802.11n: In Full Effect

The much-hyped wireless standard promises upgrades to performance, coverage, range and reliability — and it delivers.

Wireless networking has become a standard feature in the network infrastructure of many government and educational organizations. The increasing reliance on wireless connectivity has its good and bad points. On the one hand, it has enabled staff to stay connected without being tethered to their desks. On the other hand, the reality of wireless networks has sometimes failed to live up to its promise.

Slow, inconsistent performance and limited range have stifled the types of applications organizations can deploy wirelessly. In many cases, it has forced network managers to install more wireless access points (APs) than expected.

The hope is that the rapid adoption of 802.11n technology (the standard having recently been approved by the IEEE) will address most of these concerns. This latest version of the networking standard will improve throughput over previous standards such as 802.11b and 802.11g.

The 802.11n standard promises a host of new capabilities and will open up a new world of wireless possibilities for organizations. When it comes to wireless networking, it looks like the final result will live up to the hype.

Though the new wireless standard was only recently officially approved, organizations have been migrating to it since the Wi-Fi Alliance's certification of products conforming to a draft version of it in 2007. So there are already a great number of 802.11n compliant devices on the market.

802.11n's Big Boost

The 802.11n standard represents a significant improvement in performance, coverage, range and reliability over earlier wireless protocols. The previous protocol, 802.11g, delivers a maximum bit rate of 54Mbps with a maximum indoor range of 150 feet.

But 802.11n claims to a maximum bit rate of up to 600Mbps, more than 10 times the throughput of 802.11g. And with a maximum range of 300 feet, organizations will require fewer access points to keep everyone connected.

"802.11n significantly increases the amount of bandwidth that's available to users," says Greg Pisano, worldwide director of segment and channel marketing at HP.

"The real throughput is varied depending on how many users are sharing a particular access point," he adds. "But the general rule of thumb is somewhere around 150Mbps is going to be the realistic throughput when all is said and done."

Also, 802.11b/g operates in the 2.4GHz frequency band, which is prone to interference from devices such as microwave ovens, cordless telephones and Bluetooth devices. That's because the 2.4GHz band offers only three nonoverlapping channels.

One of the great improvements that 802.11n offers is that it operates in the 5GHz band. That means it can take advantage of several nonoverlapping channels (12 in the United States and 23 worldwide).

Also, you can find 802.11n APs that support dual radios. This offers the option of operating in either the 5GHz or 2.4GHz bands, a valuable benefit for organizations looking to upgrade gradually to the new technology.

"If you buy an 802.11n product, we recommend buying a dual-radio product," says Craig Mathias, founder of Farpoint Group, a wireless communications advisory firm. "But even if it has just one radio, as long as it can operate in the 5GHz band, then you can operate your 802.11n network in parallel with your 11g network, and they won't interfere with one another."

Because 802.11n makes use of more nonoverlapping channels than 802.11b/g, it can take advantage of a technology called channel bonding. This means it can simultaneously use two separate, nonoverlapping channels to transmit data.

Traditional 802.11 technologies use a 20MHz-wide channel to transmit and receive data. Networks running 802.11n employ channel bonding to combine two adjacent 20MHz channels into a single 40MHz channel. Channel bonding is most effective in the 5GHz frequency because of the far greater number of available channels.

The MIMO Advantage

Another important advance offered by 802.11n is its use of Multiple-Input Multiple-Output (MIMO) technology. MIMO uses several antennas to move multiple data streams from one place to another. Instead of sending and receiving a single stream of data, MIMO can simultaneously transmit three streams of data and receive two. This allows more data to be transmitted in the same period of time.

This method allows 802.11n to (in a way) capitalize on interference, says Joe Melfi, associate director of business solutions at D-Link. "The sum is greater than all of the individual pieces. The old way of using multiple antennas on a wireless unit was diverse. This approach essentially looked for the strongest signals on the antennas and took the best of whatever it could receive," he explains.

"With MIMO, it actually gives you better reception than any one individual antenna," Melfi continues. "It brings all the pieces of the signal together to create a composite. In the 54Mbps domain, you were lucky to get half of that. In an 11n scenario, you would get better than 50 percent. It's not just a numbers game. It's actually better because of the technology."

A New World of Applications

Given their lower throughput, limited range and inconsistent coverage, the 802.11a/b/g protocols were unable to handle large, complex applications with a high degree of reliability. With 802.11n's improvements in speed and range, as well as interference tolerance, a new world of wireless applications opens for organizations.

"The benefits are that Wi-Fi networks based on 11n will help to change the way people use wireless," HP's Pisano says. "It will be able to carry a more diverse set of bandwidth applications, such as medical imaging, video surveillance and CAD.

"Given that, it will become a more attractive alternative than a wired infrastructure in terms of connecting desktop roaming user clients to the network," he continues. "It will be more pervasive regardless of the size of the organization."

The 802.11n standard can also support such bandwidth-intensive applications as video conferencing and digital signage. "Anybody that wants to do any type of video conferencing will definitely benefit," D-Link's Melfi says. "There are digital signage applications where wiring is prohibitive, and you'll want to set up a display. Rather than running wires, 11n is capable of running the data further and faster."

IP surveillance systems can also be freed from their wired domains. "If there's a security environment where you're doing IP surveillance, there are times when it makes sense to go wireless," Melfi says.

