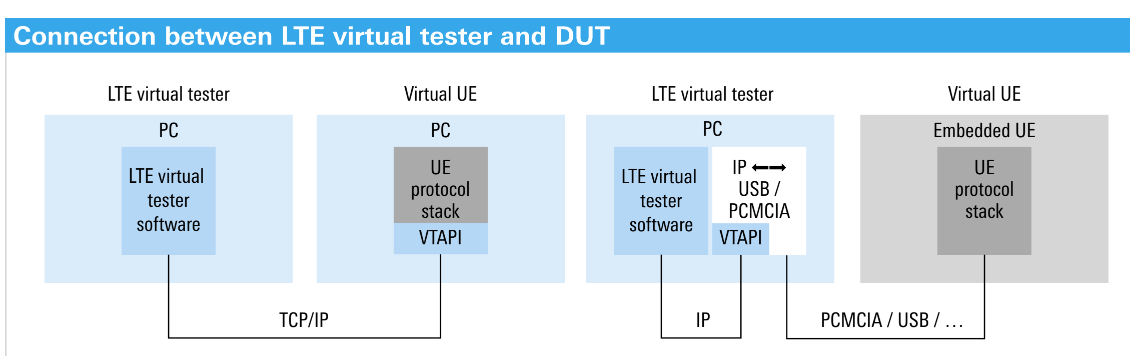


FIG 3 The connection between the LTE virtual tester and the DUT can take place via a standard IP connection as well as via a PCMCIA or USB interface.



The LTE virtual tester is made up of the following software components:

- R&S®CMW-KP502
  Standard-conforming reference implementation of the EUTRAN protocol stack (layers 2/3) in accordance with 3GPP specifications, including the virtual physical layer
- R&S®CMW-KP500/-KP501
  C++ programming interface for generating signaling scenarios
- R&S®CMW-KT010/-KT011/-KT012/-KT014
  Powerful software tools for configuring (FIG 4) and running signaling scenarios, as well as for the detailed analysis of test results based on generated log files (FIG 5)

