

Ingredients For RF Testbed Design

Essentials you should always keep in mind when designing an RF Testbed



Components to build a conductive RF Testbed for 5G and Wi-Fi 6E



RF Testbed Programmables



RF Testbed Interconnects



RF Testbed optional upgrades



Building an RF Testbed



Introduction

Decision-making at the speed of 5G

Dear Reader,

It's a new era for Telcos. Network operators historically have dealt with different vendor technologies within their national network by a geographical split, for example the south vendor A and the north vendor B. Now, with the move towards Open Radio Access Networks (ORANs), operators and integrators need to test all this technology to ensure it works together before it goes into the live commercial network.

At its simplest, ORANs are a more open architecture than previously offered. They have the potential to improve innovation, competition, network flexibility and reduce network cost.

But this doesn't come without challenges for example:

1. Concerns over the wide range of components being used by different vendors. How do you deliver the best possible service when optimizing the configuration?
2. Another major challenge is once the technology has been deployed, when a problem arises who solves it and how do you do this?

Release 1 of APITech's RF Testbed series addresses these challenges and more with our six RF Testbeds that cover certification, throughput, multipath, handover, mesh connectivity, and hybrid for wrap-around conductive RF testing. Covering vendor pairing evaluations to validate the function, performance, robustness and resilience of specific combinations, and compliance testing against relevant standards.

These new RF Testbeds will help research, product development, prototyping, and manufacturing to predict device and network performance when used in the real world, assuring they get their product to market on-time and on budget – and faster than the competition.

Our RF Testbeds are also relevant to the latest additions to the Wi-Fi standard, Wi-Fi 6 and Wi-Fi 6E. Several of the underlying technologies powering these new networks are very similar to, or in some cases even the same as, ones used for 5G networks.

With a conductive RF Testbed system, the energy within even a complex multi-port device can be accurately measured at each port. This enables accurate characterization of the network element or device's behavior.



Our conductive RF Testbed enables testing of individual sub-circuits, components, or even individual devices within a complex radio system. Non-destructive conductive testing can even be done using probes, solderable test connectors or test ports built into the RF board. Given that test signals are intrinsically shielded within the APITech RF Testbed, external shielding during testing is not usually required, and a very small test footprint can be achieved.

The Ingredients for RF Testbed Design publication is a short preview of our Cookbook for RF Testbed Design, where there is more detail as to how to build a Wi-Fi or 5G RF Testbed to meet the needs of new radio technologies considering what and how tests are performed.

For a deep dive into RF testing for 5G or Wi-Fi networks, please reach out to me.

David J Swift

Global Director of Telecom Sales, APITech

Email: Commercialwireless@APITech.com

RF Testbeds for labs

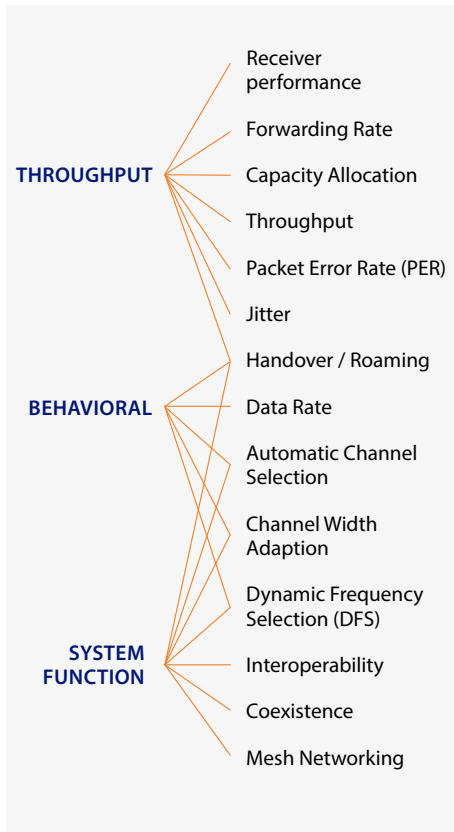
Delivering value to discover problems before launching products

