



HOW 5G FIXED WIRELESS ACCESS CAN IMPACT ENTERPRISES AND SMALL & MEDIUM BUSINESSES

A MACH Networks White Paper

HOW 5G FIXED WIRELESS ACCESS CAN IMPACT ENTERPRISES AND SMALL & MEDIUM BUSINESSES

In 5G Fixed Wireless Access (FWA) is revolutionizing the telecommunications landscape, offering businesses unprecedented speeds, reduced latency, and enhanced capacity compared to its 4G predecessor. This technology enables service providers and end customers to rapidly and cost-effectively expand their network footprint with minimal additional investment.

As enterprises increasingly migrate to cloud-based solutions, the demand for higher performance, greater flexibility, improved branch office management, and enhanced resiliency grows. 5G FWA stands out as a leading technology capable of supporting these requirements and facilitating emerging services that were previously unattainable with 4G LTE.

This White Paper delves into the critical aspects of 5G for MACH Partners and their end customers, providing essential insights into leveraging this cutting-edge technology.

WHY SHOULD YOU CARE ABOUT 5G?

While 5G enables faster internet browsing and enhanced streaming services, its significance extends far beyond these conveniences. To truly understand its impact, consider how 4G transformed our lives and industries.

One notable example is wireless failover. The integration of 4G into network infrastructure significantly improved reliability and resiliency, reducing network downtime to less than six minutes annually. For retail businesses and quick-service restaurants, this meant the ability to continuously take orders and process credit card transactions, directly affecting their bottom line.

“Bottom line is that, as a technology, 5G is now going into so many different sectors that these technology elements will be put together both in the networks and devices to make sure that these industries get enabled”

Alex Katouzian, SVP & GM,
Mobile, Compute and
Infrastructure, Qualcomm

4G catalyzed the exponential growth of social media platforms such as YouTube, LinkedIn, TikTok, Facebook, Snapchat, and Instagram. It also facilitated remote work and distance learning, connecting millions in remote areas worldwide. Essentially, 4G ensured connectivity wherever cell phone service was available. 5G, however, elevates this transformation to an entirely new level, enabling a myriad of new and emerging applications.

Technology experts widely agree that 5G's disruptive potential surpasses that of 4G by at least an order of magnitude. This is not an exaggeration; 5G makes possible a broad spectrum of Wireless Wide Area Networking (WWAN) applications that were previously unattainable with 4G.

WHAT YOU SHOULD KNOW ABOUT 5G

5G technology is built upon three distinct spectrum layers, each of which is crucial to its overall functionality. Businesses will need to familiarize themselves with these layers to fully leverage 5G capabilities:

- **Coverage Layer:** This includes 4G LTE, Gigabit-Class LTE, and low-band 5G. It provides broad coverage and ensures connectivity over large areas.

- **Capacity Layer:** Also known as mid-band or c-band 5G, this layer offers a balance between coverage and capacity, delivering higher speeds and improved performance.
- **High-Capacity Layer:** Referred to as mmWave, this layer provides ultra-high speeds and capacity, ideal for densely populated urban areas and specific high-demand applications.

The combination of the coverage and capacity layers is often termed "Sub-6 GHz" within the radio spectrum, highlighting their collective importance in the 5G ecosystem.

Each layer of the 5G spectrum possesses distinct characteristics and tradeoffs, primarily revolving around the balance between performance and propagation. Understanding these tradeoffs is crucial for effectively leveraging 5G technology:

- **High Propagation, Lower Performance:** Spectrum layers with high propagation capabilities can cover larger areas but typically offer lower performance characteristics.
- **Low Propagation, Higher Performance:** Conversely, spectrum layers with lower propagation capabilities provide higher performance but cover smaller areas

COVERAGE LAYER

Includes 4G LTE, Gigabit-Class LTE, and low-band 5G. It offers extensive coverage with moderate performance making it ideal for broad connectivity.