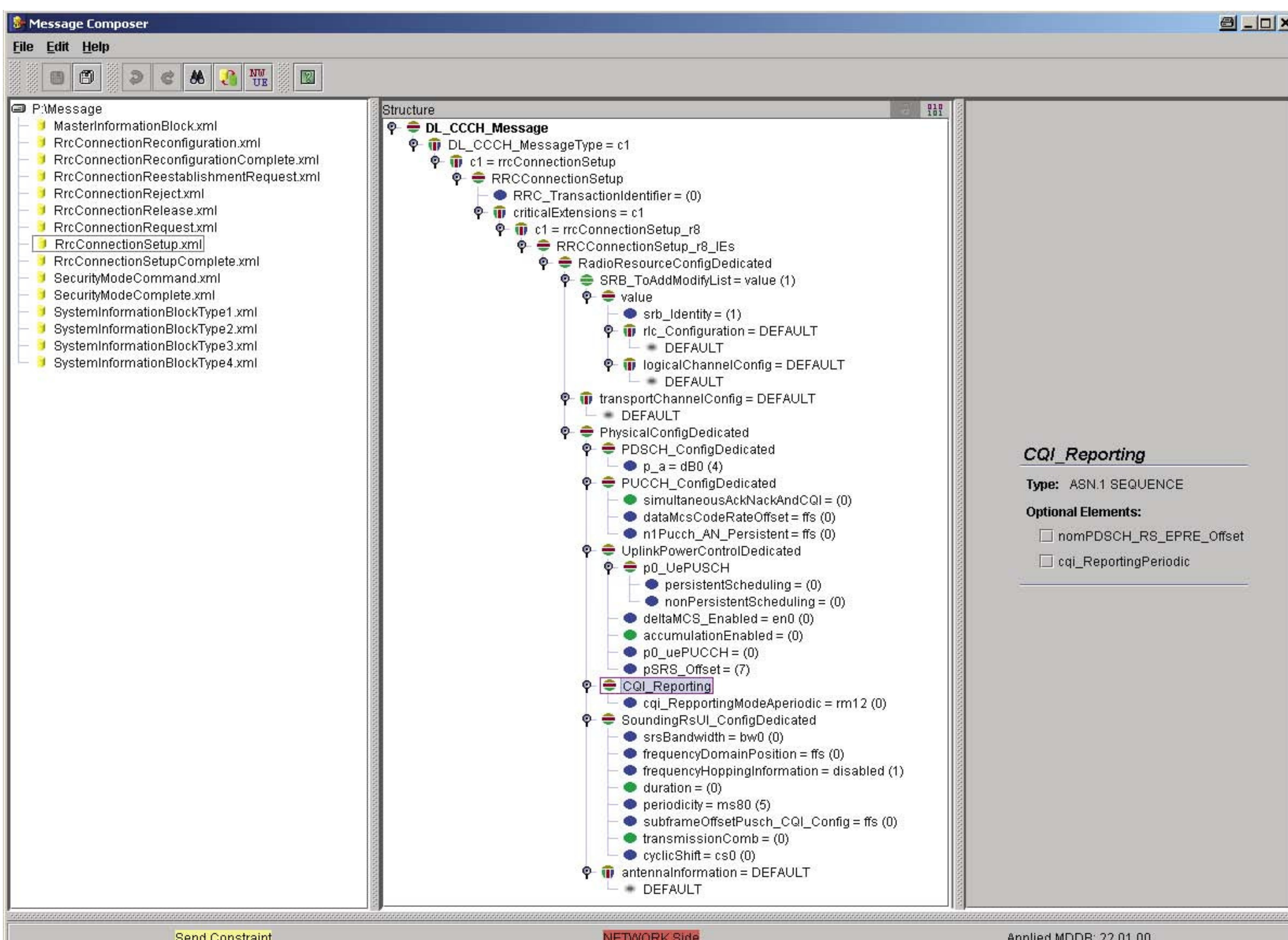
The software tools in the LTE virtual tester are identical to those in the R&S®CMW500 hardware protocol tester and cover the complete development and test process. In addition, signaling scenarios that are developed for the LTE virtual tester can be reused on the R&S®CMW500 LTE protocol tester.

VTAPI: interface for simple connection of UE stack software

The Rohde&Schwarz LTE virtual tester uses a defined set of messages and can communicate with the UE via the virtual test application programming interface (VTAPI) (FIG 2). The VTAPI interface functions are divided into two categories: protocol-independent functions for monitoring the UE connection and protocol-dependent functions for transmitting protocol information such as transport blocks.

The protocol-independent functions on the VTAPI interface allow tests in virtual system time, which means that the LTE virtual tester and the UE software under test are exclusively responsible for defining the start and end of an LTE subframe. This approach offers completely new options during troubleshooting. For example, a breakpoint can be set in order to find a software error. As soon as the UE software stops at this measurement point, the scenario stops on the LTE

FIG 4 The message composer (R&S®CMW-KT012) allows the contents of all protocol messages generated by test cases to be modified easily and without changes to the source code.



virtual tester as well. The status of the UE software can now be examined in detail. When the software continues, the test scenario also resumes on the LTE virtual tester.

The protocol-dependent functions, however, exchange transport blocks and layer 1 / layer 2 control information with the UE. In contrast to conventional test concepts, the UE CPHY configuration interface is part of the UE adaptation layer (UE L1A) and is thus independent of the VTAPI interface. This decoupling allows a flexible and rapid connection to the UE software. The UE adaptation layer always receives sufficient information via the VTAPI interface for correct communications with the RRC and the MAC layer of the UE. For the connection between the LTE virtual tester and the UE, it is therefore unimportant where the boundary between processors in the UE for layer 1 and layer 2 tasks is located.

