wightfibre
because we care

WightFibre WiFi 6 Guide

Executive Summary

WightFibre has created one of the best broadband networks in the world providing domestic and business customers with future-proofed ultrafast, full-fibre, internet access.

With such fast broadband speeds, expanding WiFi coverage throughout the whole home or business premises has never been more critical. But more than that, the explosion of wireless portable devices, smart appliances, home automation and the "Internet of Things" (IoT) not only need to be connected but they also need to be looked after and monitored for reliability, safety and security.

This white paper explains the evolution of WiFi from the days before it was given a number through to the latest evolution known as WiFi 6.

Following a few years of anticipation, WiFi 6 is making its way to homes and other connected places. WiFi 6 is seen as a transformative technology that will drastically change the consumer experience. Market adoption began in earnest in 2020, and analysts and industry experts expect to see a brisk pace of growth.

Making the most of the new benefits of WiFi 6 including higher speeds depends on intelligent design and configuration of networks and this makes it ideally suited to be used within WightFibre's service which is powered by Plume's OpenSync Platform.

WightFibre's state-of-the art network, combined with the facilities offered by Plume HomePass with WiFi 6 create the very best and secure environment not only for PCs, laptops, tablets and phones, but all of the smart devices in a customer's home.

Introduction

Hailed as a new era for WiFi connectivity, 802.11ax—known better as WiFi 6—has created much excitement and anticipation. Capable of more than doubling speeds of its predecessor, 802.11ac (sometimes known as WiFi 5), WiFi 6 promises to transform the home network.

As well as boosting throughputs, this new technology improves overall system capacity, security, and even power consumption and battery life. And the timing couldn't be better. Not only are consumers relying on home WiFi more than ever, but the smart home is also evolving to include more connected devices, immersive experiences, and bandwidth-hungry applications.

The Wi-Fi Alliance (the worldwide alliance of companies that develop WiFi) estimates over 2 billion WiFi 6 devices have been shipped to consumers and organisations. WiFi 6 products entering the market will spark renewed consumer interest in WiFi upgrades, including deployments of WiFi 6 home networks. There's no doubt that the new capabilities of WiFi 6 will improve the user experience in all connected spaces. But maximizing its full potential means optimising WiFi networks in ways that are both more critical and more complex. WiFi 6 connectivity in any space is only as good as the system controlling it. To deliver on the promise of this new technology for their customers, WightFibre has partnered with Plume and their OpenSync platform, which uses AI and machine learning to monitor and optimise the network.

The WiFi 6 Revolution

WiFi has become as ubiquitous as the Internet, so much so that many people refer to "WiFi" when referring to any aspect of connecting devices to the Internet (even though of course we know that it's the broadband that connects you to the Internet and it's the WiFi that connects you to the broadband); so considering that WiFi 6 brings not only new features to the 5GHz band and a new 6GHz band but also the first improvements to the 2.4GHz band in over a decade, the buzz around it is understandable.

A lot has changed in that decade. The home network is much more complicated and customers are increasingly relying on that WiFi connectivity for work, school, and entertainment.

The WiFi 6 market is just emerging, but the technology's potential to transform the home network is tremendous, especially as the smart home and work-from-home (WFH) trends gain momentum.

Industry Forecasts:

- 17 billion home devices will be in use by 2030 globally, with WiFi 6 accounting for a third of device sales by 2023.
- WiFi 6 will become the predominant WiFi standard both for consumers and enterprises by 2023
- On the public WiFi front, WiFi 6 hotspots will grow 13-fold by 2023, comprising 11% of public WiFi hotspots
- 2 billion WiFi 6 devices will have been shipped in 2021 to consumers, enterprises, and public agencies.

WightFibre's partner Plume reports that:

- Globally on average, 17.1 connected devices are in use per Plume household
- 28% of consumers use smart home devices such as cameras and thermostats
- By 2023 the growth of global shipments of smart devices will increase by 71% from 8215 million to 1.4 billion.

