Next Generation Wi-Fi

Introduction

Wireless networks have become a necessity in enterprise connectivity strategies, retail, health care, and industrial applications and are being stretched to maximum capacity with various new trends including bring your own device (BYOD) to work and virtual desktop initialization (VDI). These new mobile applications mean that an average worker has three or more devices (e.g., cellular phone, laptop and a tablet) at any given time and conducting data communications over wireless networks is expected to surpass wired data transmissions in 2015[1].

Knowledge within an industrial space is imperative to improve operations, productivity, and safety. Managing this knowledge involves sharing information across networks, departments, and remote sites, including wireless networks which have increased in use to aid in the flow of shared information and to create plant intelligence.

The evolution of Wi-Fi technology and standards creates opportunities for increased network capacity, higher data rates, and secure and reliable communications. The latest wave of Wi-Fi technology will be ratified by the Institute of Electrical and Electronics Engineers (IEEE) in 2013, and is being released under the standard name of IEEE 802.11ac. IEEE 802.11ac technology enhances existing 802.11n technology as described in this paper, which reviews the improvements of 802.11ac over 802.11n, the driving factors behind 802.11ac adoption, and its benefits.

Evolution of 802.11

As wireless has evolved, each standard released by the IEEE has provided improvements yielding higher bandwidth, from the early 2 Mbps 802.11 Direct Sequence Spread Spectrum(DSSS)/Frequency Hopping Spread Spectrum(FHSS), 54Mbps 802.11g Orthogonal Frequency Division Multiplexing (OFDM), 600Mbps 802.11n multiple-input multiple-output (MIMO) 600 Mbps, and now 802.11ac (1 Gbps+) providing increased security, and better performance (see Figure 1).

[1] *"Cisco Service Provider Wi-Fi: Offload Mobile Data and Create New Services", Cisco, February 2012*

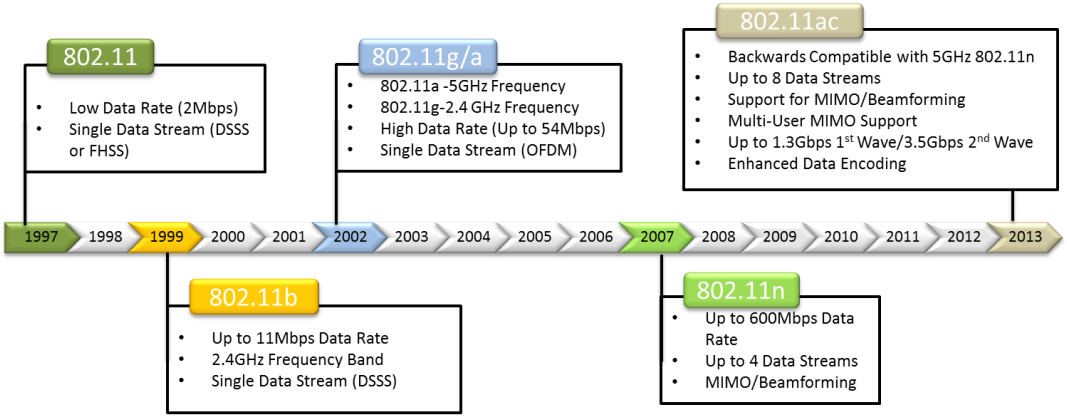


Figure 1: Evolution of 802.11

The 802.11, which the IEEE LAN/MAN Standards Committee creates and maintains, is standardized under the IEEE 802.11 wireless local area network (WLAN) for the 2.4 and 5 GHz. In addition to the IEEE, the Wi-Fi Alliance has ensured that wireless local area networking products work together and provides a third party testing program under the Wi-Fi CERTIFIED™ program. Several core programs offered by the Wi-Fi Alliance are required by Cellular Telephone Industry Association (CTIA) and government-grade security facilities. Currently, Wi-Fi CERTIFIED n is recommended for the enterprise. The Wi-Fi CERTIFIED™ ac will be the first generation testing of 802.11ac products that are based on the IEEE 802.11ac standard scheduled to be launched in late 2013. For more details see the Wi-Fi Alliance website at http://www.wi-fi.org/.

The 802.11ac standard is on track to have final ratification in late 2013 or early 2014. Despite the standard being in draft form, there are some pre-standard products on the market. Pre-standard products should not be used due to uncertainty of full compatibility and interoperability with standard products when available. There are also other products including access points, and additional handheld devices that are scheduled to be released in late 2013. It is not recommended that end users deploy access points or devices without official standard ratification by the IEEE and interoperability testing by the Wi-Fi Alliance. The Wi-Fi Alliance's website has a searchable list of certified products that have been approved and tested, and offers a copy of the products' certificate.