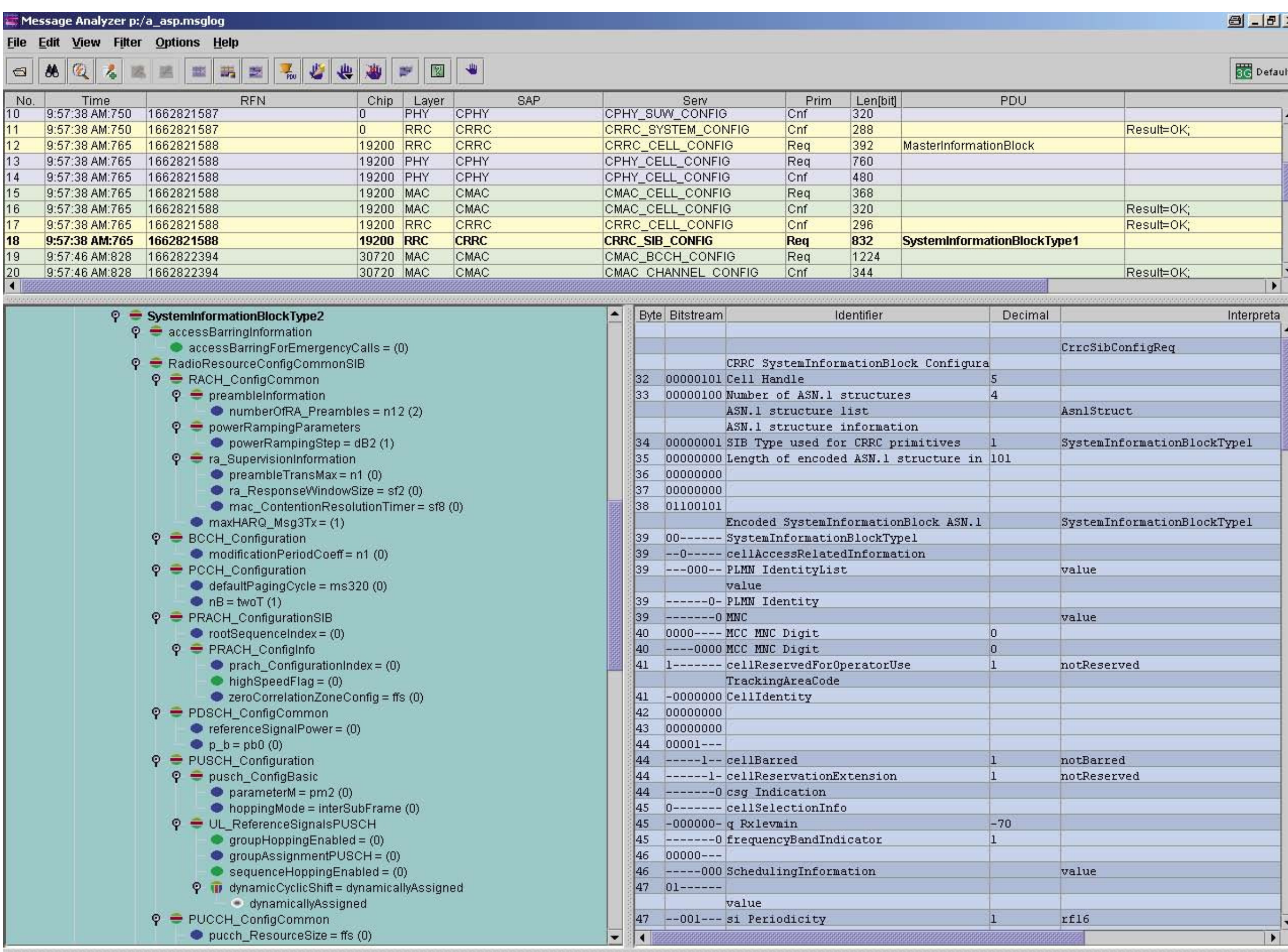
LTE virtual tester: software test environment for all phases of development

