Caution: MIMO Test Challenges Ahead

Greg Jue, RF Applications Specialist, Agilent Technologies

It wasn't all that long ago that Multiple-Input Multiple-Output (MIMO) technology first captured the cellular industry's attention by promising higher data rates for a single user using two or four streams of data transmitted (and received) with multiple antennas. Multiple antenna implementations of Orthogonal Frequency Division Multiple Access (OFDMA) signal formats such as Mobile WiMAX™ and 3GPP Long Term Evolution (LTE) can enable increased data rates relative to Single-Input Single-Output (SISO) implementations. Increased data rates can be realized by doubling or even quadrupling the number of antennas in the implementation, as is the case with two- or four-channel MIMO. Today, LTE work typically focuses on single-antenna SISO implementations but as the standards evolve and R&D engineers seek to take advantage of the higher data rates possible, such implementations will likely migrate to two- and four-channel MIMO.

It's because of this ability to deliver higher data rates that MIMO has become a key technology of emerging 4G wireless standards. Unfortunately, this benefit comes at a price. After all, MIMO is a very complex technology. As R&D engineers migrate to two- or even four-channel MIMO, that complexity will increase significantly, introducing a multitude of design and testing challenges that impact peak data rates and make it difficult to troubleshoot and debug hardware performance issues.

To ensure optimal performance in a four-channel implementation, for example, engineers will need to perform comprehensive, four-channel phase-coherent MIMO measurements like error vector magnitude (EVM)—a key metric for transmitter performance. Since RF and baseband impairments like timing errors, LO phase noise, power amplifier gain/phase distortion, and IF/RF filter group delay can contribute to transmitter EVM degradation, gaining insight into such error mechanisms will be critical to uncovering potential MIMO performance problems.

Insight into antenna crosstalk—the cross coupling of signals from one antenna channel to the next—will also be critical for engineers working on multi-channel MIMO implementations. Consider, for example, that in an actual hardware implementation of four-channel MIMO, the four transmitters introduce impairments like phase noise and gain compression, while the upconversion introduces intermodulation products. The power amplifier adds distortion (both amplitude and

phase) on the signal as it is compressed. While each of these error mechanisms plays into the overall EVM measured at the four-channel output, antenna crosstalk from the four antennas may also impact EVM and thus, overall MIMO performance.

Dealing with these challenges demands a solution that:

•Enables a quick and accurate means of performing multi-channel MIMO RF test and debug

•The ability to look at all channels individually, as well as at the inter-relationships between the channels; and

•The ability to debug both the design and the hardware.

One way to address these challenges is through the use of a time-coherent multi-channel wideband oscilloscope that is able to measure both the EVM of each channel and the antenna crosstalk from one antenna to the next. Utilization of signal analysis software to complement the oscilloscope can also be helpful, allowing the engineer to measure and analyze MIMO signals from a number of different perspectives (e.g., time, frequency and modulation domains).

Multi-channel LTE MIMO designs, while not yet widely implemented, are anticipated. They will be driven by the ever increasing demand for higher data rates. The multitude of design and test challenges this creates will require test and measurement solutions capable of performing four-channel phase-coherent MIMO measurements and diagnosing potential timing errors between transmit antenna channels. Such capabilities will be critical to enabling R&D engineers to diagnose and isolate hardware performance issues and other issues affecting system-level RF transmitter performance budgets, at any stage in the design process.

Greg Jue is an RF applications specialist in Agilent’s High Performance Scopes team. Previously he was an applications development engineer/scientist with Agilent EEsof Electronic Design Automation (EDA), specializing in SDR, LTE and WiMAX™ applications.

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