MIMO Technology

By Olga Yashkova, Program Manager, Communications Test & Measurement practice, Frost & Sullivan

LTE and MIMO: A Marriage Made in Heaven?

Smart devices are changing the mix of traffic on the network from mostly voice to integrated voice, video and data, which drive new demands in test products. Smartphones are not just phones; they are application-centric computers which become even more attractive when paired with the bandwidth offered by LTE technology. Smartphones have already presented a number of challenges for service providers due to increased backhaul traffic. There is a critical need to regulate traffic flows and to monetize new services. For example, a YouTube video on average uses 100 times more bandwidth than voice, while an average iPhone uses 400 Mb of data per month.

Since Multiple Input Multiple Output (MIMO) antenna technology is responsible for about half of the data rate capability offered by LTE, it is one of the most significant drivers for air-interface test equipment. If MIMO is not properly implemented, the end user experience will suffer.

According to Nigel Wright, VP of Wireless at Spirent Communications, “Effective testing of MIMO requires extremely complex emulation of the RF environment. As you may know, the data performance gain from MIMO takes advantage of the fact that the signals from multiple transmitter antennas take different physical paths to reach receiving antennas. Base station and device manufacturers need to carefully emulate the correlation between these paths in order to test MIMO algorithms and implementations.”

MIMO has also revolutionized testing methodologies. “MIMO testing needs to take into account the critical importance of antenna design and implementation, especially since the limitations of a mobile device form factor can result in major compromises when it comes to housing MIMO antennas. Traditional lab-based

testing uses a ‘tethered’ environment, where test gear is connected to a transmit/receive port on the device, bypassing the physical antennas. This approach does not effectively take into account the design of the antennas themselves.” adds Nigel.

Increasingly the test equipment industry has been observing a shift towards over-the-air testing of devices. “To take into account MIMO antenna performance, there has been rapid growth in the use of over-the-air testing techniques. This is, of course, a significant proposition because it requires a large and relatively expensive chamber, with faders precisely controlling the signals delivered to the chamber’s antennas. In addition, a mechanical positioning mechanism is needed to precisely move the device around in the chamber. Depending on the MIMO signals and on the antenna design, moving a device just a few degrees can result in a dramatic change in signal correlation which in turn leads to a change in data throughput. In addition, if the MIMO algorithms are poorly designed, they can fail to accurately track changes in device position, again leading to degraded data performance. This can be especially noticeable with video applications, where the user experience can go from perfect to unacceptable just because the device was moved a few degrees.” added Nigel.

Another key design challenge that device manufacturers face with LTE deployments is roaming. According to Mike McKernan, Product Manager at Spirent Communications, “The simplest way to de-correlate MIMO signals is to physically separate antennas, but device size can be a limiting factor in obtaining adequate separation. The remarkable spectrum fragmentation we’re already seeing with LTE presents the enormous design challenge of a MIMO implementation that works across multiple frequency bands, which reinforces the need for over-the-air MIMO testing.”
Another test methodology gaining momentum is the capture of real-world conditions in the field for playback in the lab environment. Spirent’s VR5 with Virtual Drive Test and Azimuth’s Field-to-Lab are examples of such effective solutions. “MIMO performance is very sensitive to multi-path reflections, but with live-network drive testing it’s impossible to precisely reproduce the RF environment across multiple runs over the same route. Solutions are now available that allow you to capture live field data and use lab-based test equipment to replay these complex RF environments in the lab in a very consistent way. This allows you to identify problems and validate potential solutions much faster.” added Nigel. With all this additional complexity in test setups, Mike stated that solutions such as VR5, which pack more emulation capability into a bench-top package, successfully address another important challenge that network equipment and device manufacturers face: limited lab space.

MIMO brings a number of unique testing challenges due to its complexity, and because of this it presents numerous opportunities for wireless test equipment vendors. As the increasing demand for high-speed mobile data forces the industry to find more spectrum, MIMO will continue to play a key role in enabling higher data rates. However, it will take some time for the industry to overcome the design challenges inherent in unlocking the ultimate performance of MIMO.

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