apitech™

A Guide to Developing Innovative 5G and Wi-Fi 6E Radio Services

Steaming Ahead to Bring 5G and Wi-Fi 6E Deployments to Life

1 The Global Perspective on 5G and Wi-Fi 6E from a spectrum innovator

Introduction

Dear Reader,

Both 5G and Wi-Fi provide the basis for an essential network to service the multitude of connections developing around the globe. Operating in both licensed and unlicensed blocks of spectrum, these rapidly evolving standards have highly specific tests and test set-ups with stringent tolerances on test parameters in order to ensure ideal performance under various conditions as well as to verify that these devices are not operating at high enough power levels to interfere with other devices. This can be seen with the Wi-Fi 6EE device power classes where standard power (SP) access points (AP) have to operate under a automated frequency coordination (AFC) system that assigns a lists of frequency to the AP based for safe operation without interfering/interference. Moreover, as IoT continues to encompass industries and applications, the need to reliably and repeatably test the low-latency, critical communications found in grid, industrial automation, public safety, and healthcare applications is increasingly important.

The 5G and Wi-Fi design and test challenges for commercial wireless manufacturers are as follows:

- **Successful conformance testing**
- **Ensuring network features perform as designed**
- **Optimizing MIMO and beamforming performance**
- **Integrating IoT as a standard network add-on**
- **Guarantee device feature compatibility**
- **Certify against standards (3GPP, Wi-Fi Alliance, etc)**

While over-the-air (OTA) testing cannot be ignored for 5G in order to test specific radiative performance parameters and conformance of radio hardware/antenna array. Conductive RF testing is also necessary to accurately characterize chipset performance and for the development of software and system protocols by:

- **Simulating real-world conditions in a controlled fashion**
- **Providing control for phase (delay), attenuation, and multiplexed interconnect that can be used to simulate every type of network configuration (e.g., star, mesh)**

This ebook discusses the backdrop of connectivity between 5G and Wi-Fi networks and how specific advancements such as MU-MIMO call for cutting-edge testing solutions. APITech offers key components for test set ups such as RF Transceiver Test Systems and RF Network Simulators with programmable attenuator matrices, butler (phase shifter) matrices, power splitters/combiners, RF switches/relays, and control modules. These conductive test solutions allow for reliable and repeatable with accurate test simulators.

To dive deeper into RF testing for 5G or Wi-Fi networks, please reach out to me.

David J Swift
Global Director of Telecom Sales, APITech

Where do APITech and 5G / Wi-Fi Meet?

APITech has over 60 years of wireless device and system heritage developed through several business units, which are now joined as one to offer the most comprehensive wireless systems development organization.

APITech has expertise in developing essential wireless communications components, accessories, assemblies/modules, and even entire systems. With the expanding use of wireless communications technology in various applications, operators and wireless systems manufacturers need knowledgeable and skilled engineers able to meet the challenges of the latest wireless communications generations. Wi-Fi 6E and 5G in particular, are presenting a new realm of testing and system design challenges, and APITech is uniquely positioned to help.

Learn more about the evolving landscape of wireless communications in this book, and how APITech can augment your business with design services, wireless hardware, and innovative wireless network testing technology.

1. **The global perspective on 5G and Wi-Fi 6E as well as the need for conformance testing.**
2. **A spectrum innovator's view on how filter technology is critical in mitigating interference for a world with an increasing device density.**
3. **Mastering the implementation of surface mount resistives in cutting edge wireless networks.**
4. **Insights on advancements in 5G and Wi-Fi call for cutting-edge test systems and how APITech uniquely serves this niche with conductive testing solutions.**
5. **Learning how RF network simulators are fundamental to reliably prototyping and validating the varying wireless propagation environments found globally.**

The APITech team

APITech Insights – Commercial Wireless

We know the 5G and Wi-Fi 6E spectrum. By leveraging the power of our expertise in component design and manufacture, we can help you prepare for tomorrow's world.

David Swift

A hands-on wireless technology specialist who believes in innovative and disruptive technologies which challenge the status quo, and make a real difference. With over 24 years' experience involved working closely with customers and partners to successfully realise their visions.

