The Home Networking Revolution: Wi-Fi Innovation, Next-Generation Access Technologies, and Software-Defined Wi-Fi Gateways

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CONTENTS

INTRODUCTION

Over the next 5 years, home Wi-Fi networks are expected to undergo a significant transformation across a number of key areas. Wi-Fi 7 and 6 Gigahertz (GHz) operation will have become entrenched, unlocking great performance gains, vastly improved Quality of Experience (QoE), and a wealth of new potential experiences for end users. The legacy access technologies of cable and Digital Subscriber Line (DSL) will have largely given way to ascendant fiber and 5G Fixed Wireless Access (FWA) technologies, delivering multi-gigabit connectivity that will underpin this increase in home networking performance. The flexibility and efficiency of software-defined gateways will also allow broadband operators to offer their customers improved QoE and a greater selection of value-added services, spurring further home networking innovation. Combined, this will represent a home networking revolution, and operators that wish to maintain a strong value proposition, increase customer loyalty, and open up new revenue streams in an increasingly competitive market will need to be at the forefront of this next wave of home networking innovation.

This whitepaper examines the catalysts for this home networking revolution , including shifting consumer habits, the demand for fresh experiences, rapid technological innovation, the challenges broadband operators are currently facing, and the need for operators to open up additional revenue streams. We will then explore the important role that the latest Wi-Fi innovations, leading-edge access technologies, and software-defined Wi-Fi gateways will play in this transition, outlining how they will help operators resolve the many challenges they are currently facing, increase their value propositions to consumers, and open up new lucrative revenue opportunities.

HOME NETWORKING EVOLUTION

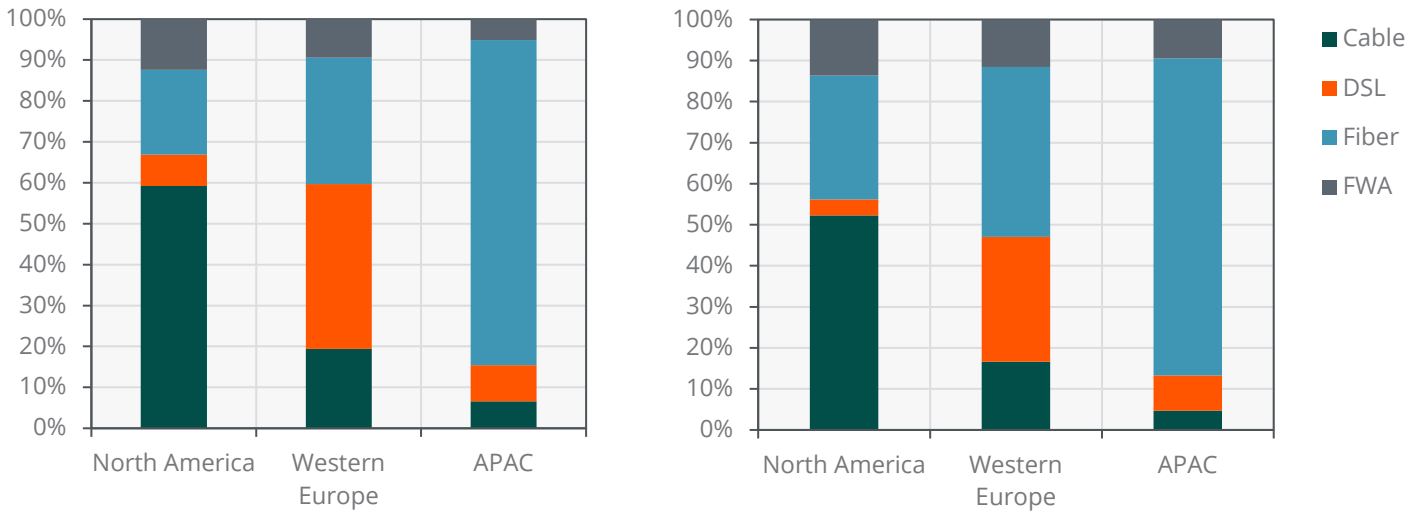
Key Trends in Home Networking

A rapid and wholesale transformation of home networking has been witnessed recently, driven by several key trends. The first is the growing number of connected devices in the home. Whereas a decade ago the typical home might only require Internet connectivity for a handful of devices—perhaps a PC or laptop, a gaming console, and several smartphones—today's home networks are grappling with an ever-increasing array of devices, with the average home now containing a total of 22 connected devices, according to Deloitte's 2022 Connectivity and Mobile Trends Survey. The second major trend is an increase in the throughput requirements of modern-day applications This is driven by the explosion of Over-the-Top (OTT) media streaming (with the transition to 4K and 8K in the future only adding to the burden), and the growth of high-resolution video calls, livestreaming platforms, High-Definition (HD) audio, online and cloud gaming, and Virtual Reality (VR), where one headset alone might require over 2 Gigabits per Second (Gbps) for 4K streaming. The third trend is shifting consumer habits, the most consequential of which is the shift to hybrid working models and remote learning, accelerated by the COVID-19 pandemic. This has given rise to an increased reliance on collaborative workspace platforms, with expectations for high-quality, reliable, and low-latency video calls, and for real-time collaboration tools. Seamless, consistent connectivity throughout the home, without blind spots or areas of weak coverage, has become a key concern for both consumers and enterprises in the era of hybrid work. Combined, these trends have and will continue to place additional demands on home networks.

Less visible, but equally as important is the evolution of the access technology that connects the home with the external Internet. The accelerating deployment of fiber-optic cable, alongside the concurrent decline of homes relying on legacy cable and DSL technologies, has significantly boosted the potential speeds available to home environments. Currently, an average of 35.9% of homes are connected by fiber across the Organisation for Economic Co-operation and Development (OECD), compared to 25.4% for DSL, and 32.7% for cable. However, these percentages vary greatly by country. One of the highest fiber penetration rates can be found in China, where 88.7% of broadband subscriptions are currently served by fiber. By 2028, this will increase to 93.2%. Western Europe trails behind China in terms of fiber penetration, at only 24.2%, but this will jump to 37.5% by 2028. In North America, cable is still predominant, with 56.3% of subscribers relying on it in 2023, as opposed to 19.7% relying on fiber. Yet as with other markets, the rate of fiber penetration will expand rapidly and, by 2028, it will stand at 32.7%, spurred by the US$42.45 billion Broadband Equity Access and Deployment (BEAD) program. The worldwide migration toward fiber, clearly visible by the contrast between the years 2023 and 2027 in Chart 1 and Chart 2, respectively, will result in Passive Optical Network (PON) becoming the predominant broadband access technology of the future. This PON adoption will enable consumers to enjoy the high-throughput, low-latency connectivity they need to power next-generation home connectivity.

