Applications

- Conductive or OTA testing
- Multi 802.11ax client testing scenarios
- OFDMA and MU-MIMO testing
- Single trip latency measure
- Functional, performance, and scalability testing
- Stability testing
- Security and authentication type testing
- AP interwork with legacy IEEE 802.11 mode
- Association processing and DHCP timing testing
- RFC2544 benchmark performance testing
- UDP stateless and TCP stateful traffic testing
- Application layer traffic testing
- 802.11ax feature testing
- Roaming, airtime fairness, band steering testing
- Test results and reports with Spirent TestCenter IQ

Spirent TestCenter WLAN C50 High Radio Count (HRC) Appliance is a compact 3U appliance with a server-grade high performance process engine and rich interfaces. It combines Spirent’s IEEE 802.11ax HRC interface cards (NICs) with Spirent’s 4-port IEEE 802.3bz BASE-T 100Mbps/1Gbps/2.5Gbps/5Gbps/10Gbps Ethernet cards on a copper interface. There are twenty (20) 802.11ax client radios integrated with the appliance. This test instrument has the industry’s highest integration in terms of radio counts within a single small appliance to realistically emulate multiple 802.11ax clients. This enables a new era of testing solutions for 802.11ax features and performance with Spirent’s protocols, testing methodologies, automation capability, intelligent data mining, and testing results and report generation.

Orthogonal Frequency-Division Multiplexing Access (OFDMA) introduced in 802.11ax is a large step beyond OFDM, which is used by previous generation 802.11 standards. Testing tools and testing methodologies must be developed to offer the industry comprehensive testing strategies to cover the increased test cases due to new features in 802.11ax, without a significant increase in investment and test time. This development strategy must include a wide range of testing scenarios for the new 802.11ax features, such as OFDMA and Multi-User (MU) Multi-Input and Multi-Output (MIMO) in scale and performance. This requires emulating multiple 802.11ax clients, each with independent transmitters (TX) and receivers (RX) for testing. Each radio interface in the C50 appliance is operated independently with a dedicated process engine for control and data plane operation. Utilizing both the Ethernet and multiple WLAN cards installed in the appliance, users can emulate many realistic 802.11ax clients with traffic generation and analysis for both functional and performance testing.
Spirent TestCenter WLAN
802.11ax C50 High Radio Count (HRC) Appliance

The C50 HRC Appliance enables users to emulate up to 20 fully featured 802.11ax clients to connect with an AP, either via cabled conductive connections or antennas installed Over-The-Air (OTA) link. Each radio stream path is characterized with the minimum internal RF signal path loss. This provides assurance for the typical 802.11ax use cases with a need to support the maximum achievable performance in radio interface level while used in OTA mode.

The appliance has an internal hardware-based clock crossing all radio and Ethernet interfaces with a high precision timing synchronization aimed at emulating realistic clients operating individually and for accurate latency measurements. This proprietary timing interface also allows inter-connection of multiple Spirent appliances and chassis to share a common Spirent signature timing clock. Consequently, two or more C50 Appliances can be easily inter-connected with an RJ45 cable to achieve an even higher OFDMA or MU client counts for higher scale test cases. Basic WLAN control plane and data plane features, along with the Spirent’s signature L2-7 and rich set of protocols for timing, traffic, and throughput performance test cases, are supported over the WLAN network involving those Wi-Fi 6 clients and APs under test. These features meet the highly intensive testing requirements of new 802.11ax features such as OFDMA and MU-MIMO.

C50 HRC Physical Port Placement and Assignment
Example: 20 Radio Ports and 4 10Gbps Ethernet Ports

The C50 HRC Appliance can be set up with either RF cabled conductive or OTA mode. An example testbed setup is shown in the following diagram with several external RF combiners and a multiple channel programmable RF attenuator to connect a C50 to an RF chamber/enclosure. The required TX power level can be properly adjusted by using the programmable attenuator. This testbed can support multiple test cases such as OFDMA, MU-MIMO, maximum throughput, rate vs range, etc.
Each radio interface can be used to validate L2 to L7 traffic performance when it is associated with an AP. The example shown is for the maximum achievable L2 UDP throughput in an OTA mode, where a 2x2 radio interface can obtain over 1Gbps throughput with 1518-byte packets. The throughput history is presented in the graph generated in real time with the Spirent TestCenter IQ tool.