John Yania

John has over three decades of experience in filter design for the harsh space environment. Co-founder and VP of FSY Microwave. Educated MSEE, Johns Hopkins University. Product Line Manager expert, responsible for design of Filter Products, RF/Microwave & Microelectronics technologies.

Norm Hansen

Norm is currently the Product Line Director for Passive Coaxial Products with over 30 years of experience in the RF/Microwave Industry including executive leadership roles in business development, sales, and marketing. He supports the wireless connectivity and optical markets.

Egor Alekseev

Egor Alekseev manages Powerfilm products for APITech Inmet, and holds PhD EE from UofM.

Aaron Singer

With over 15 years of experience with a Tier I automotive supplier, Aaron has experience with all levels of product development from concept and design to validation and production.

Nicholas Garneski

Nicholas specialisation is RF/Microwave design, computational electromagnetics modelling, test software and hardware development.

Prakash Hari

Prakash has been awarded 2 technology patents in telecommunications, with over 14 years expertise in the development of RF products, test platforms and managed services for commercial wireless, satellite and defence markets.

Jennifer Harkless

Jennifer is the Product Line Manager for Electro-Magnetic Devices at APITech, Electromagnetic Integrated Solutions Business Unit. She attended the University of Pittsburgh for Engineering and has been a Lean Six Sigma Black Belt for 18 years.

Donald Dilworth

Don is a Product Line Manager with over 37 years of experience helping the top players in wireless telecom industry solve EMI and RFI problems to improve information transfer over their network interconnects for commercial RF systems. He has an engineering degree from Ryerson University in Toronto.

The Global Perspective on 5G and Wi-Fi 6E from a spectrum innovator

A Global Perspective on 5G

5G is the fastest-growing mobile technology in history, and is being adopted four times as quickly as LTE when it was first introduced.

Even though mobile internet connections on 4G networks are perceived as fast enough for average users in that it is good for streaming HD videos or downloading music, apps, and games on the go – 5G, the next evolution of wireless networks, has already arrived and is expected to take off this year. The track is now being laid for 5G verticals, based on the demand and new business cases for mobile wireless. 5G is now poised to affect everything, everywhere.

In 2021, one of the most crucial factors in 5G development will be the type of spectrum available in each country. To have a network that achieves the full potential of 5G, an operator needs to have the right balance of low-band, mid-band, and high-band. Low-band spectrum, or sub-1 GHz bands, is needed for mass coverage and long-distance communication to truly make 5G a ubiquitous technology. Mid-band spectrum between 1 GHz and 6 GHz is crucial for a mix of capacity, coverage, and reliability dense urban and suburban environments as well as new use cases such as industrial facilities, vehicle-to-everything (V2X) communications, and for expansive public spaces. High-band, millimeter-wave spectrum, will be needed for emerging user experience features such as augmented reality/virtual reality (AR/VR), and for other applications demanding low latency communication with blazing-fast speeds.

APITech expects that 2021 will see strong movement toward full utilization of 5G's transformational possibilities.

Making 5G and Wi-Fi 6E Work

The infrastructure and technology to make 5G work is extensive between chips, network equipment, and security platforms; not to mention the devices that connect to the network such as smartphones, smart TVs, appliances, and automotive solutions.

To address the wide range of 5G use cases and applications across consumer and business segments, there will need to be a plethora of wireless device and infrastructure technology development with innovations in wireless system hardware and software design and testing. Especially for new 5G use cases such as ultra-reliable low latency communications (uRLLC) and massive machine type communications (mMTC). Inventive wireless network testing solutions are needed to simulate real-world conditions and enhance the design of 5G hardware and software.

Wi-Fi is already being used to off-load suitable LTE and 5G traffic so that overburdened cellular networks can deliver an enhanced user experience to priority users while still providing seamless, high throughput services to users within Wi-Fi network range. This will likely continue as Internet of Things (IoT) infrastructure is built-up and deployed throughout the world.