Charts 1 & 2: Household Fixed Broadband Subscriptions by Technology, 2023 and 2027

(Source: ABI Research)



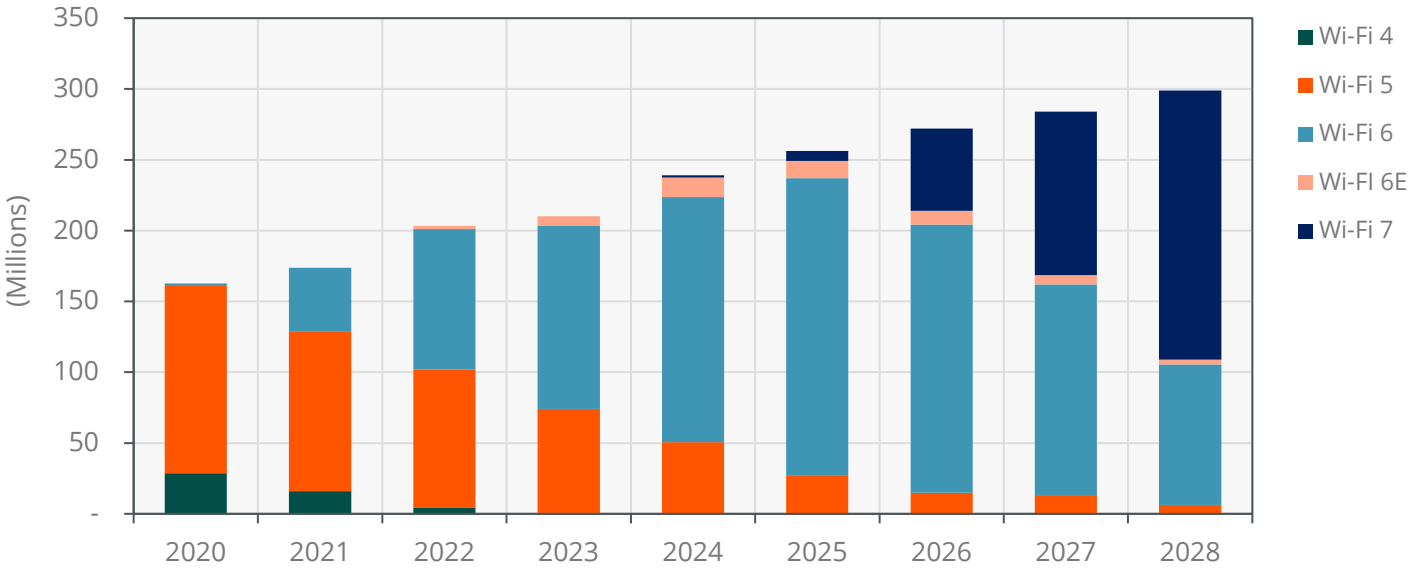
PON alone is not the only revolution in broadband access technology. 5G FWA is a relatively new but rapidly expanding form of Wi-Fi gateway. As opposed to relying on the traditional fixed access technologies of cable, DSL, or fiber for connectivity, 5G FWA harnesses existing 5G networks that operators maintain to offer consumers multi-gigabit connectivity in the home. There are several salient advantages of 5G FWA over the existing wired access technologies, including its ability to offer a rapid and easily attainable way for consumers to receive multi-gigabit connectivity, and that it does not require costly cable/fiber installation or refreshes. These attributes will help 5G FWA develop into a compelling alternative for incumbents, in many instances, replacing legacy options.

Alongside competing with the incumbent access technologies, 5G FWA can also complement other access technologies when used as a backup option. For example, a hybrid access gateway could shift to 5G connectivity should the cable or fiber access fail. By leveraging 5G FWA as a backup, operators will be able to greatly increase the reliability and QoE of their Internet packages, increasing their value to consumers. Operators can also harness 5G FWA to expand the addressable market for broadband consumers, as it will allow them to connect those either lacking traditional fixed broadband access or with sub-standard quality. 5G's role in connecting the unconnected will be especially pivotal in rural and remote regions. Operators will also continue to push the rollout of 5G FWA as it enables them to quickly monetize excess capacity on their 5G networks, and opens up new lucrative service models to offer consumers.

The growth in the number of connected devices in the home, increased performance requirements, shifting consumer habits, and a revolution in broadband access technologies have all accelerated the migration toward newer Wi-Fi standards. Relative to the transition between Wi-Fi 4 and Wi-Fi 5, consumers have been remarkedly quick to embrace Wi-Fi 6, as they have been desperate for the performance gains the standard offers. The increasing competitiveness of the operator market has also resulted in operators being keen to push the next Wi-Fi generation onto consumers. Accordingly, by 2022, shipments of Wi-Fi 6 gateways, routers, extenders, repeaters, and mesh nodes (collectively referred to as Wi-Fi Customer Premise Equipment (CPE)) already exceeded Wi-Fi 5 device shipments. Wi-Fi 7, which began to hit the market in 2023, will unlock further enhancements to Wi-Fi performance. As illustrated in Chart 3, a rapid movement toward Wi-Fi 7 is also forecast and, by 2028, shipments to broadband operators of Wi-Fi 7 CPE will supersede those of Wi-Fi 6 CPE.