Depending on how the LTE virtual tester will be used, various C++ programming interfaces are available from Rohde&Schwarz for developing test scenarios:

The low-level application programming interface (LLAPI, R&S®CMW-KP501) makes it possible to use the LTE virtual tester in a very early phase of UE development. LLAPI is based on layer 2 of the EUTRAN protocol stack and permits direct access to the configuration interfaces of the lower protocol layers (MAC, RLC, PDCP). This means, for example, that it is possible to simulate a very specific network malfunction.

With the medium-level application programming interface (MLAPI, R&S®CMW-KP500), Rohde&Schwarz offers an interface for the efficient generation of test scenarios on layer 3. This interface takes advantage of the unique RRC configurator

FIG 5 The message analyzer (R&S®CMW-KT011) makes studying the signaling sequence of an LTE test scenario quick and convenient. It can completely decode individual messages.



Abbreviations

3GPP	Third Generation Partnership Project
CPHY	Control interface for PHY layer
DUT	Device under test
EMM	EPS mobility management
EMMI	Electrical man machine interface
EUTRAN	Evolved universal terrestrial radio access network
IOT	Interoperability testing
IP	Internet protocol
LLAPI	Low-level application programming interface
LTE	Long term evolution
MAC	Medium access control
MLAPI	Medium-level application programming interface
PDCP	Packet data convergence protocol
PHY	Physical layer
RLC	Radio link control
RRC	Radio resource control
TTCN-3	Testing and test control notation version 3
UE	User equipment
VT	Virtual test
VTAPI	Virtual test application programming interface
VTIPI	Virtual test IP interface

technology developed by Rohde&Schwarz. The protocol stack on which MLAPI is based contains not only the lower protocol layers, but also the part of the layer 3 RRC that is responsible for configuring these lower layers. RRC message elements therefore automatically ensure the consistent configuration of lower layers. As a result, the programming effort and the source code needed for a test scenario are reduced considerably. MLAPI is preferred for generating R&D and IOT test scenarios.

Additional software tools for generating and executing TTCN-3 certification test cases will be available for the LTE virtual tester in the future.

Automated regression tests with the LTE virtual tester

Regular regression tests are a mandatory part of modern software development, because they can detect program errors in previously tested parts of the software. These types of program errors typically arise when changes are made during maintenance or enhancements. The LTE virtual tester allows UE regression tests to be carried out fully automatically, even overnight. If an automatic build system is already available, the inclusion of the LTE virtual tester makes it additionally possible to test the UE protocol software. The user build system and the LTE virtual tester communicate via an IP-based, remote control interface. This makes it possible to run extensive series of tests automatically. The results are immediately visible for the user because individual log files are archived for each test case. As part of the LTE virtual tester software environment, the automation manager (R&S®CMW-KT014) can also be used to start, stop and configure the virtual UE so that the commands needed for the test case can be forwarded to the UE, including, for example, AT commands such as ATD, which starts a mobile originated call.

Summary

The LTE virtual tester is a high-performance software test environment and provides excellent support for developing hardware and software in parallel. Early testing with signaling scenarios based on LLAPI or MLAPI improves quality and ensures a timely market launch of future LTE user equipment. Rohde&Schwarz offers a continually expanding portfolio of ready-to-use scenario packages based on LLAPI and MLAPI that simulate a variety of typical applications from a real LTE network. Uniform programming interfaces ensure a trouble-free transition from virtual LTE tests to real tests using the R&S®CMW500. Scenarios generated with the LTE virtual tester can be reused on the R&S®CMW500 protocol tester, making the software an excellent addition to the R&S®CMW500 family of LTE test equipment and providing support to LTE user equipment manufacturers in handling any technical challenges that may arise.

Dr. William Powell; Roland Brunnbauer