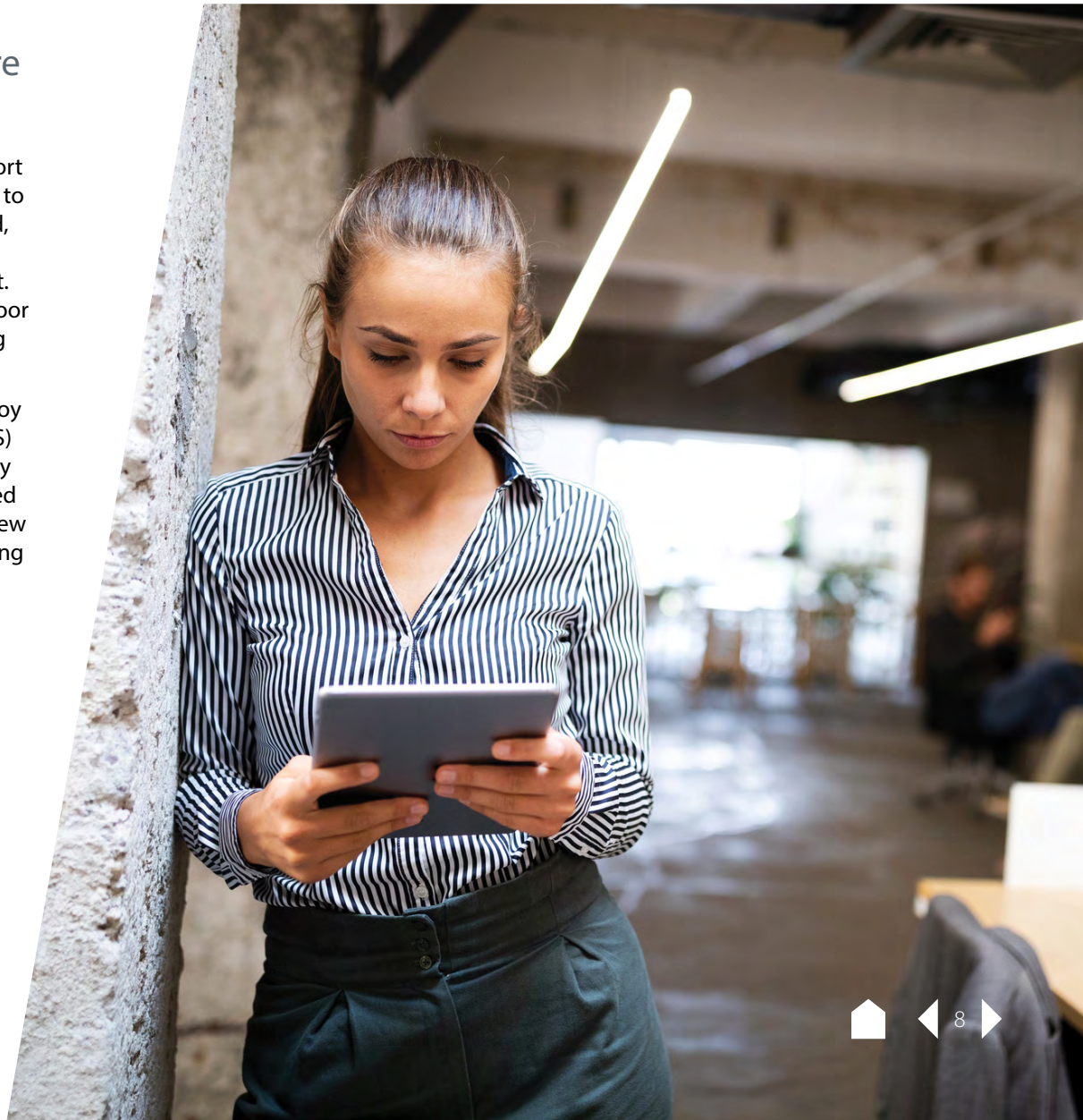
Wi-Fi 6E, and future Wi-Fi generations, are also a substantial part of this equation. 5G and Wi-Fi do/will coexist, and may eventually converge; at least in a network topology sense.

The Challenge of RF Propagation Indoors and Outdoors

The indoor coverage challenge already exists in the case of 4G. For example: 20% of buildings in the US are struggling with proper indoor coverage.

