Gigabit Wi-Fi Is on Its Way

Steven J. Vaughan-Nichols

The recently ratified IEEE 802.11n standard is today’s fastest Wi-Fi technology. But users want even faster versions for applications such as wireless video.

It was considered a milestone last year when IEEE officially ratified its 802.11n standard, the fastest version yet of the wildly popular Wi-Fi technology.

802.11n is fast enough—a theoretical maximum of 450 megabits per second, with a typical throughput of 100Mbps—to encourage some companies to use wireless networks in place of wired LANs.

However, there is still demand for more speed. For example, some users want to watch high-definition (HD) video on their smart phones. Others would like to connect elements of home-entertainment systems wirelessly, instead of using cables. These uses would require more speed than 802.11n provides.

With this in mind, IEEE and an industry consortium are working on even faster 802.11 versions. These radio-based technologies—IEEE 802.11ac, IEEE 802.11ad, and Wireless Gigabit (WiGig)—promise to deliver from 1 to 7 Gbps.

Of the standards, as well as proprietary, high-speed, video-specific technologies they hope will give them a marketplace advantage.

All of these approaches face obstacles to commercial success, including competition with one another.

According to David Dietrich, CEO of Ether2—which designs, makes, sells, and licenses networking technology—802.11n could prove to be more popular than the three new approaches.

The faster technologies will have shorter transmission ranges and thus won’t be useful in many situations. In addition, multiple vendors are working on increasing 802.11n speeds to 1 Gbps.

THE NEED FOR SPEED

The demand for higher transmission rates is driving the push for faster Wi-Fi technologies, explained Joe Epstein, senior director of technology at Meru Networks, a wireless LAN builder.

Today’s mobile users have smart phones and iPads, as well as laptops, he explained. They want speedier networking technologies so that they can have faster connections for video-conferencing, viewing HD video, and other purposes.

Consumer-electronics companies are interested in technologies that would let users wirelessly transfer a 25-Gbyte Blu-ray movie in less than a minute from a Blu-ray disc to a TV, said Michael Hurlston, a senior vice president and general manager of the wireless LAN line of business for Broadcom.

These companies want to make their products more attractive to consumers who don’t want to deal with large numbers of wired connections.

802.11ad will likely also be used to connect home-based audio/video systems’ elements wirelessly, rather than via cabling based on the High-Definition Multimedia Interface (HDMI).

In addition, businesses could use the technology for high-speed file transfers from, for example, a PC to a network-attached-storage device.

IEEE 802.11AC

IEEE 802.11ac is based on the 802.11a Wi-Fi standard, adopted in 1999. 802.11a operates in the 5-GHz frequency range and offers a theoretical maximum data rate of 54Mbps.

IEEE is likely to approve 802.11ac in late 2011 or early 2012, according to Broadcom’s Hurlston.
The technology
IEEE’s 802.11 Task Group AC is still far from deciding on all aspects of the technology.
802.11ac and ad, as well as WiGig, will work via chipsets that include transmitters, receivers, antennas, and circuitry for functions such as signal processing.
Like 802.11a, 802.11ac will work in the 5-GHz band, but it will provide larger data-transmission channels for a theoretical maximum throughput of 1 Gbps and data range of perhaps 10 meters.
Because 802.11ac uses low-frequency signals, its transmissions will be able to penetrate walls.

Wide channels and channel bonding. 802.11a uses 20-MHz-wide channels. 802.11ac, on the other hand, will work with 40-, 80-, or perhaps even 160-MHz-wide transmission channels.
802.11ac will also employ channel bonding, in which devices use two or more separate channels at the same time to transmit data. Bonding wider channels will increase throughput.
MU-MIMO. 802.11ac might utilize multiple-user, multiple-input, multiple-output technology, which would improve performance. MU-MIMO increases throughput by handling communications via multiple antennas at each of several radios’ transmitters and receivers. This new approach increases performance even more than basic MIMO, which 802.11n uses.
MIMO exploits one of radio’s oldest problems, multipath interference, to actually improve throughput. Multipath interference occurs when transmitted signals reflect off objects and take multiple paths to their destination, arriving out of phase, and interfering with and canceling out one another.
MIMO systems employ multiple antennas to use reflected signals as additional simultaneous transmission channels.