Chart 3: Wi-Fi CPE Shipments to Broadband Operators by Supporting Protocol, 2020 to 2028

(Source: ABI Research)



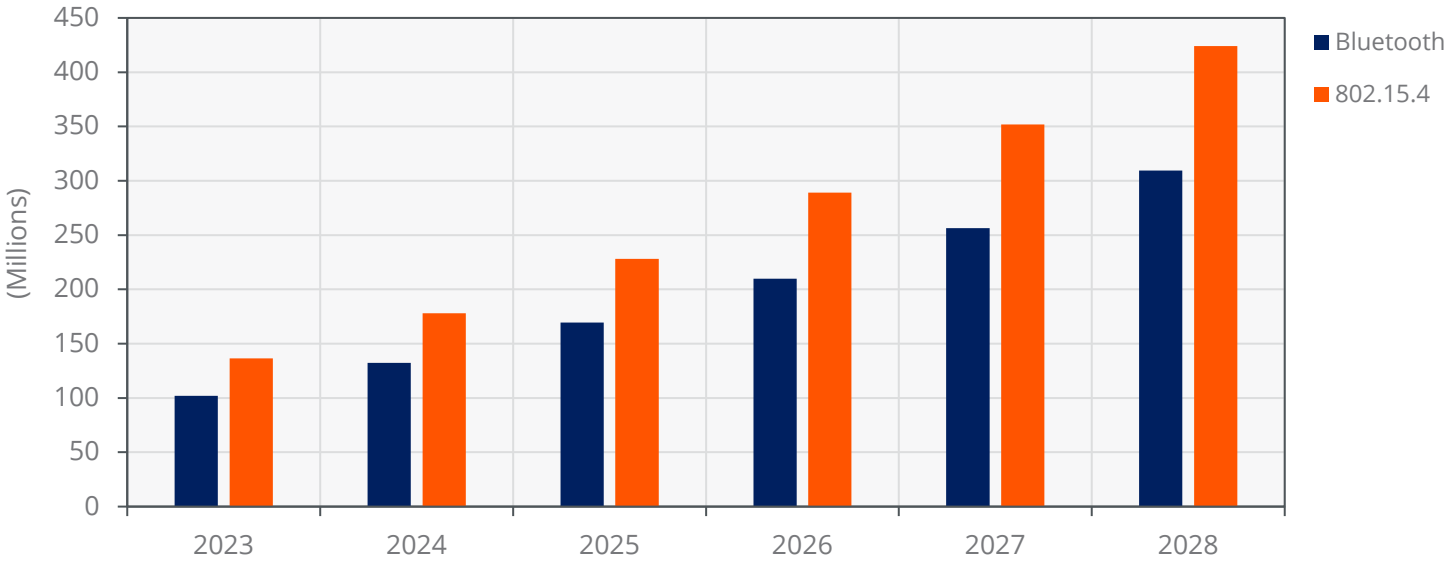
Another key aspect of the home networking revolution is the rapid growth of Internet of Things (IoT)-connected smart home devices, spanning everything from Matter-enabled lightbulbs to Bluetooth-controlled ovens. Consumers are adopting these devices for a variety of reasons, including to provide home automation, improve security, drive cost and energy savings, and simplify home management. The prevalence of smart home devices

is expected to increase sharply over the next 5 years. Shipments of Bluetooth-enabled home automation devices are forecast to increase by just over 303% between 2023 and 2028, from 102.0 million to 309.3 million, whereas 802.15.4-enabled home automation device shipments have a projected 311% shipment increase over the same period, from 136.6 million to 424.0 million.

This proliferation of smart home devices will greatly increase the complexity and congestion within home networks, making them more difficult to manage and control. Wi-Fi gateways are proving vital, as they can overcome this challenge by assuming the role of smart home hubs. Embedding smart home IoT technologies into Wi-Fi gateways enables centralizing the control and management of the broad array of IoT devices dispersed throughout the home, which is expected to grow in importance as smart home devices slowly evolve toward becoming indispensable devices relied upon for vital everyday functions. This expanded role of the IoT also makes 6 GHz spectrum adoption and migration to Wi-Fi 7 even more essential, as Wi-Fi client migration to the 6 GHz band will help alleviate congestion on the 2.4 GHz band, which is relied on by Bluetooth and the major 802.15.4 technologies, such as Matter.

Chart 4: Global Shipments of Bluetooth and 802.15.4-Enabled Home Automation Devices, 2023 to 2028

(Source: ABI Research)



Challenges Facing Broadband Operators

Broadband operators, especially those in mature Western markets, are facing an increasingly challenging business environment. Key reasons include increased competition in a saturated market, and a reduction of their traditional revenue streams resulting from the loss of bundled services (i.e., telephone, TV, and broadband) and streaming/OTT revenue. Compounding this struggle has been their inability to satisfy the multi-gigabit network demands of the modern home. Although Federal Communications Commission (FCC) data reports that over 88% of U.S. homes have access to gigabit Internet speeds, an analysis of more than 70 million unique Internet Protocol (IP) addresses by Cable.co.uk revealed a mean download speed in the United States of just 136.5 Megabits per Second (Mbps), which although ranking 12th globally, is far below gigabit levels. This is despite consumers clearly craving improved Internet speeds, as highlighted by Deloitte's 2022 Connectivity and Mobile Trends Survey, which found that 15% of home Internet users upgraded their broadband packages to attain higher speeds in 2021, and 44% also purchased "signal boosters" like Wi-Fi extenders and Wi-Fi mesh equipment to expand in-home coverage. Clearly, if broadband operators are unable to deliver multi-gigabit connectivity, then consumers will be deprived of the speeds required to power next-generation applications, and lack the capacity to support the expanded number of simultaneously connected Wi-Fi devices, the numerous nodes of mesh networks, or advanced value-added services.

In order to differentiate from the competition, reduce churn, and increase Average Revenue per User (ARPU), broadband operators are increasingly deploying more advanced Wi-Fi CPE. This has driven the accelerated adoption of Wi-Fi 6, and as seen in Chart 3, will stimulate the movement to Wi-Fi 7. These higher speeds are supported through the transition to PON technology, and over the next 5 years, the majority of shipment growth in fixed access Wi-Fi CPE will be led by PON CPE, as shown in Chart 4. Another way for operators to boost their value proposition and expand their addressable market is to introduce 5G FWA CPE, which instead of using fixed access technologies like cable, DSL, or fiber, leverages 5G signals for Internet connectivity to the Internet. This product type will experience the highest relative growth, with global shipments expanding four-fold between 2022 and 2027, from 5.6 million to 28.6 million. Unlocking the enhanced throughputs and latencies made possible by Wi-Fi 7 and the broadband access evolution will be vital in enabling next-generation experiences and supporting the high demands that mesh exerts on the network.