SPECTRUM LAYERS

A contiguous grouping of radio frequencies that have different performance and propagation characteristics.

PROPAGATION

The distance a radio signal can travel and the degree to which a radio signal can penetrate obstacles before losing integrity. If you can't get the signal, the speed doesn't matter.

Since its inception, cellular service has primarily operated within the coverage layer, utilizing spectrum below 2 GHz, predominantly under 1 GHz. This layer is characterized by strong propagation capabilities, allowing signals to cover extensive areas. However, it offers the lowest data capacity among the three 5G spectrum layers.

Today's coverage layer includes 4G LTE, Gigabit-Class LTE, and low-band 5G technologies. In 2020, several mobile operators introduced 5G services within this layer, branding it as low-band 5G. Generally, low-band 5G delivers performance comparable to Gigabit-Class LTE. Due to its propagation characteristics and limited bandwidth allocation, the performance of low-band 5G is typically capped within specific ranges.

Performance	4G LTE	Gigabit-Class LTE	Low-Band 5G
Download	10-50 Mbps	50-350 Mbps	60-400 Mbps
Upload	5-15 Mbps	30-60 Mbps	30-75 Mbps
Latency	30-60 ms	30-60 ms	20-40 ms
Propagation	High	High	High

The US carriers are currently racing each other to roll out nationwide 5G services by providing maximum coverage but are doing so at the expense of higher performance.

CAPACITY LAYER

This layer, known as mid-band 5G, strikes a balance between coverage and performance, delivering higher speeds and improved reliability.

The capacity layer, commonly called mid-band (or c-band) 5G, operates within the 2 GHz to 7 GHz frequency range. This layer provides significantly more bandwidth compared to the

coverage layer, though it has lower propagation capabilities. Mid-band 5G is often considered the optimal balance between performance and propagation, making it the current sweet spot for 5G technology.

The capacity layer offers substantial performance improvements over the coverage layer, though its propagation is not as extensive. However, it still surpasses the propagation capabilities of the high-capacity layer, also known as mmWave.

Access to the capacity layer has posed challenges for many operators in certain countries. For example, in the United States, this spectrum has been allocated to the government and various industries. In 2020 and early 2021, the U.S. government auctioned billions of dollars worth of mid-band spectrum licenses to mobile operators and private companies. These operators are now actively deploying mid-band infrastructure to enhance their 5G networks.

Performance	Capacity Layer
Download	100 Mbps -1.5 Gbps
Upload	50-100 Mbps
Latency	20-40 ms
Propagation	Medium

T-Mobile acquired a significant portion of the mid-band Spectrum, giving it a bit of a head start over the other carriers using the spectrum purchased by Sprint.

HIGH-CAPACITY LAYER

Also referred to as mmWave, this layer provides exceptional performance with ultra-high speeds, suitable for densely populated urban areas and high-demand applications.

The high-capacity layer, also known as high-band or mmWave, is characterized by its short radio wave distance and operates above 24 GHz. This layer can transmit significantly more data compared to the low and mid-band layers. However, higher frequencies in this

range are more susceptible to weather conditions, signal penetration issues, and distance limitations.

To overcome these challenges, operators have developed innovative solutions such as new antenna designs, denser network architectures, and advanced beam-forming technologies. These advancements have been integrated into the new 5G standard, and most major operators plan to incorporate mmWave into their 5G deployment strategies.

Despite its high data capacity, mmWave 5G will primarily be deployed in areas where line-of-sight signals can reach densely populated regions, ensuring optimal performance and connectivity.

