Modernizing In-Home Wi-Fi for Video: Multiple Access Points, Intelligence, and Mesh

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Abstract

Service providers are investing heavily to bring faster Internet speeds to the home, but conventional Wi-Fi equipment generally prevents subscribers from actually experiencing those speeds consistently throughout the home itself. More devices streaming video are straining the home network, and most subscribers do not realize the worst performing device (usually a smartphone or tablet) drags down the speed of all other devices in the home. Progressive operators need new solutions to ensure quality of service (QoS) for all video-capable devices and to provide a seamless TV viewing experience throughout every room in the house.

INTRODUCTION

Factors including home construction materials, the types of devices being used, and the distance to the nearest in-home access point (AP) are just some of the issues preventing subscribers from experiencing broadband speeds consistently throughout the whole home. Unlike traditional Wi-Fi, which relies on a single AP from a router/gateway, intelligent in-home Wi-Fi can be used not only to improve coverage, but to serve as the central video distribution system in the home – transforming all devices (including set-top boxes) into coordinated Wi-Fi hotspots. These APs are networked together using software to create an intelligent in-home network that prioritizes video, and dynamically routes data to ensure optimal performance across all screens in the home. In addition, these APs can be connected by a combination of wired connections – such as Ethernet, MoCA, and powerlines – and wirelessly by Wi-Fi Mesh.

THE PERFECT WI-FI STORM

Taken together, the rise in IP-connected devices connecting to domestic networks and mobile streaming creates the perfect Wi-Fi storm. For some operators, this means that

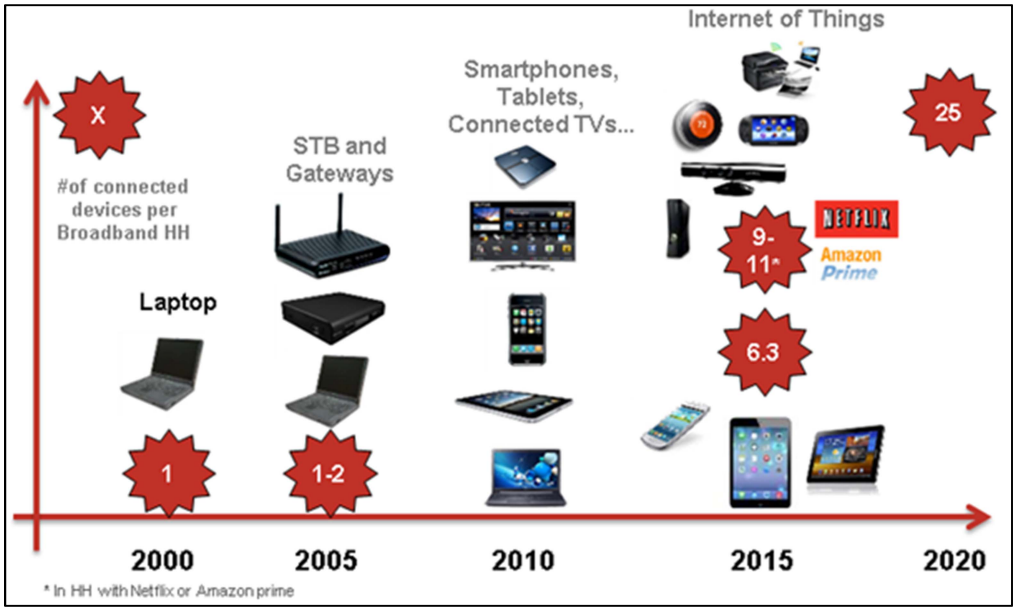

Figure 1: The Perfect Wi-Fi Storm (MRG Research)

more than half of all call-center traffic is Wi-Fi related. As shown in Figure 1, according to MRG Research, the average household in 2015 had more than six Wi-Fi devices capable of steaming video. MRG expects this figure to reach 25 devices by the year 2020. Notably, in 2015, those households that also subscribed to Netflix or Amazon Prime had between nine to 11 Wi-Fi devices capable of steaming video.