The second core pillar of this strategic shift is enabling a greater array of value-added services, which can span everything from Wi-Fi management and parental controls to emerging services like Wi-Fi sensing. Deploying these value-added services is not only a method for operators to differentiate their offering from that of their competitors, but also a route for opening new business and service models. Operators may choose to embellish the value proposition of their premium tiers by incorporating value-added services, or they may allow customers to separately purchase access to individual or a bundle of value-added services alongside their standard broadband package. In order to successfully implement these new value-added services, operators will need to ensure the guaranteed level of QoE necessary for their operation, which will require specific Service Level Agreements (SLAs) for network and application performance. This will require additional bandwidth to ensure that home networks have sufficient capacity for their operation—again reinforcing the centrality of the 6 GHz spectrum to the next wave of home networking evolution.

Wi-Fi's Role in the Home

The overwhelming majority of Internet traffic in the home today is handled by Wi-Fi. While Ethernet played a central role in the past, Wi-Fi performance is now approaching parity with this legacy technology, and is also both lower-cost and better positioned to provide connectivity for the increasing number of wireless devices in the home. Cellular only plays a minor role in home connectivity, with most cellular traffic, which is predominantly relied upon for mobile connectivity, being offloaded to Wi-Fi when in the home. At the same time, consumers' reliance on Wi-Fi is growing alongside the expansion of Wi-Fi connectivity to a broader array of devices, such as smart TVs and home electronics like refrigerators.

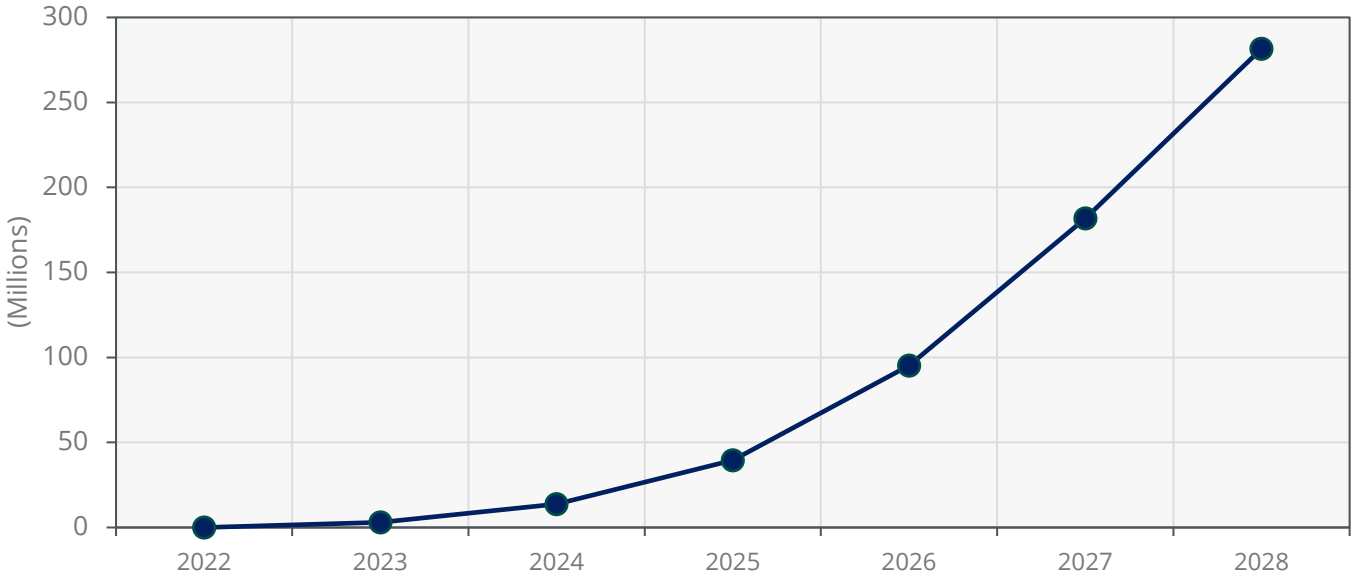
This increasing prevalence of Wi-Fi throughout the home has resulted in Wi-Fi traffic doubling roughly every 3 years, according to a 2021 study conducted by Adaptive Spectrum and Signal Alignment, Incorporated (ASSAI). Yet, due to the limited capacity of the unlicensed 2.4 GHz and 5 GH spectrum bands, this increase in traffic has had the unfortunate knock-on effect of degrading Quality of Service (QoS), bringing increased congestion, higher latencies, and heightened interference. It is perhaps unsurprising then that the ASSIA study also revealed that, in the United States, connectivity QoS in the home is increasingly limited by Wi-Fi, rather than broadband. The high reliance of consumers on Wi-Fi makes Wi-Fi QoS the main determinant of customer satisfaction, so it goes without saying that poor Wi-Fi performance will negatively impact the operator. It will lead to an increase in Wi-Fi-related support calls, which drain an operator's resources and are often ineffective at troubleshooting the core issue. Subpar performance could also chip away at customer confidence in the operator, potentially resulting in customer churn. Thus, broadband operators are under immense pressure to deliver advanced Wi-Fi QoE for their customers.

Wi-Fi 7 will be central to delivering the next wave of performance enhancements to Wi-Fi, including the theoretical possibility of 46.4 Gbps speeds, up from Wi-Fi 6's peak data rate of 9.6 Gbps. One of the most anticipated new features of Wi-Fi 7 is Multi-Link Operation (MLO), which will prove pivotal in delivering next-generation in-home experiences. For use cases like large file downloads, video streaming, and VR, MLO can unlock higher throughputs by aggregating multiple separate radio links to create wide channels in congested environments. Furthermore, for

applications demanding low latency like online gaming, MLO can rapidly alternate between the available bands to drive down latency. Additional features of Wi-Fi 7 include enlarged maximum channel widths of 320 MHz, double that of its predecessor, 4K Quadrature Amplitude Modulation (QAM), and Multi Resource Unit (Multi-RU) puncturing. Consumers who adopt Wi-Fi 7 can expect enhanced performance, enlarged capacity, improved reliability, and increased resiliency against interference—all attributes that will help the technology handle the vast array of in-home devices and enable next-generation experiences. Consumer demand for the improved performance of Wi-Fi 7 will drive a 147.2% CAGR of Wi-Fi 7 CPE shipments between 2023 and 2028.

