Q&A: 5G ANTENNA MINIATURIZATION, COMPONENT VALIDATION ARE LATEST WRINKLES IN RF/MICROWAVE TEST

By Mike Hockett, Editor-in-Chief

The field of RF/Microwave testing has been in a constant state of flux as new technologies have required increasingly advanced testing methodologies over the years. That fact has been put in overdrive with the onset of 5G.

I recently interviewed National Instruments' Senior Solutions Marketing Manager Sarah Yost, and NI Semiconductor Offering Manager Chen Chang, about what they're seeing in RF/Microwave test, how 5G has impacted it, and the outlook for 5G technology as a whole.

Mike Hockett, EE: **What trends are you seeing in the broader RF/Microwave test field, or specifically in 5G test?**

Yost

Chang

Yost and Chang, NI: With 5G upon us, the excitement is tangible as the entire wireless industry moves toward a 5G-connected world. Over the next few years, 5G will start deploying in volume, and we'll all get to experience the benefits of this technology firsthand.

As we move to wide-scale deployment, we're bringing 5G technologies off the engineers' benches, through automated verification and into full production. For the sub 6 GHz bands, the test techniques are well understood and ready today. For 5G in the mmWave bands, the challenges and business opportunity are much greater.

The move toward mmWave bands is one such area where 5G is affecting test and measurement. Most 5G components today operate between 24 and 55 GHz, which requires the presence of a greater number of antennae to ensure efficient transmission and performance. Other issues that must be contended with in the case of these frequencies include path loss and line-of-sight blockage. Manufacturers today are looking to address this through the creation of antenna arrays that help fit multiple antennae in small spaces for a range of devices, mostly mobile devices. The miniaturization of these arrays to the chip level in 5G mobile devices, however, makes it much more difficult for test engineers to obtain accurate performance measurement. Ensuring that the required 5G infrastructure is in place, hence, is an important issue to be addressed for these components to be tested effectively.

And at NI, we're very excited to be taking these challenges head-on.

MH: **RF/Microwave and 5G testing covers a lot of ground—everything from algorithm development to channel sounding. What specific areas are today's testing vendors focusing on?**

Yost and Chang: Advanced wireless research is continuing in a number of different areas. 3GPP Release 16 and Release 17 has been driving some of the research, for example, like making improvements and modifications to enable V2X communications, power optimization for IIoT applications, and even as drastic as researching new physical layer waveforms for communications above 52.6 GHz. How unlicensed spectrum will be shared between cellular communications and everything else (like Wi-Fi) is another hot topic in the standards community. Of course, 3GPP and standards bodies aren't the only ones defining wireless innovation. Topics like terahertz frequencies for communications and sensing are gaining traction as well.

MH: **5G rollout has already begun, but primarily at the mobile wireless service provider level. Large-scale 5G deployment appears to still be at least a year away. When do you foresee widespread rollout of true 5G services?**

Yost and Chang: This all depends on how "true 5G service" is defined. The majority of the world will not get 5G services in the next year. It is expensive and time-consuming to roll out new equipment, but sub 6 GHz technology is being deployed today. It will likely take 3-5 years for these technologies to be widely available, if not longer. But 5G, as it's defined, is a lot more than just sub 6 GHz technology and it's much more than just enhancements to the mobile broadband. Applications that will be built on top of

▲ National Instruments' PXI-5831 vector signal transceiver.

5G will take even longer because they need a robust 5G network as a base. Most of the more lofty applications that are associated with 5G are more realistically on a 5- to 10-year timeline. Remember, when 4G was defined, it took about 8 years for 4G and LTE to be rolled out and considered widely available for consumers. 5G will be no different.

