Delivering a fixed-grade broadband experience with fixed wireless access

White paper

The arrival of 5G fixed wireless access (FWA) technology gives service providers a viable way of delivering high-speed broadband to customers in both rural and urban environments where it is too costly or time consuming to draw fiber. As a mobile technology, FWA needs careful consideration for successful implementation. This paper examines the benefits and challenges for delivering a customer-pleasing 5G FWA service.

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Introduction

As demand for data increases exponentially from residential properties, users are more concerned with broadband service quality than the technology that delivers it. Fixed wireless access (FWA) is by no means a new phenomenon, but network and reliability challenges have discouraged widespread deployment—until now.

The arrival of 5G, with its superior speed and low latency, enables operators to deliver a fixed-grade broadband experience using mobile technology. 5G FWA broadband services can be used to meet exploding broadband service demands while ensuring a customer experience equivalent to fiber broadband.

Both mobile and converged operators are in an excellent position to optimize existing networks or create new business and residential broadband services using 5G. Sub-6 GHz and mmWave technology options enable operators to deliver competitive broadband services in urban, suburban and rural areas, connecting previously underserved residents or moving into completely new territories. Using standardized 3GPP network architectures and assets including spectrum, radio access network (RAN), and core network equipment from existing operations, FWA services can be quickly deployed using existing capacity.

Yet 4G and 5G were designed for mobile services. Mobile broadband customers accept giving up some level of performance and predictability for the convenience of mobility. That is not the case for fixed-grade services where consumers expect high, consistent, and reliable quality and performance. Ensuring a seamless FWA customer experience, therefore, presents unique challenges for operators.

What are the challenges?

5G offers much more than fast mobile connectivity: the speed and low latency of 5G provide an opportunity to deliver a wide variety of new services. Some of these opportunities will take years to develop, while others, including FWA, can be deployed today.

FWA of course needs sufficient mobile network capacity. In addition, quality of service, network reliability, and performance are important considerations as they all impact customer experience. FWA can put a strain on network performance for several reasons.

- Fixed wireless access users are likely to consume more data than mobile users.
- Multiple users in a single location, gaming, working from home, and other data-intensive applications, can quickly overwhelm a mobile network.
- A mobile operator looking to provide a seamless fixed-grade service is competing with wireline capacity, quality and availability.

In addition to maintaining network quality and performance, operators are continually challenged to ensure customer loyalty and monetize new services. Beyond price, customer experience is the primary opportunity for operators to differentiate and compete. Delivering FWA using 5G has broad appeal to consumers, provided that operators can deliver the desired experience at a competitive price.

FWA service management

Given the high costs of customer acquisition and care, it's important to target the most suitable FWA subscribers and quickly address any service issues to ensure customer satisfaction and prevent churn. FWA customer premises equipment (CPE) can be managed using existing TR-069 protocols, through an auto configuration server (ACS). However, many operators are finding that they need better visibility and management for fixed wireless services.

Designing for the worst case does not optimize capacity or network utilization. There´s need for management tools that ensure operators can plan and deliver the best possible FWA broadband experience.

- Point of sale (PoS) to immediately validate customer eligibility for FWA services based on customer location, distance to the cell site, and RAN capacity.
- Cell capacity planning tools to understand if and where free cell capacity exists, as radio resources are shared between eMBB and FWA and not guaranteed.
- Mobile applications that support the end-user self-install process by guiding the end-user to the most optimal location to install the FWA CPE for the best possible signal and service.

Spectrum considerations

5G: sub-6 GHz

4G mobile networks commonly deploy macrocells to provide RAN coverage. In a dense urban environment, macrocells typically cover a maximum distance of 500 meters, while 10-15 km is common in rural areas. While maximum coverage can be achieved using low-band spectrum, the compromise is slower speeds.

5G delivers significantly more capacity for FWA. With mid-band spectrum at 2.5 and 3.5 GHz, up to 200 MHz of bandwidth and better spectral efficiency, 5G delivers 10-15 times more capacity than 4G LTE networks. A mid-band 5G base station with three sectors can provide more than 500 Terabytes of data per month, supporting hundreds of FWA users. Using 5G capacity, operators can offer up to Gigabit peak speeds and meet specific in-country requirements for sustained rates.

