

802.11ax: Next generation Wi-Fi for the Gigabit home



EXECUTIVE SUMMARY

Increased penetration of connected devices such as smartphones, tablets, computers, televisions, media players and smart speakers is driving use of data services on the move, in the office, and in the home.

Users are demanding access to an ever-changing set of services, with video becoming a core part of the proposition – such new services demand much more than just content download. Live streaming services delivered using social networks and person-to-person messaging mean users are creating video in addition to consuming it, making upload and download performance critical.

Wi-Fi remains the most effective tool to deliver high-speed, high-performance connectivity at home, in the office, and in public places such as stadiums and shopping centres. However, to support increasing data demand and changing user requirements, a new generation of the technology is needed.

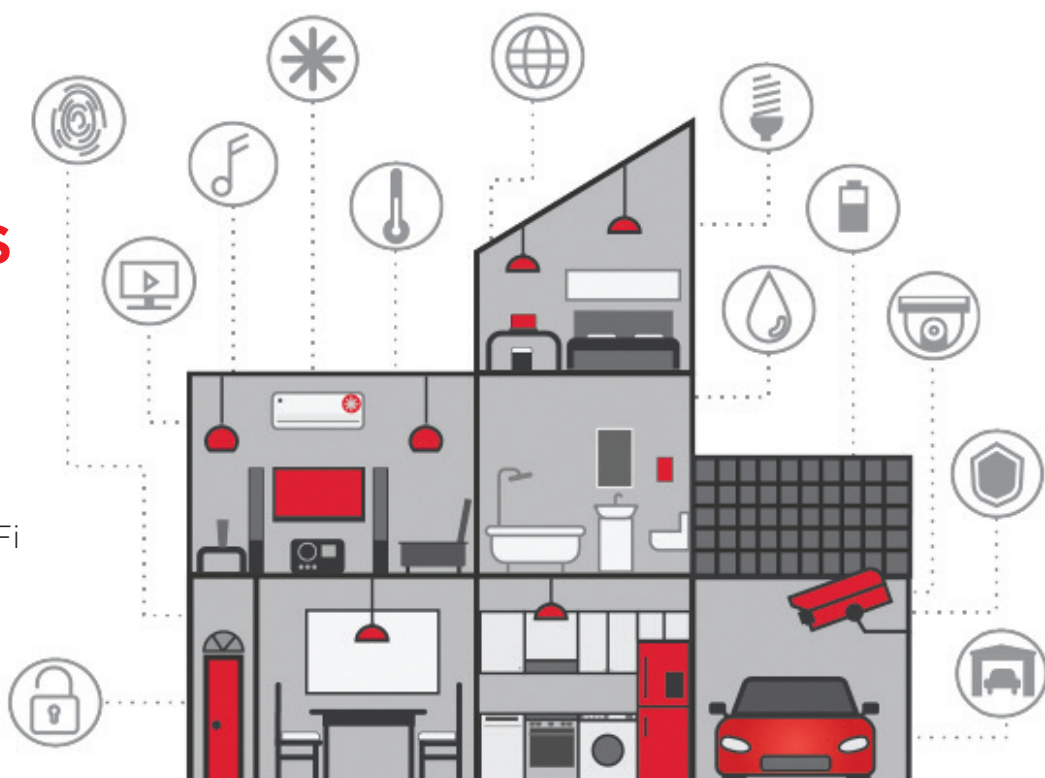
802.11ax provides features to meet this need, including levers to boost capacity and reliability as well as an increase in average user speeds.

“The Wi-Fi device and traffic explosion, higher density of Wi-Fi deployments, growing use of outdoor Wi-Fi, and the need to support a great variety of different device types, will require more efficient Wi-Fi implementations that can help to deliver richer experiences for enterprise and consumer applications that are hungry for bandwidth.”

