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Ensuring consistent Wi-Fi QoE is critical to broadband success

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airties

Contents

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Summary

As service providers continue their effort to expand full-fiber networks and gigabit broadband services, it becomes increasingly important to provide high-speed, low-latency, and consistently reliable Wi-Fi connectivity to every device in every corner of the home. Failing to do so results in customer dissatisfaction, leading to higher operational costs and customer loss.

Advanced home Wi-Fi hardware can improve speed and throughput in a house, but the fundamental physical limitations of Wi-Fi technology will always exist, leading to an inconsistent user experience. It is commonly believed that reducing the distance between the Wi-Fi access point and the end device, for instance, via the use of Wi-Fi Mesh extenders, can fix all Wi-Fi issues. However, this is not always true. Additional Wi-Fi hardware does not always solve a customer's issue and, in some circumstances, can cause more harm than good. Deploying Wi-Fi extenders to every household, therefore, would not only be cost-inefficient but can also lead to further overall customer dissatisfaction.

In conjunction with their Wi-Fi hardware roadmap strategy, service providers must adopt Smart Wi-Fi management software. The software can monitor and manage the quality of experience (QoE) for users across the entire broadband footprint, regardless of the hardware used. This report highlights the latest technological developments at Airties, a Smart Wi-Fi software vendor. Their software aims to ensure a consistent high-quality user experience while also enabling more efficient hardware deployment strategies.

Key messages

- By 2027, over 40% of households worldwide will have fiber-to-the-home (FTTH) connectivity. The adoption of advanced broadband technologies has led to faster broadband speeds, with a 500% increase in the average speed over the past five years, and a further 200% increase is expected in all regions in the next five years.

- However, although speed will remain important, it will not be the only focus for broadband service providers moving forward. For some applications, for example, cloud gaming, a consistent level of low network latency is as important as speed. In the future, more and more applications will be interactive and will rely as much on low latency as on speed. Building networks that provide high speeds and low latency, with high levels of reliability and consistency, will be critical to service providers.

- To deliver high-quality broadband services and applications, service providers must invest in advanced Wi-Fi technology to ensure the home network does not become the new bottleneck. Omdia's research indicates that customer dissatisfaction and increased operational costs follow if this occurs.

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- To keep pace with advancements in wider area network (WAN) technology, home Wi-Fi technology and standards are rapidly developing with the latest technologies capable of multi-gigabits. However, it can take years for such technology to become widely adopted by customers, and even then, its ability to provide a consistent level of service by itself may be limited owing to the natural constraints of Wi-Fi.

- Deploying a common Smart Wi-Fi platform to all households can help monitor and manage the quality of service experienced by all customers, regardless of hardware or chipsets. Utilizing the data collated, cloud analytic tools can also help in creating more efficient hardware deployment strategies and broadband marketing campaigns.

- Airties has developed a hybrid-cloud-edge Smart Wi-Fi software platform that maximizes responsiveness, reliability, sustainability, and customer privacy by keeping critical intelligence locally in the customer premises equipment (CPE). At the same time, it maximizes the scalability and efficiency of cloud data analytical resources.

- The platform has now incorporated the latest latency management and application prioritization techniques to help service providers maintain service consistency even during network congestion, as well as to enable new service opportunities around specific customer use cases in the future.

- Operators interested in reading more about how Smart Wi-Fi can be used for monetization and differentiation are also encouraged to read a prior Omdia report titled: "Marketing Smart Wi-Fi: The Key to Broadband Differentiation."

