This article is part of EDN’s Hot Technologies: Looking ahead to 2014 feature, where EDN editors examine some of the hot trends and technologies in 2013 that promise to shape technology news in 2014 and beyond.

Everyone wants more data, delivered faster and delivered everywhere, all the time. To get there, wireless communications is now receiving a significant increase in speed and complexity over those technologies currently in widespread use.

Significant changes are taking place both at the cellular and the Wifi levels. In fact, the wireless technologies coming into use are causing a convergence and bringing commonality to cellular and Wifi. On the cellular side, it’s LTE-A (LTE-Advanced) and on the WiFi side, it’s IEEE 802.11ac.

LTE-A and 802.11ac share common RF technologies, the most significant being MIMO (multiple-input, multiple output) radios and carrier aggregation. MIMO increases the number of antennas on a base station or WiFi access point from one to as many as eight, though three or four will be most commonly used. Some user devices such as handsets may use just two because of limited internal space.

With its multiple antennas, MIMO devices get higher throughput than single-antenna technologies because each antenna can deliver data. Plus, MIMO lets wireless networks compensate for interference, fading, and reflections caused by terrain and user mobility that can decrease data throughput.

Testing MIMO devices means the days of using wires between test equipment and DUTs for development and characterization are over. You simply can’t emulate what the devices will encounter in the real world. But, you need repeatability and that’s difficult to achieve in an outdoor setting. Thus, wireless devices are often test in RF chambers with multiple antennas inside. Figure 1 shows three antennas inside a test chamber.
In addition to using multiple antennas, LTE-A increases data bandwidth from 20MHz to 100MHz by incorporating up to five 20-MHz carriers called component carriers. It is, in effect, the same concept used in, 100Gbps fiber links that use 4x25Gbps channels, called "lanes" in the wireline world.

LTE-A also addresses spectral use. Wireless service providers are allocated spectrum in 20-MHz blocks, but they are not all contiguous. Because of those allocations, there will likely be blocks of unused bandwidth in a given location. Carrier Aggregation defined in (3GPP Release 10) assigns component carriers from different service providers to adjacent frequency bands. The result: Better use of the frequency spectrum and eventually, sharing of cells -- which benefits everyone.

Because most people use their wireless devices indoors far more than outdoors, indoor networks are also going to MIMO to increase bandwidth. Having the ability to seamlessly switch from Cellular to WiFi networks will ease the data burden currently on cellular networks. How the service provides will gain access to those WiFi networks is still under investigation. IEEE 802.11ac also works with MIMO, increasing channel bandwidth in a range from 80MHz to 160MHz. In areas where a 160-MHz-wide spectrum isn’t available, 802.11ac can divide the data bandwidth into two 80-MHz bands that are called “bonded.”

MIMO, whether used with LTE-A or 802.11ac, incorporates a concept called "beamforming" to adapt transmitted signals to surroundings, thus maximizing data throughput. This computationally intensive process applies a different weight to each antenna's signal. The multiple antennas provide more signal and thus more data throughput than a single antenna can.
Test equipment for LTE-A and IEEE 802.3ac is available in both bench and modular formats. The VR5 from Spirent Communications (Figure 2), available in LTE and 802.11 versions, supports up to 8x4 antenna configurations.

Figure 2. The VR5 from Spirent Communications can emulate MIMO wireless transmissions in up to 8x4 combinations.

Because many LTE-A devices such as handsets will use two antennas, test equipment such as the 7100 LTE tester from Aeroflex (Figure 3) can help with development and debugging. Capable of 4x2 MIMO, the 7100 uses its internal vector-signal analyzer and vector-signal generator to test transmitters and receivers. In addition to RF testing, the 7100 also tests for LTE protocols.
Modular systems have also taken hold in LTE-A and 802.11ac testing for production devices. Agilent Technologies and Aeroflex have introduced modular systems for development and manufacturing test. Both follow the 2012 release of the National Instruments RF Vector Signal Transceiver.

In August 2013, Agilent technologies introduced the M9391A PXI Express vector-signal analyzer (Figure 4), a combination of four PXIe modules for testing amplifiers, base stations, and transceivers.

The 160-MHz bandwidth on 802.11ac signals is bringing about upgrades to RF test equipment. Take, for example, the RSA5000B real-time spectrum analyzer from Tektronix. On November 19, the company announced that it increased the instrument's acquisition bandwidth to 165 MHz (Figure 5). 2014 should bring similar announcements as more 802.11ac products appear on the market.
As LTE-A IEEE 802.11ac cellular and WiFi equipment come on line in 2014, engineers will increasingly turn to these test products and others for testing wireless devices and networks. Ever faster networks will surely drive growth in the test-equipment market in 2014 and beyond, according to research recently published by Frost and Sullivan.

To learn more about testing LTE-A and IEEE 802.11ac components systems, and networks, see a Techonline webinar, Test to RF Standards.

Also watching:

**Touch screens as instrument controllers:** If you’ve ever used a tablet computer or cell phone as an instrument controller, you won’t want to go back to knobs or even a mouse. Instruments that connect to iOS and Android Devices first appeared a few years ago, but are gaining larger acceptance. At first, these instruments came from small companies such as Oscium (iOS oscilloscope, Figure 6) and Redfish instruments (DMM), but now Agilent technologies has gotten into the act with its 4000 X-Series. National Instruments has its Data Dashboard for developing data-
acquisition applications in iOS devices. On November 19, Tektronix announced that its MDO4000B Mixed-Domain oscilloscopes can be controlled from a Windows-based tablet. But it's not just test-equipment companies using tablets and phones. Individuals have also created instrument interfaces with tablets, as we saw in Wireless oscilloscope sends data to a tablet.

![Image of oscilloscope]

**Figure 7.** Will a 100-GHz real-time oscilloscope dethrone the 65GHz Teledyne LeCroy Wavemaster 10Zi?

**Signal integrity:** Now that 4x28Gbps lanes are gaining acceptance in 100Gbps data links, new signal-integrity problems arise. Every speed increase unveils a new set of problems that require measurement and simulation. We saw that at DesignCon 2013 and we'll see it again at DesignCon 2014. But will DesignCon 2014 bring about the long-awaited 100GHz real-time oscilloscope, topping the 65GHz Wavemaster 10Zi? *(Figure 7)* If it does, EDN will be sure to let you know.

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