**Andrew Zignani, Senior Analyst,
ABI Research**

MAX COVERS THE ENTIRE GIGABIT HOME

802.11ax eliminates Wi-Fi dead zones, covering both inside and out



INTRODUCTION

According to GSMA Intelligence figures, smartphone penetration has already passed 50 percent globally, and is much higher in developed markets such as North America (77 per cent) and Europe (66 per cent). At the end of 2016, there were 3.8 billion smartphone connections.

Touchscreen tablets have been joined by devices with detachable keyboards, and more feature-rich products are reaching the market targeting high-end and enterprise users. The laptop segment is characterised by a shift toward slimmer, lighter, better looking and more portable products.

The smart home is becoming a reality. Streaming devices including Apple TV, Google Chromecast, and Amazon's Fire TV are driving adoption of online entertainment services, and gaming is now a connected experience.

Amazon, Apple and Google are also driving new experiences, with voice-driven speakers providing access to virtual assistants and content services. In the future, more internet-enabled devices will also find their way into the home.

This explosion in the number of connected devices has been accompanied by an evolution of device use. While messaging, social networking, and internet browsing remain the bread and butter, video has become the real driver of growth, with Strategy Analytics forecasting mobile video alone will be a \$25 billion market by 2021.

The growth is driven by a range of video applications available. Person-to-person messaging, user-generated content, and professional media are all seeing growth, with content providers including Amazon, Netflix, and Sky driving adoption of 4K video. Enterprises are also making wider use of video, including markets such as education and telehealth.

Live streaming via social media – such as Facebook Live and Twitter's Periscope – means that users are creating content as well as consuming it, making both upload and download speeds equally important.

Music services have also moved from downloads to streaming, thanks to players such as Spotify and Deezer and services from internet giants including Amazon, Apple, and Google.

Connected gaming generates more revenue than Hollywood content and has high requirements for fast and robust connectivity.

Supporting this is an increasing proliferation of high-speed, high-quality connectivity. According to GSMA Intelligence, 60 per cent of the world's population is already covered by 4G networks, and 5G is on the horizon as we move into the next decade.

Alongside all of this is an all-too-often unsung hero: Wi-Fi. Providing connectivity in the home, the workplace, and public places such as coffee shops, shopping centres and event venues, and ubiquitous in devices including smartphones, laptops and connected home devices, Wi-Fi provides a fast and cost-effective way of accessing content.

According to Cisco's Visual Networking Index, Wi-Fi traffic from both mobile and dedicated devices together will account for almost half (49 per cent) of total IP traffic by 2020, up from 42 per cent in 2015. This puts it comfortably ahead of fixed/wired connections, which is generating a decreasing share of the total (forecast to be 33 per cent in 2020), and the increasingly popular cellular data (17 per cent).

All of this means Wi-Fi needs to evolve in order to continue to meet the demands of users. That evolution is 802.11ax.

"Emerging applications in video conferencing, holographic imaging, and augmented reality require the highest quality experiences and demand the highest performing wireless networks. These are networks that have low latency, high reliability and very high throughput."

Dr Amer Hassan, Senior Director, Office Communications Service, Microsoft

THE NEXT GENERATION

802.11ax marks the sixth generation of Wi-Fi technology, and sees some important changes in the way it is designed when compared with its predecessor, 802.11ac, which launched in 2012.

This earlier generation introduced crucial innovations necessary to address the needs of users at the time. Support for wider channels and more efficient data packing led to a three times improvement in speed over earlier Wi-Fi incarnations. In addition, beamforming – a technology which is now coming to cellular networks – gave the ability to improve range and coverage.