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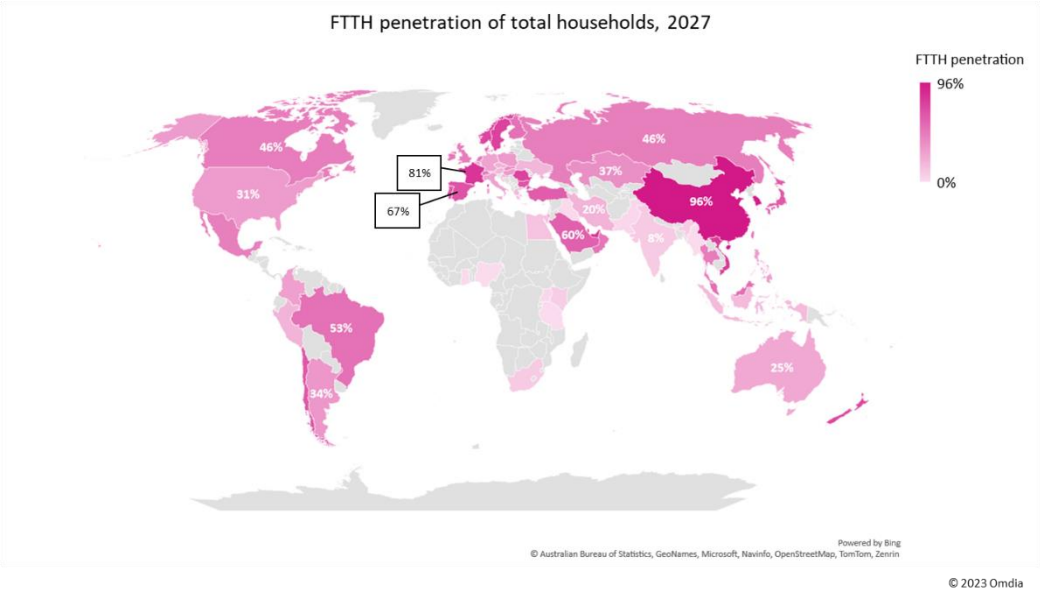
Pushing gigabit broadband to deliver the next generation of internet applications

The march toward FTTH

Since the late 1990s and early 2000s, broadband networks and services have undergone significant advancements. Early deployments largely relied on legacy copper-based infrastructure, with services typically in the hundreds of kilobits per second range. However, in the last two decades, there has been a tremendous upgrade, and gigabit broadband services are now common, with an average global broadband speed of 200Mbps.

One of the biggest drivers in this development has been the shift from copper to optical fiber-based infrastructure. In 2014, less than 10% of households worldwide had access to optical fiber connections. However, by 2027, this number is expected to increase to 41%, with many countries reaching over 50%. In Europe, some countries are expected to reach up to 87% penetration rate, while China is expected to have an even greater penetration rate (**Figure 1**).

Figure 1: FTTH penetration of total households, 2027



Notes: By 2027, over 40% of households will be connected via FTTH.

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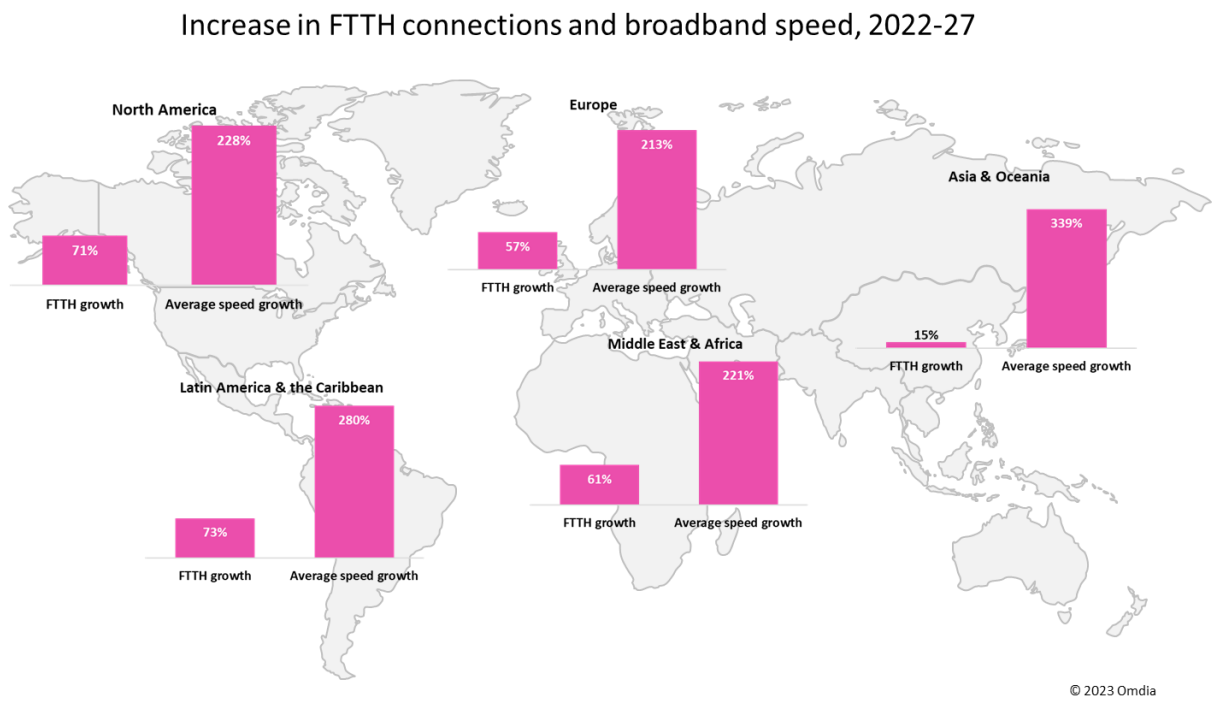
Source: Omdia