Next Generation Wi-Fi: 802.11ac

Drivers for 802.11ac

- Enhanced support for capacity: cellular offloading and video conferencing
- Enhanced support for high bandwidth applications: live video streaming such as YouTube.com, real-time gaming, etc.
- Higher network capacity: more users on the network simultaneously
- Improved battery life for client devices: tablets, laptops, and mobile phones due to faster transmit rates and improved reliability
- More robust radio performance for radio frequency RF challenging environments: manufacturing floors or warehouses

802.11ac Technology Improvements over 802.11n

- Allows 33% increase in physical layer due to higher modulation
- Additional spatial streams
- Wider channel bandwidths allow for bonding additional channels, thus reducing transmission overhead
- Higher data modulation
- Standardized transmit beam forming improves signal at receiver
- Additional signal processing power

Capacity Improvement of 802.11ac vs. 802.11n

When deploying a Wireless LAN solution, one of the main design parameters is the client density based on the applications supported by the wireless network. For instance, casual web browsing may not create high traffic on the network, but other applications such as file transfers and on-demand streaming video are bandwidth-intensive[2]. Wireless communications is performed over the air, which is a shared medium. In existing 802.11a/b/g/n standards, an access point can communicate only with one client at a time, and vice-versa. Clients that require high-bandwidth applications degrade the capacity and performance of a wireless access point. Therefore, the amount of clients the access point can serve effectively is reduced.

Client capacity is significantly improved with 802.11ac. When 802.11n was released, it improved data rates that yielded higher client counts over 802.11a/b/g networks due to implementation of multiple antenna technology and improved transmission techniques. The 802.11ac standard picks up where 802.11n ended. When the first wave of 802.11ac is ratified, it will improve the client capacity of 802.11n by

[2] Cisco White Paper *"Wireless LAN Design Guide for High Density Client Environments in Higher Education"*

2-3 times. Future releases are expected to be much higher. The second wave of 802.11ac will also feature the ability of a single access point to transmit to multiple users (MU-MIMO), further increasing transmission efficiency and network capacity.

Deployments

Upgrading Existing Deployments

Most buildings today support some type of Wi-Fi network, whether in limited areas or a building-wide deployment. Wi-Fi is a mature technology and most network operators and CTOs are aware that an existing Wi-Fi deployment will require future upgrades. A survey conducted by *InformationWeek* revealed that the majority of existing 802.11a/b/g networks are either being upgraded now or will be upgraded within 3 years[3]. To accommodate this upgrade, policies should be established to implement a wireless network refresh cycle. The wireless network should comply with a technology refresh lifecycle that reflects the organization's needs. It is important to establish a migration plan not only for supporting a diverse and fast-changing mix of client devices, but also for new applications supported by the wireless network.

How Fast is 802.11ac Coming? When Should I Upgrade my Network?

A real challenge with existing deployments is the support of legacy devices in a mixed environment along with state-of-the art devices. Supporting legacy clients such as 802.11b is not realistic and significantly degrades the performance of the wireless network. State-of-the-art Wi-Fi clients today use 802.11n. According to ABI Research, most of the devices (including phones, access points, tablets/PCs, smart phones, etc.) shipping in year 2016 will be combination 802.11n/802.11ac. It should be noted that 802.11ac is backwards compatible with 802.11n and devices are expected to operate and co-exist in the same frequency band. As 802.11ac devices enter the market, support for them will be required in the near future. Figure 2 lists user needs and technology improvements associated with 802.11ac.

[3] *InformationWeek "2013 Wireless LAN Survey"*

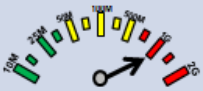
	USER NEEDS	TECHNOLOGY IMPROVEMENTS
 Higher Bandwidth	Support for higher bandwidth applications: • Video streaming • Real time applications • High speed Data Transfer	• Wi-Fi (802.11ac) offers higher bandwidth channels (from 20-40MHz to 80-160MHz) • Higher encoding density (64QAM to 256QAM) • Increased number of spatial streams (from 4 to 8)
	Enhanced power sources: • Enhanced battery life on clients • Smaller batteries • Environmentally friendly • Reliable power source	• Wi-Fi (802.11ac) offers higher encoding density (64QAM to 256QAM) • Faster data transmission cause clients to jump off the network quicker • Energy harvesting • Enhanced battery saving/sleep modes
 Higher Capacity	Support for higher capacity: • High user density • Video streaming • Higher level of QoS to more users	• Higher bandwidth channels (from 20MHz to 40MHz) • Higher encoding density (64QAM to 256QAM)
 Enhanced Coverage	Enhanced RF propagation: • Larger coverage area • Dead zone removal • High signal reliability • RF challenging indoor environments not impacted by multi-path	• Multi user MIMO • Higher encoding density (64QAM to 256QAM) • Beamforming
 Security	Pain points: • Robust network availability • Intrusion protection • Secure data transmission	• Network authentication • Network VLAN segmentation • Firewalls • Spectrum intelligence • Wireless data encryption

Figure 2: Summary of Benefits

Conclusion

The Wi-Fi wireless landscape is rapidly changing in response to user needs for higher bandwidth, higher network capacity, enhanced coverage, and network security. 801.11ac products are available currently and reflect changes proposed in the new 802.11ac standard. These changes have resulted in specifications and products that will help to improve throughput and the overall user experience. All proposed changes in the IEEE 802.11ac standard will need to be analyzed for interoperability testing (IOT) with clients and network hardware. Existing Wi-Fi network deployments should ensure a plan is in place to support upcoming 802.11ac devices.