ZYXEL

Your Networking Ally

WiFi 6

– what difference will it make?

White Paper

Why WiFi 6 Could Herald A New Era In The Classroom As Well As The Commercial Sector

The new 802.11ax wireless networking standard, or WiFi 6 as it is also called, offers significant benefits over 802.11ac in terms of speed and even more significantly, the density of users it can support. In this document, we will set out the key benefits of WiFi 6 and where and when it can or should be usefully deployed by organizations.

We also explain why it could trigger a new wave of technology adoption within schools, by enabling the classroom of the future, as well as bringing greater flexibility and capacity to other commercial and public sector organizations, of all sizes.

How did we get here?

WiFi has become an essential part of our working and personal lives. It's now more or less assumed that wherever you go, that you will be able to connect to a wireless network. This has been great for mobile workers who want to stay productive while they are on the move. It's also great for people in their everyday lives as it means, wherever they are, they can get information, watch video clips and use social media, wherever they are and without using the cellular data allowance.

WiFi has also brought a whole new level of flexibility to the education sector, enabling pupils and students to access online resources and information within the classroom and across the whole of a school or college.

Wireless technology has, of course, continued to develop over the past decade, to the point where we now have the 802.11ac Wave 2 standard. This is the later iteration of the fifth generation of WiFi. It has been around for several years now and is the most widely used form of WiFi globally.

802.11ac Wave 2 makes use of MU-MIMO technology to deliver wireless speeds in excess of 2 Gbps and with some clever design and configuration, a theoretical maximum on excess of 6 Gbps. It also supports additional spatial streams, which means that by placing a second antenna on a device, it is possible to connect more users at higher speeds.

Wave 2 access points are quite fast compared to most networks and broadband connections, and in most situations today, the speed of the WiFi is not really an issue. But although 802.11ac Wave 2 increased the number of simultaneous connections it could support, compared to the previous standards, it still has some limitations in this regard.

The problem is caused by the collision-detection method used to manage traffic in Wave 2. It uses the CSMA-CA (carrier sense multiple access/collision avoidance) protocol to manage the different streams of transmission. This is essentially a contention-based service that – as the name implies-avoids collisions on the network.

It does this by checking the availability if a channel before transmitting a packet of data. If the channel is free, it reserves the channel and then transmits the packet. Once it's finished, it makes the channel available again. If a channel is occupied, the transmission has to wait until it's free before it can transmit.

All this happens in microseconds, and it is fine and hardly noticeable when there are only a few devices connected to the access point. But as the number of connections rises and the volume of traffic increases, there is more contention. More transmissions spend more time waiting for channels to be freed-up and performance starts to degrade.

The change would be detectable at surprising low numbers of connections. Once you have perhaps 12 or 15 users or devices connected to an 802.11ac Wave 2 access point, you may start to notice a difference.

More organizations are now having to think about how WiFi performance is affected when the number of users rises sharply. As we said at the start of this paper, the expectation now is that WiFi will be available everywhere, so we are seeing more situations in which there are many users trying to connect within a relatively small area. But with Wave 2 technology it's a challenge to provide fast and reliable performance for large numbers of simultaneously-connected users.

Where this is the case more or less all the time – in large corporate offices, in airports and railway stations, hotels, conference and exhibition centres, for example, the cost of adding additional infrastructure – additional access points along with additional bandwidth management and controls in order to reduce the amount of contention on the WiFi network – can almost always be justified. But this approach only ever goes so far, and it incurs additional and often quite significant outlay. It also adds complexity to the network and increases the management overhead.

For other organizations, where it's necessary to support a higher density of users less frequently, it is harder to justify. Some organizations – schools and colleges for example – may not have the budget to cover the cost of additional infrastructure or bandwidth and application management solutions.

How does WiFi 6 solve the problem?

