The increasing global deployment of long term evolution (LTE) networks has offered significant opportunities and challenges for test and measurement (T&M) vendors. According to Frost & Sullivan, revenues for the global LTE test equipment market stood at $945.8 million in 2012. With the growing uptake of LTE services, these are expected to cross $2.8 billion in 2018. Currently, there are over 160 commercial networks across the world, which will increase to 195 by end-2013. The number of available LTE devices increased from 269 in January 2012 to about 600 by end-2012. The trend is likely to continue, thereby creating a significant demand for T&M solutions for network integrators and device manufacturers.

Growth drivers

According to a recent report by Heavy Reading, the strongest driver for utilising LTE T&M solutions over the next two years will be lower costs. Telecom operators' business is rapidly evolving into that of a low-cost utility service provider. They must cut costs through automation by reducing their workforce and by avoiding duplication of infrastructure. T&M solutions will help in cost reduction while expanding coverage and increasing efficiency.

Another key driver for T&M uptake in the LTE segment will be its ability to ensure quality of experience (QoE) and quality of service (QoS). It is important for operators to remain focused on testing, monitoring and ensuring QoE and QoS. End-users expect seamless access to mobile services any time and anywhere, as well as personalised interactions with service providers. As operators move to LTE, delivering these services will gain importance for mobile service providers, especially for remaining competitive. Any degradation in QoE or failure in a live network may result in major implications for the mobile network operator's business and the network equipment manufacturer's reputation.

Other key reasons for using T&M solutions for LTE networks are that these improve the operators' ability to offer the latest functionalities, and facilitate deployment and management of networks.

Challenges

LTE represents a significant radio access technology shift, the realisation and deployment of which is a major challenge. The test requirement arises across the entire LTE equipment supply chain, from components to end-user services including base stations and handsets. There is a need for test equipment to support not only the frequency division duplex version of LTE as the natural evolution of GSM/UMTS networks, but also time division duplex. Further, with CDMA-based network operators also announcing plans to migrate to LTE, there is interest in the internetworking of LTE with multiple wireless technologies.

However, the newness and complexity of LTE technology poses several engineering design and test challenges. These are:

- In order to support the shift to other radio access technologies such as TD-SCDMA, and CDMA2000 technologies in addition to GSM/UMTS, multiple radio standards will need to be supported, especially due to the lack of voice support in early LTE networks.

- Another challenge is to maintain data throughput rates at cell edges, where the signal-to-noise ratio is usually the lowest, and in crowded cell conditions. LTE will deliver peak data rates of 300 Mbps in the downlink and up to 75 Mbps in the uplink. It is, therefore, important that both receiver and transmitter performance is optimised, making the best use of the available signal in a noisy environment.

- The variable channel bandwidths specified for LTE increase the system's flexibility and capability, but add to its complexity. The use of multiple antenna configurations and orthogonal frequency division multiple access (OFDMA) to support high data rates adds to the complexities, though it is expected that by the time LTE products reach the radio frequency (RF) testing stage, test engineers will be able to apply the lessons learnt from implementing multiple input multiple output (MIMO) and OFDMA in Wi-Max. However, the use of single carrier frequency division multiple access in the uplink will pose challenges unique to LTE. With exceptionally high performance targets set for LTE, engineers have to make careful design trade-offs to cover each critical part of the transmission chain.

Also, there are issues related to wireless design. The overall system performance depends on the performance of both the baseband and RF sections, and each has particular impairments – for example, non-linearities and high noise in an RF up-converter or down-converter, phase and amplitude distortion from a power amplifier, channel impairments such as multi-path and fading, as well as those associated with the fixed bit width of baseband hardware.

Carrier aggregation and VoLTE

LTE has become a global phenomenon, but with only three years of real-life deployment, the technology is still in its infancy as compared with 2G/3G technologies. However, things are changing quickly and it is not surprising that the first LTE improvements have already been discussed and agreed on in 3GPP standardisation. Moreover, the technology components specified in 3GPP Release 10 – also known as LTE-Advanced (LTE-A) – are gaining industry-wide traction. The key feature of LTE-A is carrier aggregation, which is a complex and powerful technology enhancement. The variances allowed in carrier aggregation increase mobile device complexity. Receiving multiple frequencies with an overall increased bandwidth requires significant redesign in the receiver chain. Primarily, the higher data rate capabilities need to be tested on all layers (the physical layer, the protocol stack and engineer-to-engineer). This also requires verifying the correct end-user behaviour in terms of the response to radio resource control messages. At the base station, a major design challenge is at the transceiver front end, which must support multiple band combinations. This requires the use of highly flexible switches, wideband power amplifiers and tuneable antenna elements.

Another emerging trend in this market is VoLTE network deplotment. The first movers to LTE technology have already deployed commercial VoLTE services. According to Arc Chart, there will be over 74 million VoLTE-enabled handsets in the market by 2016. So far, the delivery of LTE has been reliant on a 4G network model with a fallback option to 3G networks. However, this will soon be replaced with a fully integrated VoLTE system with a stringent requirement for QoS tolerances to deliver quality voice.

With VoLTE, operators are able to deliver an end-to-end QoS through the evolved packet core as well as over the radio network – which is also improved through MIMO antennas. This provides engineering as well as T&M challenges for mobile operators that are moving rapidly towards VoLTE. The vendor ecosystem has responded with the provision of big data geoanalytics platforms that provide operators an end-to-end view of user QoE across the core and radio access networks.

However, significant engineering considerations have to be taken into account to ensure the successful implementation of VoLTE and the delivery of VoLTE quality assurance. Real-time monitoring and network analysis tools need to be put in place to provide operators with an end-to-end view of the network and service performance.

Conclusion

While LTE has the potential to enhance current deployments of 3GPP networks and provide significant new service opportunities, its commercial success requires the availability of measurement solutions that can keep pace with standards development.

Going forward, LTE service providers will start offering stringent service-level agreements to enterprise customers. This will require a deeper level of monitoring usage and the ability to proactively troubleshoot failures. Meanwhile, the T&M industry must continue to focus on developing large-scale testing solutions, especially in terms of user plane traffic analysis and high-scale field-portable tools to accurately identify faults.