One might think that with a 500% increase in global average broadband speeds over the last five years alone, such trends would be slowing down. The rising number of connected devices, the growing popularity of bandwidth-intensive applications such as high-quality video and XR, and the shift toward cloud-based intelligence all contribute to an increasing demand for broadband networks. This trend is expected to continue and gain momentum in the future. Over the next five years, average broadband speeds across all regions will see further increases of more than 200% (**Figure 2**).

Figure 2: Increase in FTTH connections and broadband speed, 2022–27



Notes: FTTH connections and broadband speed will continue to see double- and triple-digit growth.

Source: Omdia

Speed is no longer the only focus for service providers

In most developed broadband countries, gigabit broadband services are now widely available, and subscriber penetration is expected to increase over the next five years and beyond. The rise of high-quality 8K video and XR technology will require speeds ranging from 300M to 2Gbps per stream, making high-speed internet even more crucial. However, the next generation of Internet applications will become far more interactive and will heavily rely on cloud intelligence. Therefore, in some cases, such as cloud gaming, low latency, and network consistency, providing a better user experience is more important than raw speed. In some cases, such as XR applications, ultra-high fast

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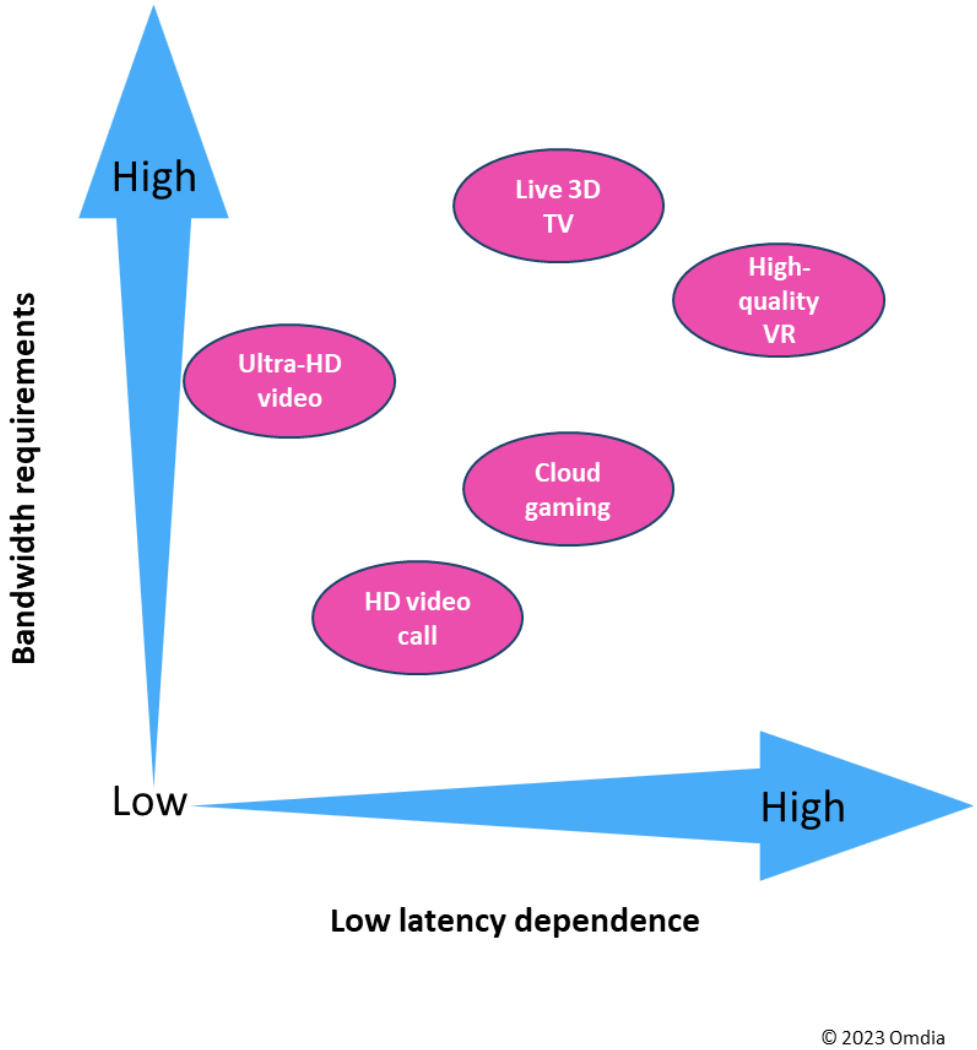
speeds and ultra-low latency are equally as important (**Figure 3**). If such services are to be delivered with adequate quality, it is therefore essential for operators to develop next-generation optical fiber networks that offer multi-gigabit access speeds, low levels of latency and jitter, and high levels of reliability and consistency.