The development of the 802.11ax standard has focused strongly on increasing support for higher densities. It does also deliver significant speed increases – around 40 percent on 802.11ac Wave 2, and thanks to the other technologies that are included in WiFi 6, performance won't degrade as more devices connect to the network.

Essentially, there are two technologies that make a real difference in WiFi 6 – orthogonal frequency-division multiple access (OFDMA), and spatial re-use, which is also referred to as Basic Service Set (BSS) colouring. These make WiFi 6 a much more efficient technology than 802.11ac.

OFDMA, an uncontended method of accessing and managing channels that has been developed from techniques that are already used in LTE (long-term evolution) cellular communications technology. This approach has thus been proven to work very well in higher-density environments and as it is contention-free, overcomes one of the main and well-known issues with previous generations of WiFi.

Simply put. OFDMA allows more than one signal to be sent over the same line or channel at the same time. This works by assigning a time-interval to each transmission. This is then used to split the frequency and allow each transmission or device to take its turn at the assigned interval. This allows multiple users to transmit at the same time but without any contention. While the frequency is effectively split, and transmissions are sent in sequence, it all happens so quickly, it's imperceptible to the user.

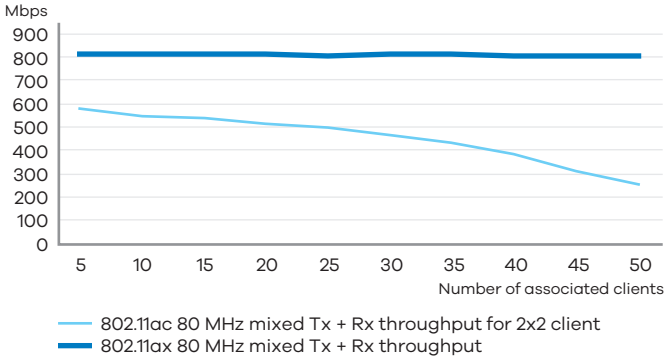
The result is that the connections are streamlined and much more efficient (shown in figure 1). It means that more transmissions can be sent, without any delay or contention. All that business of checking to see if a channel is available, then waiting and checking again, and reserving and then freeing-up a channel no longer happens.

Major chipset developers have been working on adding OFDMA capability to their technologies and these advances have made it possible for the IEEE to include it in the 802.11ax standard.

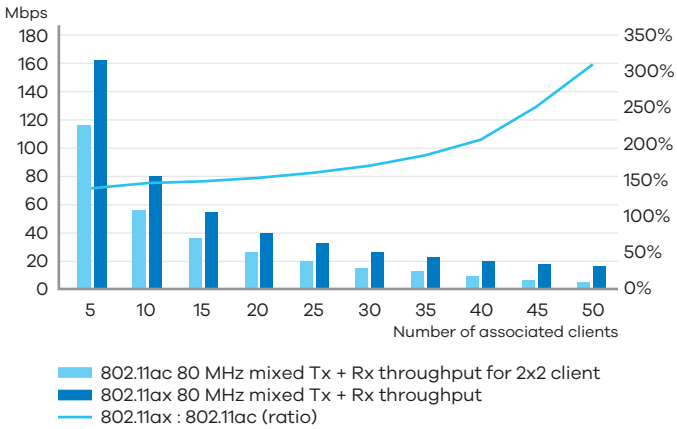
Spatial reuse, or BSS colouring, is a similar technique but is used to reduce any contention between access points. It thus works in harness with OFDMA to provide even greater density.