MH: **Before anything can be formally rolled out in 5G, there are many challenges to overcome in the area of RF/Microwave testing. What are the key challenges here for vendors, or their customers?**

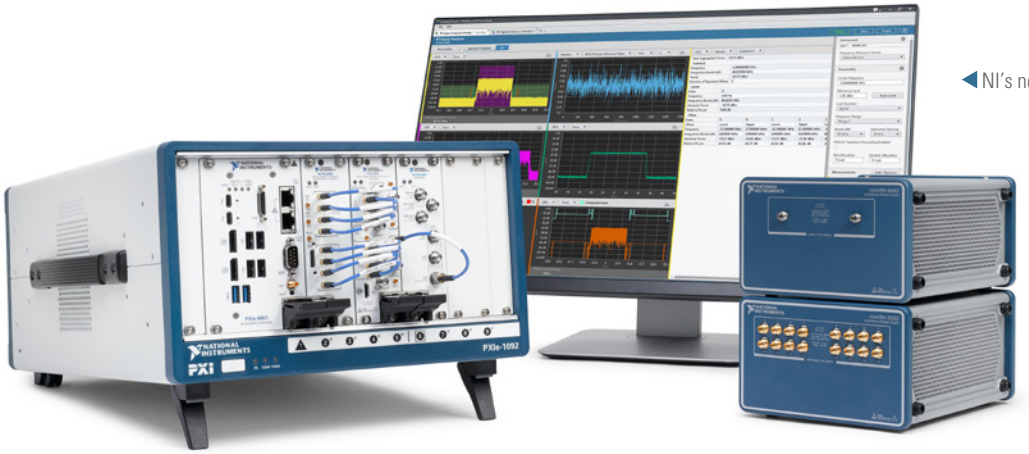
Yost and Chang: The next-generation communications network is about more than fast data rates and greater capacity. It's about the seamless, real-time interaction between humans and billions of intelligent devices. Although it presents vast possibilities, 5G new radio (NR) presents significant design, prototype, and test challenges.

Waveforms are wider and more complex, and engineers need to work with highly complex, standard-compliant uplink and downlink signals that have larger bandwidths than ever before. Additionally, engineers need cost-effective test equipment to configure more test benches for a shorter time to market. These new benches must support high linearity; tight amplitude and phase accuracy over large bandwidths; low-phase noise; extensive frequency coverage for multiband devices; and the ability to test for coexistence with other wireless standards.

Meanwhile, component characterization and validation require more testing. Engineers must not only test innovative designs for multiband power amplifiers, low-noise amplifiers, duplexers, mixers, and filters, but also ensure that new and improved RF signal chains support simultaneous operation of 4G and 5G technologies.

Given the mmWave challenges mentioned above, the industry is consistently looking for new innovations that can adapt to dynamic telecom requirements. Over-the-air (OTA) testing is one such technique that has found success within the industry, but has also proved difficult and more complex. OTA testing does away with the need for physical connections between each antenna device—utilizing wireless capabilities for increased test and measurement accuracy. Ultimately, the move to OTA testing will help create a system that will be able to adapt to future testing demands, but how to do it efficiently and cost-effectively is a big challenge.

MH: **Obviously, 5G is the big topic of discussion right now and will be for years to come. But with the vast majority of us still operating on 4G or even 3G connectivity until the fifth generation of wireless communication is available, how are**



◀ NI's new mmWave vector signal transceiver.

vendors protecting their investments in 4G test & measurement equipment?

Yost and Chang: Since the beginning of cellular communication, test engineers have been iterating on an accepted set of measurements and techniques to test wireless communications technology in high volumes, from RF semiconductors to base stations and mobile handsets. But with 5G, the technology inside these wireless devices will be more complex, and the highly optimized techniques that have been used to test previous generations will need to be rethought.

For anything sub 6 GHz, we can solve for upgrades in test and measurement equipment with our software. By using a software-defined platform, when new standards or waveforms come forward, it is easier to keep current and old technology updated with the new requirements.

However, mmWave technology adds another layer of complexity that is fundamentally different than 4G and previous technologies, so it does require further investments. Test managers must make additional business considerations to ensure product quality while minimizing the impact to time to market, capital cost, operating cost, and floor space (to accommodate OTA chambers). Over the next few years, the test and measurement industry will be rapidly responding to these challenges with many new innovations. Test groups should consider highly flexible, software-defined test strategies and platforms as a way to ensure their capital expenses today can keep pace with this rapid cycle of innovation. EE