17.1
Connected devices are used in the average global household, served by Plume[1]

28%
of consumers use smart home devices such as cameras and thermostats[2]

71%
growth expected for the number of global shipments of smart devices between 2019 and 2023 (from 814.8 million to 1.4 billion)[3]

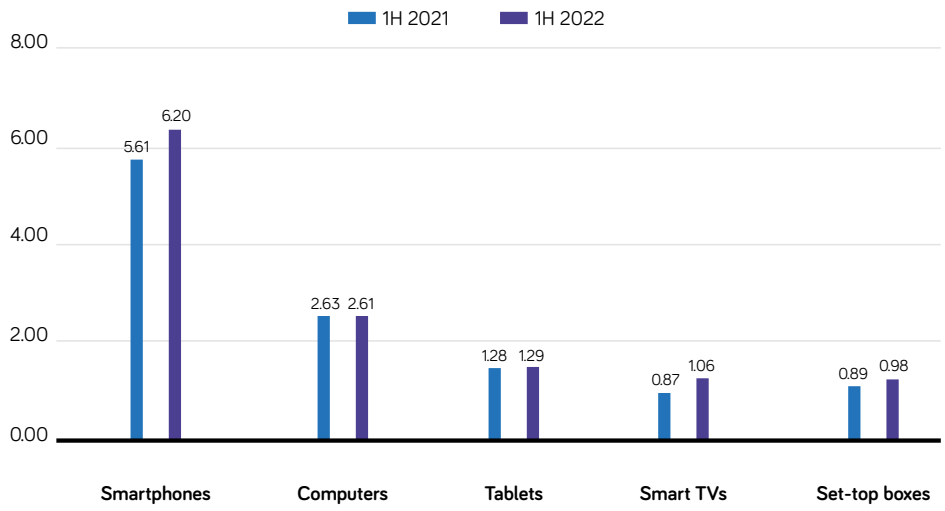
[1] PlumeIQ August, 2022
[2] "Connectivity and Mobile Trends Survey," Deloitte, 2019
[3] "Smart Homes 2020," eMarketer, December 2019

WiFi 6E and the 6Ghz band

WiFi 6 only came into being in 2018, and in 2019 the Wi-Fi Alliance created their certification programme. By the start of 2021 they had already certified nearly 1400 different WiFi 6 products.

A further development is WiFi 6E, which is an extension to WiFi 6 operating in the 6GHz band. The 6GHz band has been freed up in most parts of the World for WiFi 6E use though the exact channels available varies between territories. WiFi 6E certification began in early 2021.

WiFi 6 and 6E devices are entirely backward compatible with the original 2.4GHz and 5GHz bands.



Average number of devices per home

A Brief History of WiFi

WiFi 6 is the latest WiFi standard and is arguably the biggest step change in WiFi since the original 2.4GHz band was joined by the 5GHz band.

You may be wondering what happened to WiFi 1 to 5? WiFi 6 is the first standard really to be given its own customer-friendly name (in much the same way that mobile phone data has been called 2G, 3G, 4G and 5G). Previously the WiFi types have mainly be known by their technical standards and sub variants with numbering only applied retrospectively, so, in brief:

- WiFi 1: IEEE802.11 -2.4GHz, 1 to 2 Mbits
- WiFi 2: IEEE802.11b - 2.4GHz, up to 11 Mbits
- WiFi 3: IEEE802.11g - 2.4GHz, up to 54 Mbits
- WiFi 4: IEEE802.11n - introduced the 5GHz band, 54 up to theoretical 600Mbits
- WiFi 5: IEEE802.11ac..400 Mbits becomes widely achievable with several Gbits in theory.

WiFi 6(E) by comparison will also add the 6GHz band to the pre-existing 2.4GHz and 5GHz WiFi bands and looks to rival many of todays wired network speeds. WiFi 6 compatible devices should more easily achieve higher speeds, whilst compatibility is maintained for old devices, and cheap 2.4GHz IoT devices.

