Understand 3G LTE testing challenges

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With over 2.5 billion users and growing, the GSM/3GSM radio access technology dominates today's global cellular landscape. To keep pace with this growth and the demand for faster, more bandwidth-intensive services, it is essential that the technological infrastructure continue to evolve while remaining efficient, competitive and successful.

Key to this is the development of the underpinning technology. Over the last three years, the 3G Partnership Project (3GPP) standards forum has been specifying the next major evolution of GSM/UMTS standards. This evolution has two threads. First is the enhancement of the existing W-CDMA universal terrestrial radio access network (UTRAN) through the high speed packet access plus (HSPA+) specifications and the second is the Long Term Evolution (LTE) specifications for the Evolved Universal Terrestrial Radio Access Network (E-UTRAN).

Commercial reality

At present, HSPA technology has over 120 commercial networks delivering broadband mobile capability to more than 300 different device types. HSPA+ is expected to access the remaining potential of the existing 5MHz W-CDMA radio access networks (RANs), offering improved response times and peak data rates up to three times that of HSPA.

LTE, together with System Architecture Evolution (SAE), promises a more significant system evolution that will deliver peak data rates of 300Mbit/s for downlink and up to 75Mbit/s for uplink, as well as faster response through reduced latency.

The LTE/SAE specifications define a simplified, optimized, all-IP core network that can deliver operational improvements. These improvements include higher spectral efficiency and flexibility, higher numbers of users per cell and lower per-Mbyte cost. The LTE/SAE network architecture will also accommodate co-existence and interoperation with other radio access technologies including GERAN/UTRAN and WiMAX.

Much of the spectrum required for LTE will come from 3G extension bands and GSM spectrum refarming, which is fragmented and spread over a wide frequency range—from 400MHz to over 3GHz. The 3GPP LTE specifications aim to address this issue of diverse allocation of spectrum resource through the support of variable RF bandwidths ranging from 1.25MHz to 20MHz, paired and unpaired frequencies and multiple RF bands. Other radio access technology changes employed in LTE are the adoption of OFDM access, and increased spectral efficiency from MIMO antenna technology and higher order modulations. The demanding pace of standards development has so far yielded the specification at around 90 percent of the fundamental layers of the LTE RAN. In January, these specifications received approval for inclusion in the 3GPP Release 8 standards.

There has been impressive progress on the implementation side with several LTE experimental demonstrations and pre-commercial trials already underway and major new trials due to run this year. Aeroflex supports a number of these programs through its TM500 LTE test mobile and PXI waveform generator solutions.

This momentum bodes well for the rollout of the first 3GPP LTE commercial systems, forecast to start in early 2010. Meanwhile, the 3GPP HSPA+ technology is expected to enable operators to offer early access to evolved services and facilitate a smooth transition to LTE. It ensures that there is no competitive gap between today's HSPA and future LTE networks.

Great progress has been made in establishing the first formal 3GPP LTE RAN specifications and early proof of concept trials. However, there are plenty of challenges ahead. The completion of the specifications, followed by implementation, test and initial rollout of commercial systems will continue to require huge efforts from the cellular industry. In these early stages, the fast pace of development, implementation of a new air interface and the architectural changes in the RAN are likely to be demanding.

Development challenge

The fast pace of LTE development means that the implementation of early systems is, in a number of areas, running ahead of formal 3GPP specifications. In particular, the early "proof of concept" systems have been developed in the period preceding the availability of formal 3GPP specifications. This has led to solutions incorporating substantial elements of proprietary assumption and customization.

There are also holes in the 3GPP specification. From the PHY perspective, these undefined areas are mainly concentrated on the uplink and downlink control signalling. From a higher-layer perspective, the specifications are not expected to be ready for formal release until September. In the meantime, proprietary solutions continue to add more customization as required to enable the early higher layer operation.

For these LTE systems under development, it is essential that the test process and equipment can support the latest core 3GPP specifications and proprietary assumptions and customization.

New air interface

The LTE/SAE architecture enables significant reuse of legacy infrastructure especially in the core network. Within the air interface, the LTE E-UTRAN borrows from earlier access technologies but it is essentially new, thus requiring a significant development program.

It will be important to gain

Aeroflex has rolled out the TM500 LTE test mobile and PXI waveform generator solutions for LTE testing.

early debug, test and validation of the key enabling features of the new specification. This includes MIMO, fast, low latency HARQ procedures, 64QAM and the broad set of RF band and BW combinations/configurations that provide spectrum flexibility. Establishing the fundamental building blocks early on will enable test and validation procedures to proceed up to system level as quickly as possible.

Changing architecture

The LTE/SAE requirements for minimizing the overall network architecture and protocol as well as reducing latency can lead to significant differences between the E-UTRAN and UTRAN architectures.

The UTRAN employs relatively "dumb" PHY radio base stations (called NodeBs). These connect in a star topology into radio network controllers, which carry out the management of the radio resource and connect in turn to the core network.

By contrast, in E-UTRAN, much of the radio resource management is devolved into the base stations (called eNodeBs). The eNodeBs (eNBs) now connect directly into the core network gateway via a newly defined "S1 interface." eNBs are also interconnected to adjacent eNBs in a mesh via the "X2 interface." Apart from the new layer 1 and layer 2 functionalities, the eNB will also handle radio resource control, admission control, load balancing and mobility.

The high level of functionality and performance required from the eNB base station make it a complex and critical entity in the LTE architecture.

Solutions

To achieve fast time-to-market of E-UTRAN infrastructure with evolving specifications, new technology and different architectures demand a rapid and efficient development and test program. Having the right test equipment when needed is a critical factor in this process.

Test equipment like the Aeroflex TM500 and PXI 3000 Series are designed to address the challenges mentioned. The Aeroflex solutions employ both a software-defined radio platform and a fast, efficient software development process. This enables the equipment to support the core 3GPP LTE specification and its evolution as well as proprietary customization. It seems clear that the "long" in LTE means it will serve the mobile industry for the long term—and without delay.