Paving the Way for 5G Wireless With mmWave Cellular Systems

Submitted by National Instruments

Overview
Wireless consumers’ insatiable demand for bandwidth has spurred unprecedented levels of investment from public and private sectors to explore new ways to increase network capacity and meet escalating demand. Industry analysts predict demand will outpace capacity; it’s simply a matter of when. Wireless researchers continue to present ideas to address capacity challenges and explore network topologies that not only tackle capacity concerns but also offer features and functions never thought possible. Transitioning from concept, which is largely a software exercise, to a working prototype with real signals and waveforms requires extensive investments in time and money, and has been an impediment to the adoption of new technologies and capabilities. Design approaches that embrace software reconfigurability with an accelerated path to prototyping can expedite the design, exploration, and deployment of these technologies in new and exciting ways.

1. Meeting the Demand With mmWave Bands
The highest radio frequency band in practical use today is mmWave or EHF (Extremely High Frequency), which is the next band above microwave. It includes frequencies from 30 to 300 GHz. Because this band has a wavelength of between 1 and 10 mm, it has given rise to the name millimeter band or millimeter wave, also called mmWave or mm wave.

To increase spectral efficiency of current commercial cellular systems, researchers are exploring physical layer techniques such as massive multiple input, multiple output (MIMO); interference coordination; network densification; and many others. In addition to these techniques, availability of large chunks of spectrum in licensed and unlicensed mmWave bands (above 28 GHz) have generated interest from researchers, in both academia and industry, as a way to meet the multigigabit per second data rate demand of 2020 and beyond.

Using these bands for cellular communication poses some challenges. In addition to the high path loss, some of the bands suffer propagation loss due to water vapor and oxygen absorption. However, recent channel measurement campaigns in dense urban environments have shown that the necessary link budget for cellular systems can be achieved using a combination of steerable antenna beams and new network topology. In addition, cost-effective CMOS technology has strengthened the viability of mmWave 5G cellular systems. In the coming years, a significant amount of research will go from theory to a practical and commercially viable mmWave cellular network.

2. Defining a New Frontier
NI is playing a key role in providing tools and technology for prototyping and defining this new frontier for wireless communications. The NI hardware and software platform gives researchers the ability to innovate faster by providing a path from theoretical research to rapid prototyping. The NI PXI Express platform has been configured to perform all the signal processing, synchronization, control functionality, and I/O necessary to implement wireless protocols to meet the multigigabits per second requirements for 5G cellular systems. The integrated software
solution, NI LabVIEW, provides a graphical system design environment that helps researchers focus on their specific areas of research while abstracting the other necessary components of the system. Synchronization, timing, data, and control flow across modules are essential parts of such a system and are key components of NI platforms. When configured appropriately, the modular nature of the platform provides the flexibility needed to achieve the 10 Gb/s per user target data rate for 5G cellular access technology, and orders of magnitude higher for mmWave backhaul needs.

The mmWave baseband platform

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