

# AEROFLEX

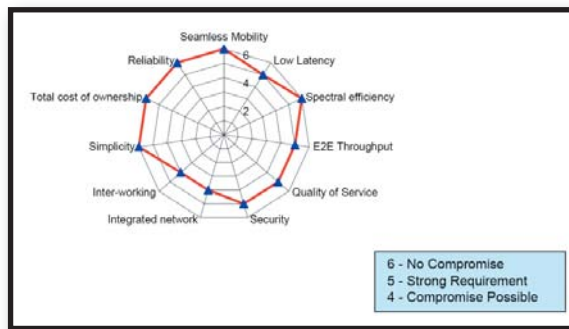
A passion for performance.



# LTE PRODUCTS

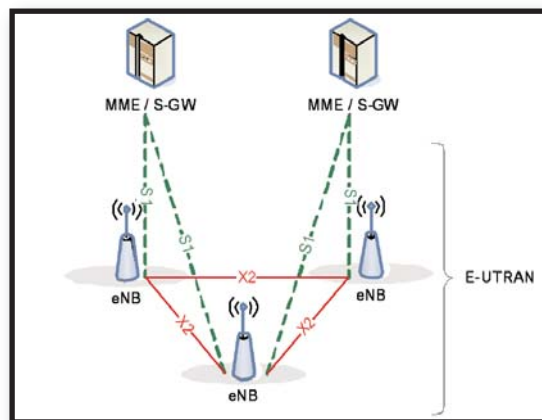
# WHAT IS LTE?

LTE is the standard for mobile communications developed by the 3GPP standards development organization to meet the requirements of the next generation of mobile network operators. The first release of the standard, Rel-8 of the 3GPP standards and referred to as E-UTRAN (Evolved Universal Terrestrial Radio Access Network), introduces many changes in both the radio interface and the system architecture. The purpose of the changes is primarily targeted at increasing user data rates and reducing packet latency, providing a user experience more similar to wireline broadband services. In addition, LTE addresses issues relevant to the efficient and cost-effective operation of an advanced high-speed radio network: spectrum efficiency, lower cost-per-bit, seamless mobility, reliability, see the below diagram. In addition, co-existence and compatibility with current and legacy technologies is required, allowing for the gradual roll-out of network coverage without disrupting existing, revenue-earning services.



**Relative priorities of key characteristics**  
(NGMN White Paper 'Beyond HSPA & EVDO' v3.0)

To achieve these requirements, a major change in technology has been required. LTE networks are entirely packet-switched, allowing a wider range of services to be readily supported through the use of TCP/IP-based standards. The SAE (System Architecture Evolution) design of an all IP core network is being undertaken to provide the simplified architecture. This will result in a network topology which has been flattened to minimize the number of interfaces, reducing end-to-end packet delays across the system.

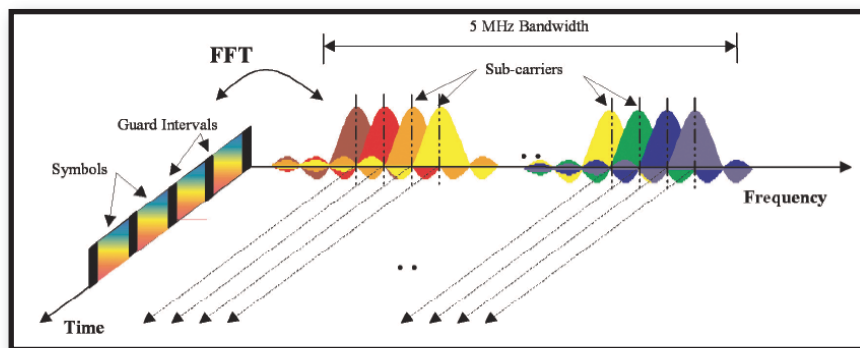


LTE network architecture from TS 36.300 V8.6.0





The radio interface uses OFDM (Orthogonal Frequency Division Multiplexing) technology to provide a flexible transmission bandwidth scalable from 1.4 MHz to 20 MHz to optimally use the available spectrum. OFDM makes use of multiple, closely spaced orthogonal subcarriers each of which is modulated with a conventional digital modulation such as QPSK, 16QAM or 64QAM. The large number of subcarriers support data rates equivalent to a single carrier broadband signal of equivalent bandwidth but with a lower symbol rate. The lower symbol rate makes the signal more resistant to multi-path interference than the conventional single carrier signal. The diagram below from TS 25.892 V6.0.0 provides a graphical representation of the signal.



