wightfibre
because we care

WightFibre
Adaptive WiFi 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.

Traditional centralised WiFi routers fail to provide adequate coverage for the whole home, and accompanying WiFi repeaters or extenders fail to reliably extend the WiFi connection. In order to completely solve the WiFi problem, a new architecture is required. This architecture requires a deeply distributed WiFi access network with an intelligent controller to manage the delivery of WiFi speed, reliability, and coverage. Each network must be able to adapt to each customer’s home size, environment, and usage based on device usage and historical insights of customer patterns.

This white paper explores the existing solutions such as WiFi extenders and mesh system and explains how WightFibre’s solution powered by Plume’s OpenSync Platform automatically configures and adapts the network using Cloud AI and machine learning.

WightFibre’s state-of-the art network, combined with the facilities offered by Plume HomePass with Adaptive WiFi create the very best and secure environment for PCs, laptops, tablets, phones and all of the smart devices in a customer’s home.

Introduction

Today, in their homes, people are consuming ever more content, interacting via richer communication mediums, and relying on various internet-delivered applications and services to make their lives more comfortable and safer. Led by the emergence of HD and UHD video-on-demand and IoT connected devices, consumers are using the corresponding applications and devices in even more places in the home. WiFi is becoming the standard way these devices and applications are connecting to the internet. The broadband internet connection available in most homes today is extremely reliable and consistent with 99.9% uptime. Moreover, the upstream infrastructure and resources–compute, storage, Content Distribution Networks (CDNs), Domain Name Servers (DNS), and other cloud platform services–are even more reliable, with a 99.99% uptime. However, today’s consumer experience is often frustrating with choppy video, dropped sessions and inconsistent speed. This problem is largely due to the WiFi network inside the home, the last few meters of the connection. Some of the key factors of this inconsistent performance are wireless interference, congestion, coverage impairments, and device (mis)behaviour.

Does Your Home WiFi only work well in some places some of the time?

Many people have exactly this issue and start looking for solutions, often starting with cheap WiFi extenders.

Whilst they are a relatively cheap option, they are cheap for a reason and so basic WiFi extenders can yield quite disappointing results. To work well they need to be positioned to receive a good signal from the main WiFi router as otherwise they will simply relay a poor signal (a common mistake is to put them in the part of the house you want to improve the signal in rather than bridging the gap to that part of the house). The other issue is that part of the available bandwidth is used to relay the signal and in cheap devices each "hop" typically halves the bandwidth available.

A next step beyond a basic WiFi extender is to use a "powerline" extender. These plug-in devices attempt to use your mains network instead of high-speed network cables. In small properties with a single ring main these can work fairly well but it needs to be remembered that domestic wiring simply isn't designed to carry the high-speed signals that proper data networking network cables are. Despite the claims of some of the newest adaptors, in practice they are found to deliver maybe half of their claim and even then only on a clean modern ring circuit. Many larger and older properties may have multiple rings and signals may not cross well between them (or even at all) and interference from other powerline systems or even things like plug in rodent deterrents can scramble the system.

More recently "mesh" systems have become available from multiple vendors. Many of these go some way to solve the problems above, for example using the 5GHz band as the "back channel" to avoid halving bandwidth in the 2.4GHz space, but aside from being expensive, most mesh systems are still static with each node acting independently and not coordinating with the other mesh nodes and rest of the network. This can lead to inconsistent and unpredictable performance.

Ideally what is needed is an intelligent network with mesh components that are constantly learning and improving and this is where the solution from WightFibre's Plume solution comes in.

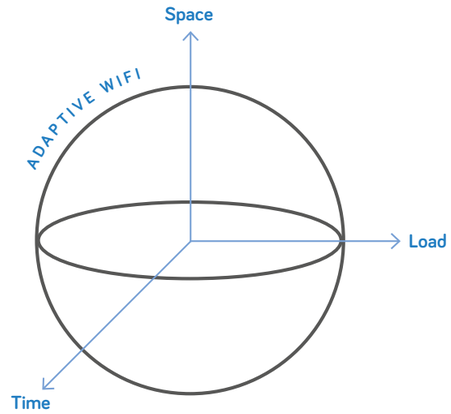
Solving the WiFi Performance Problem Properly

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.

