DATASHEET

Octobox Pal-7

Spirent's Wi-Fi 7 testbeds incorporate RF chambers and instruments controlled by an integrated server with a browser-based UI and a complete API for test automation. The Octobox Pals function as Wi-Fi 7 traffic endpoints or Octobox Synchrosniffer probes probes for performance testing and expert analysis of Wi-Fi devices and systems. This document describes the Octobox Pal-7 subsystems shown below and the Octobox personal testbeds that incorporate them.

Octobox Pal-7

Wi-Fi 7 and legacy Wi-Fi
Qualcomm Waikiki chipset QCN9274

Octobox Smartbox-7

Octobox chamber with
built-in instruments add, built-in Pal-7 4 sniffer probe with virtual stations (vSTAs) supported

Octobox Mini Server

The Octobox Mini Server is a useful add-on device for Wi-Fi 7 testbeds. The Mini Server is a high performance industrial form factor computer pre-integrated with Octobox.

Suggested Usage

- As a traffic generator end point (WAN or LAN) to enable high throughput measurement scenarios (3 Gbps+)
- With a bridged device to improve Pal performance

Performance

- Built-in Multiperf tested up to 9.5 Gbps throughput
- Separated traffic and management ports to enable simultaneous measurement and data visualization

Features

- 802.11be up to 4x4 MIMO OTA transmission
- 2.4, 5, and 6 GHz 802.11a/b/g/n/ac/ax/be radios
- Pal-7 supports 6 GHz Wi-Fi 7
- Octobox Wireshark Synchrosniffer with sniffer probes on Pal-7
- Complete isolation from outside interference
- REST API for test automation
- Quickly and easily verify new and legacy Wi-Fi devices in the ideal MIMO-OTA environment that supports MU-MIMO
- Use multipoint-to-multipoint traffic while automatically recovering from dropped links during long test sequences
- Use a Smartbox to combine off-the-shelf devices with the built-in Pals
- Perform root cause analysis of issues using built-in multi-probe Synchrosniffing

Benefits

- Verify 6 GHz using the Pal-7
- Quickly and easily verify new and legacy Wi-Fi devices in the ideal MIMO-OTA environment that supports MU-MIMO
- Use multipoint-to-multipoint traffic while automatically recovering from dropped links during long test sequences
- Test OFDMA and MU-MIMO simultaneously using a compact Octobox personal testbed
- Use a Smartbox to combine off-the-shelf devices with the built-in Pals
- Perform root cause analysis of issues using built-in multi-probe Octobox Synchrosniffing
- Pal-7 can function as traffic endpoints or Synchrosniffer probes. Pal-7 also implements TBD vSTAs, Pal-7 as a stand-alone or built into an Octobox chamber, making that chamber a Smartbox. The Pal-7 open form factors can be used with an antenna system for testing in open air or in a walk-in test chamber
- Pal-7 supports all the Wi-Fi protocols: IEEE 802.11a/b/g/n/ac/ax/be. Pal-7 also supports the new Wi-Fi 7 6 GHz frequency band and AP (access point) modes

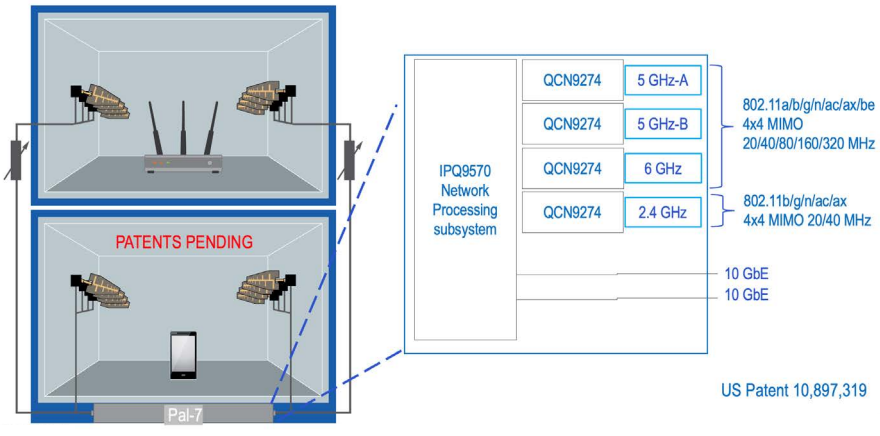
Parallel Throughput and Synchrosniffing

Based on the latest 6 GHz capable 802.11be chipset and with fine controls at the firmware and driver level, Pal-7 can function as an station or as an AP. For example a set data rate, bandwidth and number of spatial streams (Nss). To test receiver sensitivity, Pal-7 can operate at a fixed modulation coding scheme (MCS).

Pal-7 features four 802.11be radios. The 6 GHz radios support up to 4x4 MIMO in channels of up to 320 MHz. The 5 GHz radio supports 4x4 up to 160 MHz and the 2.4 GHz radio 4x4 up to 40MHz.

Pal-7 features three 10GbE ports, two for traffic and one other for streaming plot statistics and PCAP captures.