Figure 3: Key requirements for future applications



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All-fiber networks push the bandwidth bottleneck into home networks

As our reliance on high-quality advanced digital applications continues to grow, it is vital that the broadband network qualities are not only strong from the core network to the broadband router but also extend all the way to the end device. To achieve this, a highly advanced home network is required to plug the gap between the end device and the broadband access network.

If the home Wi-Fi network cannot keep up with the wider capability of the broadband access network and the demands of new applications, then the home network will quickly become the new bottleneck in delivering broadband QoE—that is, the part of the network that restricts the users' broadband experience.

The home Wi-Fi environment remains imperfect

Like broadband access and core networks, home networking technology has developed significantly over the years. There are numerous infrastructure options for the home network, including new fiber-to-the-room (FTTR) technology. But with more than eight out of 10 devices on average in the home connected via Wi-Fi, it remains the most popular option by some margin and will remain so for the foreseeable future.

Wi-Fi technology is standardized by the IEEE, and the standards are continuously being developed and amended to keep up with future networking demands (see **Table 1**).

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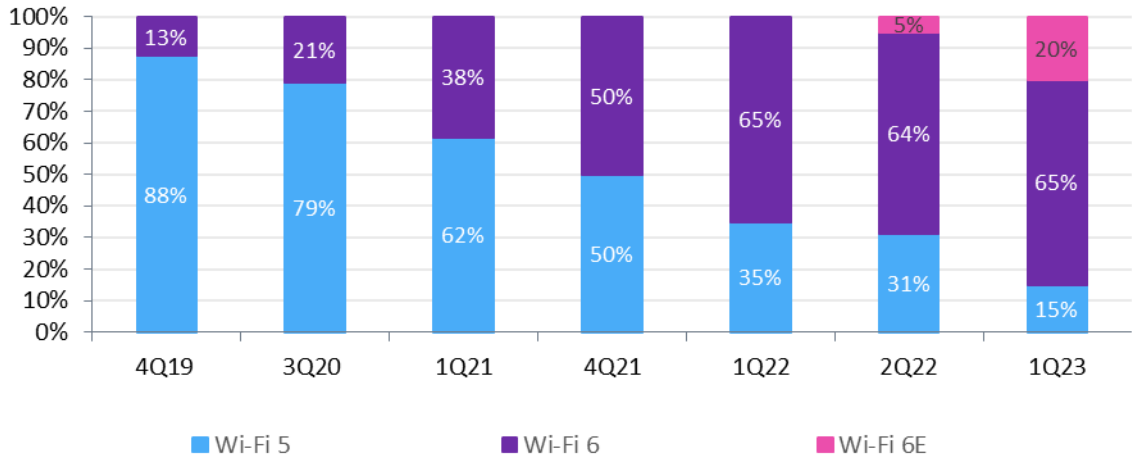
Table 1: Summary of Wi-Fi generation characteristics

Wi-Fi generation	Maximum theoretical speed	Typical real-world speed	Modulation technique	Approximate indoor range	Year of release
Wi-Fi 4 (802.11n)	72Mbps–600Mbps	100Mpbs–300Mbps	MIMO-OFDM (64 QAM)	70m	2009
Wi-Fi 5 (802.11ac)	430Mbps–6.9Gbps	300Mbps–800Mbps	MU-MIMO OFDM (256 QAM)	35m	2014
Wi-Fi 6 (802.11ax)	574Mbps–9.6Gbps	1Gbps–2Gbps	MU-MIMO OFDMA (1024 QAM)	30m	2019
			As above		
Wi-Fi 6E (802.11ax)	574Mbps–9.6Gbps	1Gbps–3Gbps	Additional 6GHz band	30m	2021
Wi-Fi 7 (802.11be)	1.3Gbps–11.5Gbps	1.45Gbps–4Gbps*	MU-MIMO OFDMA (4096 QAM)	30m	2024