Solving the WiFi Performance problem throughout the home brings many benefits, not just to be able to use PCs, laptops and smart phones and tablets easily but also the rapidly emerging IoT and smart home category. These require adaptive WiFi as a fundamental enabler to handle the growing number of connected devices consistently and reliably. The distributed nature of Plume's Adapt ensures that the distance (range) between IoT devices and the home infrastructure is always short. Such an architecture is critical for IoT devices which are small and low-powered, and cannot afford to transmit signals all the way across a home to a single Access Point (AP).



Adaptive WiFi Dimensions

Also with the planned switch off of the traditional "Plain Old Telephone System" (POTS), in 2025, everyone will need Voice Over IP (VoIP) technology in their homes to receive normal landline phone calls and the expectation is that WiFi VoIP phones will rapidly supersede DECT cordless phones, which will make WiFi throughout the home even more essential.

How does Plume Adapt Work?

Wireless signals degrade with distance, more so when passing through walls made of common construction materials. This attenuation is particularly dramatic if the walls are brick or stone (like may UK homes), contain wire mesh (traditional plaster), or metal foil (common in insulation in newer homes). The wireless signal corresponding to the WiFi 11ac and 11ax standard degrades even more rapidly with distance since it uses the 5GHz spectrum as compared to the 2.4GHz spectrum used by earlier, slower versions of the standard. As the consumer is starting to use increasingly more bandwidth-hungry WiFi devices at more and more places in the home, the approach taken by the high-end routers is to use increasingly more powerful hardware in the router in the hopes of driving the WiFi signal to more places in the home. More powerful hardware means using more radio chains (antennas) with sophisticated signal processing (MIMO) and higher-power amplifiers to generate a stronger signal. This approach leads to higher cost, size, and consumption. In addition, very few devices are able to fully use the MIMO capabilities. In all cases, the increase in range that can be achieved this way is relatively incremental and reflects diminishing returns for larger increments in power and complexity.

Figure 2 shows the resulting improvement in coverage achieved by such higher-end routers. As distance increases, the rate of performance of the WiFi signal is greatly diminished, and expensive increases in signal power and parallel transmissions provide only marginal WiFi performance at distance.

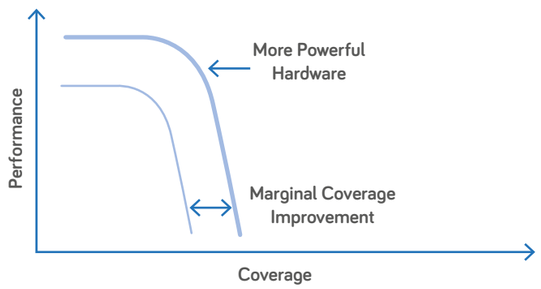


Fig. 2 Coverage Improvement with single WIFI Router HW Improvement

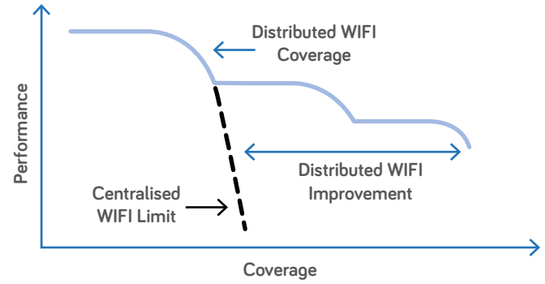


Fig. 3 Coverage Improvement with Distributed WIFI System

Figure 3 highlights a more sophisticated distributed WiFi approach, in which coverage is improved by sprinkling the smaller, lower power AP hardware (pods) across the home. The WiFi signal is forwarded across the optimally placed pods around the home to reach all client devices. With a sufficient number of pods (depending on the size of the home), the WiFi signal never needs to travel very far between pods, or from the last pod to the final client device. By substantially shortening the distance that the WiFi transmissions need to travel, this solution dramatically reduces the degradation of the WiFi signal allowing for substantially higher data rates throughout the entire