The added advantages of 5G in the mid-bands are cost and time to market. Signal range at these frequencies is good, meaning network densification is not required; the existing mobile footprint can simply be upgraded from 4G to 5G to support both mobile broadband and fixed wireless access. However, since the radio network is shared with mobile broadband, care must be taken to ensure that mobile services are not impacted when FWA customers are added, and that residential sustained speeds can be maintained.

5G mmWave

5G operating in the mmWave spectrum range (24 to 40 GHz) delivers up to 1.2 GHz bandwidth to operators. This ensures there is sufficient bandwidth to support multi-Gigabit peak speeds with sustained speeds that rival that of fiber.

There are a number of factors that have made mmWave a more viable complement to sub-6 GHz 5G for FWA. Initially, mmWave spectrum was only available in the US and parts of APAC, and now we see spectrum becoming available in all major markets. Secondly, the mmWave ecosystem is maturing with more capable FWA chipsets coming to market. And, thirdly, mmWave technology has already been introduced in consumer handsets. The consumer handset market drives significant economies of scale, benefiting the entire 5G mmWave eco-system.

Building on the existing radio network

Existing radio networks are an excellent starting point for offering FWA services. Unused spectrum in urban, suburban and rural areas is a great asset and a large investment has already been made. The fit for FWA is excellent and operators can combine 4G, 5G sub-6 GHz, and 5G mmWave to create a high-capacity and reliable connection for a variety of deployment use cases.

Mid-band 5G can be deployed quickly on existing 4G base stations to launch FWA services. 5G mmWave can be deployed as required to boost capacity for subscribers within range while freeing up sub-6 GHz capacity for homes and businesses that are beyond the reach of mmWave.

We see new deployment strategies for mmWave that increase the usefulness of this spectrum:

- An urban, high-density FWA service, where densification of the mobile infrastructure is required (due to non-line-of-sight or limited line-of-sight). Densification of this scale comes with a few operational challenges in site acquisition, power, backhaul, and network design. The lack of well-located available sites in these high-density urban environments will lead to significantly higher costs compared to the theoretically optimal network design. Furthermore, on those sites, power and fiber for backhaul are not always easy to access.
- In rural environments with a sparse population and limited or no internet access service, some operators aim to use mmWave over long distances to solve these rural connectivity challenges. This use case requires a direct line-of-sight (LoS) deployment with highly directive antennas using outdoor FWA devices and requiring an engineer installation, for example to determine an elevated installation position for FWA CPE to achieve the required LoS conditions.
- Operators that own mmWave and sub-6 spectrum, in urban and suburban areas, have the ability to use both for a more robust and cost-effective deployment. mmWave FWA can be used to relieve sub-6 GHz capacity bottlenecks. In this model, mmWave RAN equipment can be added as capacity overlay to existing macro sites. mmWave will then offload capacity from sub-6 resources and make it available more towards the edges of cells, with end-users receiving better throughput as a result. This has the added advantage of preserving precious spectrum for eMBB applications and providing better service to the existing coverage area. This dual spectrum deployment model is simpler to achieve than densification, allowing operators to reserve densification, with its higher cost, for delivering high sustained rates in dense urban and suburban areas where the take-rates make it commercially attractive.

Spectrum efficiency

Low-cost FWA devices and personal Wi-Fi dongles tend to waste a lot of radio spectrum to deliver FWA services. There's a need for a solution that maximizes revenue per Hz and achieves optimal spectrum efficiency. The right CPE—both indoor and outdoor—should be determined during service qualification to ensure that the FWA service delivered to each customer is the best it can be.

The importance of antenna gain

Antenna gain is a critical aspect to consider when choosing a FWA solution. It is one of the factors that can transform a FWA service from a me-too, personal Wi-Fi offering, to a competitively differentiated service.

In rural areas where signal strengths are weak, an outdoor high-gain antenna can avoid first-wall penetration loss and bring a basic broadband service to a home that is unable to connect using personal Wi-Fi. In suburban and urban areas where base station densities are higher, and more spectrum is typically utilized, indoor devices with high-gain antennas are a good option. Indoor devices can be easily installed by customers, which reduces deployment costs while still making the most of the signals that penetrate the home.