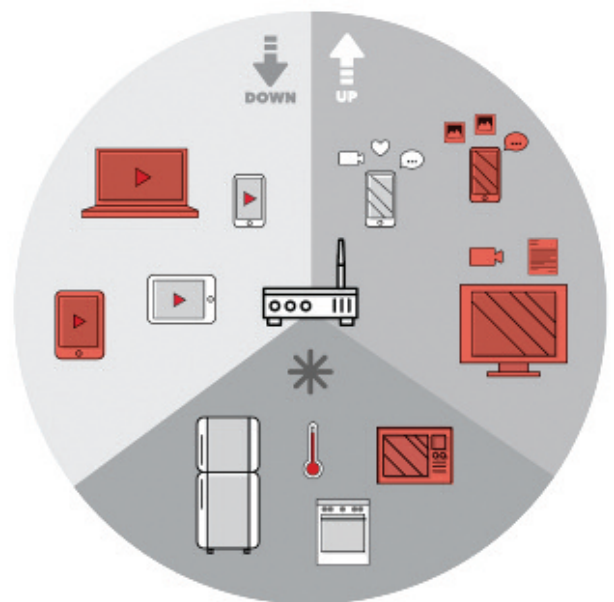
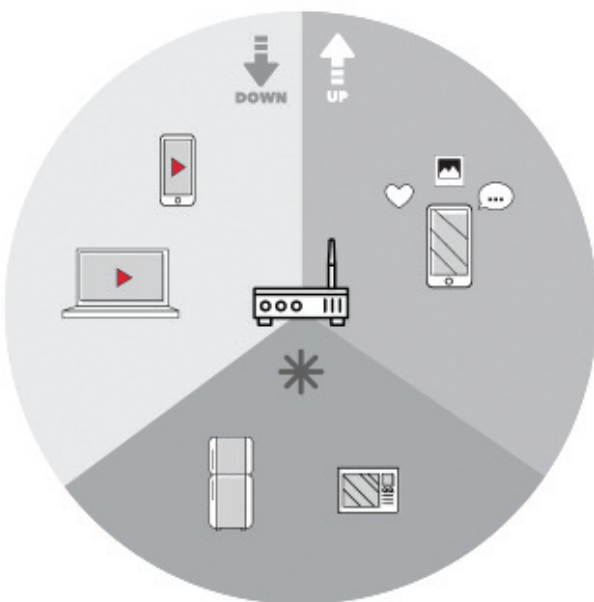
By design, previous versions of Wi-Fi deliver the best speeds when there is a single device demanding large chunks of data. As the number of devices increases and data requirements reduce, the network becomes inefficient and overall speed drops.

While this has been suitable – and indeed hugely successful – in supporting current data requirements, without significant changes future Wi-Fi networks would need to be extremely sophisticated (and expensive), or users would be stuck with a network that is no longer best suited to their needs.

Previous generations of Wi-Fi were also not designed to support the massive increase in users uploading high-resolution video content, enabled by applications including Facebook Live and Periscope. The increased importance of upload performance also means Wi-Fi needs to be updated.

The fifth-generation Wi-Fi will face challenges supporting these new social experiences alongside the expected growth of Internet of Things (IoT) applications. IoT is characterised by a ballooning number of devices in the home, workplace and public places, which generally send small amounts of data to the cloud regularly. This needs wireless networks designed to support small bursts of data from a large numbers of devices.

THE 11AC CHALLENGE



“Today people expect to be connected to work, family, and friends anywhere, anytime, and anyplace and a majority of that connected time is over Wi-Fi. 802.11ax is the most efficient Wi-Fi standard developed to date that can deliver the performance, scalability, and capacity that elevates Wi-Fi to utility-grade in today’s challenging enterprise environments.”

Alan Amrod, Senior Vice President, Aerohive Networks Products Organization

OFDMA

Orthogonal frequency-division multiple access



STRIDING FORWARD

For Wi-Fi's sixth generation, there has been a ground-up reworking of the core technology to make the best use of available spectrum. This included the adoption of Orthogonal Frequency Division Multiple Access (OFDMA) as used in 4G networks (and continuing into 5G mobile).

The basic reason for selecting OFDMA in cellular – to make the most efficient use of spectrum – is equally applicable to Wi-Fi networks. Its use helps address both the new demands placed on networks, as well as taking the performance that has made Wi-Fi so popular, to the next level.