Performance	Capacity Layer
Download	300 Mbps -13 Gbps
Upload	50-200 Mbps
Latency	10-40 ms
Propagation	Low

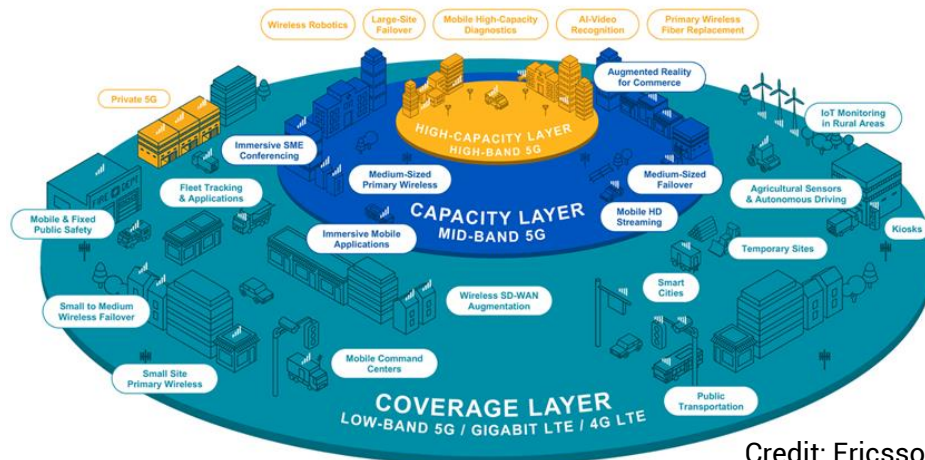
High-capacity or mmWave 5G will roll out more slowly than the capacity layer and will initially only cover small parts of large cities. However, its performance is comparable to cable or even fiber-type services.

SUMMARY OF SPECTRUM LAYERS

The 5G landscape is inherently multi-faceted, requiring organizations to strategically deploy their sites, vehicles, and IoT solutions across different spectrum layers. Some deployments will operate within the coverage layer, utilizing LTE, Gigabit-Class LTE, or low-band 5G. Others will leverage the mid-band capacity layer or even the high-band mmWave layer.

To maximize the benefits of 5G, organizations must ensure that their edge networking solutions can seamlessly adapt to each spectrum layer. This adaptability is crucial for supporting and capitalizing on the various phases of cellular carrier rollouts of 5G services.

The diagram below illustrates each spectrum layer within the 5G landscape and sample use cases suited to each band. While many applications will perform adequately in the coverage layer, others will necessitate the higher performance offered by the mid-band or high-band layers. Organizations can optimize their 5G deployments to meet diverse operational needs by understanding and strategically utilizing these layers.



Credit: Ericsson 2023

The mid-band capacity layer, operating between 2 GHz and 7 GHz, necessitates greater network densification compared to the coverage layer, making it less pervasive. However, it performs significantly better, making it ideal for high-bandwidth applications.

Due to its shorter reach and lower propagation characteristics, the high-capacity layer (mmWave) provides limited coverage compared to other spectrum layers. Applications requiring the highest performance can leverage mmWave, provided it is available in their area.

Several applications naturally perform well across multiple spectrum bands, including temporary sites, public transportation, and augmented reality for commerce. Some applications operate in independent environments, such as Private LTE/5G networks.

By understanding these nuances, organizations can strategically deploy their 5G solutions to optimize performance and coverage based on specific operational needs.

If you fail to plan, you are planning to fail

Benjamin Franklin

WHAT CAN YOU DO WITH 5G?

To fully realize the transformative potential of 5G, it is essential to have foresight and align resources effectively today. Below is a suggested planning exercise designed to bring significant value to your organization:

Meet with Customers and Assess

Current Infrastructure: Meeting with customers and understanding their long-term plans is highly valuable. Not only will you learn more about their business, but you can also forge valuable relationships for later deployments. Evaluate their network infrastructure to identify areas that can benefit from 5G integration.

At a minimum, you will want to:

- Understand their goals and objectives
- Discuss how Wireless WAN can help them accomplish these goals
- Diagram possible 5G WWAN solutions
- Show them how you can provide up to 5 nines reliability (< 6 minutes of network downtime/year)
- Discuss a proof-of-concept WWAN project to show them how it can impact their business
- Go the extra mile and show them which carriers offer the best 5G service for each end location

Document the direction in a technology roadmap.