Chart 5: Global Shipments of Wi-Fi 7 CPE, 2022 to 2028

(Source: ABI Research)

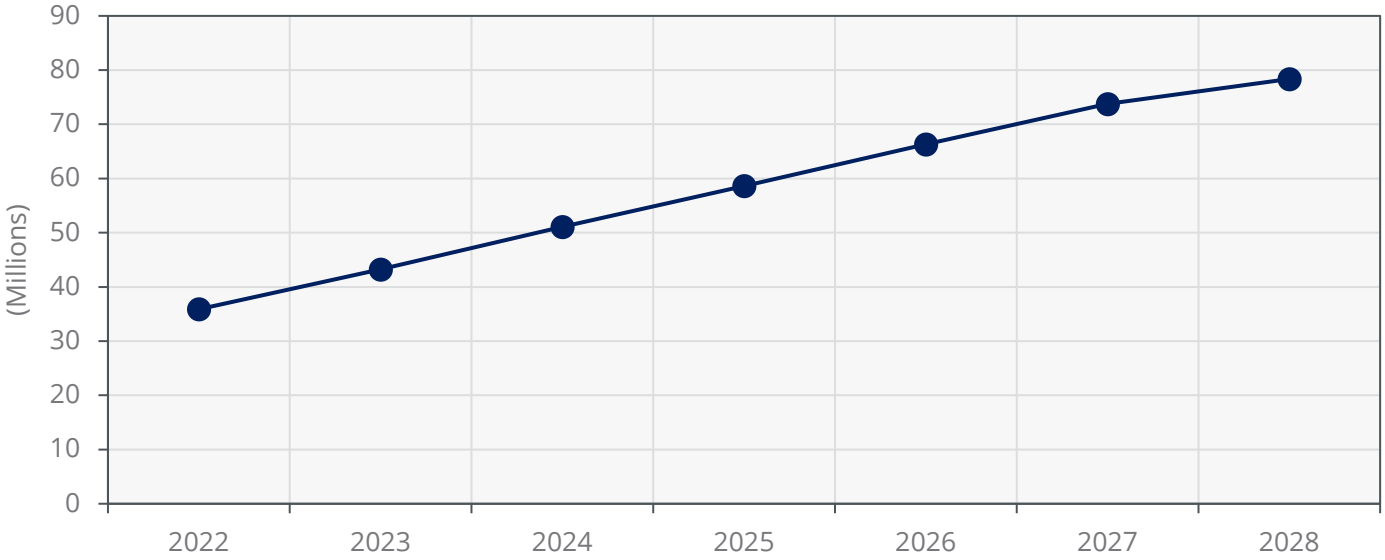


The recently released 6 GHz spectrum will greatly increase network capacity, enabling the handling of more devices and the delivery of higher performance. At the same time, the migration of 6 GHz-enabled clients to the 6 GHz band will alleviate congestion on the legacy 2.4 GHz and 5 GHz bands, reducing interference for Wi-Fi devices without 6 GHz compatibility and 2.4 GHz IoT devices. The United States will be able to enjoy the full capabilities of Wi-Fi 7, as the market, alongside the majority of the Americas, has access to the entire 1200 MHz of the band (this additional capacity effectively doubles the available spectrum for Wi-Fi). However, not all regions have such favorable policies toward 6 GHz. Europe can only leverage the lower portion for Wi-Fi (5925 – 6425 MHz), whereas China and India currently have no unlicensed access to the band. The MLO feature of Wi-Fi 7 will prove particularly useful in such regions, as it will help extract the maximum spectrum efficiency from the available spectrum. Harnessing the 6 GHz band requires an additional 6 GHz Wi-Fi radio within Wi-Fi gateways, so demand for 6 GHz spectrum support will drive rapid growth in shipments of tri-radio Wi-Fi gateways, with a radio for each—2.4 GHz, 5 GHz, and 6 GHz. By 2028, 55.2% of all Wi-Fi gateways shipped will be tri-radio.

Alongside the adoption of the latest Wi-Fi standards, the role of Wi-Fi gateways in the home is also evolving, as they increasingly serve as the hub for a network of several mesh Wi-Fi nodes dispersed throughout the home. These nodes can extend connectivity to a further distance from the core gateway, resolving blind spots and ensuring seamless and consistent connectivity throughout the home—pain points that consumers are facing, and that operators need to address to deliver good QoE. The trend of consumers increasingly turning to mesh networks as the solution to their connectivity troubles will drive a 12.6% CAGR for residential Wi-Fi Mesh equipment shipments between 2023 and 2028.

Chart 6: Global Shipments of Mesh Wi-Fi CPE, 2022 to 2028

(Source: ABI Research)



While 5G connectivity is seldom relied upon in the home, advancements in the technology are directly impacting Wi-Fi networking outside the home. This is because the increase in mobile data consumption required to deliver the performance and capacity gains of 5G has placed considerable additional load on cellular networks, in some cases negatively impacting user experience. Operators are looking to offload as much of this traffic as possible onto local Wi-Fi networks to alleviate this burden. 5G to Wi-Fi handover is particularly important for Mobile Virtual Network Operators (MVNOs) with business models that rely on licensing spectrum from the operators that own it and repackaging services under their own brand. This is because it enables them to achieve significant reductions in operating costs. Standardizing this handover has presented profitable monetization opportunities for both operators and participating venues. As the continuing growth of mobile traffic exerts increasing strain on cellular networks, the seamless transfer of devices from 5G to local Wi-Fi networks will become vital for ensuring a high mobile QoE; therefore, Wi-Fi will have a key role to play even for operators that do not sell Wi-Fi services directly to customers.

