IMS: Phased-array antennas and beamforming

Martin Rowe - June 17, 2017

Beamforming, based on multiple-input, multiple-output (MIMO) phased-array antennas, looks to make up a component part of the overall 5G cellular technology. While phased-arrays have been the basis of radar for generations, they're finding new applications in wireless communications. At the 2017 International Microwave Symposium held in Honolulu from June 6-8, 2017, Analog Devices and Keysight Technologies had demonstrations of the technology, albeit on a small scale.

Analog Devices created a demonstration for its analog beamforming ICs. The demonstration consisted of 12 receive antennas, each connected to an 8-LED bar graph to indicate signal strength (Figure 1).

Figure 1 A beamforming demonstration used 12 receive antennas, each with an LED bar graph.
The demonstration, given by ADI’s Radar and Phased Array Applications Manager Peter Delos, also used a pair of RF transceivers to generate the signals. Analog beamforming was accomplished using eight transmit elements driven by two four-channel analog beamforming ICs. As the single beam, operating in the X-band (8 GHz to 12 GHz) steered across the transmit antennas, you could see the bars illuminate relative to signal strength, shown in the video below. The X-band signals are used for military and satellite communications and thus won’t be used for wireless communications. Today, wireless signal use frequencies under 6 GHz. Future 5G radios could operate at 28 GHz and higher frequencies that are currently under consideration.

Keysight Technologies also demonstrated beamforming, but used a PXI-based system to generate signals for phased-array antennas. In this demonstration, not only could the transmitted beam be electrically steered, but the transmit antennas could be mechanically rotated by ±45° using a stepper motor. A PXI signal generator, modulator, frequency reference, and upconverter (Figure 2) created a transmit signal at 28 GHz, a mmWave frequency under consideration as part of 5G. The chassis also holds a signal analyzer used to receive signals from a fixed horn antenna.

![Figure 2](image) A PXI-based system generated a 64QAM signal for a beamforming demonstration at IMS 2017.

The transmit antennas (Figure 3) consist of a 8×8 phased array transmitting a 64QAM signal.
Transmit antennas in the Keysight demonstration consist of a motorized 8×8 array. The arrays can mechanically change angle or azimuth and electrically change through beamforming. Keysight's Signal Studio software shows the constellation diagram, received signal power, and other data. In the video below, Keysight's 5G Testbed Program Director Randy Becker explained how the systems work and that the transmitted signal contains side lobes.

While these demonstrations are small scale compared to what will be needed in cell towers, they do demonstrate how beamforming using phased-array antennas can direct signal power to a receiver.

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