Look at today's Wi-Fi as a delivery van which delivers one package for every trip. In comparison, OFDMA divides up the spectrum and allocates it to different users, akin to a delivery truck which carries packages from different senders on a single trip – which is clearly more efficient from the outset.

In a network with a large number of IoT devices requiring short bursts of data, OFDMA is in its element – and this applies for both data being sent to the cloud and data received from it. In many cases, the capacity of an 802.11ax network improves by a factor of six compared with 802.11ac (with the same network configuration), enabling and future-proofing the Wi-Fi network for IoT.

OFDMA in the uplink (UL-OFDMA) is also the answer to the increase in data upload requirements, such as for live video streaming applications.

In this case, the analogy is taking a scheduled shuttle bus to work with colleagues instead of driving alone. The shuttle is effective for fuel and can use bus lanes, and is hassle-free – as long as you arrive at the station on time. Use of scheduling in UL-OFDMA delivers a smoother, low-latency experience to multiple users at the same time.

To further improve the uplink, 802.11ax also uses another technology: Uplink multi-user multiple input multiple output (UL-MU MIMO).

While UL-OFDMA helps with a low-latency uplink experience when a large number of users are on the network, the benefits of UL-MU MIMO are better experienced with a high volume of data from a smaller group of users – for example in the home.

By focusing transmission from a user device to the router (rather than blasting energy in all directions), MU-MIMO delivers high speeds to multiple users simultaneously while optimising network efficiency.

802.11ax also offers notable range improvements. For outdoor devices which require small amounts of data, the standard enables data to be sent across a smaller slice of spectrum, with extra measures to enable longer distance transfer. Using a 2MHz channel, 802.11ax improves range by 50 per cent.

"As consumer use of high-bandwidth applications increases, best-in-class Wi-Fi routers will need to utilise 802.11ax technology to support increases in throughput to more and more devices."

Andy Chen, Vice President/GM of Networking BU & International Sales, TP-LINK

BATTERY BOOST

According to a survey of US smartphone users conducted by YouGov late last year, the single feature which appealed to most was a longer battery life – ahead of shatterproof screens, water resistance, and better cameras. As device owners take advantage of more and more demanding applications, battery life has correspondingly become more of an issue, particularly at the end of the day for those who spend their time on-the-go.

Device makers have come up with a number of tricks to try to boost battery performance, for example using low-power processor cores to run background apps, and quick charge to swiftly bring smartphones back to life once the battery has reached its limits.

802.11ax is Wi-Fi's opportunity to further contribute. The new Wi-Fi generation implements Target Wake Time (TWT), which enables phones and other devices to turn off transmitters when not exchanging data, significantly reducing drain on batteries.

Under current Wi-Fi implementations, a smartphone or other device has to look out constantly for others, and wait until there is an opportunity to transmit. With TWT, a time is pre-negotiated, and then a device can stop transmitting until it is their turn – reducing battery consumption.

With popular apps like FaceTime not transmitting data for 95 per cent of the time, this translates to a significant drop in Wi-Fi battery drain which is a clear benefit for users.

SPEED DEMON

So it is clear to see that 802.11ax is much more than just a faster version of Wi-Fi. But it also brings benefits in terms of speed – a whopping 38.7 percent over 802.11ac.

This is achieved using more efficient packaging of data for the same spectrum, technology called 1024-QAM (quadrature amplitude modulation). This is similar to using a double-deck bus to make the best use of a bus lane, and is the main driver behind the speed gains.

However, also in the mix are longer guard intervals, which enable the double-deck buses to avoid collisions with each other.

Some 802.11ax products will also offer a “turbo boost”, enabling data transmission on 160MHz channels – the widest possible for Wi-Fi. Alongside the packaging gains, this can deliver speeds nearly three-times faster than 802.11ac devices, and a 1,200-times increase over the first Wi-Fi devices 20 years ago.