Identify Key Applications: Determine which applications and services will most benefit from 5G's enhanced capabilities.

Allocate Resources: Ensure that the necessary financial, technical, and human resources are allocated to support the 5G rollout.

Engage Stakeholders: Involve key stakeholders from across the organization to ensure alignment and support for the 5G strategy. Hold several sessions, if needed, to examine the business from a visionary perspective.

Questions might include:

- How will your market and customers change in 1, 3, and 5 years? And how can technology help monetize those changes?
- What technology gaps could prevent you from seizing these opportunities?
- What role can wireless wide area networking play in these advancements?

Monitor and Adapt: Continuously monitor the deployment process and be prepared to adapt the strategy as needed based on emerging technologies and market conditions.

WHAT TO CONSIDER IN A NETWORK EDGE REFRESH

The hardware and carrier services that enable 5G connections are just one aspect of what is required for a next-generation Wireless WAN. To implement it effectively, a fully managed solution is essential. This involves a single provider capable of delivering optimal 5G network services for each edge location, efficiently provisioning and installing products and services, remotely monitoring and managing edge devices, and managing data usage to prevent excessive charges. Additionally, ongoing technical support and comprehensive device life-cycle management are crucial.

Furthermore, it is important to consider essentials for a secure and reliable network infrastructure, such as robust security measures, redundancy, and compliance with industry standards. By addressing these aspects, organizations can ensure a seamless and efficient deployment of their next-generation Wireless WAN.

REVIEW VPN TUNNEL DESIGN

Reducing latency is a key objective of 5G technology. However, the latency introduced by VPN tunnels can undermine these benefits. To fully leverage 5G's advantages, your IT team should consider revising the VPN architecture. One approach is to design architectures that minimize data transfer between the edge, the cloud, and data centers. Another strategy is to enable branches to connect directly to cloud applications using TLS, thereby reducing latency and improving performance.

PLAN FOR MULTI-ACCESS EDGE COMPUTING ADVANTAGES

Applications previously hindered by high latency can now become feasible with the advent of Multi-Access Edge Computing (MEC), a key component of 5G technology. MEC strategically positions computing resources at the network edge, enabling real-time processing and significantly reducing latency. Organizations should collaborate with cloud service providers and network operators to effectively leverage these ultra-low latency capabilities to deploy and manage edge computing resources.

CONSIDER A DISTRIBUTED ARCHITECTURE AT THE NETWORK'S EDGE

Critical tools such as firewalls, routers, and VPNs add latency to edge networks. The closer these services can move to the network's edge and away from a centralized architecture, the better it is for latency.

IMPLEMENT HIGHER-THROUGHPUT DEVICES AT THE NETWORK EDGE

As organizations look to refresh their edge infrastructure, they should consider minimum interface speeds of 2.5 Gbps. Processors should be able to run full services and broadband speeds well over 1 Gbps to best prepare for the future. With the possibility of multi-gigabit speeds, it would be a shame if their interface speeds and CPU capabilities limited network edge devices. Backbone infrastructure changes take time, so planning ahead is important.

INCREASE CORE NETWORK BANDWIDTH

As the capacity at the network edge expands significantly, it is logical to anticipate a corresponding increase in demand on the core network. Therefore, it is crucial to proactively plan for enhanced core network bandwidth to accommodate this growth effectively.

SET UP A 5G EXECUTIVE BRIEFING

Offer a personalized half-day 5G executive briefing to help the organization understand and begin developing strategies for taking advantage of 5G. The facilitators should be seasoned telecommunications veterans who have participated in the 5G working groups and have been involved in early 5G network trials.

THE FUTURE OF 5G

5G is set to revolutionize our digital landscape in unprecedented ways. Far from being merely an incremental upgrade in connectivity, 5G

signifies a transformative leap that will redefine enterprise operations and facilitate seamless, near-real-time communication.