Innovator's RF Testbed DNA serving the present and future testing needs:

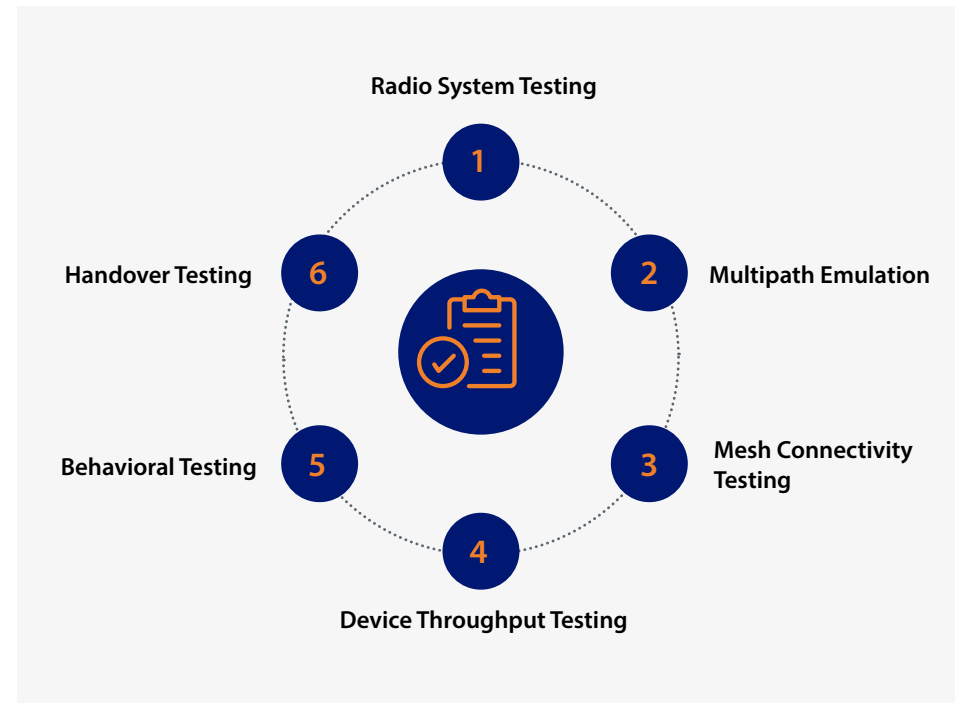
Throughput – tests the manner in which a physical system acts or functions under specified conditions. This is the most common performance test, but there are many other important tests. For example, voice and other real-time transmission such as video conferencing and gaming command stringent tests regarding packet error rate and jitter, access point testing validating forwarding rate and capacity.

Behavioral – tests verify the implementation of mobility and adaptation functions to evaluate overall performance. Focus tests such as data rate MCS adaption, channel selection, adaption and dynamic selection and roaming can help identify problems like poor throughput and packet error rate performance.

System Function – tests validate the behavioral, interoperability and coexistence protocols that must work properly to ensure reliable wireless service operation.



In response to this need APITech has designed a portfolio of six blueprint Testbeds for 5G and Wi-Fi 6 addressing the new complex requirements that need to be tested to ensure the right user experience is delivered.