To unlock the full potential of the features of WiFi 6, it is really important to be able to configure the network and Access Points to their optimum and in being able to do this automatically, Plume's OpenSync enables customers to get the very best out of their WiFi 6 Access Points and devices.

Some of the features of WiFi 6 that achieve the much higher speeds are quite technical. For example WiFi 6 uses orthogonal frequency-division multiple access (OFDMA), which allows a single transmission to be shared between multiple devices greatly improving efficiency and capacity. However getting the benefits of OFDMA requires OFDMA-aware client steering – so in some circumstances better performance may be achieved for an individual device by it being able to "hear" an OFDMA transmission, which may not necessarily be in the nearest Access Point (or the one with the highest raw signal strength). This is where OpenSync and its cloud-based machine learning and optimisation comes into its own, providing a centralised intelligent network controller that provides rigorous optimisation and maximises efficiency.

The Benefits of WiFi 6 and How it Works

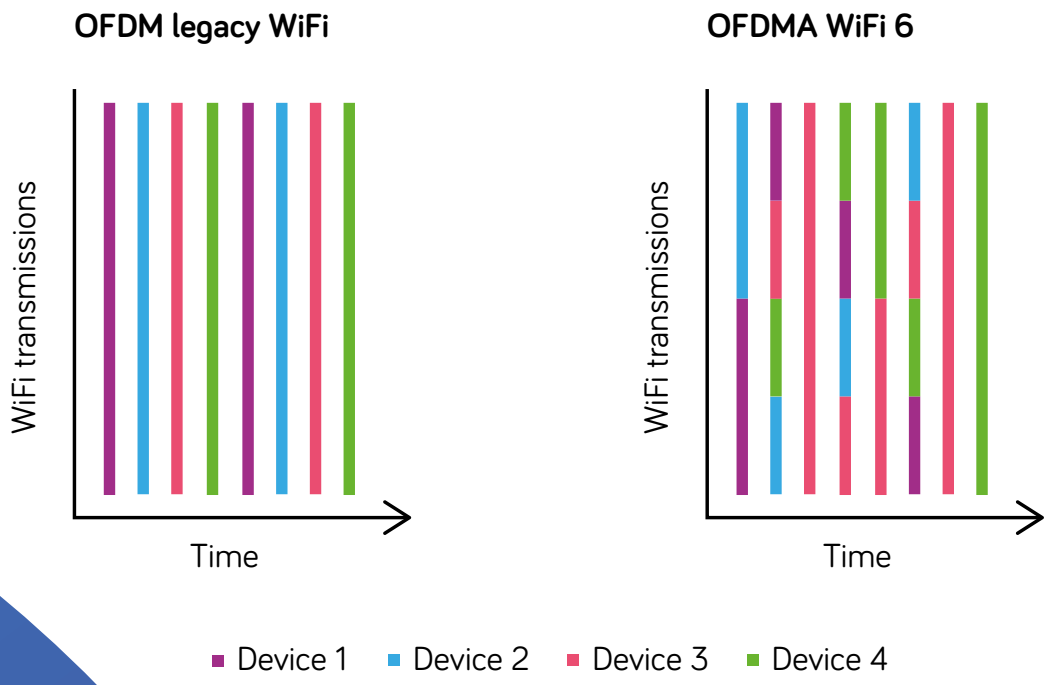
In the home environment, the network is becoming more congested as a larger number of devices connect to WiFi and customers run more bandwidth heavy applications such as 4K video streaming, virtual reality (VR) gaming, and video conferencing. WiFi 6 brings key changes to several areas in practice, including:

- Twice the throughput in low-congested environments
- Improved power efficiency
- Twice as many devices can be supported efficiently per access point.