Figure 1

Aggregated throughput



Per client throughput comparison

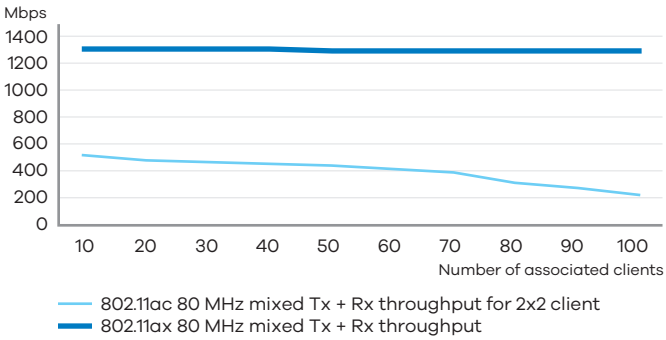


In this method, a colour is assigned to each basic service set (BSS) or type of transmission. If the same kind of service is trying to transmit on the same channel at the same time, this can cause a high level of interference. By using colour identifiers, transmissions of the same kind emanating from different access points can be kept apart, thus avoiding co-channel interference (shown in figure 2). This allows multiple access points to be used in the same vicinity and without having to wait for space to become available on that channel.

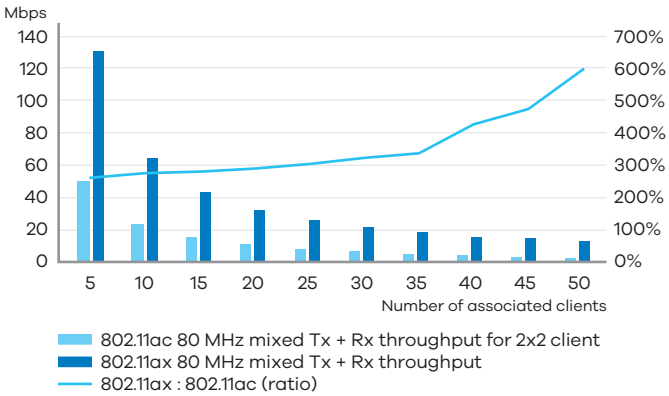
It is worth mentioning that Zyxel's already-developed and unique smart antenna technology it will be possible to reduce co-channel interference even further and deliver very good spatial reuse performance over shorter ranges. This will really help in exceptionally very dense environments.

Figure 2

Aggregated throughput



Per client throughput and improvement



What else does 802.11ax offer?

While they are amongst the most significant improvements that it delivers, WiFi 6 it is not just about OFDMA and spatial reuse. It will increase speeds by as much as 40 percent over fifth-generation wireless networking technology, and in comes with more than 50 new features or enhancements.

It is theoretically around 40 percent faster and should support speeds of up to 10 Gbps. This is achieved mainly through more efficient use of both the 2.4 GHz and 5 GHz spectrums, using them simultaneously instead of assigning connections to one or the other. And on the latter, it offers bandwidth of 160 MHz. All this helps to streamline performance and the introduction of other technologies, including OFDMA and BSS colouring also helps even more, especially in averting any degradation of performance by eliminating contention.

There are also important improvements to Multi-User – Multiple Input Multiple Output (MU-MIMO) technology in 802.11ax. MU-MIMO enables an access point to communicate with multiple devices simultaneously. But in the previous standard, this beam-forming technology only worked on the downlink and could only support groups of four clients on one frequency. It made it easier to transmit, but not to receive.

With WiFi 6, the connection is two-way – there is an uplink as well as a downlink, and up to eight clients can be grouped together on the same frequency. This, in combination with OFDMA, really helps to increase the density of connections that can be supported through a single access point.

Compression technology has also been improved in WiFi 6. The 802.11ac standard included 256-QAM (Quadrature amplitude modulation), but 802.11ax supports 1024-QAM. This technology modulates radio signals, enabling more data to be crammed onto the same frequency. With 1024-QAM, throughput is increased by around 25 percent, compared to 802.11ac.

Another enhancement in 802.11ax is support for Target Wake Time (TWT), which can be to preserve energy by scheduling when client devices should wake up and be powered down. This technology will be used chiefly in supporting IoT deployments where sensors or other devices are being used to gather data at defined periodic intervals, so it won't be relevant to many potential adopters of WiFi 6 just yet.

Where will WiFi 6 deliver benefits?

