

The technology advances witnessed during the last decade have driven changes in areas such as modulation techniques, operating frequencies and information protocol. These changes have ushered in a revolution in the test and measurement (T&M) equipment sector, leading to new and revised standards for wireless communication equipment as well as optical networks. The ever-rising need for speed and capacity are further fuelling this growth.

### **Evolving needs for optical communication**

Although optical networks have been in existence for many years, the communication technologies pertaining to them are evolving on a continuous basis. Optical systems are already dominant in core networks and with increasing user needs for triple-play services, their presence is set to increase in access networks as well.

Testing needs in optical communications range from development to deployment of networks. There are broadly two sets of T&M requirements in this space: testing of optical networks during installation and commissioning, and testing for research and development (R&D) and manufacturing.

Several technological developments have taken place in optical communication systems, leading to evolution in T&M technologies. First, it is important to certify the physical media (for attenuation, polarisation mode dispersion, chromatic dispersion, etc.) to ensure that the link works on the desired technology. This is followed by testing the specific technology and the rate at which it is being deployed. Different technologies will need to run different tests.

Further, significant developments have taken place in optical communication capacity enhancement. Fibre at 10 Gbps suffers from bandwidth limitation and other non-linear effects that interfere in the system. To counter these, a new concept of optical modulation, similar to radio frequency (RF) modulation, has been designed. Systems based on optical modulation require special test equipment like modulation analysers. Test equipment should be developed in a way that it can be integrated into an automated monitoring system, connected to a network

operation centre to alert technicians about faults as they occur.

## **Emerging wireless technologies**

With the introduction of 3G services and proposed launch of broadband wireless access services, the demand for T&M instruments that support the development and manufacture of RF components is on the rise. Wi-Fi, Bluetooth, CDMA, GSM and now 3G are some of the dominant technologies prevalent in the Indian telecom space. 4G technologies like LTE and Wi-Max are also evolving in India. Both fixed and mobile Wi-Max have very complex requirements in terms of characterisation. In fact, conducting even basic RF transmitter measurements on Wi-Max requires high performance test equipment with advanced measurement functionality.

Further, ensuring the operational readiness of LTE networks is imperative not only during the initial technology launch, but also as the network and services grow and mature. From a testing standpoint, this means more complex conformance testing. Testing the components of a 4G network requires comprehensive test coverage of RF, protocol and system-level elements including base stations, cell sites, handsets and network infrastructure.

## **Developments in T&M**

The introduction of next-generation wireless technologies and upgradation of existing ones demand constant innovation on the part of T&M vendors. Since product life cycles get shortened with increased frequency of upgradation, it is a challenge for T&M vendors to keep pace and ensure interoperability as well as conformance with regulations.

Such a scenario calls for test equipment that is designed for testing to specific standards. Peripheral component interconnect extensions for instrumentation is a modular test equipment architecture that allows customers to design custom-test applications. Since these systems can be rapidly customised and reconfigured, it plays an important role in standards-based testing. Its high speed translates into greater throughput, resulting in lower costs. Other advantages include system expandability, small form factor, a wide range of instrumentation and vendors, mass data transfer, and integrated timing and synchronisation.

Digital RF is a key enabler of wireless technology and has contributed to rapid growth of technologies such as Bluetooth, Wi-Fi and Wi-Max. These applications often exist within the same parts of RF spectrum. This requires complex, time-varying signals using adaptive modulation, frequency hopping and bursting techniques to avoid interference. Thus, this signal variability over time calls for T&M equipment that can look within domains of time, frequency and modulation simultaneously when testing these RF applications.

Telecom T&M vendors are working to develop platforms that can be used across multiple products to achieve economies of scale. Wireless operators look for such solutions that can provide maximum return on investment and where the same platform can be used to meet future requirements as well.

Networks, devices and high bandwidth applications will continue to be the major drivers for growth in mobile data traffic. This will further lead to high demand for feature-rich, cutting-edge T&M tools. With the advent of next-generation technologies, the telecom T&M sector is likely to witness strong demand in the coming years.

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