Test and measurement (T&M) plays a critical role in the entire life cycle of a handset, from overall product development to manufacturing and repair. T&M solutions adopted by mobile handset manufacturers are designed to screen out manufacturing defects, load software, achieve optimum performance and verify key functional criteria.

An ideal handset testing process involves connecting the phone to a tester, running the test and documenting the results. This level of simplicity is achievable, but requires a considerable amount of upfront preparation. It is important to select a tester that is easy to programme, and generates accurate and fast results. Further, each type of phone to be tested needs to be characterised to understand the losses produced while transmitting signals from the tester to the phone. A test suite also needs to be defined for each phone to identify potential defects in the least possible amount of time.

In the development process, prototypes need to be tested to verify their performance against design specifications. On the manufacturing line, finished phones must be tested to ensure that they will deliver customer satisfaction. Finally, when a customer brings a phone for repair, tests are performed first to diagnose the problem and later to ensure that the repair has been properly performed.

Changes in the handset testing process

Over the years, there has been a marked shift in the process of handset testing. This could be attributed to the change in handset dimensions. Earlier, handsets were bulky with hundreds of discrete components on multiple printed circuit boards. At the time, manufacturers needed to ensure that the handsets conformed to the relevant network standard with a combination of design validation processes and manufacturing verification processes. Printed circuit boards were structurally tested using manufacturing defect analysis techniques or in-circuit test techniques. Structural testing of printed circuit boards was undertaken for inspecting correct assembly placement and correct values of individual components. This was followed by functional radio frequency (RF) testing and adjustment of performance. The received signal strength and adjacent channel performance using interferers were tested at this stage. After the final assembly, actual phone calls were made in order to test the overall functioning of the phone.

The test processes have now been aligned with the technological advancements in handsets, with the latter becoming more sophisticated with countless more features.

Testing of 4G handsets: Opportunities and challenges

The advent of 4G long term evolution (LTE) technology and multiple-input- multiple-output (MIMO) antenna schemes in the wireless realm has significantly changed the way wireless devices and networks are tested.

For 2G- and 3G-enabled handsets, simpler antenna configurations and lower-speed data protocols could be tested in a closed laboratory environment. Under this, manufacturers simply plugged a cable into a port on the device, thereby eliminating the need for testing the antenna. This process focused mainly on receiver and transmitter performance as well as algorithms for cellular handoffs.

However, test instruments intended to evaluate a 4G smartphone must emulate not only the transmitting and receiving characteristics of a 4G base station, but also environmental conditions such as signal fading and multipath.

In this context, over-the-air (OTA) testing has emerged as the preferred T&M method for 4G devices. OTA testing involves the physical evaluation of the prototype handset in field conditions where subscribers will actually use it.

A key challenge associated with the testing of 4G-enabled handsets is the lack of spectrum harmonisation for 4G services. Globally, operators are using different spectrum bands for time division duplex-LTE networks. For instance, companies in the US use spectrum in the 700 MHz and 1800 MHz bands to provide 4G services while those in Europe utilise the 2.6 GHz band. Operators in India use the 2.3 GHz and 1.8 GHz bands while those in Japan use the 2.1 GHz band. These bands conform to and operate on different standards and configurations. This requires equipment vendors to manufacture a wide range of testing instruments, specific to different standards. Owing to the multiplicity of radios within handsets, RF engineers face significant design and test challenges in ensuring consistent performance across multiple

bands. In addition, the currently available LTE-enabled T&M equipment can cater only to a limited number of spectrum bands, which are used in mature markets, as they were the early adopters of technology.

Another challenge is dealing with interoperability. Since 4G is a relatively new phenomenon, handsets must be able to operate seamlessly between existing 3G networks and the newer 4G/LTE networks. They must do so without dropping data connections or calls. In addition, optimisation is required on both the network and device sides.

Dealing with voice calls in smartphones also poses test challenges. For instance, some operators use their 2G network for voice while data is transmitted on the 3G and/or 4G/LTE networks. This two-radio approach can have a significant effect on the handset's battery life if the optimal design criteria are not taken into account.

Data performance of smartphones is also a critical test area. For instance, with channel bandwidths of 20 MHz, data rates should theoretically reach 50 Mbps. However, the performance in terms of real-world speeds is often unsatisfactory with many factors such as MIMO implementations and network issues coming into play.

In addition, there is a need to ascertain how handsets handle data retry for 4G/LTE, that is, whether the handset that is trying to establish a data link to a server relentlessly hammers the signalling channel until it connects or it retries after a certain time interval.

Impact of MIMO technology on handset testing

The arrival of MIMO technology has brought about the biggest change in the way mobile devices are tested today. It has resulted in the proliferation of test schemes that involve intensive field testing of devices.

MIMO tests are typically undertaken in two stages. The first stage involves taking measurements in a cabled environment to establish a performance baseline for the receiver and baseband processing. The basic purpose of this is to measure the RF throughput, rather than

the IP throughput. After this, most test labs undertake external signal fading to get a sense of how the throughput varies under changing signal conditions. At the second stage, RF measurements are taken again, but in an anechoic non-echoing chamber, duplicating the environment of a cabled framework. The effects of the antenna are considered in this stage.

However, the major issue with respect to MIMO technology is how well the conditions captured in the field can be translated to the test bench. Recreating the environment in a test lab that is replete with multipath reflections and the Doppler shift is exceedingly difficult, but is critically important for network operators, infrastructure vendors and chipset makers.

Chipset testing

Testing of chipsets is critical to ensure that devices deliver exceptional performance under all required use cases and do not impair the performance of other devices sharing these crowded networks. Testing should be conducted under many different radio conditions and active frequency bands.

Chipset and device makers develop platforms and reference designs, which provide wireless modem channels to multiple end-products. Protocol testers for the development of these core platforms need to support leading-edge technology and features to help with initial feature development such as a digital baseband interface that can be used prior to baseband integration with the RF front end.

Developers need to ensure that the chipsets continue to work perfectly when code changes are made. Regular builds and frequent regression tests are needed to detect any unwanted side effects of a new feature implementation at the earliest opportunity. Further, protocol testers for regression analysis need to support automated testing of multiple technologies so that a broad functional test coverage can be achieved with minimal human intervention. In addition, it is essential for smartphone and other device makers to integrate the core wireless platform into their end products. They need to find a way to create a comprehensive set of reference tests that can be easily extended as new platform features are integrated into the handsets.

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