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What's Next for Wi-Fi?

– John Cox, Network World

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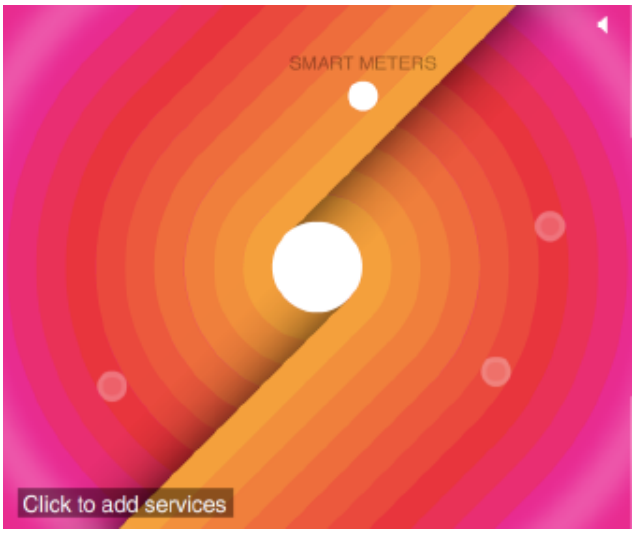
The recent formal approval of the IEEE 802.11n wireless standard marks not the end but the start of a wave of Wi-Fi innovation. In the next three to five years, the Wi-Fi experience will be very different from today.

Wireless Definition and Solutions

802.11n price wars already underway

The huge 11n performance jump -- to 300Mbps data rate and roughly 100M to 150Mbps throughput -- will become the basis for unwiring work and life to a much greater extent than ever before. You can picture it as a fast-growing archipelago of wireless connectivity, with access points becoming more prevalent, interlinked in meshed clusters, and able to cooperate far more closely with smarter Wi-Fi clients. Here we've focused on eight ways Wi-Fi will change for the better, enabling improved signal quality, more reliable connections, optimized bandwidth, increased battery life and stronger security.



1. Broader broadband

Although the IEEE has launched two projects intended to bring gigabit and multi-gigabit data rates to the 802.11 standard, neither has come up with a first draft.

But the 11n standard makes possible a range of high data rates, which can be adapted to different functions and devices. Today, all 11n radios support two spatial data streams that are sent and received using some combination of two or three antennas, and these radios are set to appear in mobile devices. Apple's newest Wi-Fi-only iPod touch, for instance, has a Broadcom radio chip that supports but doesn't yet use11n.

Soon, more Wi-Fi chips will support three and even four data streams, with respective data rates of 450Mbps and

600Mbps. Early in 2009, Quantenna Communications demonstrated its 4x4 chipset in action, streaming several high-def TV signals through a home-sized space.

"While there will not be a lot of client devices that support four spatial streams, properly designed access points will take advantage of the 600Mbps physical layer data rates to enable high-speed, wireless backbones," says William Kish, co-founder and CTO of Wi-Fi equipment vendor Ruckus Wireless.

You'll be able to mesh these high-end nodes via the 802.11s standard (due in September 2010), creating Internet-like Wi-Fi networks that are redundant and can route around failures.

2. Tougher radio frequency signals

More of 11n's optional performance features will appear in radio chips, and be used in wireless clients and access points to make RF signals more resilient, consistent and reliable. In other words, more like a wire.

"This new [11n] physical layer technology will make Wi-Fi more robust, with higher data rates at given ranges, and at longer ranges," says William McFarland, CTO for chipmaker Atheros Communications.

These performance features include: low-density parity check coding, which improves error correction; transmit beam forming, which uses feedback from a Wi-Fi client to let an access point focus the RF signal on the client; and space-time block coding (STBC), which exploits the multiple antennas more for improved signal reliability than for higher data rates.

"Today when you walk around a building with a [Wi-Fi] laptop, you'll find data rates drop or fade out," McFarland says. "But with STBC, the connection will still work."

3. The Wi-Fi-zation of things

Big innovations in power consumption and management are making it possible not only to extend battery life for Wi-Fi smartphones, but also to embed Wi-Fi into swarms of new devices and now even wireless sensors: medical monitoring devices, building control systems, real-time location tracking tags and consumer electronics. The result is the ability to continuously monitor and collect data, which can be personalized based on a user's identity and location.

"There's nothing that other contemporary limited-distance RF technologies can do that Wi-Fi can't," writes wireless consultant and Network World blogger Craig Mathias.

"With an enterprise wireless LAN, this infrastructure is already in place," says Atheros' McFarland. "Just add the low-power sensors."

Embedded Wi-Fi vendor Summit Data Communications recently announced 802.11a radios in various plug-in formats to let devices use the uncrowded 5GHz band. Start-up Gainspan offers 11bg Wi-Fi radios, with an IP software stack, that use so little power that wireless sensors can run for years on standard batteries. (Read about other wireless and mobile start-ups worth watching here.) And Redpine Signals offers a single-stream embedded 11n radio.

4. Improved security

One of the most corrosive impacts of the Internet is the victimization of its users, via identify theft, denial-of-service attacks, privacy violations, spying and the corresponding lack of trust these abuses create. Mobility has the potential to make this even worse, if users become convinced that Wi-Fi connectivity opens them up to unacceptable risks.