Likewise, according to the 2015 Cisco Video Index (VNI) Global IP Traffic Forecast, shown in Figure 2, Internet video represents 43.4% of exabytes of IP traffic per month.

Research is clear: the amount of video streaming is rising dramatically (and will continue to do so in the years ahead), which will place increasing strain on the home network, as the slowest performing device in the home drags down the speed and performance of all other devices.

DEVICE AND HOME LAYOUT IMPACT ON OVERALL IN-HOME PERFORMANCE

Based on results from AirTies' study of Wi-Fi performance in homes with just one AP, distance, barriers such as walls and ceilings, smartphones and tablets equipped with low end chips, and contention between multiple users degrades not just individual device performance but total Wi-Fi capacity as well. The problem here is not Wi-Fi itself. The latest IEEE 802.11ac provides plenty of bandwidth on paper.

As shown in Figure 3, simply moving a device away from the home's main router can dramatically impact performance for every

Figure 2: Global IP Traffic by Application Category (Cisco 2015 VNI)

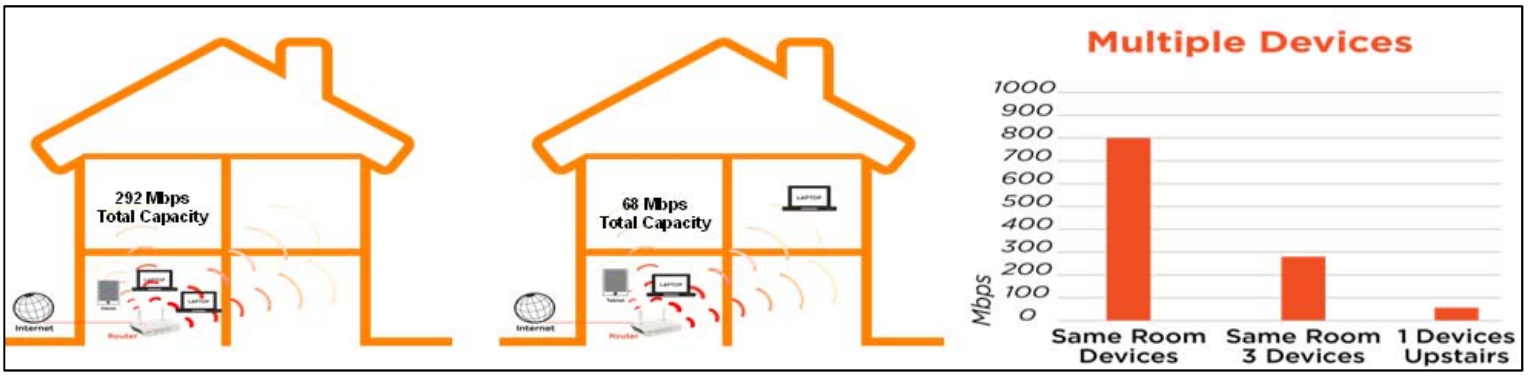

Figure 3: Device Impact on Overall In-Home Performance

device in the house. Our data shows that this is true even with the most advanced Wi-Fi devices. For example, in a room receiving 802 Mbps, sharing data amongst three devices – between an iPad 4 (2X2 11n), and two MacBooks (3X3 11ac) – total capacity drops to 292 Mbps in the same room because of the iPad (11n device). Moving one MacBook (3X3 11ac) upstairs drops the total capacity to 68 Mbps in the room previously receiving 802 Mbps, shared between the three devices. If the iPad 4 was moved upstairs, much worse results would be obtained.

Our research shows that streaming device-to-device (as opposed to each device connected to the Internet individually) reduces total capacity by 96%. For example, in a room with an iPad 4 (2x2 11n), DVR (3x3 11ac), and set-top box (3x3 11ac) total capacity drops from 292 Mbps to 175 Mbps, as displayed in Figure 4. Moving the DVR (3x3 11ac) upstairs drops total capacity even further, to 38 Mbps.

