While previous generations of Wi-Fi primarily focused on faster throughput, the arrival of Wi-Fi 6 (802.11ax) delivers so much more - allowing us to use Wi-Fi technology in new and different ways.

Wi-Fi 6 introduces aspects from cellular technology (such as Orthogonal Frequency-Division Multiple Access or OFDMA) to improve capacity, latency and efficiency in high challenge environments such as large indoor areas (malls, airports) or dense and congested public outdoor areas (stadiums, business parks).

As a result, these new capabilities have a considerable impact on traditional Wi-Fi testing.

**In order to evaluate device performance in increasingly demanding deployment scenarios, incorporating channel emulation into the test strategy becomes critical.**

This brief provides insight as to what’s different about Wi-Fi 6, including the new IEEE standards and the technology that enables them. It provides information on how Spirent Communications Wi-Fi test solutions enable NEMs, OEMs and service providers to develop and deploy next-generation Wi-Fi 6 access points, devices and networks quickly, efficiently and with confidence.
Performance Testing of Wi-Fi 6 Devices

What’s New and Different with Wi-Fi 6

Wi-Fi 6 (802.11ax) provides benefits that weren’t available with previous generations (802.11ac, 802.11n, etc.):

- Introduces tri-band support: operation in 2.4 & 5 GHz bands plus upcoming 6 GHz
- Increases average throughput per station by at least 4x in dense deployment scenarios
- Expanded environments for indoor and added outdoor applications
- Scenarios such as dense public areas, corporate offices, outdoor hotspots, dense residential apartments, and stadiums
- Improvements to station power efficiency, channel and bandwidth efficiency
- Key enhancements: DL/UL OFDMA, DL/UL MU-MIMO, higher constellations (1024 QAM), longer OFDM symbol, extended bandwidth, BSS color coding (for interference management) and more spatial streams with 8x8 MIMO

These new requirements create complex scenarios that can greatly impact the user experience; as such, they heavily influence test strategy.

The Value of Introducing Channel Emulation to the Wi-Fi 6 Test Bed

The addition of a channel emulator into the WLAN emulation test bed will be an important factor in comprehensive Wi-Fi 6 performance testing.

- A radio channel emulator is a complex simulation instrument used to emulate air interfaces in wireless communications. It mimics the real-world radio channel including all the complex aspects that can interfere with the signal (buildings, motion, speed, reflections, path loss, noise, etc.).
- A channel model is a mathematical model of all these effects. Channel models are a powerful method for bringing the real world into the lab and have been instrumental in advancing the cellular user experience we all enjoy today.

The channel emulator takes an RF signal input, impairs the signal according to a specific channel model (either specified by a standard such as IEEE or customized for unique scenarios) and outputs the impaired signal that represents a real-world scenario. It is modulation and protocol independent, meaning it can handle any waveform including 5G-NR, LTE, proprietary, and Wi-Fi.

Channel emulation can replace or minimize the need for costly field testing by creating countless real-world scenarios in the lab. Testing in a lab environment is less expensive, more reliable, repeatable, can be automated, improves quality, and reduces time to market.

With the channel emulator and associated Wi-Fi 6 specific channel models, a NEM or OEM can now test their Wi-Fi 6 solution in a repeatable fashion under complex real-world conditions to assure optimal performance of the Wi-Fi 6 user experience.
A Complete Wi-Fi 6 Performance Test System

Spirent’s integrated solution for Wi-Fi 6 performance testing is comprised of the following components:

- **Spirent’s Vertex channel emulator** to simulate the high-challenge propagation scenarios as given by IEEE specification P802.11 for TGn channel models. The Vertex High Frequency Converter (HFC) can be added as needed for testing the new 6GHz frequency range.
- **Spirent’s C50 appliance** configured with WLAN 11AX test modules and **Spirent TestCenter** software to generate traffic and act as an end device or access point (depending on the DUT)
- The **device under test**, which can be either a commercial Wi-Fi 6 access point or mobile device, physically connected to the system to ensure receipt of the exact specified channel model propagation conditions

A Look at Sample Test Results... There’s a Difference

When comparing DUTs at the exact same input power and traffic loads, there was a significant difference in the performance of two access points from different manufacturers and chipsets.

As seen here with identical outdoor channel models, Device A struggles to maintain a consistent signal while Device B reaches as much as 66% higher DT for the Urban micro Line of Sight (UMi LOS) model. However, although Device B generally performs better with stronger power levels, Device A can hold onto the connection at lower power levels (or longer distances). These factors must be taken into consideration when evaluating devices for their target application – Device B would likely perform better in smaller, denser spaces while Device A might do better in larger areas.
Performance Testing of Wi-Fi 6 Devices

The Components

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<tr>
<th>Vertex Channel Emulator</th>
<th>C50 + Spirent Test Center</th>
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<tr>
<td><img src="image1.png" alt="Vertex Channel Emulator" /></td>
<td><img src="image2.png" alt="C50 + Spirent Test Center" /></td>
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- Field configurable for a broad range of applications
- Pay-as-you grow from 2 to 32 RF channels
- Field-replaceable modules for upgrades and serviceability
- Specialized RF modules for bidirectional applications and frequencies
- Up to 32 RF ports and 256 digital links in one 6U height
- Up to 200MHz bandwidth, 30MHz–6GHz frequency range + mmWave with Vertex HFC
- Real-time fading accelerates R&D applications
- Extensive channel model and connection setup libraries

- One platform for multi-client any/or multi-AP emulation
- Supports 8x8 MIMO on 5GHz, 4x4 MIMO on 2.4GHz
- Supports two 4x4 MIMO on 5GHz, one 4x4 MIMO on 2.4GHz (per NIC)
- New 802.11ax features support:
  - 1024QAM
  - 20MHz, 40MHz, 80MHz, 160MHz
  - OFDMA
  - MU-MIMO
- WPA3 authentication
- Test up to 4Gbps Wi-Fi throughput with 802.11ax 8x8 MIMO
- Concurrently test 802.11ax on 2.4GHz and 5GHz band

The key to assuring performance is as expected is to incorporate all of the IEEE recommended indoor and outdoor channel models into Wi-Fi 6 device test plans. If you’re not testing with all the new propagation models, you’re not testing the new technologies and the promises they are making.

For more information on the Vertex Channel Emulator, reference [this webpage](#).
For more information on the C50 and Spirent TestCenter for Wi-Fi 6, reference [this datasheet](#).

Contact Us
For more information, call your Spirent sales representative or visit us on the web at www.spirent.com/ContactSpirent.

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