The IEEE recently approved the 802.11w standard, which protects the wireless management frames used to make the radio link work better, says Matthew Gast, chief strategist at Trapeze Networks, now a Belden company. Today, a Wi-fi client can receive and obey a "get off the network" message that may have been generated by an attacker spoofing the MAC address of an access point. The 11w standard shuts down this line of attack.

More generally, says Michael Tennefoss, head of strategic marketing for Aruba Networks, Wi-Fi will

increasingly liberate users through the use of identity-based security. In Wi-Fi networks, security policies are associated with a user, not with a switch port. A related benefit: Users can move between home, work, hotel, branch offices and public hotspots without compromising their security, Tennefoss says.

5. Cooperation with non-Wi-Fi networks

Today, if you're a T-Mobile Wi-Fi subscriber, but are in range of a Wi-Fi hotspot from another provider, you're out of luck. In the future, your Wi-Fi device will be able to query that "foreign" service, find out if you can use it and then join it securely. And your cellular subscriber identity will travel with you, enabling you to make use of various Wi-Fi services.

Some of this ability to stitch together the several networks on which users increasingly live will be enabled by the 802.11u standard, for inter-working with external networks. In the future, Wi-Fi networks will advertise their services, and the terms under which you can link to them. Based on your identity with a network service provider, you might be able to access all or some subset of services of another network. In emergencies, you would have access to a narrowly defined set of essential connections and functions. The 11u standard is planned for June 2010 final approval.

6. Self-managing Wi-Fi clients

Wi-Fi vendors have been creating a range of proprietary goodies to make user devices inherently smarter about how they work with an access point. Today the access point usually marks the limit of Wi-Fi network management; client radios are in a relative management vacuum.

If you add intelligence, via new standard Wi-Fi management protocols, to both the client and the access point, they could cooperate in a lot of interesting ways.

Imagine that your netboook's Wi-Fi adapter, or your Wi-Fi VoIP phone, can chop power use when the radio isn't sending or receiving. Or with shared location data, an access point can re-direct a Wi-Fi voice session to a more optimal neighbor, or to a less-loaded one if the access point is in danger of traffic overload. Wi-Fi network infrastructures can locate a client's position, for example, outside of a building, and block or grant connectivity based on that data.

The 802.11v standard, which is likely to be finalized in July 2010, has a number of elements to tackle improved Wi-Fi management. It will add an array of counters for statistics gathering, add power management to improve battery life and improve support for location data. It will have to be implemented on both client and access point radios.

This broad idea of client coordination also is being addressed by the Wi-Fi Alliance's Wi-Fi Multimedia Admission Control specification, currently in development. It will let wireless networks negotiate and manage streaming media sessions, so a request for a high-definition video doesn't choke off Wi-Fi voice users on the same access point. The Alliance is weighing a specific Wi-Fi network management specification, borrowing from several relevant IEEE standards and adding additional management features.

7. Improved mobility via smarter RF management

A similar lack of cooperation plagues RF management, because access points and client radios typically don't know a lot about each other or their neighbors in terms of understanding their respective radio frequency environments. This one-sidedness makes it harder to optimize and manage RF.

For example, as a Wi-Fi mobile phone moves away from one access point, it triggers a demanding process of blindly reaching out to find another one. But if the client can ask its access point, "who are your neighbors and which is the best one to connect with next?" then device and network can cooperate better. At the same time, Wi-Fi access points will be able to "see" the client's RF environment, identifying weak signals or poor coverage, and take steps to optimize the connection.

The IEEE 802.11k radio resource management standard was published last year to address this, but Wi-Fi vendors had already been implementing an array of proprietary features to address this challenge. They all involve extending control and intelligence to the Wi-Fi client, and coordinating its requirements, behavior and activities with the Wi-Fi access point infrastructure. Aruba's 2.0 release of its Adaptive Radio Management technology is one example.

Meanwhile, the Wi-Fi Alliance is crafting its Voice Enterprise certification using some of the features in 11k. The goal is optimizing call quality in large-scale, enterprise Wi-Fi voice environments.

8. Personal area Wi-Fi

Today, "your" Wi-Fi is a point-to-point connection to an access point. In the future, a Wi-Fi radio in any one of your personal devices will be able to link directly with other client devices. Ozmo Devices, for instance, has low-power silicon to let peripheral devices connect to your laptop via Wi-Fi.

The recently announced Wi-Fi Direct (WFD) project, from the Wi-Fi Alliance, will let a Wi-Fi card in your laptop bypass an access point and link directly with wireless printers, cameras, projectors, sensors or plasma screens. As an industry specification, WFD will introduce new protocols implemented in firmware, but no hardware changes will be needed.

At the same time, Wi-Fi access points will also become enablers of peer-to-peer connections, via the 802.11z standard (scheduled for July 2010 completion), which will offer extensions for direct link setup. In this arrangement, a client device will request from an access point "permission" to connect directly to another nearby client device, without going through the access point. But your client still remains associated with the access point, and its full panoply of security and management services.

"Having these DLS extensions offers some of the efficiencies of direct communications, without surrendering the infrastructure benefits," Trapeze's Gast says.