Source: Omdia (*expected values)

Service providers are eager to keep up with the latest home Wi-Fi technology, which is now considered a key differentiator, to market to their customers. Although older generations are still commonly available for lower-tier broadband customers, **Figure 4** shows that as of 1Q23, 85% of broadband services in Omdia's *Service Provider Smart Wi-Fi Tracker and Benchmark* offered Wi-Fi 6 or 6E technology to their premium broadband customers.

Figure 4: Percentage of service providers adopting Wi-Fi 6 technology



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Note: Telcos are keen to bundle in the latest Wi-Fi technology for their premium customers.

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Source: Omdia

At first glance, today's home Wi-Fi services should be more than capable of delivering the common broadband applications of today and even most of the more advanced future applications shown in **Figure 3**. However, this is often not the case owing to two main reasons:

- The range and capability of installed Wi-Fi technology across a service provider's footprint can vary wildly, with some customers going years without upgrades.
- Even with the latest technology, end users may not experience the speeds shown in **Table 1** on their end device.

Despite significant development over the years, Wi-Fi is still vulnerable to performance owing to several factors, all of which can be commonly found in any home:

- Physical obstructions: Signal loss caused by objects such as masonry walls. The level of loss can depend significantly on the number of obstructions and the type of building material used throughout the home.
- Distance: Natural loss of network capacity owing to the reduction in Wi-Fi signal power over distance.
- Interference: Signal weakened owing to electromagnetic interference from other devices and consumer electronic items within the range of the local area network (LAN). The impact of interference can also increase as the distance from the router increases.
- Contention: Wi-Fi is a shared medium, and therefore, throughput must be shared amongst all the devices connected to the network.

The above factors reduce speed and available throughput, which then influences other important network characteristics, especially latency. A reduction in network throughput can cause traffic queues to form, resulting in variations in network latency that negatively affect certain applications.

Impact of poor Wi-Fi on applications and customer satisfaction

Failing to invest in the home network can have a significant impact. According to Omdia's research with leading broadband service providers, a lack of investments in home Wi-Fi can result in:

- An increase in customer support calls, with up to 60% of all broadband service calls relating to Wi-Fi.
- An increase in operational costs because:

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  - Without the proper tools, calls related to the home Wi-Fi network can be complex for the support team to resolve and, therefore, can cost up to $30 a time, with 10–15% of customers needing more than a single call to resolve the issue.
  - Up to 80% of routers that are returned as faulty are found to have no physical defect, known as no fault found (NFF). Such inefficiency leads to a further increase in operational costs.

- A decrease in customer satisfaction because:

  - Without the right diagnostic tools, it can be difficult for support staff to identify the issue and help the customer. Not being able to resolve a customer's Wi-Fi problem can result in a reduction of Net Promoter Score (NPS) by up to -40 points.
  - However, 50–60% of subscribers with Wi-Fi-related issues do not report the problem, for various reasons. Such customers typically report a lower NPS of up to -20 points, and consequently, Wi-Fi issues are a growing driver of broadband customer loss.

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While hardware is beneficial, it cannot solve all issues

As previously mentioned, the further a device is from the Wi-Fi router, the weaker the Wi-Fi signal becomes. Consequently, the end user's broadband experience will be affected negatively. Therefore, it is common to assume that the easiest way to fix poor Wi-Fi is by using additional Wi-Fi extenders or access points to reduce the distance between the Wi-Fi router and the end devices. Mesh Wi-Fi extenders can create a communications network made up of radio nodes organized in a mesh topology, enabling greater resilience and efficiency.

Even if range is not an issue, high levels of interference can still happen. Using extenders, even with mesh technology, to solve Wi-Fi problems may not be cost-effective as they cannot improve the experience of customers who are dealing with interference issues. Unless customers have access to Smart Wi-Fi that can optimize extenders based on real-time home conditions, adding more access points into a network can worsen the customer experience. Radio spectrum is a shared medium, meaning that as more devices join the network, they contend for increasingly scarce resources and potentially cause increased traffic contention. Providing additional hardware (especially if there is an associated cost) can frustrate and anger customers, damaging a service provider's brand. It is important to remember that the primary reason for adding hardware is to extend coverage or range, not to resolve issues such as interference or latency performance. Smart Wi-Fi management platforms can help service providers identify exactly which homes need extenders and which do not to minimize capital expenses for operators.