802.11ax Configuration and Statistics

UDP Throughput Performance
Example showing 2x2 MIMO, 1518-byte, Time Series from Spirent TestCenter IQ
IEEE 802.11 standard is a packet-based protocol. Each physical layer conformance procedure (PLCP) protocol data unit (PPDU) contains preamble and data fields. With OFDMA support, multiple users can simultaneously share a full channel bandwidth for channeling data sessions more effectively. The combination of the frequency section and the transmission time is a bandwidth segment called a Resource Unit (RU). These test cases need a testbed with many independent client radio interfaces to emulate realistic use cases with different types of RU assignments, managed by an AP for OFDMA operations defined in IEEE 802.11ax standard, to achieve repeatable testing results.

All 20 emulated clients within the C50 can be used for OFDMA testing with limited real-time statistics and counters reported. In this test configuration, Single User (SU) vs Multi-User (MU) is usually focused in a statistical level. Users can see real-time statistics such as PPDU type, MU counter, and SU counter. Users can then understand the MU activities from those statistics and counters. A shadow mode is also available to set a dedicated sniffer radio behind each AID for real-time statistics and counters capturing, decoding, and reporting. This includes PPDU type, RU index, RU counters, MU counter, SU counter, and RU placement on per Association Identification (AID) basis.

For APs that use HE multicast triggering-based frames for OFDMA operation, it also provides a single sniffer mode with only one dedicated radio to obtain the statistics and counters mentioned above with the shadow mode. One radio sniffer is a unique solution to decode and report useful RU information for OFDMA testing much more economically. The results table shows an example where 19 clients are used for Downlink (DL) OFDMA testing and the results are reported accordingly.
Features & Benefits

• Support 802.11 b/g/n/ax on 2.4GHz and 802.11 a/n/ac/ax on 5GHz frequency bands
• Support dual-band 2.4GHz and 5GHz concurrently
• Support single 2.4GHz or 5GHz band
• Support 1x1 SISO and 2x2 MIMO
• Support 20MHz and 40MHz channel bandwidths for clients on 2.4GHz band
• Support 20MHz, 40MHz, 80MHz, and 160MHz channel bandwidths for clients on 5GHz band
• Switchable between SU-MIMO and MU-MIMO configurations
• Support various 802.11ac/ax client configurations for MU-MIMO grouping testing
• OFDMA RU testing with up to 20 RUs per PPDU
• Support various RU types including RU26, RU52, RU106, RU242, RU484, and RU996
• Support per AID based unicast sniffer for HE packet capture
• Support synchronized multiple AIDs based sniffer captures
• Support up to 1Gb sniffer capture buffer on per radio basis
• Report real-time PPDU type, RU type, RU counter, and RU allocations for OFDMA testing
• Support 802.11ax PHY features such as long training field; HE duration-based RTS; dual-carrier modulation
• Support various channel selection plan for different geographic regions globally
• Maximally interoperable with various chipset vendor’s WLAN AP products
• Best in class realistic traffic generation and analysis over WLAN and Ethernet interfaces
• Capable of providing multiple traffic flows per client with each flow offering traffic at layers 2 through 7
• Capable of generating realistic and stateful WLAN client traffic individually on per client basis
• Support individually controlled client behavior providing accurate control of 802.11, 802.3, and IP characteristics, including medium access control, authentication and encryption, frame size, and rate
• Emulate client association mode in either a designated sequential or more realistic random fashion
• Support various RFC2544 test cases for throughput benchmark performance testing
• Each emulated client supports the full MAC per 802.11 standard independently
• Upper layer protocols (e.g., DHCP and TCP) are fully supported using independent protocol tasks
• Test AP data plane performance using flow packets of different sizes, protocol types, encryptions, and rates
• Support different 802.3 Ethernet packet length control functionalities including fixed, increment, decrement by user-defined step or automatic, list, random and shuffle
• Support user configurable iMIX traffic testing profile
• Filter options with specific types of packets (e.g. SSIDs, BSSIDs, etc.) for reducing capture file size or for a longer capture
• Extensive 802.11 statistics, counters, and statistics reporting in either real-time or periodically on per client or per port basis
• Support 802.3 and 802.11 real-time port statistics, per flow statistics, and port-level histogram
• Support per spatial stream statistics and counters
• Time series or history result report with Spirent TestCenter IQ
## WLAN NIC Technical Specifications