WiFi 6 introduces numerous new technical features and builds on others from earlier WiFi standards to provide its benefits:

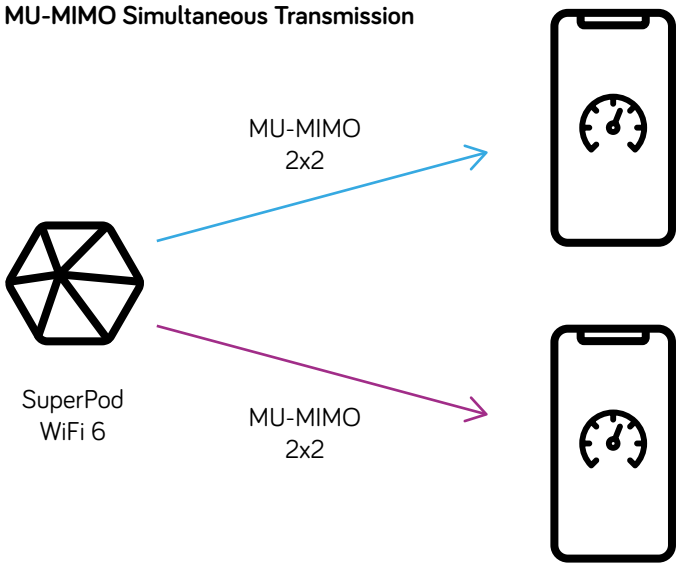
- 160 MHz Channel bandwidth: Although this isn't new (it's available in WiFi 5), it is very rare for it to be enabled in earlier WiFi standards as many devices only supported 80MHz. Many public hotspots stick to 40MHz for maximum compatibility and reliability, automatically limiting the WiFi's maximum throughput. The expectation with WiFi 6 is that 160Mhz will be used far more frequently.

- OFDMA: Orthogonal Frequency Division Multiple Access multiplexing. This mouthful of a technical phrase means that a single transmission from a WiFi Access Point (AP) can communicate with several devices rather than one. Earlier WiFi standards used a simpler form of multiplexing meaning that in any given time slot, the AP could only communicate with one device.



- 1024-QAM: This relates to how the signal is actually transmitted. Older WiFi standards use up to 256-QAM (Quadrature Amplitude Modulation). The increase to 1024 packs up to 25% more data bits into the wireless signal increasing the overall data rate for the channel.

- UL-MU-MIMO: MIMO, or Multiple Input Multiple Output has been around for a while and is most often seen in the sales promotion materials for advanced home WiFi routers. MIMO uses multiple antennas to send signals to different devices enabling more than one device to transmit to an AP at once. The UL-MU extends this principle so that Multiple devices can "Up Link" or transmit to the AP at once.



- Resource Unit Reservations: The resource units, or smaller frequency slices, that OFDMA operates with can get allocated to particular client devices. This allocation changes dynamically over time, which is what allows a single, wide, efficient transmission to serve multiple clients at once. Reserving resource units for particular clients or data flows provides guaranteed Quality of Service (QoS) to those clients or flows because a fixed amount of bandwidth within the network is allocated specifically for that traffic

- Target Wake Time: This technique was originally developed for an offshoot of the main WiFi standards called 802.11ah (also known as 900MHz WiFi or WiFi HaLow). The idea is to provide as guaranteed connectivity as possible for devices that only transmit very periodically such as remote smart monitoring devices. The AP creates a schedule with specific times for each client to be awake and reserves that time so no other devices can transmit during that window, giving the waking devices clear airwaves to quickly communicate and return to sleep.

- BSS "Color": This technique has been developed to help APs deal much better with interference and the situation where they are using frequencies overlapping with other APs. It marks (thing of it as "colour coding") shared frequencies at the start of transmitting a packet of data to indicate which network the packet belongs to and enables devices to make a very quick assessment if they are safe to transmit or must defer to traffic coming from a network with a different "colour".

- 6GHz Frequency: WiFi 6E extends WiFi 6 capabilities to the 6 GHz spectrum, previously only available to licensed users. This is considered a big step, as the need has become more urgent to prevent congestion on existing frequencies. The new spectrum makes available up to three super-wide 160 MHz channels in the UK (up to 7 in some countries) that can support high-bandwidth applications such as unified communications and industrial IoT. For home networks, this brings the benefit of for example low latency, higher-speed WiFi for augmented reality and virtual reality gaming.