RF Testbed Roadmap

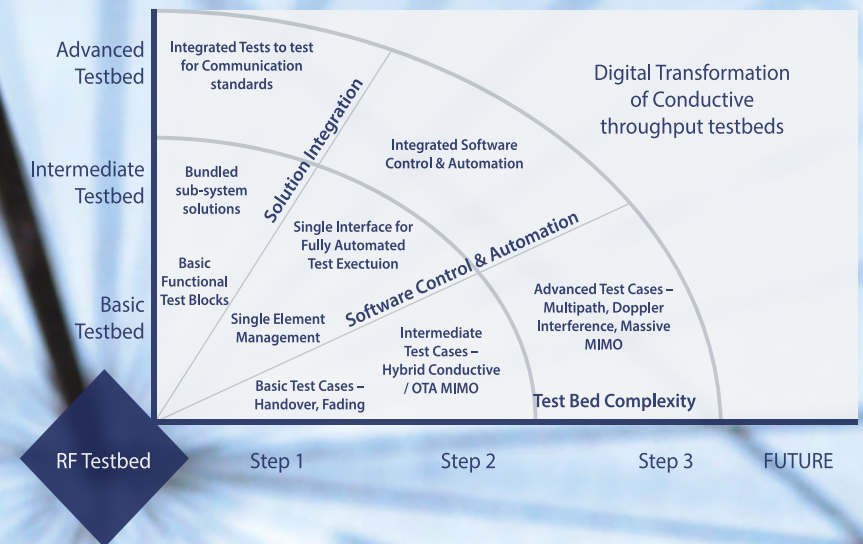
Ensuring wireless connectivity performance is fundamental

In APITech's experience, most RF Testbeds start with solving simple test-cases, such as throughput testing, handover, fading, etc.

These conductive test cases are built using basic functional test blocks such as programmable attenuators, Butler Matrices, coaxial connectors and adapters. As test-cases evolve and become more complex and the number of test devices scale up, the complexity of the test-cases also become higher.

Today's RF Testbeds require smart bundling of sub-system testing functionality necessitating tighter integration between sub-systems. At this stage, manual control of the individual test blocks is no longer feasible. The user requires a single interface to have the ability to control a variety of parameters across the different systems within the Testbed. Advanced software control and automation is desired.

The ultimate goal of the RF Conductive Testbed is the full digital transformation, which includes integrated tests with integrated software control and automation with the ability to simulate advanced test cases such as multipath, Doppler interference, Massive MIMO etc.



Six RF Testbed's for your Lab

An overview of the test enabling platforms

Our RF Testbeds provide a controlled and repeatable RF Test environment, that significantly reduces testing time. The APITech Digital Lab Assistant minimizes time-consuming setup and test execution. APITech RF Testbeds are ideal for device and network element certification, thereby confirming the highest achievable performance. APITech RF Testbeds supports the latest requirements in 5G/LTE and Wi-Fi technologies.







Capabilities	Throughput Testing	Certification Testing	Hybrid Testing
Testbed			
Applications	Designed for characterizing the RF performance of wireless devices.	Designed for the certification of wireless radios in a controlled environment.	Designed to perform simultaneous controlled conductive and over the air testing, where device under test may not have accessible RF antenna port.
Tests Performed	<ul style="list-style-type: none"> Throughput Jitter Packet error rate vs range Device orientation Other aspects of device performance 	<ul style="list-style-type: none"> Throughput Forwarding rate Packet Error and Jitter Rate Data rate adaptation Associated capacity Receiver Performance 	<ul style="list-style-type: none"> Access Point Coexistence Channel Selection Receiver Sensitivity Maximum Throughput
Technology	4G, 5G, Wi-Fi 6E, Bluetooth, Zigbee	4G, 5G, Wi-Fi 6E, Bluetooth, Zigbee	4G, 5G, Wi-Fi 6E, Bluetooth, Zigbee
Website product page			







Capabilities	Multipath Testing	Handover Testing	Mesh Connectivity Testing
Testbed			
Applications	Designed for emulating real-world multipath conditions in a virtual indoor or outdoor environment.	Designed for the testing of roaming or handover scenarios in a wireless environment.	Designed for the testing of a multi node mesh RF network conductively.
Tests Performed	<ul style="list-style-type: none"> Throughput Jitter Packet error rate vs range Device orientation Other aspects of device performance Horizontal and Vertical handovers 	<ul style="list-style-type: none"> Fading Simulation Received signal level and quality Inter system horizontal handover Inter technology vertical handover 	<ul style="list-style-type: none"> Data Plane Performance per Hop Performance in different Mesh configurations Station Load Balancing Fast Roaming with 802.11k/v/r
Technology	4G, 5G and Wi-Fi 6E	4G, 5G and Wi-Fi 6E	4G, 5G, Wi-Fi 6E, Bluetooth, Zigbee
Website product page			