Implementation
Industry observers expect 802.11ac chipsets to be deployed in mobile phones, PCs, laptops, and mobile devices such as iPads.
Mobile-phone makers are already working on 802.11ac-based designs.

The new technologies could benefit from the support of major vendors.
For security, 802.11ac and ad, as well as WiGig, will use Wi-Fi Protected Access v2, which provides services such as encryption and authentication.

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WiGig and IEEE’s 802.11 Task Group AD is beginning to work on 802.11ad.
As currently envisioned, the standards would basically function the same way. It’s unclear whether the two groups ultimately will work independently or together.
WiGig and IEEE 802.11ad will operate very similarly to 802.11ac but will transmit signals in the 60-GHz spectrum band, which is widely available for unlicensed use around the world. The technologies will offer theoretical maximum data rates of 7 Gbps, albeit with a relatively small transmission range that would let them work only within a standard-size room.
Both WiGig and 802.11ad will be largely backward compatible with existing Wi-Fi standards, according to Wireless Gigabit Alliance chair and president Ali Sadri.
According to Broadcom’s Hurlston, IEEE might not standardize 802.11ad until 2013.

The technology
IEEE’s 802.11 Task Group AD still has many decisions to make about 802.11ad technology.
Development is further along on WiGig than on 802.11ad.
Because of the amount of bandwidth available in the 60-GHz band, both approaches would use four channels, each 2.16-GHz wide. These are 50 times wider than 802.11n’s channels. Thus, 802.11ad won’t need to use channel bonding.
When finalized, the standard might include MU-MIMO.
Transmitting in the 60-GHz band will enable WiGig and 802.11ad to offer higher data rates because there is so much bandwidth available in that frequency range.
Unlike 802.11ac, WiGig and 802.11ad will use beamforming to enable communications over longer distances. Beamforming uses multiple antennas to steer a signal to the receiving antenna, explained Mark Grodzinsky, marketing vice president at Qualcomm.
president for Wilocity, a developer of high-speed wireless chipsets and a member of the Wireless Gigabit Alliance’s board of directors.

Rather than allowing a signal’s energy to travel in all directions, beamforming focuses it on the receiving antenna, thereby extending the transmission range.

However, even with beamforming, transmissions in the 60-GHz range, unlike those in the 5-GHz range, work at frequencies too high to pass through walls. They thus generally will be useful only within rooms and not for wireless LANs.

**Implementation**

WiGig and 802.11ad chipsets will be used principally with HDTVs and consumer electronics, to enable the transmission and transfer of data-intensive high-definition signals, said Wi-Fi Alliance technical director Greg Ennis.

The technologies could also be deployed in mobile phones, laptops, and even peripherals such as printers.

“The first application that will demand these technologies probably will be streaming or copying movies [to a hard drive or video monitor] from Blu-ray discs wirelessly, rather than over an HDMI cable,” predicted Kurt Scherf, senior analyst with market research firm Parks Associates.

WiGig and 802.11ad might not work reliably in areas of high humidity and lots of rain because these conditions interfere with high-frequency transmissions, said Joe Milam, wireless sales manager for technology distributor ScanSource.

All of the high-speed Wi-Fi technologies face several practical obstacles, according to Meru Networks’ Epstein.

For example, he explained, using the technology’s wider channels in microcell systems—which utilize many small base stations close to one another to serve densely populated areas—could cause interference problems that will slow the network.

WiGig and 802.11ac could face challenges from other fast wireless connectivity technologies.

In December 2009, the WHDI Consortium—which includes Hitachi, Motorola, and Sony—finalized the Wireless Home Digital Interface standard.