As we have already said, WiFi 6 will deliver the most benefits in any situation where a high density of connections will need to be supported without any loss of performance. As support for high density will come with all 802.11ax devices, it will, as it were, level the playing field from an end-user perspective. Organizations that could not afford to implements more sophisticated bandwidth management under 802.11ac, will be able to get the same benefits at no additional cost.

In our view, schools and colleges will be one of the biggest beneficiaries of adopting 802.11ax technology early. Good connectivity is arguably even more important in education than it is in the commercial world, and with the need to provide good, consistent performance for a large number of users – perhaps across several buildings and open areas across a campus – educational institutions will undoubtedly benefit from adopting WiFi 6.

In many schools, WiFi 6 will also pave the way for the much-discussed and anticipated classroom of the future, in which all students and multiple devices – tablets, large format displays, interactive touch tables and other devices such as video cameras and temperature and environment sensors – are always connected within a fully integrated learning solution.

Other public sector organizations – local government offices, town councils looking to provide free WiFi, will also want to consider early take-up of the standard.

In the commercial sector, any enterprise through which large numbers of people are going to be connecting on a day to day basis, such as hotels, conference centres, railway stations and airports, will certainly see efficiency and performance gains from using WiFi 6. As indeed, will businesses that run large offices, warehouses or assembly and production facilities. Smaller businesses that are seeing to attract the general public through their doors – guest houses, bars, cafes, shops – will also benefit from upgrading to WiFi 6 as soon as the penetration levels reach a critical mass.

For smaller businesses and consumers, the need to adopt equipment that supports 802.11ax will be less urgent. But any organization – or indeed, any household – that expects to connect more and more devices to their access point is going to benefit in some way from moving to WiFi 6 eventually.

The point at which it makes sense to upgrade may come sooner than expected. The standard is here now and access points and routers that support WiFi 6 will be available in the final quarter of 2019. At the same time, mobile devices – notebook PCs, tablets and smartphones – that can take advantage will also start to appear.

Throughout 2020, WiFi 6 will start to take over as the prominent wireless technology. With 802.11ax, there will no longer be haves and have-nots when it comes to WiFi density. We expect the early adopters to be schools, colleges and other organizations that have, up to this point, been unable to implement wireless networks that can support higher densities due to budget limitations.

When should I switch to WiFi 6?

The decision of when to switch to WiFi 6 will depend on a number of factors and of course, it will be different for every organization. We expect three main phases of adoption. The first will see organizations who have had users experiencing degradation of wireless performance with 802.11ac, migrating as quickly as possible. They will see immediate benefits.

The second phase will be driven largely by the need to ensure that the speed and consistency of WiFi performance is meeting expectations. As the new generation of WiFi 6-capable devices start to become more prevalent, organizations will be expected to match the performance of these devices.

Gradually, WiFi 6 will take over as the uniform standard and the third phase of adoption will see all businesses, organizations and consumers using the standard as a matter of course.

The key for many public and commercial sector organizations will be not to leave it to late. Adopting the new, more robust, stable and faster technology, will show that they are ready and willing to embrace new technologies that will deliver improved performance and reliability to their WiFi users.

Finding out more

Zyxel is developing WiFi 6 solutions for release in the final quarter of 2019. Details of the products will be available soon. If you would like to know more about the 802.11ax standard and how it might be used to benefit your organization by delivering consistent and stable performance in high-density environments, please contact your local Zyxel office or partner. You can find out more at www.zyxel.com.

About Zyxel Communications

Focused on innovation and customer-centricity, Zyxel Communications has been connecting people to the Internet for nearly 30 years. Our ability to adapt and innovate with networking technology places us at the forefront of creating connectivity for telcos and service providers, business and home users. Zyxel is building the networks of tomorrow, unlocking potential, and meeting the needs of the modern workplace — powering people at work, life, and play. Zyxel, Your Networking Ally.