Configuring and tuning all of these parameters by hand to optimise a WiFi network would be very difficult to do manually, but with WightFibre Whole Home WiFi, powered by Plume, all of this is done automatically.

WightFibre Whole Home WiFi and WiFi 6

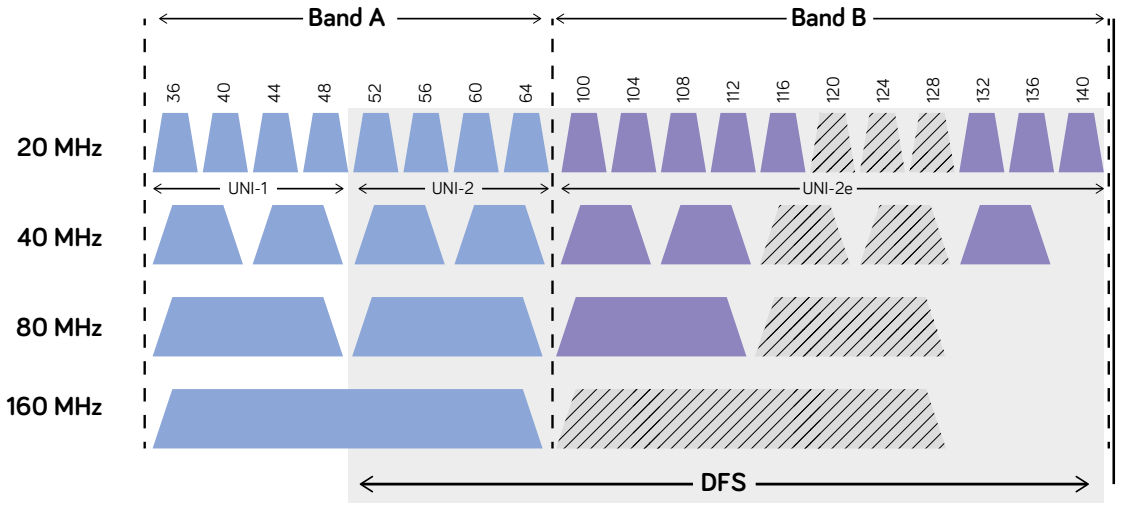
WightFibre's Whole Home WiFi is available with any WightFibre broadband package and is powered by WightFibre's partner Plume's OpenSync Platform.

OpenSync is designed to deal with the complexities of dynamic WiFi networks automatically configuring and monitoring the network and then adjusting it to optimise it. This makes it ideal for making the most of WiFi 6's potential.

160MHz Channels

With more 160MHz channels available this should be an easy way of doubling throughput compared with 80MHz. However even though there are more 160Ghz channels, in the UK there are only five, two in the 5GHz band and three in the new 6GHz band, so in a busy town or city environment and especially blocks of flats, neighbours could easily find themselves using the same channels.

What you need is intelligent sensing and prediction of interference and intelligent channel allocation and bandwidth selection. This simply doesn't happen in an environment where a customer configures their own router (or more than likely leaves it set to its defaults); The Plume Pods used in WightFibre's Whole Home WiFi can do this sensing and use the cloud AI to apply the best 160GHz channels where they can bring the best benefits. Better still, if several neighbours all have WightFibre, then the networks will naturally optimise themselves so as to not conflict with each other.



OFDMA

Another challenge is making the most of OFDMA. Typically, many smart devices on the "Internet of Things" (IoT) have low data rates but each 802.11 packet itself has significant overhead, and to avoid collision with other transmitters each transmitter must listen first to the medium for some time. Even if each transmission sends a modest amount of data, the overhead consumes a lot of airtime.

OFDMA allows transmission to multiple users simultaneously in one packet, eliminating overhead and wasted time. This capability only improves efficiency when a significant number of IoT devices are on the same AP, each device sending or receiving a modest amount of data. But modern WiFi networks in smart homes will not always end up with a significant number of IoT devices on the same AP.