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Optimizing home networks via Smart Wi-Fi platforms

Smart Wi-Fi platforms help broadband service providers improve the broadband experience in the home by integrating a common software management platform over all CPE devices (regardless of hardware vendor or chipset) that can monitor and manage the Wi-Fi connection.

Airties has developed a hybrid-cloud-edge Smart Wi-Fi software platform that maximizes responsiveness, reliability, sustainability, and customer privacy by keeping critical intelligence locally in the CPE while then maximizing the scalability and efficiency of cloud data analytical resources. The functions of the edge software include

- Centralized controller for responsive and efficient home-wide network optimization and data collection
- Real-time client roaming to efficiently connect devices to the optimum Wi-Fi access point as they move around the home
- Mesh topology optimization
- QoS management

The cloud-based monitoring platform, Airties Cloud, then utilizes its data analytics capability to continuously monitor the quality of experience of each customer, enable self-optimization and dynamic network adaptation, and provide remote diagnostics and troubleshooting. The platform also provides deep insights and analysis on connected devices and data consumption patterns within the home, along with proactive recommendations. Such data and information can be used by customer care teams, network operations, and installation teams, as well as business strategy and customer marketing departments.

Some of the key features of Airties Cloud include

- Wi-Fi Experience Index: a clear and simple mechanism to allow service providers interpret the overall Wi-Fi performance across their entire footprint or at individual household level
- Automated Channel Planning: dynamic optimization of Wi-Fi through continuous assessment of network conditions
- Wi-Fi performance optimization and pinpointing of end-user issues

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- Wi-Fi visibility and KPI tracking to understand how broadband services are being used in customer homes
- Identification of network bottlenecks end-to-end between broadband CPE, Wi-Fi network, and Mesh devices: Leveraging passively collected Wi-Fi speed and capacity data to combine with active measurements to pinpoint any bottleneck
- Application QoE Management: conference calling, cloud gaming, video streaming, and other applications are detected in real time and prioritized for the duration of the application session
- Latency Management: providing application-level metrics and insights into root causes of poor application quality, further helping ISPs to improve their end-to-end Internet service

Creating smart extender strategies

It is crucial to have a clear understanding of which homes are experiencing Wi-Fi issues and the specific type of issue they are facing. This helps in optimizing the overall customer experience. With this detailed understanding, devices that are experiencing channel or external interference issues can be handled efficiently through software or remote support, while only those households that are genuinely facing Wi-Fi range issues can be prioritized for extenders.

Airties has developed a Wi-Fi Experience Index to help service providers improve their customers' overall Wi-Fi experience and radio path relevance. This index scores the customer's Wi-Fi experiences and identifies the radio path relevance to that score. By identifying and prioritizing only the customers with low Wi-Fi Experience Index scores and high Radio Path Relevance percentages, service providers can develop more efficient and targeted Wi-Fi extender campaigns and reduce capital expenses. This approach will minimize the cost of that campaign and target the customers most in need, providing the maximum return on investment (ROI) in terms of overall customer satisfaction.

Managing latency can help alleviate Wi-Fi connectivity issues

Application prioritization is the latest tool service providers use to ensure high QoE over Wi-Fi networks. By prioritizing a particular application—either across all devices connected in a home network or on a specific device such as the main TV or work laptop—the network can better meet the required application QoE metrics even when facing challenges such as poor Wi-Fi range, high levels of interference, or high levels of contention. For example, a high-definition video conference or a gaming session can be prioritized over other demands on the network, such as a large BitTorrent download that will be less affected by a temporary decrease in bandwidth or an increase in latency.

Utilizing technologies such as digital fingerprinting to identify devices connected to the Wi-Fi network and application identification to identify specific application traffic types, vendors can leverage solutions that prioritize specific applications either from specified devices or across the home network. In Airties case, the Airties Cloud provides visibility of the home network and manages an up-to-date set of application fingerprints and application optimization profiles. This information is then pushed through to the Airties edge for execution. To manage the end-user experience, multiple optimization techniques can then be applied to the selected traffic stream:

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- On-demand Wi-Fi multimedia (WMM) quality of service (QoS) configuration
- Application-specification steering profiles
- Additional layer 2/3 QoS configurations

Airties has formed a strategic partnership with latency specialist Domos to provide broadband service providers with enhanced latency management capabilities. The two companies jointly own an advanced latency monitoring software module, which is being integrated into Airties Smart Wi-Fi software. With this new capability, Airties will be able to better measure latency at the device and application level and use that data as part of Airties' analytics dashboards and optimization services. Airties plans to offer this new latency monitoring and data analytics as part of the Wi-Fi Experience Index as a value-added capability.