The Plume Adapt Advantage

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

With a single router the WiFi performance at different places in the home will vary based on the placement of the router. This is because there is only one way for the signal to get from the router to a given device. With a distributed WiFi system the signal can take several paths to get to the client device. Therefore the system can be optimized to choose the most effective path.

Maximize Configuration

Most WiFi client devices (e.g. phones, PCs, TV boxes, IoT devices) use one or two antennas and do not benefit from the four or more radio chains built into the most powerful routers. A distributed WiFi system can use a similar radio configuration as supported by the devices in affordable pods without losing performance on the client connection speed.

Multiple Pods, Any Number of Channels

A centralised WiFi router can only use a limited number of channels and those channels have to bear the load for all the clients on the home network. The multiple pods of a distributed WiFi network like Adapt's can operate over any number of channels, thereby spreading the radio spectral load without causing interference. The distributed network also benefits from load balancing allowing devices to be distributed among the multiple APs in the home relieving congestion in the AP to client links.

<I've left out the section on MU-MIMO in the original paper as technical knowledge is assumed that would be difficult to impart in brief in a paper aimed at end consumers>

MU-MIMO Technology is Limited

Some of the recently launched 11ac wave2 routers use MU-MIMO technology to allow a single router to send traffic to multiple client devices in parallel by using different subsets of its multiple radio chains. Similarly, 11ax (WiFI 6) routers will use OFDMA technology to communicate with multiple devices in parallel. However, the resulting capacity increase is modest due to operating in the same channel from the same radio when compared to the significant capacity gain achieved from separating the multiple radios of a distributed WiFi network in frequency and space. MU-MIMO gains are further limited by the fundamentally fragile nature of the nulling based technology.

Software Automatically Manages the Network

The proliferation of WiFi nodes or pods throughout the home provides large degrees of freedom for traffic routing between the end-device and internet gateway connection. The number of potential connections between nodes increases exponentially greatly increasing the ability to deliver a reliable, high-performance WiFi service.

However, distributed WiFi networks are more complex to configure and manage, specifically to deliver the optimal performance commensurate with their capability. This complexity is best handled with a centralised software entity with knowledge across the entire network. In essence, a distributed WiFi approach achieves a superior wireless system by shifting the complexity from hardware to software.

The Advantage over WiFi Repeaters and Mesh

WiFi repeaters can be used to extend coverage in a way that may seem similar to the distributed WiFi approach but repeaters act as independent nodes and do not coordinate with the central router or other repeaters (nodes) in the system. Therefore, unintelligent repeaters cannot adapt to the changing needs of wireless networks and can only be used to boost (repeat) the signal from the central router.

Some WiFi repeaters repeat the signal on the same channel, thereby reducing the overall capacity of the network by introducing self-interference. Even in the case where a repeater attempts to repeat the WiFi signal onto a different frequency channel, it requires sophisticated management by the user to optimize performance.

Any configuration created by the user will be a single static configuration, unresponsive to changing conditions or interference from neighbouring networks.

Moreover, in traditional repeater-enhanced WiFi networks, the selection of the connecting WiFi node per client device is completely controlled by the device. Devices operating on their own will often fail to automatically choose the path of maximum performance. For example, customers can experience extremely poor performance when their devices "stick" to a distant repeater rather than connecting to the nearby router.

Finally, coordination of changes in the WiFi network, such as channel or SSID changes, are hampered by the lack of a centralised authority. Typically, consumers changing their WiFi network name or password end up in a tangle of reboots, disconnected devices, and partially connected networks. In summary, the use of WiFi repeaters or extenders to increase range often leads to inconsistent results and often lessens the performance of the network as a whole.