This problem is exacerbated with 5G due to the use of high frequency bands – the short wavelength signals are not only quickly attenuated in the atmosphere, they also tend to reflect and scatter when hitting obstacles. Lower frequency signals, on the other hand, experience much less atmospheric attenuation and have the useful ability to diffract around objects, allowing a receiver to detect a large part of the original signal content. This is a serious concern not only in congested outdoor environments, but also in indoor environments where signal can get absorbed or entirely reflected, causing building penetration losses that are unacceptably high.

The 3.1 to 4.9 GHz band is a commonly used frequency range, but 5G will also employ the millimeter-wave band above 30 GHz. And, at such frequencies, line-of-sight (LoS) is required for proper signal reception. Even at the 5G frequency of 10 GHz, the only current indoor coverage option is to place the receiving device as close to an untreated glass windowpane as possible. However, the energy-conserving glass used in many new buildings, and other forms of treated glass panes, effectively attenuate the signal making indoor coverage extremely difficult.

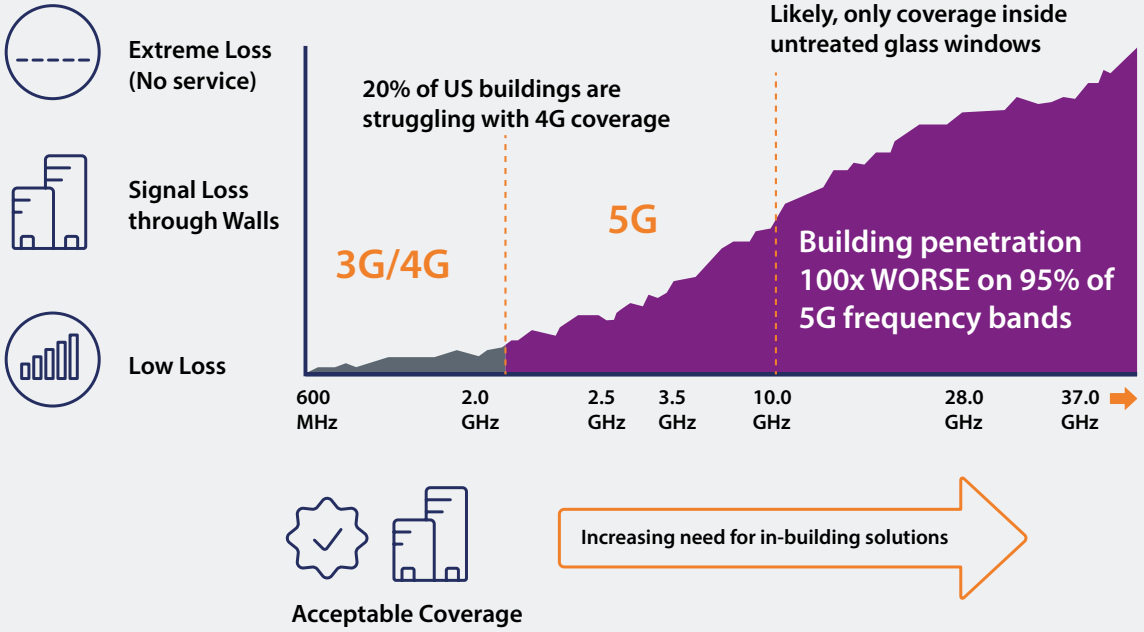


The Need for Conformance Testing

The use of new high frequency spectrum is forcing operators and equipment manufacturers to seek out hardware and testing systems in the millimeter-wave spectrum, which has traditionally been the realm of defense and aerospace applications.

The new frequencies and performance requirements of 5G and Wi-Fi 6E necessitate that millimeter-wave components and testing scale and adapt to the new commercial demand. This is the commercial reality facing mobile operators today.

The chart below shows the increasing loss in signal as the frequency increases. Building penetration is 100x worse than 3G/4G on 95% of the 5G frequency bands.



Source: The Difference Between 5G and 5G Colin Berkshire, TalkingPointz Insider, April 2019

This is where APITech steps in. APITech's RF components, subsystems, and conductive testing systems are used by Chip and Equipment Manufacturers Labs, Mobile Network Operator Labs, and test facilities to ensure equipment conforms to Third Generation Partnership (3GPP) and Wi-Fi Alliance standards and continues to evolve with these standards. APITech focuses on innovative new spectrum management, signal conditioning, and wireless network test solutions that are used to optimize 5G and Wi-Fi air interfaces through conductive testing.