Consequently, OFDMA operation requires OFDMA-aware client steering. To make complex decisions, a centralised, intelligent network controller would need:

- Knowledge of which APs and clients are WiFi 6 capable.
- Historical observation and forward prediction of the data needs of each device in the home.
- The ability to make intelligent, optimized choices about which of the multiple APs each device in the home should connect to considering the capabilities, traffic load, signal strength, and data rate each device can achieve.
- The ability to steer and hold devices on the correct AP.

For all the APs and clients to work efficiently, the best arrangement must be created through rigorous optimisation. This should include the ability to steer clients to APs and hold them there, even if those aren't the closest APs. The steering mechanism must be specific to each type of device because different devices behave differently to various steering mechanisms.

The Plume Pods used in WightFibre's Whole Home WiFi can do this sensing and use the cloud AI to optimally steer devices to the correct AP.

Network Slicing

Network slicing is another way of allocating frequencies and time among different clients to improve Quality of Service (QoS). This is essentially a time-division multiple access (TDMA) method (where transmissions occur at reserved times) but has the added overlay of a divided frequency spectrum. In a home with multiple APs or where lots of neighbours' WiFi is within range, network slicing could normally lead to high collision rates when both networks schedule the same time periods. The result is poor QoS, defeating the point of the time/frequency reservations. Centralised, intelligent controls can mitigate this issue by coordinating among the multiple APs.

The Plume Pods used in WightFibre's Whole Home WiFi can do this sensing and use the cloud AI to optimally handle network slicing and improve QoS.

The 6 GHz Frequency Band

Although the 6GHz band has been made available in many territories, there are still limitations in use as there are already point to point microwave links already in the 6GHz band. The issue is particularly complicated in the US where an AP isn't allowed to operate on a frequency where it might interfere with a microwave link and actually has to look up the location of microwave links in a database. Even without this requirement, most other territories must operate in a Low Power or Very Low Power mode.

For the low-power transmission, more complicated, multi-AP configurations will be required for an optimization system to select the appropriate network topologies, frequency assignments, and client steering options.

The control system needs to take into account the client types, loads, and capabilities to decide how to allocate the network's radio resources. Depending on the capabilities of the clients in the network, it is not always optimal to put one of the AP's radios in the 6 GHz band. For example, using a 6 GHz channel for the backhaul connection may help the backhaul, but it may take away the high-performance radio in the AP from the 5 GHz band. High performance clients that do not have a 6 GHz capability may therefore connect at lower speeds, actually degrading the experience in the home.

Summary

WiFi 6 brings long-anticipated improvements to a technology that's now over 20 years old. The new features will solve many challenges created by the ever expanding, increasingly more congested home network. It's undisputed that this technology takes the home network to a new level. However, making the most of WiFi 6 brings additional complexities.

Using Plume's innovative platform, WightFibre provides operational enhancements that increase the home network's speed, capacity and Quality of Experience. The Plume SuperPod with WiFi 6, coupled with the Plume Cloud, addresses the WiFi 6 demand for added intelligence. Plume's cloud-based, AI-driven algorithms learn from data collected across millions of networks and clients to identify the best steering techniques, predict interference, and perform complicated analyses to apply dynamic controls and rigorous optimization to networks with multiple APs and where neighbouring APs might interfere.

As with most new technologies, it will take a few years for WiFi 6 to become ubiquitous. But the possibilities are thrilling once the technology is fully developed and implemented. The greatly enhanced speed and performance of WiFi 6 will open new doors for emerging technologies such as IoT and AR/VR.

It is not only a new era for consumers but also an opportunity for WightFibre to take advantage of the technology to enhance and expand the services it provides to Customers.

WiFi 6 is, indeed, powerful. But it doesn't eliminate the need to optimize the network—on the contrary, the complexity of this technology creates an even greater demand for intelligent management - the intelligent management provided by WightFibre's Whole Home WiFi powered by Plume.

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