A newer class of WiFi products form a mesh network to coordinate with each other to increase the WiFi range. Current mesh routing protocols are designed to provide reachability of traffic between mesh nodes, only ensuring that the traffic makes it to the internet gateway in some way. This focus of mesh routing largely ignores the routing demands of the connected devices. These unsophisticated routing protocols do not address application performance or wireless network capacity to achieve the desired customer Quality of Experience (QoE). In fact, most mesh systems available today operate on a single channel backbone thereby significantly limiting the overall capacity while being prone to self-generated interference. Additionally, the locally managed, traditionally distributed control plane mesh routing architecture increases the complexity of each individual node, making it difficult to continue to add capabilities by adding additional nodes and routes to the mesh system.

How is Adapt Different?

WightFibre's adaptive WiFi system powered by Plume continuously adapts to the environment and user behaviour to optimize the overall network capacity and application performance.

Some of the differentiating aspects of Plume's Adapt system compared to repeater or mesh systems are:

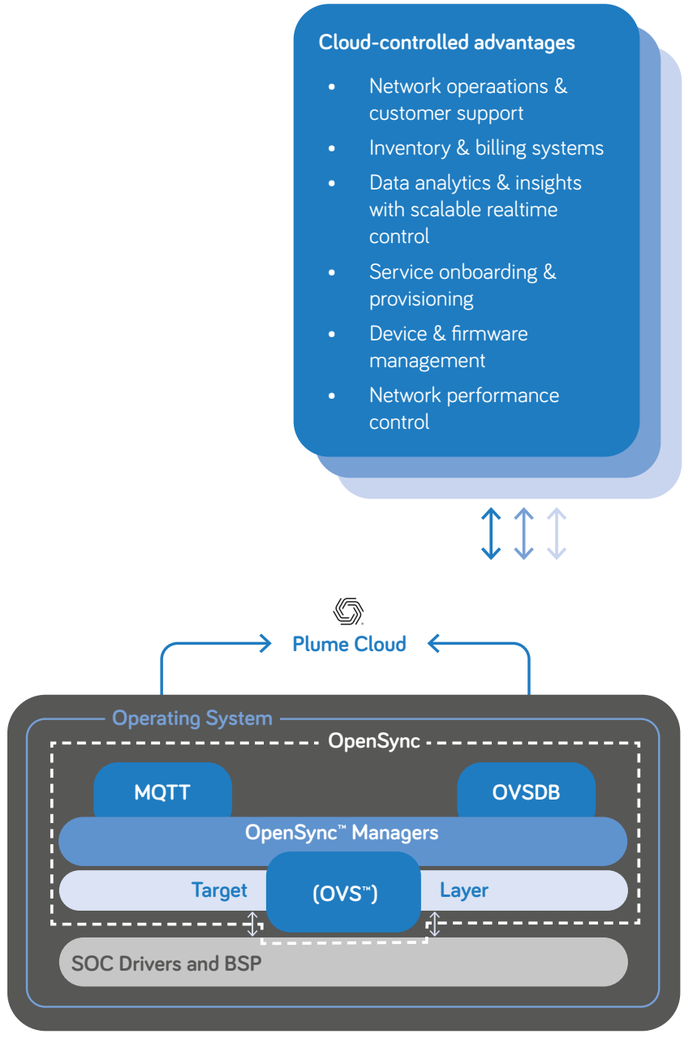
- Continuous monitoring and avoidance of interference from neighbouring networks.
- Leveraging multiple, non-interfering channels to operate the network routing paths thereby increasing capacity.
- Routing algorithms designed to balance the network load, maximize the network capacity, and optimize end-application performance based on client device requirements
- Traffic shaping/prioritization for application-level performance.
- Ability to optimize network performance by steering clients to different pods in the system consistent with the optimized route topology.
- Fast client hand-off across nodes improving quality of experience.

