Overcoming the Limitations of Wi-Fi Technology in Fixed Wireless Broadband

By employing a well-balanced approach to distributed real-time signal processing and multi-antenna design, ngFWA architecture can overcome the limitations Wi-Fi–based technology poses to deliver fixed wireless access service.

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Fixed wireless access (FWA) has become increasingly common in telecom networks over the past 20 years. It provides last-mile connectivity to tens of millions of households and small businesses worldwide via myriad small-scale deployments on the fringes of wired-solution coverage areas. Of the many technologies FWA products use, systems based on Wi-Fi technology are the most common. Wi-Fi has become commonplace in indoor networks since its introduction more than 20 years ago, serving users successfully in a wide variety of public and private spaces.

Today, every mobile phone includes Wi-Fi, and billions of Wi-Fi chipsets have been sold worldwide. Given their high production volumes, Wi-Fi chipsets and other related wireless components are available at low cost, so it's not surprising that vendors have leveraged this technology to build FWA products.

FWA service providers (mainly WISPs) often choose Wi-Fi–based systems because of the low cost and accessibility. Unfortunately, FWA gear powered by Wi-Fi technology bears most of the blame for the stigma of unreliability around fixed wireless, for reasons explained below. The root cause of the problem is that Wi-Fi was simply not designed for outdoor fixed wireless at the required scale, and this substantially limits performance of Wi-Fi–based FWA systems.

As FWA operators move toward the larger-scale deployments required to close the digital divide, the question arises: Will Wi-Fi–based FWA platforms be able to deliver the required performance?

WI-FI TECHNOLOGY LIMITATIONS FOR FWA

Though Wi-Fi works well for its intended use in indoor networks, it faces numerous serious challenges when applied in outdoor FWA applications. For one, physical obstructions such as trees or buildings significantly impede connectivity. They can limit operators to exclusive use of line-of-sight (LoS) links between their infrastructure (e.g., tall structures such as cell towers or multistory buildings on which base station radios are mounted) and client devices (e.g., remote radios) mounted on homes. LoS links are much more rare than common in typical residential neighborhoods, comprising on average less than 15 percent of links beyond a couple hundred yards. For this reason, FWA systems must support non-line-of-sight (NLoS) connections to deliver reliable broadband service at scale in most markets. This is simply not possible with Wi-Fi–based FWA platforms.

Second, every communications technology consumes a portion of its capacity with its protocol's necessary control messaging for various functions, often referred to in sum as "overhead." Wi-Fi in particular has a relatively high level of protocol overhead, driven by the need to support various client device types; many mobile client capabilities, such as mobility, battery power conservation, sleeping and roaming; and requirements for backward compatibility with prior versions of the standard. The latest 802.11 standard (IEEE 802.11ax, a.k.a. Wi-Fi 6) consumes 30 percent of its potential capacity with this protocol overhead, much of which is irrelevant to FWA applications.

The third and most problematic issue is that fixed wireless equipment that repurposes Wi-Fi technology is completely exposed to interference from other devices operating in the same band – both within a network and between competing networks or devices.

The carrier sense multiple access/collision avoidance (CSMA/CA) protocols of 802.11 enable Wi-Fi systems to share the unlicensed spectrum in a controlled manner. CSMA/CA attempts to ensure only one 802.11 device is transmitting at a given time on the same frequency. CSMA/CA works well in a lightly loaded network with a few clients, but network performance degrades as the number of clients increases and contention consumes increasing amounts of airtime.

The 802.11 MAC protocol was designed for peer-to-peer networks – each station has an equal opportunity to access the shared medium. This is counter to the design of fixed wireless networks in which the base station controls access to the medium and the schedule for transmissions from all clients. FWA systems based on Wi-Fi technology must implement a scheduler on top of the CSMA/CA protocol,

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which inherently limits precision and efficiency in the network.

Though the 802.11 standard offers a large breadth of mobility and client features, it does not define any explicit mechanism to mitigate interference other than CSMA/CA.

Each limitation and design compromise reduces the performance of Wi-Fi–based FWA systems in the real world. The theoretical maximum performance on the Wi-Fi chipset data sheet is possible only indoors in a noise-free environment with links of a few feet. Outdoor performance is materially lower than in ideal indoor conditions. Communicating at extended range (on the scale of miles) reduces performance, and noise and interference degrade performance even further. Line-of-sight links are required. As a result, these systems cannot meet the requirements of mainstream residential broadband at scale.

NGFWA TO THE RESCUE

In contrast to fixed wireless systems based on Wi-Fi technology, operators focus on solving the technical challenges of large-scale fixed wireless networks operating in the unlicensed bands using next-generation fixed wireless access (ngFWA) – a completely new architecture optimized to provide fast, reliable residential broadband at scale.

ngFWA solves the two major wireless communication issues that plague fixed wireless systems: interference and obstructions in the path of long-range wireless links. Interference cancellation is critical because fixed wireless systems are designed to operate in the chaotic unlicensed bands where anything can happen. Working around obstructions is essential because the large majority of homes in a typical residential neighborhood do not have direct line of sight to the wireless base station.

FWA based on Wi-Fi is not the best tool for the widespread connections needed for the future of telecom: It simply wasn't designed for delivering reliable residential broadband at scale. ngFWA architecture employs a well-balanced approach to distributed real-time signal processing and multiantenna design. These innovations deliver excellent performance over NLoS links, exact interference cancellation within and between radios in the network, and unprecedented resistance to interference from competing radio sources in unlicensed bands.

ngFWA allows operators to provide high-capacity, reliable broadband service in the congested unlicensed bands and supports NLoS links with hundreds of megabits of capacity. It's a practical solution to the world's connectivity challenges and is the clear choice for accelerating efforts to address them.

In conclusion, though traditional Wi-Fi–based FWA is immensely popular, it has serious limitations. ngFWA allows operators to provide high-capacity, reliable broadband service in the congested unlicensed bands and supports NLoS links with hundreds of Mbps of capacity. ngFWA is a practical solution to the world's connectivity challenges and is the clear choice for accelerating efforts to address them. It offers more solutions for the world's connectivity issues and is the best choice for providing wireless broadband in hard-to-reach areas.

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