Programmables

Attenuators, Switches, Phase-Shifters, and Butler Matrices, the building blocks for wrap-around conductive RF testing

APITech RF programmable products form the basic building blocks for RF Testbeds. They are extensively used in labs and production test environments to perform RF conductive testing for a variety of use-cases and applications. They are available in a variety of performance levels, configurations and bandwidths and each product comes as “plug-and-play” supported by our Digital Lab Assistant and easy-to-use control scripts.







Capabilities	Attenuators	Switches	Phase Shifters
Programmables			
Applications	For transmission loss simulation, signal fading and handovers.	For routing RF signals between various inputs and outputs without changing the setup.	For changing the transmission phase angle of an input signal by adding propagation delay.
Technology	Programmable attenuators are available in either solid-state or electro-mechanical configurations, providing precise level control with accurate, repeatable performance for a wide range of test applications from 'true' DC to 43 GHz.	Programmable switches are ideal for simulating wireless fading and hand-over use-cases. Operates over 10 MHz to 8000 MHz. Available in electro-mechanical or solid-state, operating from DC to 8/18/26.5/40 GHz frequency range.	Programmable phase shifters, phase accuracy down to 2° phase resolution. Electro-mechanical versions, DC to 6 GHz. Phase shift range from 0° to 630° in 10° steps & 0° to 126° in 2° steps @ 6 GHz. Solid-state versions attenuation range of 0 to 63.75 dB in 0.25 dB steps and phase range of 360° in 5.625° steps.
Website product page			



Capabilities	High-Power Attenuators	Butler Matrices	Digital Lab Assistant
Programmables			
Applications	Enables high power (up to 400W) radio testing & profile simulation.	For multichannel MIMO testing in a controlled conductive environment.	For setup, control and automation of test measurements using APITech programmable products.
Technology	High-power programmable attenuator supports up to 6 channels at 400 watts C.W. The range includes hot switching versions, with power handling up to 100 watts on average. Available in 0-15 dB or 0-31 dB attenuation range configurations, delivering low insertion loss, high accuracy and repeatability. Custom configurations are available.	A Butler Matrix allows the user to control the direction of the antenna beam, or beams. Available in 4 or 8 channel versions covering 5G FR1 and Wi-Fi 6E bands up to 8 GHz. They offer a high degree of isolation between the input ports 16 to 18 dB. With an output phase accuracy as low as ±10°.	Digital Lab Assistant software facilitates test automation allowing the user to: Perform sweep or hop of attenuation and/or phase levels. Set up test profiles with specific attenuation patterns. Simplify multiple device test setups with the creation of test macros enabling step through sequence of commands sequences for complex test schemes.
Website product page			

Connectors and Adapters

Accelerating High-Quality Testing with low PIM connectivity

At first thought, cables, connectors and adapters for FR1 set ups may seem like they are a trivial aspect that can be mixed and matched as needed. In practice, connectors will influence test results in various and sometimes unpredictable ways. Test equipment can compensate for some of these influences but often with detrimental effects. The best setup would have the lowest attenuation to ensure high accuracy results.







Capabilities	Attenuators	Terminations	Adapters
Connectors and Adapters			
Applications	Low PIM up to 50 GHz to reduce signal amplitude without degrading its integrity.	Used to absorb energy and prevent RF signals from reflecting back from open-ended or unused ports.	Passive components used to transfer signals from one connector interface to another.
Website product page			

Capabilities	DC Blocks	Bias Tees	Connectors
Connectors and Adapters			
Applications	Preventing the flow of DC signals, while allowing the higher frequency signals to pass through.	Designed to inject DC current into an RF circuit without affecting the RF signal.	FR1 attenuation up to 6 GHz from entering interconnections. EMI low insertion loss construction options-mixed pin loading, and selectively loaded lines.
Website product page			

Advanced Test Upgrades and Options

Extended Testbed Capabilities

APITech has built its reputation on delivering robust and rugged solutions for aerospace applications. We have applied that same expertise to the commercial sector by designing and building a range of optional testbed upgrades for your Lab RF environment to handle specific use-cases or better lab device management.