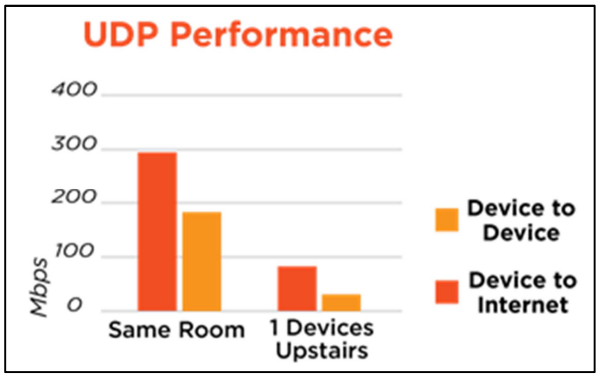

Figure 4: Device Streaming Effect on In-Home Performance

Patchy coverage is also a common issue in larger homes or in homes where walls impede wireless signals. Things as trivial as bathroom tiling, stucco walls, concrete support beams, and more all play a factor.

For example, AirTies ran tests in multiple sites around the globe. At an apartment in Europe with 20 Mbit/s of broadband access, streaming video from an iPhone in the same room as the Wi-Fi router provided the expected or better performance than what the subscriber paid for. However, moving the iPhone to the next room over dropped the performance from 20 Mbit/s down to 1Mbit/s. (Anything below 5 Mbit/s on Wi-Fi will be perceived as poor performance by the user.)

In an Asian apartment (MDU) with a 1 GBit/s fiber connection, using the best available routers and laptops, where the receiving device is located in the same room as the router, the laptop downloaded at 177 Mbit/s. However, moving the laptop down the hall dropped the performance from 1 GBit/s to 108 Mbit/s. Moving the laptop even further into the bedroom dropped the performance from 1 GBit/s to 0.8 Mbit/s.

Another AirTies test-case showed the worst-case scenario in a three-story European home built with concrete walls and floors, whereby coverage was only available on the same floor as where the residential gateway came into the house.

This leads some users to deploy repeaters to boost the signal, which may partially solve coverage issues but also creates new problems by consuming extra bandwidth that results in service degradation. This can happen when users are within range of the repeater and the original AP at the same time, consuming twice as much airtime capacity as necessary, and negatively effecting overall network performance – especially in the case of video streaming. In essence, repeaters can half the performance of in-home Wi-Fi rather than helping.

Traditional PLC/Wi-Fi or MoCA/Wi-Fi extenders treat the Wireline as a backbone. But, actual Wireline throughput varies widely. Frayed wiring, distance or noise are typical causes that limit the total network performance to the weakest link.

TABLETS AND SMARTPHONES MAKE POOR CONNECTION DECISIONS

As seen in Figure 5, mobile phones and tablets often make poor decisions as to where to connect to an AP or band – typically based on signal strength, with no knowledge of the network or optimal path(s). The RF characteristics of 2.4G give higher signal strength and therefore most mobile clients tend to connect to it, although the 5G 11ac connection typically performs 10X better.

Furthermore, mobile/tablet clients are often "sticky", in that once they make a connection to a particular AP they stick with it, even if the signal strength has dropped significantly or there is a better device that is closer. Due to the poor connection, they start consuming more of the total available airtime capacity, in particular if they are streaming video. This is often referred to as the "Bad Apple" Wi-Fi performance problem, where the slowest performing device degrades overall performance for all other devices in the home.

Mobile devices are equipped with low end 1X1 chips due to size, power and costs and thereby have inherently low performance to begin with. As the device moves around the home, away from the AP it was initially connected to and behind walls, the original AP devotes more and more capacity to serving that particular device's needs. In reality, from a network management point of view, it should have re-connected to a different AP, if available, or switched to a different channel. The combination of low end chips and distance from the connection consumes large amounts of airtime and dramatically reduces overall network performance, which becomes more acute when streaming video.