**Frequency-time representation of an OFDM signal**

The downlink transmission uses a modified form of OFDM as an access technology, OFDMA (Orthogonal Frequency Division Multiple Access) which allows subsets of the subcarriers to be allocated to different subscribers as required.

The uplink uses another modification of the basic OFDM concept for its access technology called SC-FDMA (Single Carrier Frequency Domain multiple Access), this differs from the downlink waveform by supporting each symbol on all the subcarriers. The benefit of this technique is reduced battery power consumption due to the low Peak-to-Average Power Ratio (PAPR) uplink signal transmitted by the UE.

As a result, a new generation of test equipment has emerged to meet the demands of development teams working on terminals designed to meet the requirements of the next generation networks.

The Aeroflex 7100 LTE Digital Radio Test Set provides all the tools required during the design, development and test stages of UE chip sets and terminals meeting the new Rel-8 standards. All the key measurements are provided for characterizing the performance of LTE mobile devices, both at the radio interface and throughout the protocol stack, including the PDCP and IMS layers. End-to-end performance can be accurately assessed, along with correct idle mode and in-call behavior with the 7100's Network Simulation mode. Typical users of the 7100 LTE Digital Radio Test Set include RF developers, protocol stack teams, integration test groups and pre-conformance labs that are developing sub-systems and integrated designs that meet the requirements of the LTE standards. The 7100 also supports end-of-production line manufacturing test, allowing sample tests on high-volume production lines to be executed. These teams benefit from the ease of use, comprehensive test capability, speed and low cost of ownership offered by the 7100.