A Bird's Eye View of Wireless Test

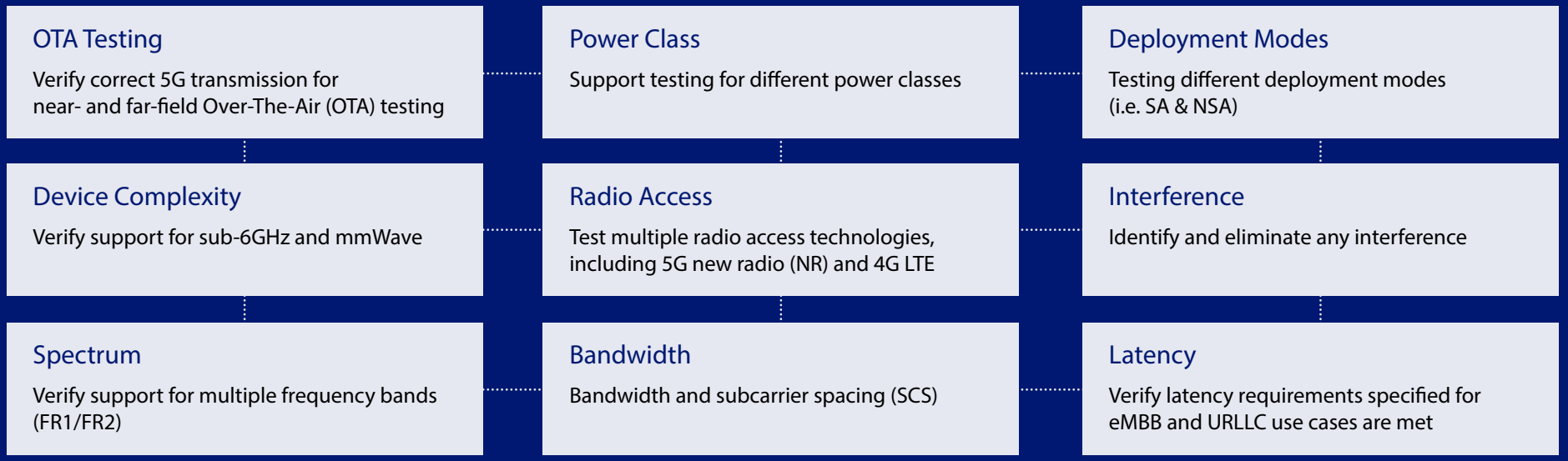
The commercial wireless testing architecture is notionally based on the timeline for Third Generation Partnership (3GPP) and Wi-Fi Alliance standards releases and equipment/device vendor offerings. For instance, for millimeter-wave 5G the first phase is new radio non-standalone (NR-NSA) architecture, which relies on existing 4G LTE networks to connect devices to 5G service.

The second phase of millimeter-wave 5G upgrades the network to new radio standalone (NR-SA) mode. The modular elements of the framework are organized by architecture, spectrum, application traffic, network, and 5G innovations. Wi-Fi 6E is also evolving to Wi-Fi 6E extended, which is able to operate on the new 1.25 GHz swath of shared spectrum at 6 GHz.

The current ecosystem of wireless test not only hosts these differing deployment modes but also various forms of OTA testing for devices of varying power class, complexity, radio access, interference, spectrum, bandwidth and latency requirements.

The image below highlights the taxonomy of current wireless testing with its specific requirements based upon the standardized attribute of the user equipment.