HYBRID MESH SYSTEMS TO CONNECT MULTIPLE ACCESS POINTS

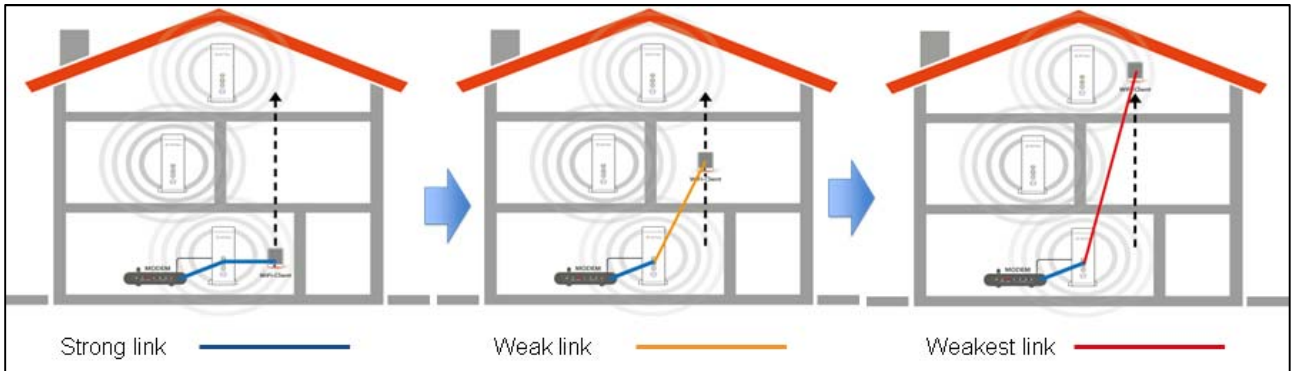

Figure 5: Mobile/Tablet Clients Make Poor Connection Decisions

Many of the issues discussed can be resolved by deploying intelligent Wi-Fi Mesh. Mesh creates a managed Wi-Fi domain that exploits multiple APs to provide multiple paths to overcome obstacles, and allows mobile clients to connect at their maximum capability, while creating resilience, extra capacity and eliminating dead zones. The Mesh operates logically as a single network with just one SSID (Service Set Identifier), dynamically configuring links between them, as the APs are relocated or as clients move around the house – and also switching Wi-Fi communications between paths as signal conditions change. Intelligent networks also use both 2.4 GHz and 5 GHz Wi-Fi signals to expand capacity, with the latter effectively providing backhaul between the APs for added performance.

For example, in the aforementioned three story home, with AirTies' solution installed, the user was able to simultaneously stream three HD streams around the house (one to the basement, one to the first floor, and one to the second floor), while simultaneously downloading a movie to a laptop from the in-home network-attached storage (NAS) device. There were up to 90 Mbit/s worth of traffic going throughout the concrete home with only 50% consumption of airtime capacity. In this scenario, the user was able to get 180-200 Mbit/s on a sustained basis.

AirTies' hybrid Mesh treats Ethernet, PLC, and MoCA as individual point-to-point Mesh connections, in addition to the wireless Mesh links available. This not only overcomes corner cases like steel walls, but can also be used to increase the total network capacity. AirTies' Mesh nodes select a combination of wired and Wi-Fi hops to best route packets, and run links in parallel, which dramatically increases total network capacity. A best path is determined by taking factors such as source and destination location, number of hops required, and best point-to-point link speed into account, rather than just signal strength.

Hybrid Mesh supports failover, so that for example, a PLC link could cut in when a Wi-Fi signal fades to ensure service continuity