One of Adapt's advantages though is that it is cloud-controlled.

Adapt Cloud Control

WiFi network controllers first emerged in the business environment to handle coordination among multiple Access Points. Business vendors have been steadily migrating towards virtualised controllers (controllers deployed as software in the cloud). Using the benefits of a similar architecture to manage a distributed WiFi home network offers several advantages:

- Centralised management simplifies coordination among distributed nodes, and can more readily apply widespread optimisations across multiple customers. These optimisations are particularly beneficial where WightFibre customers live next door to each other as their networks can automatically dynamically adjust to not interfere.
- Similar to channel frequency and bandwidth assignment, the assigning of client devices to pods (client steering) can be done more effectively with a centralised global view of the network including all client devices.
- Roll-out of new features and services is simpler, faster, cheaper and less risky by updating the centralised cloud controller without having to update the firmware on the in-home devices themselves.
- Network stability issues are eliminated with a centrally controlled network. Optimisation is performed in the cloud, the result is configured in the network and the network will remain in that state until the cloud decides to modify the configuration. This alleviates the problems experienced with distributed mesh systems in which each of the nodes are running independent algorithms, making localised decisions with arbitrary timing, thereby creating inconsistent and unpredictable network behaviour.
- A cloud-based management system is able to aggregate data from many homes for analysis and learning. Improved methods for network optimisation, client behaviours and bugs, and typical device/user patterns and behaviours can be extracted from such a cloud-based centralised database.
- The computational, storage, and memory complexity of each individual node is reduced, making the nodes smaller, less power-hungry and easier to develop and deploy. The cloud, with virtually unlimited compute power and memory, can run complex algorithms to learn and optimize.



The HomePass User App

End-user experience is very important. An easy and intuitive installation process including the adding of new nodes is critical.

Plume's Adapt solution is mobile-first, enabling customer action through iOS and Android apps. These apps are focussed on the way consumers will be using them rather than aimed at technical people more interested in the nuts and bolts of configuration.

For the first time in consumer WiFi customers are in control of the performance of, and access to, their home WiFi. Cloud-enabled features such as one-touch guest network access, remote performance monitoring and troubleshooting, IoT device connection, parental controls, advanced AI security and whole-home motion awareness are features which can be continuously rolled out via the cloud platform.

Adapt shifts the focus of wireless performance to one focused on the quality of the user experience. As such attention is paid to whether the consumer can get the internet performance they require everywhere in the home. Adapt ensures application performance, reliability and coverage through cloud-controlled network optimization on a continuous basis.

Visibility and support is the third key attribute of a great consumer WiFi system. The consumer is provided beneficial performance metrics, status indicators and data insights for each client device—and the internet connection—with in-app troubleshooting to assist with questions when things are not working well.

Additionally, WightFibre is able to provide the very best customer support and bring new features to customers without the need for complicated phone calls or home visits – exactly the future-proofed WiFi offering you would expect to go alongside a future-proof broadband offering.

Rest assured that the Adapt Cloud controller is very secure and it is strictly concerned with the technical aspects of ensuring your WiFi performs at its best. It doesn't monitor what you are actually using the Internet for so your personal privacy is maintained. Even when making use of the Guard feature of HomePass, for example to apply parental controls, your privacy is maintained.

Conclusion

The unique capabilities of the Plume Adapt service, a distributed, dynamic WiFi system with cloud-based control, provides the best quality of customer experience when compared to other available WiFi architectures. This is why WightFibre has adopted Plume to complement its' broadband service.

The advantages can be seen in the network topologies themselves including the use of multiple frequency channels in the backhaul, optimized selection of the number of hops, and channel frequency assignments. It can also be seen in the management of the client devices in the networks, including simple installation and coordinated client steering. Finally, the approach brings network management advantages including superior visibility and support, and the ability to easily upgrade and enhance capabilities by changing cloud software rather than code on an in-home device.

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