WHDI is designed for use in connecting elements, even from different vendors, of home-entertainment systems in single or multiple rooms, said Joseph Kilmer, spokesperson for both the consortium and Amimon, a wireless-chip maker that belongs to the industry group.

WHDI, which transmits in the 5-GHz frequency range, provides a theoretical maximum 3-Gbits-per-second data rate and 5-meter transmission range in a single 40-MHz channel.

The WirelesssHD Consortium’s Wireless HD standard, which uses the 60-GHz spectrum, provides 10-Gbps data rates over 10 meters for connectivity in consumer electronics, personal computing, and mobile devices.

This year, Intel released its Wireless Display (WiDi) technology, which operates in the 2.4-GHz frequency range and offers a theoretical maximum data rate of 130 Mbps and transmission range of 3 meters. It’s designed to stream media wirelessly from the PC to the TV.

Technologies such as the USB Implementers Forum’s wireless USB and the WiMedia Alliance’s ultrawideband (UWB) provide short-range, high-bandwidth wireless connections that offer data rates still somewhat below 1 Gbps. They’re designed primarily for wireless video and home-electronics connectivity.

The problem with some of these technologies is that they are primarily promoted by start-up chip companies, with little market clout, according to principal analyst Brian O’Rourke with market research firm In-Stat.

UWB is more established, he continued, but numerous vendors have closed their doors in the last few years.

All the technologies could have trouble competing with new versions of Wi-Fi, which has been widely used and well-known for years.

**OBSTACLES**

WiGig and IEEE 802.11ac and ad face ratification issues, said Broadcom’s Hurlston.

“A lot of debate will happen about specific features that are mandatory and optional. That takes quite a while, and there are a lot of variables because this involves new hardware and some of the protocols will be very different,” explained Wi-Fi Alliance CEO Edgar Figueroa.

Some equipment makers might not implement the technologies right away because they will be new and untested in commercial settings.

WiGig and 802.11ad would require completely new access points.

Building chipsets for these two approaches will be a challenge because they require a 60-GHz radio, noted principal analyst Brian O’Rourke with market research firm In-Stat.

As transmission frequencies increase, the potential for signal leakage on the radio chip, which can cause interference, grows, complicating the design and manufacturing processes, O’Rourke explained.

WiGig and IEEE 802.11ac and ad face potential challenges from other fast wireless technologies, as the sidebar “Alternative High-Bandwidth Wireless Connectivity Technologies” discusses.

**WHAT’S NEXT**

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IEEE’s adoption of 802.11n for years and are likely to work together on the new approaches, said Wiocity’s Grodziski.

The Wi-Fi Alliance, which promotes Wi-Fi and certifies standards-compatible products, and the Wireless Gigabit Alliance have announced they will work together to promote compatible chipsets, said the Wi-Fi Alliance’s Figueroa. The two groups have many of the same companies as members.

Said Phil Solis, practice director for market analysis firm ABI Research’s Wireless Connectivity Division, “By cooperating, the groups have set a course for interoperability and backward compatibility that will accelerate the adoption and usefulness of multigigabit wireless networking.”

With the advent of new Wi-Fi technologies using different frequency ranges, said the Wireless Gigabit Alliance’s Sadri, many future chipsets will have 2.4-, 5-, and 60-GHz radios so that users can work with multiple approaches.

The fast wireless technologies will be widely deployed because the Wi-Fi market is growing quickly and the technology will be useful in the types of devices—such as smart phones and home-entertainment systems—that will become increasingly popular during the next five years, predicted In-Stat principal analyst Allen Nogee.

In addition, the standards will benefit from the support they have received from major vendors. Ether2’s Dietrich predicted 802.11n will remain a dominant technology because it is already widely deployed.

New technologies take time to become reliable and perform as designed, and demand will have to build for the Wi-Fi approaches, explained Jay Botelho, director of product management at WildPackets, which develops hardware and software network-performance products.

“Bottom line,” he said, “it’s far too early to know which will win, and it’s even too early to know if they will even survive.”

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