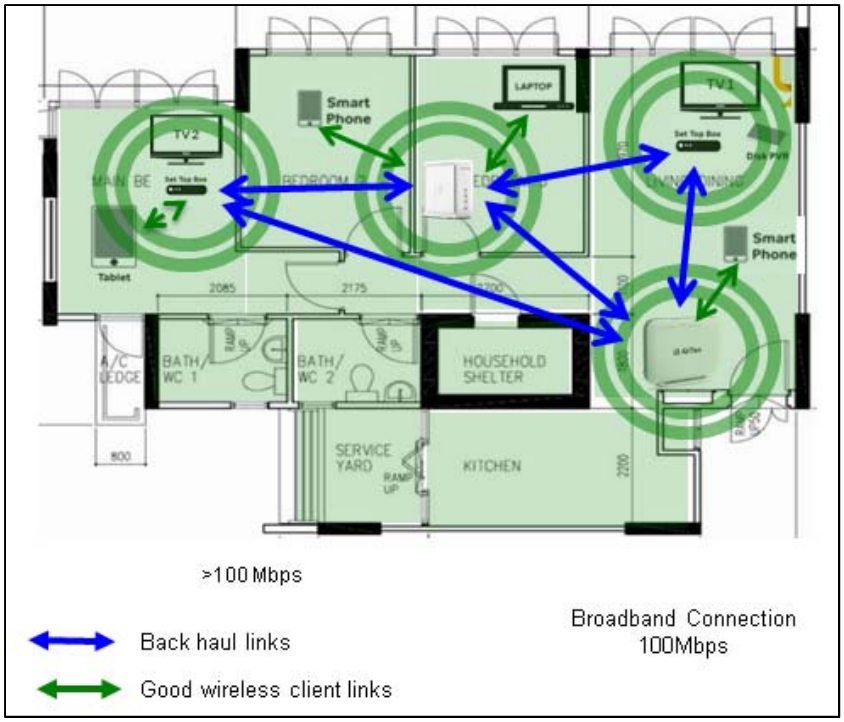

Figure 6: Hybrid Mesh Connects Multiple APs

and graceful degradation.

AirTies' modular approach to video and Internet distribution in the home gives operators a solution for guaranteed QoS to the end device, whether wired or wireless. AirTies' software lets operators meet the needs of individual homes with a complimentary and dynamic wired/wireless approach. Previous dark spots can be eliminated by the simple addition of another device using the network resource best equipped to reach it.

A major attraction for operators is that Mesh achieves effective control over the Wi-Fi domain that they have been lacking, while also giving consumers freedom to deploy the APs themselves and thereby avoiding the costs of onsite visits. Operators can be confident that Wi-Fi will extend their broadband service to the end device and enable the same performance guarantees. Operators can simultaneously keep their customers and support staff happy by reducing the number of call-center issues related to Wi-Fi.

NETWORK DECIDES WHERE DEVICES SHOULD CONNECT

An intelligent network uses a technique called "client steering", which effectively decides where and how devices connect within the home – whereby an intelligent home network, not the subscriber's devices, routes data in the most efficient way.

Traffic is routed around the network in a manner analogous to the way in which IP packets are routed around the Internet: across a best path instead of a single one, which is dynamically configured and re-configured depending on the number of active devices, the traffic profile, and the QoS required by the subscriber's agreement with the service provider. As seen in Figure 7, the APs communicate with each other and decide what is the least network capacity cost path, and the network steers the mobile device to that path. Based on AirTies' deployment data, client steering can improve average performance eight-fold by keeping mobile devices connected to the best AP location and 5G/11ac connection speeds.

THE NEED FOR MULTIPLE ACCESS POINTS TO SUPPORT VIDEO DISTRIBUTION

Instead of relying on one Wi-Fi hotspot in the home, every managed CPE can become a smart Wi-Fi AP as well.

These APs can include not only routers but also IP-enabled set-top boxes and DVRs.