While raw speeds improve by close to three times, the benefits are far more evident in networks with multiple devices. As OFDMA effectively schedules data from these devices and avoids the inefficiencies associated with collision and contention-based access, it can deliver up to four times better download speeds and up to six times better upload speeds.

While these speed gains are good in their own right, they also offer other benefits. The network can be more efficient and transfer data in a shorter time, enabling more devices to be served while preserving battery life.





ENTERPRISE OPTIONS

Enterprises are an important – and prolific – user of Wi-Fi networks. Fuelled by the increasing number of mobile devices in the workplace, including smartphones and tablets, as well as “nomadic” laptop users, current enterprise Wi-Fi networks are often overstressed, leading to frustration and impacting productivity.

802.11ax is the ideal tool to address these challenges. Due to its focus on capacity and efficiency, it is able to serve more devices at the same time, allowing enterprises to control their costs while still meeting evolving user and application demand.

Away from the office, improved support for IoT applications will be important for many businesses. And in various markets, video – and in particular two-way video – is becoming a much more important tool, which will also reap benefits from 802.11ax.

Of course, enterprises will need to take into account the higher speeds available via 802.11ax when planning upgrades to their wired backhaul networks in order to avoid creating bottlenecks.

For operators and other companies offering hotspot services – such as venue owners – 802.11ax will enable reduced deployment and operating costs, which are expected to rise due to growing demands and the need for denser networks. However, these cost savings do not come at the expense of user experience, which will still be improved due to the enhancements at the core of sixth generation Wi-Fi.

“Enterprise networks are growing increasingly dense, making 802.11ax a much-needed technology for next-generation access points. 802.11ax will greatly enhance capacity and coverage so users will be able to stream video, download content quickly, and not be hindered at times of high-traffic use.”

Dr Liu Yiping, VP and General Manager, Wireless Business Unit, New H3C

BROADCOM SOLUTIONS

Broadcom's Max WiFi is a family of connectivity solutions using 802.11ax. The products are designed to kick-start the ecosystem of routers, home gateways, enterprise access points, and devices supporting the 6th generation of Wi-Fi.

BCM43684 is a chip targeted for the residential Wi-Fi market, while BCM43694 is optimised for use in enterprise access points. They offer full compliance to IEEE and WFA 802.11ax specifications.

"Our reliance on Wi-Fi has increased tremendously as we stream live experiences over social media and upload pictures and files to the cloud while also connecting the many 'things' around our home. Max WiFi, based on 802.11ax, is designed from the bottom up to address these evolving consumer needs. With the launch of the Max WiFi ecosystem, Broadcom has yet again pioneered the generational transition of Wi-Fi."

Greg Fischer, Senior Vice President and General Manager, Broadband Carrier Access, Broadcom

Key features include:

- Support for 4-streams of 802.11ax
- 4.8 Gbps PHY Rate
- 160 MHz Channel Bandwidth
- 1024 QAM Modulation
- Uplink & Downlink OFDMA
- MU-MIMO
- ZeroWait DFS
- AirIQ Interference Identification

BCM4375 is a smartphone combo chip. Key features include:

- Support for 2-streams of 802.11ax
- Bluetooth 5.0+ including Low-Energy Long Range (LELR)
- Real Simultaneous Dual-Band (RSDB)
- 1.429 Gbps PHY Rate
- 1024 QAM Modulation
- OFDMA
- MU-MIMO



Key Takeaways

- 802.11ax is the new generation of Wi-Fi and introduces a number of new technologies to deliver benefits in reliability, capacity and speed.
- 802.11ax is better suited to a number of new use cases, such as live video streaming and IoT, than previous versions of Wi-Fi.
- 802.11ax will also support larger numbers of connected devices, while delivering an improved experience to multiple users.
- Chips supporting 802.11ax are available for integration into retail routers, enterprise access points and smartphones now.



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