Transformation of the Connected Home

Over the next half a decade, we will witness an incredible increase in annual Wi-Fi-enabled device shipments, from 3.5 billion in 2022 to more than 5.5 billion by 2028. Yet, this number alone does not tell the full story, because alongside this overall market expansion will be the shift in the type of experiences that these devices provide consumers. At present, the enablement of many fresh and immersive home experiences is being ham-strung by limited bandwidth and legacy Wi-Fi standards in consumer homes, but these restrictions will gradually be lifted over the coming half decade as adoption of the new 6 GHz spectrum expands network capacity and the migration to Wi-Fi 7 helps deliver the ultra-high throughputs and low latencies that next-generation applications require.

One consequence of these developments will be the need to provide the necessary 100 Mbps speeds required for the transition to 8K streaming. These speed advancements are forecast to lead to a jump in shipments of 8K flat panel TVs from 0.6 million in 2022 to more than 50 million by 2028. VR headsets are another new product type with multi-gigabit and low-latency requirements that can only be met by next-generation networks. Upon the realization of these enhanced throughputs and latencies, VR headset shipments are projected to increase from just over 18 million in 2023 to above 92 million in 2028. Enabling these new applications will lead to increasing consumer demand to use them, adding further burden on the network, which will then require operators to enhance in-home network performance to support these new applications. Operators that are unable to power these latest use cases will be left uncompetitive and face the prospect of high levels of customer churn.

Chart 7: Wi-Fi-Enabled Device Shipments, 2022 to 2027

(Source: ABI Research)

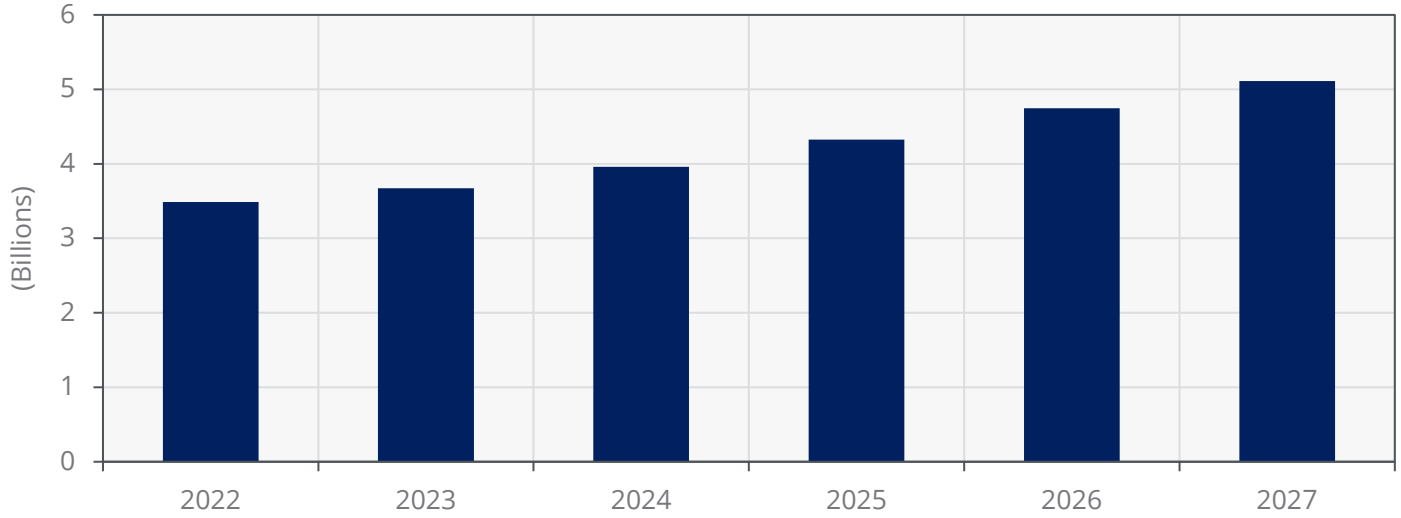


Chart 8: 4K & 8K Flat Panel Television Shipments by Region, 2020 to 2027

(Source: ABI Research)