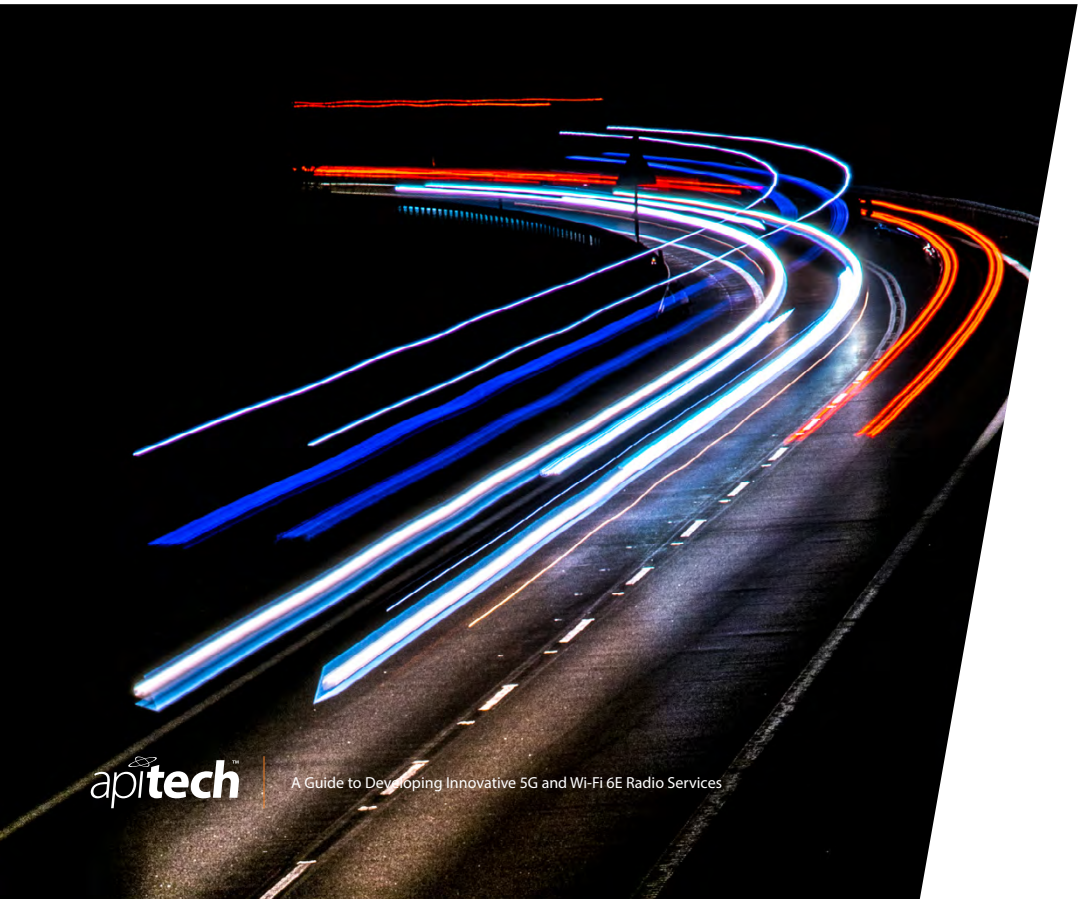
Wireless: Test market taxonomy and attributes