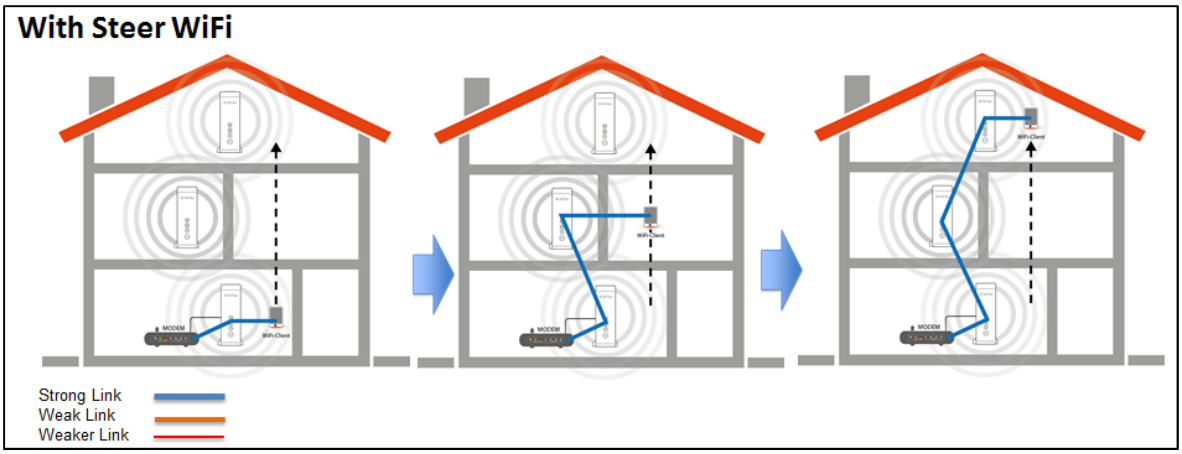

Figure 7: Network Steers Device to Best Connection

For example, Sky Europe's Sky Q is using AirTies' software in all of its devices (set-top boxes included) to transform them into coordinated Wi-Fi hotspots, which creates a robust network of multiple APs and results in better coverage and consistency throughout the entire home.

REAL-WORLD DEPLOMENT OF VIDEO-CENTRIC HYBRID MESH WI-FI

Sky Europe's Sky Q is a family of advanced products that connect wirelessly to create a new ecosystem that makes it easier for customers to access their favorite TV content. Sky Q's "Fluid Viewing" enables subscribers to watch content on up to five screens simultaneously, while recording four other channels, pause on one device and resume viewing on another, watch live, recorded or on-demand content from any device around the home, and take recordings on-the-go with a mobile device.

The AirTies Mesh solution is part of Sky Q's next generation of Internet Routers, TV set-top boxes and accessory devices, and is a key contributor to Sky's Fluid Viewing by enabling a superior Wi-Fi and video experience throughout the home. All of Sky Q's CPE is also part of the smart in-home Wi-Fi network to support streaming on both managed and unmanaged devices.

With a single, open Wi-Fi network delivering video content from broadcast, OTT and broadband, as well as locally stored content, customers can access Internet and video anywhere around the home. As mobile devices move throughout the house, AirTies' Mesh software maps the home network, monitoring the shifting demands for broadband and TV streams from a multitude of devices. It decides in near real-time which path to send data packets through to optimize performance. AirTies' Mesh improves connection speeds for Sky customers, while also enabling a simplified and improved user experience.

According to Andrew Olson, Director of New Products at Sky: "As Europe's leading entertainment provider, ensuring that our customers enjoy the best TV experience possible is our top priority. Working with AirTies has helped us create an amazing new customer experience across screens with Fluid Viewing, as well as take the Sky experience to the next level by enabling Sky Broadband customers to turn all their Sky Q boxes into smart hotspots."

Utilizing Wi-Fi Mesh enables a convergence of video IP systems throughout the home, as demonstrated by Sky Q's next generation, open Wi-Fi network that delivers video across every room. This type of deployment validates the fact that having multiple APs smartly linked together is the way forward for optimum home network performance. It is also likely to be a bellwether for other operators around the globe that are looking to provide a ubiquitous viewing experience throughout the whole home, on any screen.

CONCLUSION

Compared with typical Wi-Fi configurations based on a single AP, AirTies' modular approach to video and Internet distribution is an optimal choice for progressive operators that are looking to provide new solutions that ensure QoS for all video-capable devices and provide a seamless TV viewing experience across the whole home. Hard to reach areas see performance improvement by the simple addition of another device. The AirTies system can utilize MoCA, PLC, Ethernet, or Wi-Fi Mesh

to create smart links between the APs to ensure video quality in every room, even in thick, stone-walled homes. And, the Bad Apple Wi-Fi performance problem is resolved via an intelligent network of APs spread throughout the home.