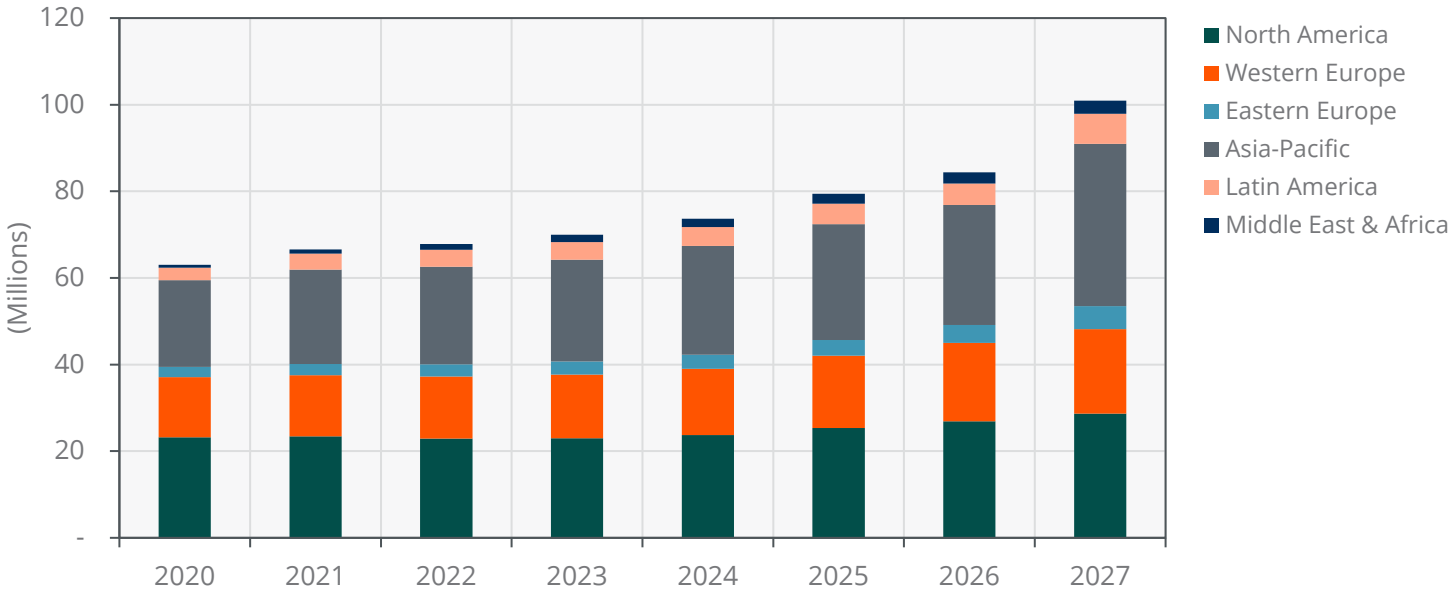
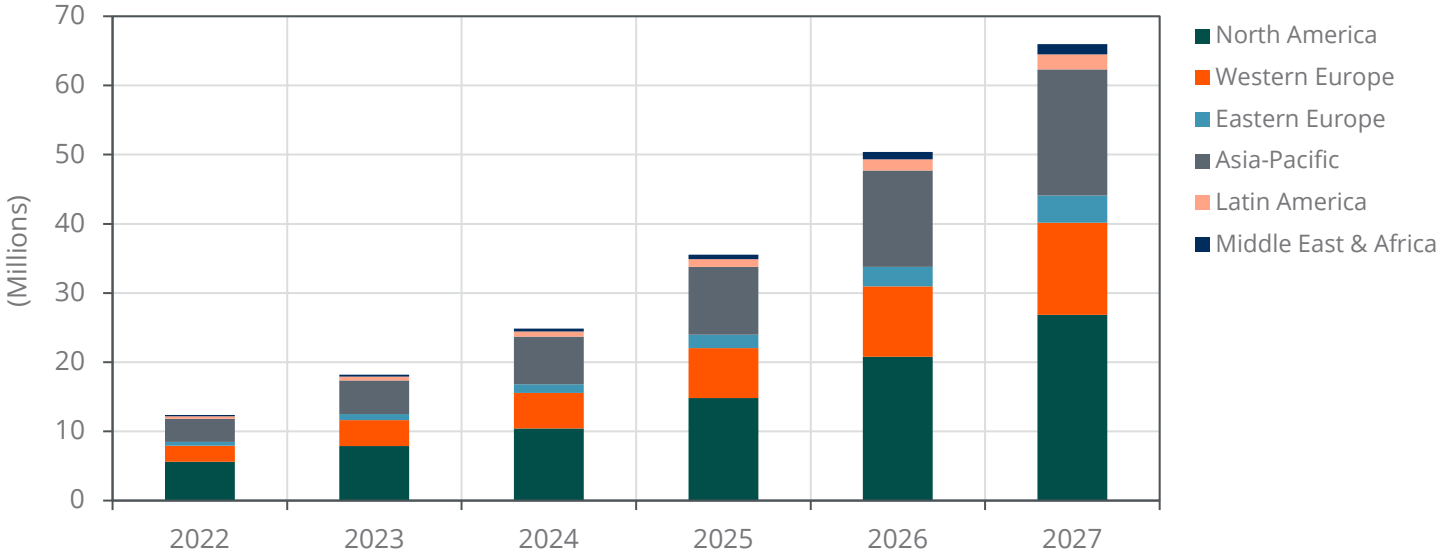


Chart 9: Virtual Reality Head-Mounted Displays Shipments by Region, 2022 to 2027

(Source: ABI Research)



It is not purely a desire for new experiences that is driving innovation. The shift to home working has also spurred the development and upgrading of a range of tools to facilitate this new working model. One aspect of this is collaboration platforms, whose reliable operation is now considered to be mission critical given their centrality to effective home working. Another aspect is new Wi-Fi hardware form factors, notably Wi-Fi mesh, which support home working by expanding Wi-Fi coverage and addressing blind spots. Both of these require improved reliability and additional bandwidth, and as home working transitions from a temporary arrangement for tackling the COVID-19 pandemic to a permanent work style, consumer demands on the network will increase accordingly. Operators need to be prepared if they wish to retain customers.

Increasing Importance of Value-Added Services

The increase of value-added services—software-level programs that add additional features to Wi-Fi CPE—has fundamentally transformed the dynamics of the broadband operator market. This has opened a new front in the competition between operators, expanding package differentiation beyond the traditional throughput and performance metrics, and into providing services that include Wi-Fi management, cybersecurity, enhanced privacy, parental controls, and Wi-Fi motion sensing. These services raise the value proposition of operator offerings, and simultaneously enable fruitful new monetization opportunities. If leveraged skillfully, income from these value-added services could help compensate for the revenue declines operators have experienced across their bundled services and OTT segments. The rich and insightful data gathered from these services has the additional benefit of supporting operators in optimizing consumer experiences and reducing operating costs.

Perhaps the most widespread value-added service on the market today is Wi-Fi management. This service allows consumers to directly monitor and manage their network through a dashboard, with analysis and automated troubleshooting to facilitate network optimization. Proactively addressing Wi-Fi issues can also reduce support calls from clients and increase customer satisfaction. Another core value-added service is cybersecurity, which can prevent unauthorized devices accessing the network and protect consumers from threats that include viruses, botnets, malware, ransomware, and phishing attacks. This service will become increasingly vital as the number of IoT devices on the network continues to increase, because these devices are typically the most vulnerable aspect of the network. Alongside providing additional upsell opportunities, protecting consumers online also helps increase their satisfaction with a broadband operator's service, which can be key to maintaining competitive value propositions.

Strong monetization opportunities also exist for services centered around SLAs optimized for specific applications. For example, a gaming service will guarantee the QoS requirements necessary for optimizing online gaming performance. Several such services are available on the market today, with one example being packages targeted at gamers, which promise to improve gaming experiences by delivering less latency, fewer ping spikes, and reduced jitter. The guaranteed delivery of specific performance metrics could be applied for a host of potential services, such as home working, remote learning, Ultra-High-Definition (UHD) and 8K video streaming, remote support, telehealth services, and VR, or even emerging services like Wi-Fi sensing.

Reliable and stable Wi-Fi performance is essential for operating these lucrative value-added services, and if stringent QoS requirements are not met, then operators will be unable to exploit these new revenue opportunities, their value proposition will be damaged, and they will be at a competitive disadvantage. Latency and capacity are particularly important, as many services require low response times and rely on dedicated bandwidth for their operation. In order for operators to remain competitive, they must prepare their networks for the age of value-added services.