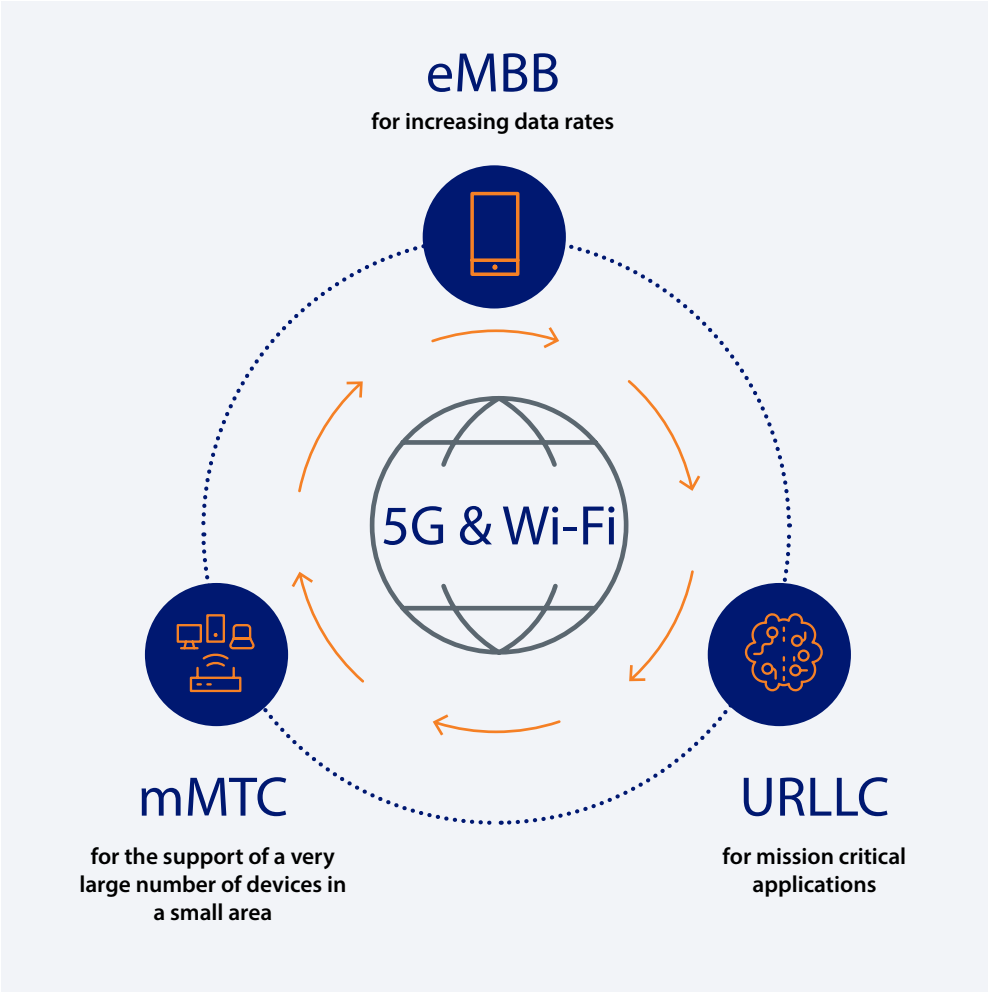


5G and Wi-Fi Cocktail Conversation

The goal of both 5G and Wi-Fi 6E is to flexibly support three main service families:

1. **Enhanced mobile broadband (eMBB) for gigabit-per-second user data rates.**
2. **Massive machine type communication (mMTC) targets cost-efficient and robust device-to-everything (D2X) connectivity.**
3. **Ultra-reliable, low latency communications (uRLLC) supports new requirements from vertical industries such as autonomous driving, remote surgery, or cloud robotics.**





How Can We Help You Conquer Your Commercial Wireless Strategy?

Making the most of RF technology is at the heart of this telecommunications revolution.

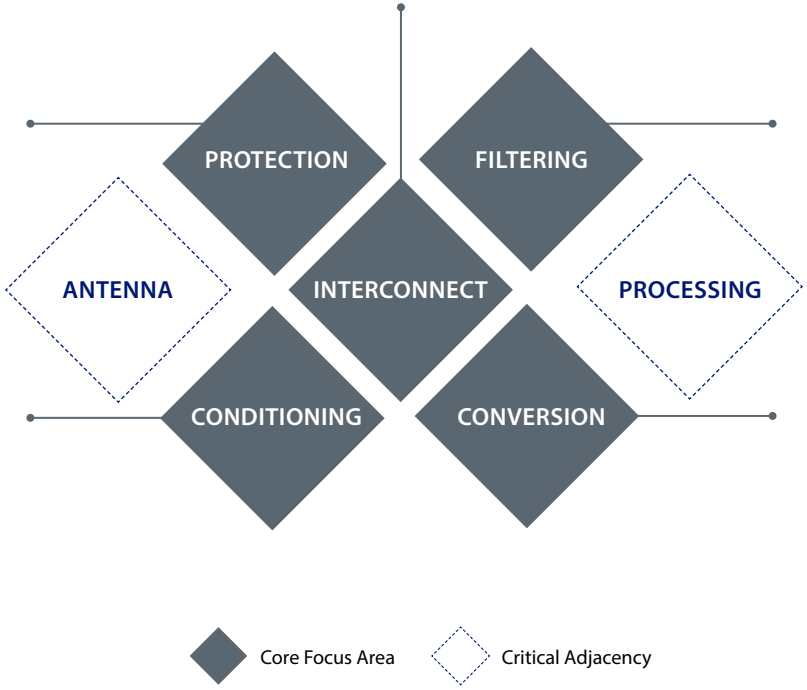
RF hardware and test systems are the keystone in bringing 5G to the masses and realizing new mobile wireless use cases. The competitive and fast pace landscape of mobile wireless is now expanding into new spectrum and technology developers are now facing previously unforeseen design, testing, and deployment challenges.