Modern businesses, which require uninterrupted and delay-free data transmission, stand to gain significantly from 5G features like network slicing. This advanced network architecture allows multiple virtualized networks to coexist on the same physical infrastructure, optimizing resource utilization and enhancing performance.

5G Standalone Core (SA)

Early 5G deployments use 4G Non-standalone (NSA) for signalling. 5G SA will provide improved efficiencies and lower latency.

WHAT IS 5G NETWORK SLICING?

5G network slicing can be likened to bespoke suits for connectivity. Just as a custom-tailored suit fits perfectly, network slices are designed to meet the specific requirements of various business applications, all utilizing the same underlying infrastructure. This approach allows the network to support a diverse array of services, from high-speed consumer internet to mission-critical applications like autonomous vehicles and industrial automation.

For instance, critical applications such as operational and navigation systems can be assigned to a low-latency slice, where the carrier allocates priority resources. This premium service might come with a higher cost and a service level agreement (SLA), while less critical, best-effort services can be placed on a different slice at a lower cost. Initially, network slices will likely adhere to the original 5G standard recommendations.

5G network slices are virtual networks that operate on shared 5G infrastructure, available exclusively on 5G networks with a standalone core. Each slice is optimized for a specific business purpose by customizing throughput, latency, speed, reliability, and security parameters. Custom slices can be developed to meet unique business needs, including a default slice for best-effort traffic.

ENHANCED MOBILE BROADBAND (EMBB)

Tailored for use cases requiring high throughput and low latency, the eMBB slice enables mobile video streaming and broadcasting, in-car entertainment, mobile gaming, and social networking from user devices in dense areas.

ULTRA-RELIABLE LOW LATENCY COMMUNICATIONS (URLLC)

URLLC slices are designed to meet strict reliability, availability, and ultra-low latency requirements. They support autonomous vehicles, AR/VR, mobile robots, and remote-control applications.

MASSIVE OR CRITICAL MACHINE-TYPE COMMUNICATIONS (MMTC OR CMTC)

Reserved for low-cost, long-life IoT devices, mMTC or cMTC slices are designed for transmitting or receiving small data volumes, including applications like meters, sensors, trackers, and wearables.

PUBLIC SAFETY

Built for government and public safety agencies, these slices enable reliable, high-bandwidth connectivity for push-to-talk communications, IoT operations, and remote monitoring feeds. Each slice can be further divided to support unique business needs. Carriers can develop custom slices, including a default slice for best-effort traffic.

THE EVOLUTION OF 5G

Looking ahead, carriers will enhance 5G performance beyond merely utilizing different spectrums. A key method will be carrier aggregation, which combines multiple carriers into a single channel to improve network capacity. While this technique has primarily been used to boost 4G speeds, it is expected to become widely adopted to enhance 5G performance.

Carriers will likely focus more on increasing uplink speeds as 5G continues to evolve. Traditionally, the emphasis has been on optimizing downlink speeds. However, with the growing demand for applications requiring faster upload speeds, such as interactive video and autonomous functionalities, meeting these connectivity needs is crucial.

As the 5G landscape evolves over the next few years, staying informed about changes is essential. This involves not only keeping up with technology news but also engaging with top-tier vendors, resellers, and operators who can help you prepare for the future. For more information on fully managed 5G network solutions, visit MACHnetworks.com.

About MACH Networks

MACH Networks makes it quick, easy, and profitable to add 5G solutions to your portfolio. MACH is a pioneer in Wireless WAN, offering fully managed 4G and 5G solutions to service providers, MSPs, and VARs. SMBs, Enterprises, and public sector agencies rely on MACH to provide reliable, secure network services whenever and wherever they need them, connecting fixed and temporary sites, vehicles, IoT devices, and remote employees. MACH was established in 2008 and is headquartered in Carlsbad, CA.

Learn More

(866) 972-7677, ext 2
www.MACHNetworks.com