Capabilities	RF Isolation Chambers	Multipath Emulator	Mesh Network Emulator
Advanced Test Upgrades and Options			
Applications	RF quiet zone for designing, integrating or testing the next generation wireless systems, ensuring tests are reliable and repeatable.	Simulates 'true' multipath effects in an RF conductive environment.	Allows simultaneous interconnection of up to n devices in mesh connectivity environment.
Technology	Interference-free testing environment for: Cellular – PCS, GSM, 3G, 4G, LTE, 5G, - Wi-Fi 802.11 – all series - WiMax, Bluetooth, RFID, IoT - EMI, RFI test, Part 15.	Designed to create the conditions described by the TGn-B channel model, as detailed in IEEE 802.11-03/940r1. The emulator includes 4 individual channels creating the conditions described in the TGn-A channel model.	Simplifies the creation of complex fully meshed environments, easily controlled and managed with independently variable attenuation on every path. Number of paths, operating frequency and path attenuation up to 127 dB can be customized.
Website product page			

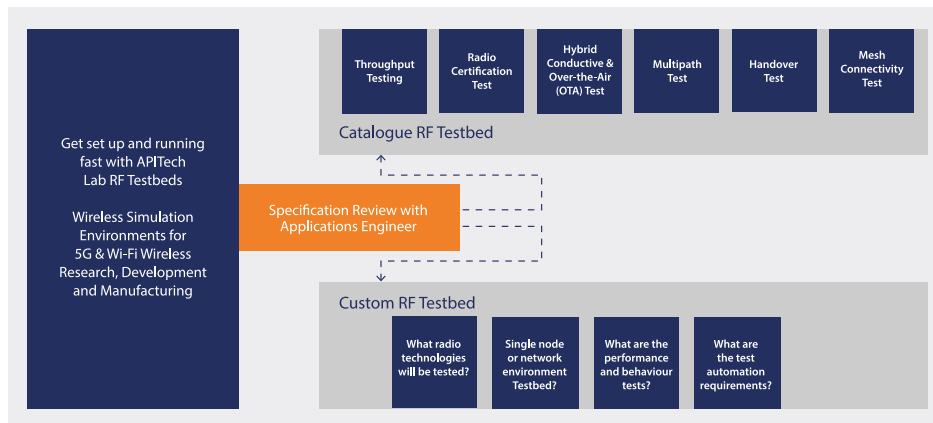
Capabilities	Power Distribution	Power Filters	Cable Management
Advanced Test Upgrades and Options			
Applications	Smart power distribution for both AC and DC with remote control and power monitoring.	Filtering AC or DC power entering a test platform preventing radiated or conducted EMI.	Manage, organize and protect your RF cabling in a complex lab test environment. Ideal for coax, fiber, copper wiring, patch cords, and other various needs.
Technology	Power options AC - Single Ø:100-127, 200-240, DC - -48 VCC or +28 VDC input power. User configurable power up sequence and delay. Monitoring covers:- line voltage, input current, output channel and internal temperature. Configurable alarm levels. Network Interface supported:- SSH, and HTTPS (with SSL/ TLS V1.3) secure protocols, SNMPv3 (optional).	Rating up to 500 Amp. Supports voltages up to 400 VDC and 240 VAC. Standard custom versions available on request. Insertion loss effective filtering from 100 KHz to 30 MHz operating over temperature ranges -25°C to +85°C.	Management of cable runs and connections in complex, lab test environments using a standard 19" rack-mountable panel. Options to include other essential RF components and test accessories can be integrated.
Website product page			

RF Testbed Design Support

How Can We Help You Conquer

Our RF Testbed configurations deliver industry tools to ensure reliable connectivity.

