Layer 1 tests for WCDMA and HSDPA made easy

Why layer 1 tests?

The implementation of layer 1 (physical layer) involves major effort on the part of manufacturers of chip sets for WCDMA terminal equipment. Unlike GSM, a high degree of flexibility in layer 1 has been stipulated by the WCDMA standard from the start: Services with different quality requirements can be multiplexed for transmission using the same physical resources. Different channel coding can be selected for each service in order to make the most efficient use of the available bandwidth. Manufacturers and network operators can thus offer a customized range of services as well as optimized transmission quality. This flexible concept, however, makes layer 1 implementation more complex and thus calls for more sophisticated test equipment and concepts for 3G mobile phones.

3GPP Radio Access Network (RAN) specifications stipulate that complex tasks such as power control, compressed mode and transmit diversity be implemented in layer 1. Moreover, the downlink data rate is boosted to as high as 14 Mbit/s by the High Speed Downlink Packet Access (HSDPA) standard defined in 3GPP WCDMA Release 5, which makes layer 1 requirements even more stringent. Extensive tests of 3G layer 1 implementation during the development phase and prior to integration are therefore indispensable for every manufacturer.
Software concept

The layer 1 test software from Rohde & Schwarz with a Windows®-based GUI (FIG 2) provides a convenient and extremely flexible test environment for layer 1 implementations in WCDMA and HSDPA chip sets and terminals. This test environment is available as a software option not only for the Protocol Tester R&S® CRTU-W, but also for the more economical R&S® CRTU-M platform (FIG 1). The two instruments are based on identical hardware; the R&S® CRTU-W however features software that provides more comprehensive functionality. If necessary, the R&S® CRTU-W and the R&S® CRTU-M can be upgraded to fully configured protocol test environments and are thus ideal for use at all stages of terminal design – from layer 1 development and protocol integration up to conformance tests.

The software basically acts like a WCDMA or HSDPA base station. It can generate complex downlink signals at layer 1 and test their reception and processing by the implementation under test. In the uplink, the software analyzes the signals received from the DUT. Moreover, the software can test correct interaction between the downlink and the uplink in the DUT, which is indispensable in HSDPA tests, for example. The DUT is operated in the non-signaling mode, where no signaling by higher protocol layers is required.

Channel configuration

In the downlink, the test software generates all conventional channels defined by 3GPP Release 99 and Release 5 (FIG 3). It offers unique configuration options for the WCDMA transport channels, coded composite transport channels and physical channels (FIG 4). The user can define the transport formats for each transport channel, generate any combinations of transport formats from them (FIG 5) and store these combinations permanently. To develop an efficient layer 1 implementation, it is mandatory that a maximum number of combinations be tested. Otherwise there is the risk that errors will crop up later in development or, even worse, in real operation. The test cases specified by the standard cover only a small number of the permissible configurations, so that manufacturers should in no case rely on the standard test cases alone.

You can choose from among a large number of channel combinations predefined by Rohde & Schwarz. For example, channel combinations for AMR and...
ISDN services are available in addition to the reference measurement channels defined by the standard. Plus, the test software can be used for verifying further layer 1 functions such as compressed mode, power control and transmit diversity in addition to configuring channel combinations.

**Reconfiguration during the test**

The layer 1 test software allows you to modify the test scenario while the test is in progress. Any parameter changes can immediately be activated via the GUI. This does away with the need for tedious recompilations of test scenarios.

**HSDPA**

HSDPA boosts downlink data rates to as high as 14 Mbit/s. In layer 1, the HSDPA standard provides for two new physical channels in the downlink and one new physical channel in the uplink. The modulation and coding of the useful data in the downlink channel are continuously adapted, based on the channel quality information returned by the subscribers. If errored packets are received, subscribers will request their retransmission using the hybrid automatic repeat request (ARQ) protocol. The adaptive modulation and coding as well as the hybrid ARQ, therefore, call for continuous interaction between the downlink and the uplink.

The layer 1 test software allows you to configure the new HSDPA channels as required (FIG 7) and to define the behavior of the tester in terms of adaptive modulation and coding as well as the hybrid ARQ protocol. This enables you to generate practically any test scenario you like. You can extensively test the behavior of your layer 1 implementation both in normal operation and under special conditions.

**Scripting interface**

The test software not only allows the manual generation of test scenarios via the graphical Windows GUI. It also features a scripting interface based on the Microsoft COM standard. Test scripts can be generated in Visual Basic, for example, to define the behavior of the layer 1 test software (FIG 6). Previously defined channels can be integrated in scripts. This provides you with a cost- and time-saving means of performing fully automatic regression tests, and thus makes it easier for you to meet the extensive 3G test requirements.

**Summary and future developments**

The layer 1 test software offers test functionality indispensable for the development of layer 1 implementations in WCDMA and HSDPA terminals. The demand for test solutions for such applications will continue to grow. For example, Release 6 of the 3GPP WCDMA standard, which will cover High Speed Uplink Packet Access (HSUPA), will include many new requirements with respect to layer 1.

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**FIG 4 WCDMA model for transport channels, coded composite transport channels and physical channels.**

![Diagram of WCDMA model](image)
FIG 5 Definition of permissible transport format combinations.

FIG 6 Example of Visual Basic script for performing automatic tests with layer 1 test software.

FIG 7 Configuration of HSDPA channels.