### 802.11 Protocols
- IEEE 802.11 b/g/n/ax on 2.4GHz band
- IEEE 802.11 a/n/ac/ax on 5GHz band

### Number of Radio per NIC
4

### Maximum Number of Clients
4 per NIC, 20 per C50

### MIMO
Support MIMO configurations 1x1 and 2x2

### MU-MIMO
Support DL MU-MIMO clients with 1x1 or 2x2

### Frequency Band
- 2.4GHz (802.11 b/g/n/ac) and 5GHz (802.11 a/n/ac/ax), single band or dual-band

### Selectable Channel Bandwidth
- 20MHz or 40MHz on 2.4GHz band, 20MHz, 40MHz, 80MHz, and 160MHz on 5GHz band

### Guard Interval
Guard interval selection—800/400 ns for 802.11 n/ac, 800/1600/3200 ns for 802.11ax

### DL OFDMA
Support DL OFDMA up to 20 RU per C50

### UL OFDMA
Support UL OFDMA up to 20 RU per C50

### Rate Adaptation
Supports Spatial Multiplexing, Cyclic-Delay Diversity (CDD), Low-Density Parity Check (LDPC), Space Time Block Code (STBC)

### Coding Rates
- FEC coding rates - 1/1, 2/3, 3/4, 5/6
- Maximum Ratio combining (MRC)

### MCS Type
- Full MCS index support in 802.11 n/ac/ax
- all 0-15 MCS index for 802.11n
- all 0-9 MCS index for 802.11ac
- all 0-11 MCS index for 802.11ax

### Code Rate
- 1/1, 2/3, 3/4, 5/6

### Maximum PHY Rates in 802.11ax with short GI= 800ns

<table>
<thead>
<tr>
<th>MCS</th>
<th>Modulation</th>
<th>Phy Rate (Mbps)</th>
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<tbody>
<tr>
<td>0</td>
<td>BPSK 1/2</td>
<td>8.6</td>
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<tr>
<td>1</td>
<td>QPSK 1/2</td>
<td>17.2</td>
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<tr>
<td>2</td>
<td>QPSK 3/4</td>
<td>25.8</td>
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<tr>
<td>3</td>
<td>16QAM 1/2</td>
<td>34.4</td>
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<tr>
<td>4</td>
<td>16QAM 3/4</td>
<td>51.6</td>
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<tr>
<td>5</td>
<td>64QAM 1/2</td>
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<td>64QAM 3/4</td>
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<td>7</td>
<td>64QAM 5/6</td>
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<td>8</td>
<td>256QAM 3/4</td>
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<td>11</td>
<td>1024QAM 5/6</td>
<td>143.4</td>
</tr>
</tbody>
</table>

### Channel and Frequency
- 2.412 to 2.484 GHz: 1 to 14
- 5.180 to 5.320 GHz: 36, 40, 44, 48, 52, 56, 60, 64
- 5.740 to 5.825 GHz: 149, 153, 157, 161, 165

### Interface Connector
Antenna interface connectors: SMA female connector, standard thread, AC coupled, 50 Ohms

### Encryption Support
WEP-40 and WEP-104, TKIP (WPA), AES-CCMP (WPA2/WPA3)

### Physical Specifications
- 3.5" (H) x 13.9" (W) x 11.2" (D); Weight: 13 pounds (without external power adapter)

### Power Supply Safety
Input voltage range: 100V-240V 50-60Hz 750W
- FCC Part 15 Class A
- UL 60950-1-2007 R10.14

### Description
C50 4-Port 10G/5G/2.5G/1G/100M Copper, 802.11AX Wi-Fi NICs for 20 OFDMA/MU Clients, 2x2 MIMO, 2.4GHz/5GHz, and HW Timing

### Part Number
C50-KIT-11AX-6

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

[www.spirent.com](http://www.spirent.com)