Yes, a new technology might sound great in theory but unless it can cope with the real world it is unlikely to be adopted by a target market. This is where APITech's six RF Testbeds step in. It is now easier than ever for tech entrepreneurs to test their new innovations – identify and solve potential issues and debug in the early stages before presenting to their customers. Custom RF Testbeds can be designed and built to your specification. Contact us with your specialized needs.



The next read

To find out more – download a full digital copy of our RF Cookbook

In the full RF Cookbook edition, we provide greater details about the selected portfolio of APITech components & subsystems, and look in greater detail at how to build a Wi-Fi or 5G RF Testbed to meet the needs of new radio technologies considering what and how tests are performed.

The four chapters of the cookbook are:

- 1 Building an RF Testbed – The complexity of traditional RF testing environments has steadily grown over time. APITech shares RF Testbed configurations to simulate, explore, and test with a low PIM RF Testbed.**
- 2 RF Testbed Lab Programmables – Learn about our programmable product portfolio designed for Lab and production test environment.**
- 3 RF Testbed Lab Connectors and Adapters – products will influence test results in various and sometimes unpredictable ways. Find out about our product portfolio specifically designed with low PIM for RF Testbeds.**
- 4 RF Testbed Lab Optional Upgrades – to handle specific use-cases or better device management.**



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How Can We Help You Conquer Commercial Wireless Strategy?

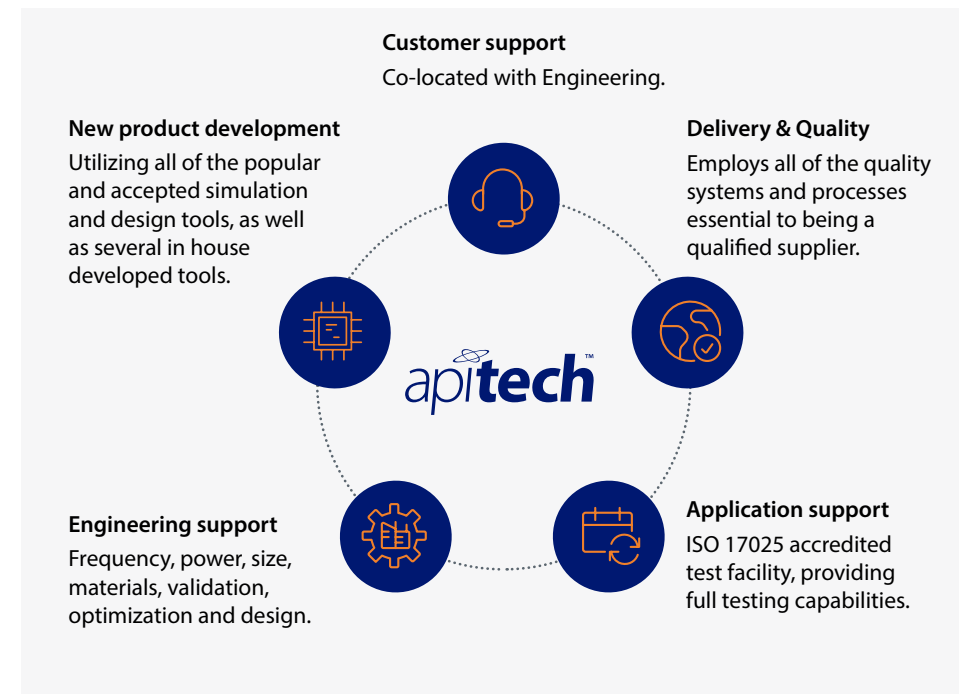
APITech can help 5G and Wi-Fi device manufacturers and telecommunications operators overcome these challenges and unleash a new paradigm of connectivity with a unique three stage approach:

- **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.

David Swift
Global Director of Telecom Sales

Commercialwireless@APITech.com



www.apitech.com

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