As shown in the defense block diagram below, APITech provides solutions in five core focus areas. From basic passive and active RF components, to integrated microwave and multifunction assemblies. APITech brings its unique legacy and multi-disciplinary expertise to modern wireless systems – allowing for support at every stage of product development and telecommunications deployment.

High-reliability interfaces and **INTERCONNECTS** for distributed RF systems

PROTECTION against increasingly congested electromagnetic spectrum for military and commercial systems

FILTERING to ensure the optimal mix of products are passed on to stages of an RF system to maximise mission success



Size, weight and **CONDITIONING** optimized for distributed processing of RF signals

Multi-disciplined integration enables complex **CONVERSION** of RF signals

How Can We Help You Conquer Your Commercial Wireless Strategy?

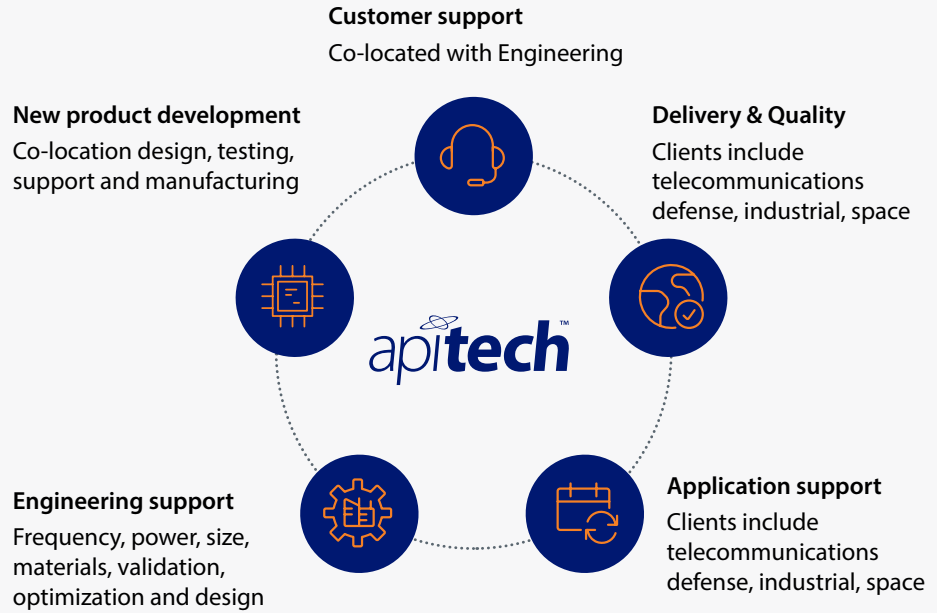
APITech can help 5G and Wi-Fi device manufactures and telecommunications operators overcome these challenges and unleash a new paradigm of connectivity with a unique three stage approach:

- **Design Thinking Workshop**
- **Hackathon Prototype Strategy**
- **Product Fabrication Services For Full Commercial Rollout**

This approach leverages APITech's proprietary design thinking frameworks to discover insights and implications of a client's challenges. This strategy also benefits from APITech's design scenario driven style that takes into account the changing dynamics across industries and delivers new opportunities for key industries. APITech facilitates this process by engaging in dialogue and generating strategic options to bring 5G and Wi-Fi solutions to life.

APITech is here for you at every stage of product development and telecommunications deployment.

Contact APITech to learn more about our offerings for 5G and Wi-Fi technology. From passive components to EMI filtering and RF conductive test solutions, we cover the increasing RF power, frequency, and bandwidth constraints in next generation wireless protocols.



Contact us

Please get in touch if you would like to talk to us about anything related to 5G & Wi-Fi spectrum innovation.

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