UNDERSTANDING THE NEXT WAVE OF WI-FI GATEWAY INNOVATION

Wi-Fi gateways of the past are not equipped to address the core pain points that broadband operators face today and will struggle to deliver next-generation home networking experiences to their customers. Therefore, to facilitate the next wave of home networking innovation and to enable broadband operators to increase their value propositions to consumers, the industry needs to transition toward a new form of Wi-Fi gateway. This next-generation Wi-Fi gateway will be defined by three key elements: 1) support for high-performance in-home connectivity; 2) advanced connectivity to the home; and 3) the adoption of a software-defined architecture.

High-performance connectivity in the home will be made possible by Wi-Fi 7 and the 6 GHz spectrum, which combined will help deliver higher throughputs and lower latencies, greater spectrum efficiency, superior reliability, and improved resiliency against interference. This will prove vital for enabling next-generation home experiences and for handling the increased number of connected devices in the home. Advanced connectivity to the home, on the other hand, will be achieved by migrating toward fiber and 5G FWA, a transition that will become necessary to ensure that the access technology does not become the network bottleneck. Operators that do not adopt these leading-edge access technologies will face large opportunity costs, including limited Wi-Fi gateway performance, an inability to deploy new value-added services, and difficulties in effectively implementing cloud orchestration. This will all result in impaired QoS levels for end users, severely damaging an operator's value proposition to their customers.

The third aspect of this revolution is the movement toward a software-defined gateway, essential for the software-level flexibility that operators desire. This will help operators deliver vastly improved QoS management for their customers and allow them to continuously innovate. Central to this process will be disaggregating of the hardware and software on the Wi-Fi gateway. This will mean that instead of being locked into one software ecosystem, operators will have the freedom to pick and choose from an assortment of value-added services. They can, for example, leverage their own proprietary solutions alongside those from third parties. Moreover, through containerization, in which all the resources required to run the value-added service are self-contained within one container, it will be possible for the operator to add and remove value-added services with ease. The movement toward a software-defined model will exert additional requirements on the Wi-Fi gateway—namely that it must support powerful compute and additional memory to reduce latency and costs for the cloud integration necessary to deploy these new services. However, it will reward operators with the capability to build a richer, more compelling array of services into their packages. The separation of the hardware and software will also help spur further Wi-Fi gateway software innovation, moving the industry forward and unlocking additional value.

Another important benefit of the software-defined approach is the ability for improved QoS management. In the past, home networks were treated as though they were static, but they are, in practice, constantly changing environments with network demands constantly in flux. The number of devices and applications in use at any one time is unpredictable, and their performance requirements are erratic. Roaming, guests entering the network, and interference all add additional challenges. With cloud orchestration possible through a software-defined model, gateways will have an improved ability to dynamically adapt to such continuously shifting conditions. This is because they can leverage end-to-end visibility from the client through to the cloud, and will be able to use advanced telemetry, collecting and analyzing data from the network and connected devices to help understand what challenges the network is facing and to identify root causes of issues. Management platforms can then optimize network operations based on these advanced network insights, enabling traffic prioritization and dynamic adaptation to changing network conditions.

Operators can harness this end-to-end QoS management to optimize the customer experience and generate additional value. For example, service and application aware traffic prioritization will allow operators to fulfill advanced SLAs by guaranteeing the performance of specific application classes on the network. Advanced telemetry will then allow for validation of the fulfillment of these SLAs. End-to-end management is also central to implementing consistent policy throughout the network, from the cloud to the device. The importance of improved QoS for the functioning of next-generation Wi-Fi applications and advanced value-added services will make software-defined gateways increasingly necessary over the coming decade.

Alongside recognizing the many opportunities that software-defined gateways will bring, it is also important to acknowledge the challenges that this transition will pose for operators. It will require a wholesale revision of traditional business models and forming new strategic partnerships, a pivot that may be tough for operators resistant to change. The more dynamic ecosystem that cloud orchestration permits will readjust the industry standard for operator value propositions, placing a greater emphasis on value-added service delivery and flexibility. Operators will need to build competencies for this shift in order to remain competitive. Ultimately, these are all challenges that cannot be avoided, as operators that do not adopt a software-defined approach will be left at a competitive disadvantage.

CONCLUSIONS

Vast improvements to home networking are on the horizon, and broadband operators need to harness these developments in order to build a compelling value proposition for their consumers. The four pillars of the next wave of home networking evolution will be: 1) adopting Wi-Fi 7 and 6 GHz; 2) migrating to the ascendant access technologies of fiber and 5G FWA; 3) an expanded role for value-added services; and 4) transitioning to software-defined Wi-Fi gateways. Combined, these four trends will underpin the service quality improvements required to handle the increasing load and complexity of home networks and to deliver next-generation Wi-Fi experiences. They will also enable operators to demonstrate customer experience improvements and create additional value, allowing them to overcome their current challenges and open up new revenue streams.

Revitalized operating strategies, taking account the four major trends discussed above, are central to this shift. Broadband access, the foundation of the home network, must be capable of supporting the complex demands of modern networks, so operators should accelerate fiber deployment or strengthen partnerships with firms from which they can lease fiber lines. To further expand their addressable customer base, they can explore 5G FWA or FWA alternatives. This access revolution must also be accompanied by the latest Wi-Fi technologies, and operators should be swift in adopting Wi-Fi 7 to ensure that Wi-Fi does not become the network bottleneck. The advanced features of Wi-Fi 7 and expanded capacity of 6 GHz will ensure meeting the complex modern network demands and satisfying the requirements for emerging applications.

Value-added services will also constitute a fundamental component of operators' revamped value propositions, although they should not be deployed in isolation or simply for the sake of it. Instead, multiple mutually complementary value-added services should be integrated together, allowing enhanced capabilities through convergence and simplifying user interaction. Last but not least, software-defined gateways will be another important element in the evolution of home networking, bringing a slew of enhancements, including improved reliability, interoperability, and enhanced network visibility. This will help deliver benefits such as application-aware service prioritization for mission-critical use cases, consistent policy spanning the network to the device, and end-to-end service management for performance optimization and enhanced troubleshooting.

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