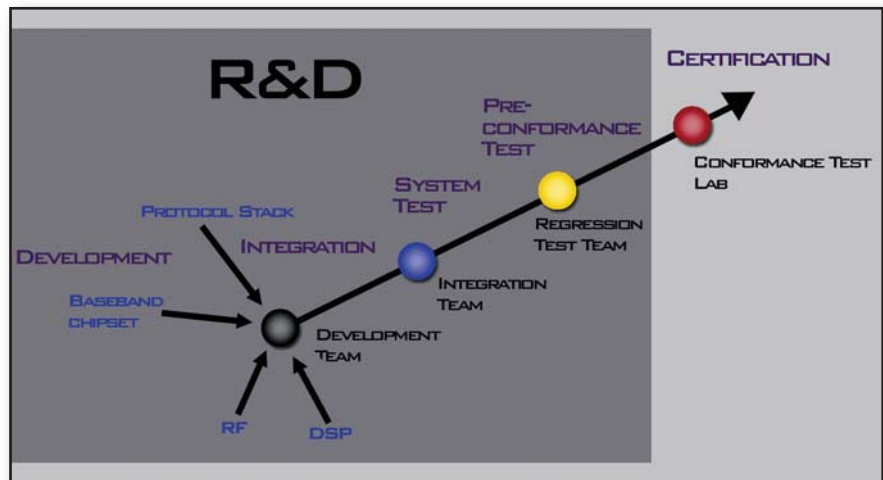


# 7100 LTE DIGITAL RADIO TEST SET

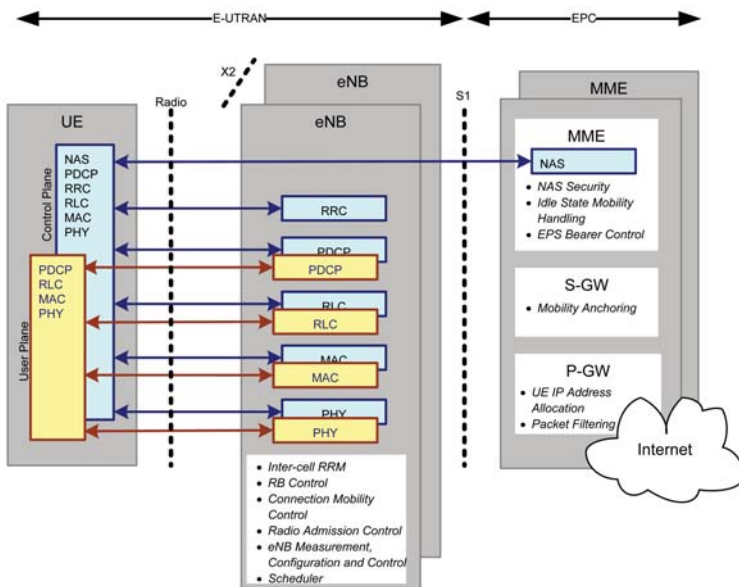


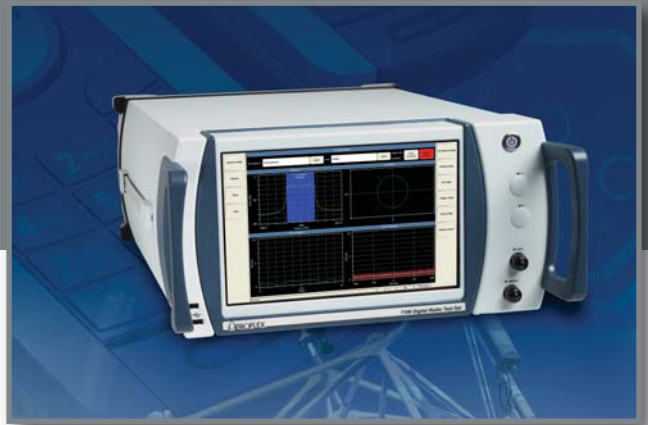
## Covering All Phases of LTE Terminal Testing

The Aeroflex 7100 Digital Radio Test Set is a compact, bench top instrument that provides easy to use test features covering the entire spectrum of R&D test activities for LTE terminal devices, starting with initial RF, baseband and protocol stack development, through integration, regression and pre-certification testing.



The 7100 incorporates a 3GPP Rel-8 compliant protocol stack and physical layer to emulate an eNB (evolved Node B) and the EPC (Evolved Packet Core) network, covering all potential spectrum allocations up to 6 GHz. A comprehensive range of RF tests is included, including some based on the 3GPP TS 36.521 RF test specification, covering all key transmitter, receiver and transceiver measurements. These tests use the built-in protocol stack to configure the correct RF conditions for testing. An integrated IMS server allows complete functional testing to be performed, permitting end-to-end throughput and latency to be measured in a controlled environment.





## Advanced Protocol Testing

Protocol testing is based on the Aeroflex Script Editor environment and uses a C++ API to construct signalling sequences. A message editor allows programmers to build customized messages for use in protocol test scripts. All protocol layers can be tested:

- MAC
- RLC
- RRC
- PDCP
- NAS
- IMS

## Growing to Meet Your Requirements

As the LTE standards mature, additional test capability will be introduced, including:

- TDD mode, for non-paired frequency bands expected to be deployed in China
- 2x2 MIMO, for testing data throughput robustness at high data rates
- Second RF interface for handover testing between different carrier frequencies
- Built-in Fading Simulator for real-world signal simulation of actual network conditions
- Digital I/Q interface for baseband testing without the RF transceiver connected, essential in module design stages

Because LTE terminals will be combined with other access technologies, the 7100 will be extended to include these protocols, enabling comprehensive inter-system handover testing:

- WCDMA/HSPA
- GSM/GPRS/EDGE
- CDMA2000 1xRTT, EvDO

The 7100's large touchscreen display and built-in PC provides intuitive access to this comprehensive set of test features:

- RF parametric measurements
- Functional testing
- Network simulation
- Protocol testing
- End-to-end performance testing

## Summary Specification

- 6 GHz frequency range as standard
- Optional second RF carrier, 3 GHz
- Integrated protocol stack
- Comprehensive RF measurements based on 3GPP TS36.521
- Functional tests built-in
- Programmable protocol testing with C++ API



# TM500 LTE

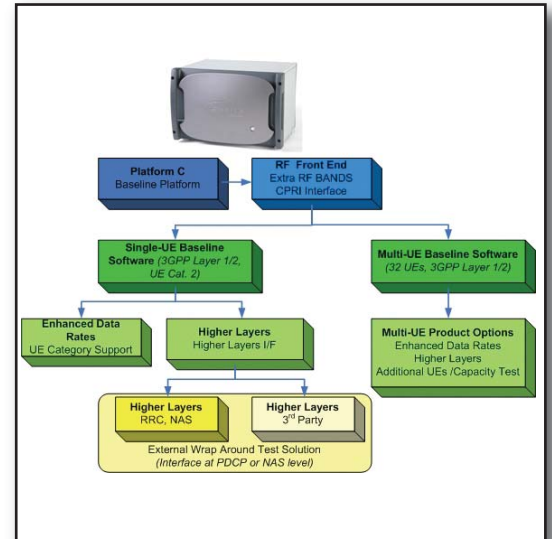


## LTE Infrastructure Testing Now

The TM500 LTE product range is a major development by Aeroflex to support the current and future technologies based around 3GPP's Long Term Evolution programs. Based upon a new and scalable software defined radio platform, TM500 LTE provides a set of product options targeting development, testing and demonstration of 3GPP LTE infrastructure equipment.

Launched in 2007 the initial product in the range is the TM500 LTE FDD Single UE. This has been in use with the major infrastructure vendors worldwide, making TM500 LTE the leading product in UTRAN base station test equipment.

The range now also includes options for higher layers, higher category UEs, TDD and Multi-UE operation. With its layered operation and automation interfaces the TM500 LTE can additionally operate within an automated or wrap around test configuration. The Multi-UE test system targets scheduler, load and capacity test.



TM500 LTE product family

The figure below illustrates the current and near term product options available with the TM500 LTE product line. Further product options extend the TM500 LTE's capability by adding support for higher data rates (to UE Cat. 5).

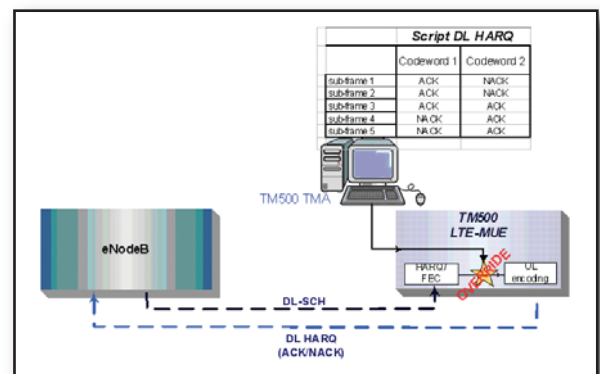
## LTE Layer 1 Layer 2

The TM500 LTE FDD Layer 1/Layer 2 product provides full 3GPP LTE functionality of PHY, MAC and RLC layers supporting 3GPP category 2, 3 and 4 UEs. These provide 2x2 DL MIMO with data rates up to 150 Mbps DL, 50Mbps UL.

Through experience in WCDMA test and LTE demonstration systems, Aeroflex has developed a wide range of features and tools to support LTE eNodeB and network equipment development, integration and test. The TM500 incorporates test modes for an incremental, layered approach to development and testing of the LTE stack. Specific test modes targeting HARQ, MAC, RLC and PDCP operation are provided. These modes enable detailed functionality to be tested at a modular level, and thus very early testing of eNode B features.