"With 11g, you can only put so many clients on it, whether it's a camera or a PC, and you share that whole 54Mbps with all the clients," he adds. "With 11n, you've got better coverage and you've got much more throughput, so you can support more wireless clients, which is really good for streaming video."

D-Link introduced a series of 802.11n-compatible network surveillance cameras in the first half of 2009. The D-Link 802.11n Wireless Network Camera (DCS-1130), for example, enables remote monitoring of live streaming video from a web browser.

Wireless Voice over Internet Protocol (WVoIP) should also get a boost from 802.11n. Although a single stream of voice data doesn't require much bandwidth, multiple streams would quickly overwhelm older wireless protocols. But 802.11n can handle multiple data streams. And the fact that it's less prone to interference means VoIP systems will be less subject to voice degradation.

"If you're going to do multiple streams and you want to maintain voice integrity, you not only have the pure bit-rate type of challenges, but you also have varieties of wireless interference," Melfi says. "But in a wireless domain, you've got all kinds of interference that can happen. So 11n is much better suited for VoIP applications."

Lowering the Wireless TCO

Along with opening up new applications to the wireless domain, 802.11n's performance improvements can also help organizations save money. Instead of building out an extensive wired network, organizations can run their operations on an 802.11n wireless network.

"It can save them the capital expenditure of wiring Ethernet to each individual office, which can add up very quickly," HP's Pisano says. "Especially if you're establishing a new office, or in today's economic climate, you may have branch office consolidation."

The challenge is that you need to be able to accommodate those additional people. With money being tight, wireless becomes a very attractive alternative. You don't have to wire up an additional 10 to 20 people. You can just put an access point up to support those people who might be consolidated into the office.

"The rule of thumb is that it typically costs around $100 per cable run," Pisano adds. "Say you have 100 coworkers; you can expect to pay around $100 to run Ethernet wire to each desk, assuming there was no cable infrastructure there previously. Alternatively, for just a few hundred dollars, you can add an access point. It becomes a fraction of the cost from a wiring perspective."

Incremental Upgrades

Organizations looking to migrate to 802.11n can do so incrementally. Products designed for 802.11n are backward-compatible with all previous wireless protocols (802.11a/b/g), making it easy for organizations to integrate the new products into their existing infrastructures.

"We generally say buy 11n APs, run them at 5GHz and put your power users on it, so that will free up capacity on the 2.4GHz network," says Farpoint's Mathias. "Then gradually replace your client cards on your 2.4GHz network and move everybody onto 11n."

Of course, taking full advantage of 802.11n's improvements requires upgrading the entire infrastructure, including the wireless access cards on client machines, such as PCs. You can quickly add 802.11n capability to a notebook through a USB adapter.

But even if staff still access the network with 802.11g-compatible clients, it may be worthwhile to add a few 802.11n APs. Doing so now will allow you to get the most out of your organization's existing WLAN. And it can help you build a future WLAN foundation on 802.11n to serve for years to come.

"It's supposed to work better if you use an 11n router with an 11g client," D-Link's Melfi notes. "But I use 11g in my laptop with 11n all the time. It's less prone to some of the interference issues, even though it's still 11g, because the router has better control of the synchronizing between the clients. It tends to grab a signal and hang onto it better. You get a more consistent connection."

As with any network deployment, it's important to conduct a thorough evaluation of your organization's particular needs before committing to an upgrade of your wireless network. HP's Pisano recommends assessing what types of applications you'll be running on the network. Also consider which users will be using those applications before embarking on an upgrade.

"You can have a variety of different types of users, different applications," Pisano says. "Our products allow you to set different QoS [Quality of Service] parameters around users, applications and devices. It's really important to make sure you've done your homework in terms of understanding what it is you're trying to do."

For those organizations looking to upgrade, 802.11n will bring plenty of new capabilities to your network. The improvements in speed, range and reliability promise to make wireless connectivity as strong and efficient as wired networks.

As Melfi says, "It's the first wireless technology that actually works as advertised."

Accessing 802.11n

IT managers want to be able to enjoy the performance improvements of up to 600Mbps throughput and the increased coverage that the new 802.11n wireless standard promises. To help get the most out of the wireless standard, your organization should consider purchasing modular access points.

The current generation of 802.11n products don't yet support the full theoretical potential of 600Mbps speeds. Modular products allow you to more easily swap out the networking cards (to facilitate an easier migration to 802.11n). But keep in mind that you may find yourself upgrading hardware in a few years if the higher speeds are important to your organization.

Most wireless equipment manufacturers offer 802.11n access points that function in several operational modes. The three primary modes are:

- Mixed mode: This lets 802.11n devices coexist and interoperate with legacy 802.11a/b/g devices on the same wireless LAN. Most enterprise WLAN equipment will use mixed mode by default to ensure legacy compatibility.

- Legacy mode: In this mode, the AP behaves like an 802.11a/b/g AP with improved performance because it uses some of the 802.11n physical layer enhancements. This configuration could be used when an organization includes new 802.11n APs but is not yet ready to enable full 802.11n operation.

- 802.11n mode: Some manufacturers' access points can be configured to accept association requests only from other 802.11n devices. Some IT departments may choose this configuration to achieve the best possible throughput.

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