By utilizing such techniques, service providers can define a prioritization policy for their entire installed base (i.e., all online video traffic) to optimize the experience for all without the need for customer interaction or can provide a level of control down to the end user (see **Figure 5**). Both methods can be used to create new broadband service models, such as a broadband gaming bundle that includes broadband, device, and content features, with prioritization of gaming traffic. These use cases can also be switched or timed, allowing the user to switch between a 'working from home' profile during the day and a 'gaming profile' in the evening. Early examples of tiered profile services (mainly focused on gaming) are already on the market, with many other service providers exploring the potential options.

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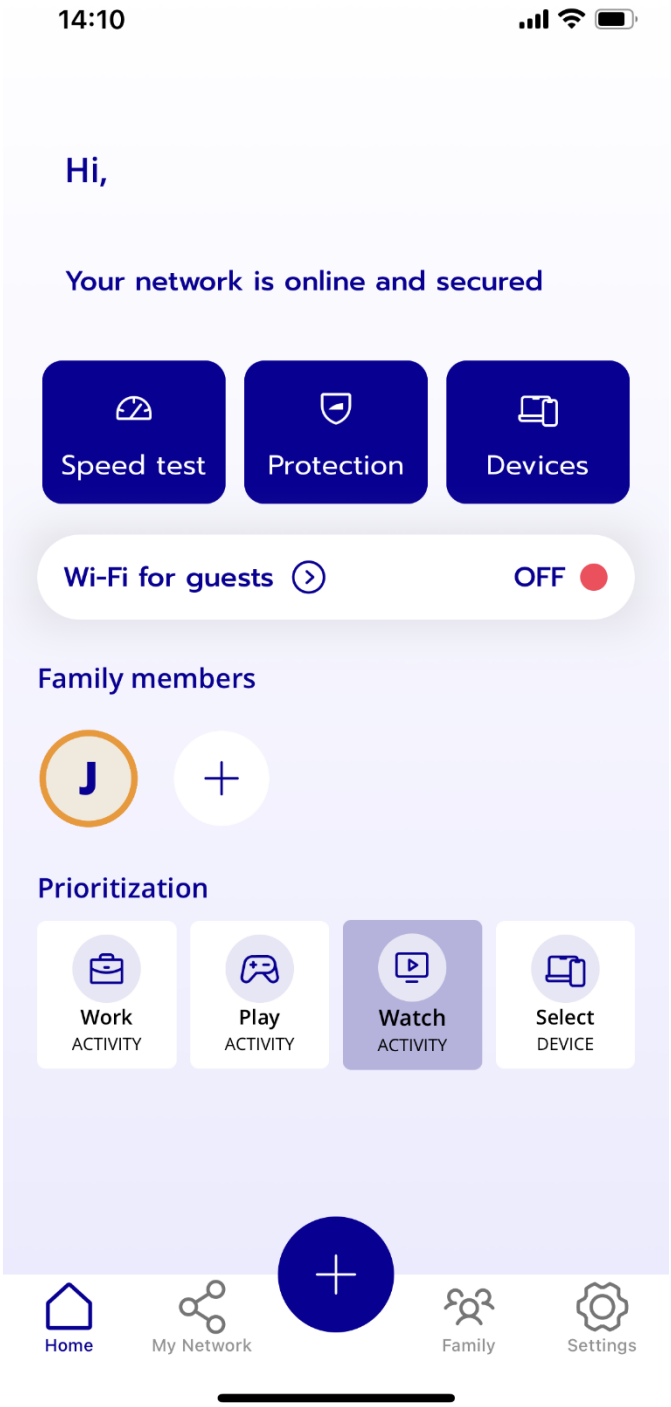
Figure 5: User interface with prioritization options example



Source: Airties

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Appendix

Methodology

Omdia Case Studies leverage in-depth interviews with key stakeholders and a review of any available documentation, such as financial reports, press releases, and company presentations.

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