Operation of the TM500 LTE is via the Aeroflex integrated and flexible control & logging user interface (the TMA). The TMA provides a set of comprehensive control, measurement, data logging, display and analysis tools for use at all layers. The TM500 LTE can also be operated via an external automated or wrap around test system.

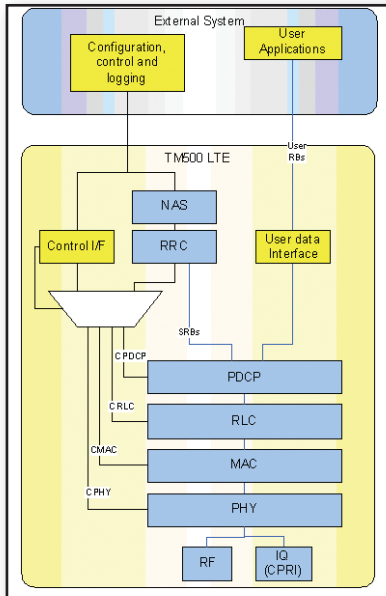
TM500 additionally supports enhanced test features, including the scripted override of L1/L2 control information enabling early test of closed control loops or to simulate error or fault conditions.



Control override of DL HARQ operation



## LTE Higher Layers



TM500 LTE Higher Layers

A “single box” solution is available for 3GPP LTE testing by adding the Higher Layers option. This adds full PDCP, RRC, NAS and USIM functionality to the baseline TM500 LTE Layer 1/Layer 2 product. The full 3GPP LTE compliant stack runs internally on the TM500 LTE platform minimizing Layer 3 latencies and with real-time dynamic state behavior.

The TM500 LTE simulates the behavior of a real handset with USIM and AT command interfaces, but with the added advantage of full control and logging of all Layer 1, 2 and 3 operations via a single common front end GUI for configuration.

There are also test features including scripted control of measurement reports and negative test scenarios.

TM500's modular software design also enables it to be incorporated into automated and wrap around test systems, with control either at PDCP level or via AT commands at NAS level.



## LTE Multi-UE

Aeroflex introduced the concept of “Multi-UE” testing for cellular infrastructure with the TM500 HSDPA Multi-UE product whereby the operation of large numbers of UEs are simulated within a single cost effective platform.

At layer 1/layer 2, Multi-UE testing enables load and stress testing of the eNode B as well as validation and optimization of the complex data scheduling algorithms. With the additional of higher layers and higher numbers of UEs TM500 LTE can support system load and capacity testing scenarios.

The baseline TM500 LTE Multi-UE product provides 32 UEs with PHY, MAC and RLC functionality, as well as higher layer full stack operation as an option. The scalable platform enables future options to increase the number of simulated UEs from 32 to 96 and beyond to support capacity test scenarios.

## Future

As the 3GPP LTE specifications develop in the coming years to support the LTE Advanced functionality of Release 9, 10 and beyond, TM500 LTE provides both a committed roadmap and clear migration path.

The future TM500 LTE roadmap already includes enhanced Multi-UE and capacity test support plus higher data rates to DL 300 Mbps and UL 75 Mbps using 4x4 DL MIMO. Aeroflex is monitoring 3GPP LTE-A developments as well as working closely with our customers in order to develop new options and tools as the cellular technology advances.

TM500 LTE provides a clear migration path through the powerful and scalable Software Defined Radio platform. This not only supports the future LTE technology roadmap but also maximizes return on investment.



## TM500 Summary Specifications

- 3GPP LTE FDD & TDD
- L1, L2, RRC and full system level modes
- Single UE, Multi-UE and Capacity test solutions
- 150 Mbps, 20 MHz, MIMO, Multiple RF bands and CPRI
- Cabled or over the air operation
- Comprehensive logging, control, display and analysis tools

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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.