For CPE with high-gain antenna, operators can achieve cell edge throughput increases that can double performance. When footprint density of the RAN increases or coverage is extended, performance improves even more.

MIMO

With MIMO, the same spectrum can be re-used by splitting the carrier signal into different paths. Theoretically, we can double (2x2 MIMO) or multiply by 4 (4x4 MIMO) the bitrate. MIMO uses multiple paths and independent polarization to boost the spectral efficiency. Field trials have shown that 4x4 MIMO contributes significantly to 5G FWA performance in urban and suburban environments.

Network partitioning with slicing

5G brings a quantum leap in speed and throughput of data to the wireless network along with low latency and high reliability. These capabilities enable operators to deliver a wide variety of targeted services. Multiple services with a variety of network QoS and access requirements all use the same physical network. Using network slicing, operators can create multiple virtual networks—network slices—for each distinct use case, and optimize network resources based on specific end-to-end requirements.

Network slicing is built into the 5G standard as defined by the 3GPP specifications. Since FWA shares radio resources with other services, like mobile broadband, managing limited radio assets to guarantee service levels can be challenging. Using network slicing to deliver FWA overcomes this challenge. Operators can define a slice to deliver broadband using FWA connections and prioritize cell capacity for FWA over enhanced mobile broadband (eMBB).

Within the home, operators can deliver Wi-Fi slicing within a single FWA connection. Operators can set priority slices on the home Wi-Fi for specific applications like cloud gaming with low latency, working-from-home or IPTV that would require guaranteed bandwidth even if all members of the household are connected to the internet. Using Wi-Fi EasyMesh traffic separation, multiple SSIDs can be deployed in the home and home users are bridged to a captive portal. As a result, end-to-end network slicing is achieved all the way from the cloud, 4G/5G core, transport, RAN and through the FWA CPE to the home user's device delivering the QoS and access control that each application requires.

Whole home Wi-Fi

Operators deliver high quality broadband to homes and businesses using a variety of access technologies including fiber-to-the-home (FTTH), copper, and FWA, with many residential customers having access to broadband services of 1 Gb/s or higher. Ultimately however, any broadband experience is only as good as the in-building Wi-Fi. If the Wi-Fi network performs poorly, the whole experience is bad, regardless of the service delivered to the home. Of course, customers don't know or care where the problem is, and broadband providers get the blame.

Wi-Fi coverage is a critical piece of the broadband experience and, when there are multiple simultaneous users in different rooms and on different levels, they all need a fast-broadband connection. Delivering high-performing, whole-home Wi-Fi has become as essential for operators as high-quality network access when delivering the best possible broadband experience for customers.

Fortunately, ensuring high-quality Wi-Fi is getting easier. The first ingredient is Wi-Fi 6, introduced in 2019. Compared to Wi-Fi 5, Wi-Fi 6 delivers higher throughput (+39% per MIMO stream), especially in dense urban areas, and better security (WPA3). The second ingredient is mesh technology, to blanket the whole home

with Wi-Fi. Operators require standardized mesh technology to increase flexibility and avoid vendor lock-in. However, while the EasyMesh™ standard dictates how the mesh controller needs to communicate with the mesh agents, it does not standardize how the controller monitors and manages the mesh Wi-Fi network.

Conclusion

While fixed-wireless access has been with us for many years, it has often been dismissed by operators as unreliable in urban areas and too expensive in rural areas. 5G changes all that. Its high speed and low latency solve many of the problems associated with delivering reliable and cost-effective FWA services. And as 5G technologies evolve, operators are finding that FWA is now a viable service offering for many customers. Especially when considering that customers don't really care about the technology behind their broadband service—they care about performance, reliability, and price.

Fixed-wireless access is a vital, viable and valuable technology in the race to connect everyone and everything with high-quality broadband.

Abbreviations

4G	Fourth generation mobile
5G	Fifth generation mobile
ACS	Auto configuration server
CPE	Customer premises equipment
eMBB	Enhanced mobile broadband
FTTH	Fiber-to-the-home
FWA	Fixed wireless access
LoS	Line-of-sight
MIMO	Multiple-input and multiple-output
PoS	Point of sale
QoS	Quality of service
RAN	Radio access network
SSID	Service set identifier

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