Pal-7 open module



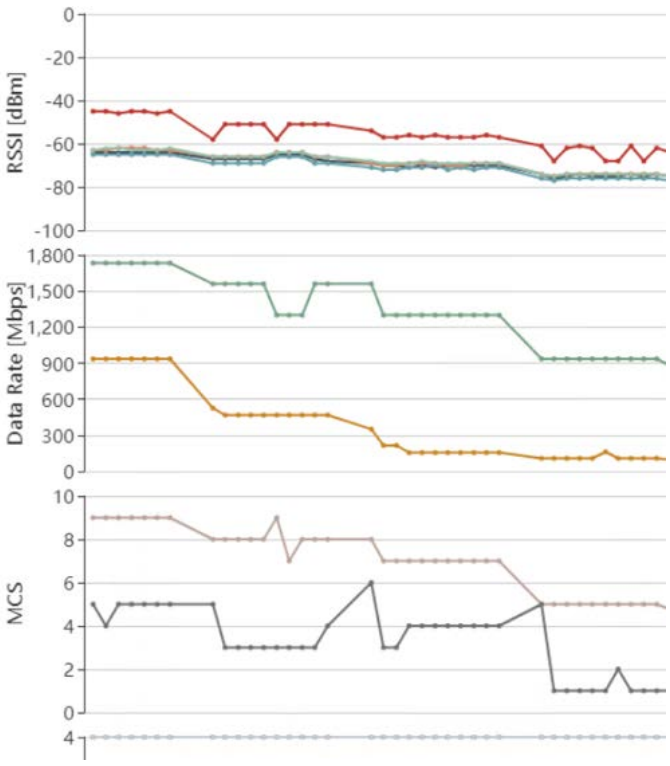
Pal-7 built into the Smartbox; block diagram

Pal-7 open with the antenna subsystem

Pal-7 can function as a real-time analyzer to show adaptation behavior of modern Wi-Fi systems. It can monitor and plot RSSI, data rate, number of spatial streams, channel width and other physical layer information.

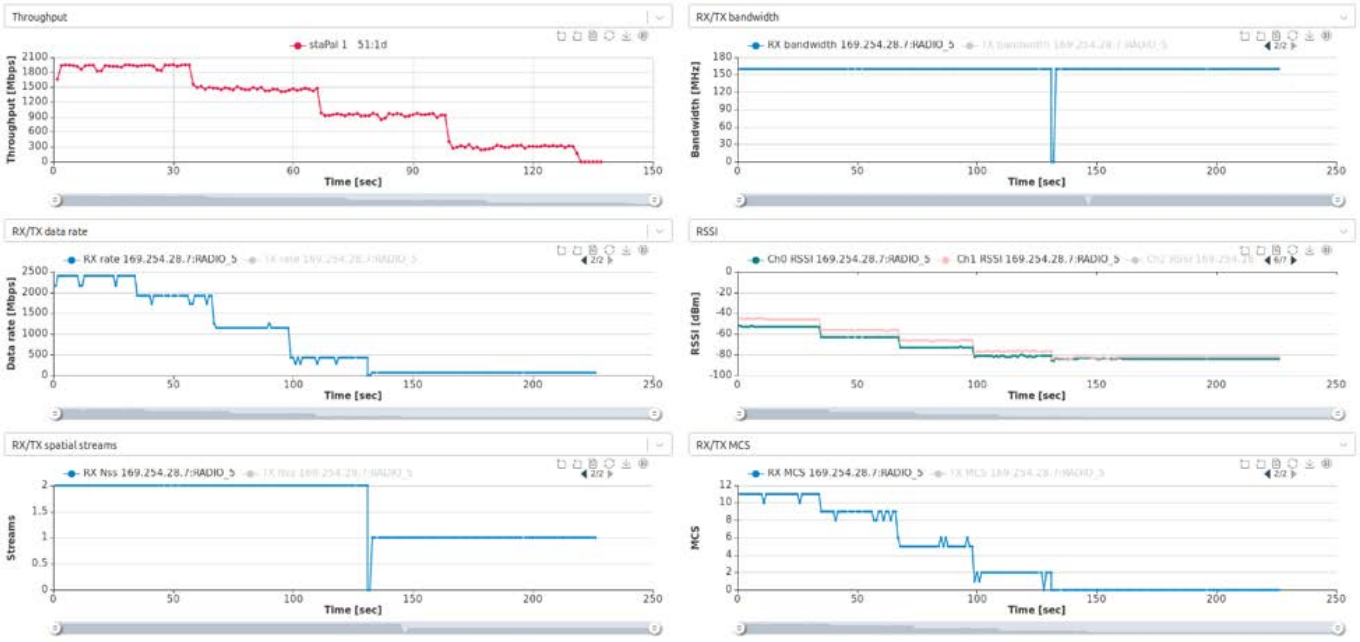
Access Point Testing

To test access point (AP) performance or to emulate a realistic network with multi-station traffic, Pal-7 can emulate up to TBD vSTAs.



Station Testing

The Pal-7 radios can be configured as APs so they can be traffic partners to the station under test. The radios can also be used as sniffers. Station tests include throughput vs. range vs. orientation, RX sensitivity, data rate adaptation performance, roaming, and more.



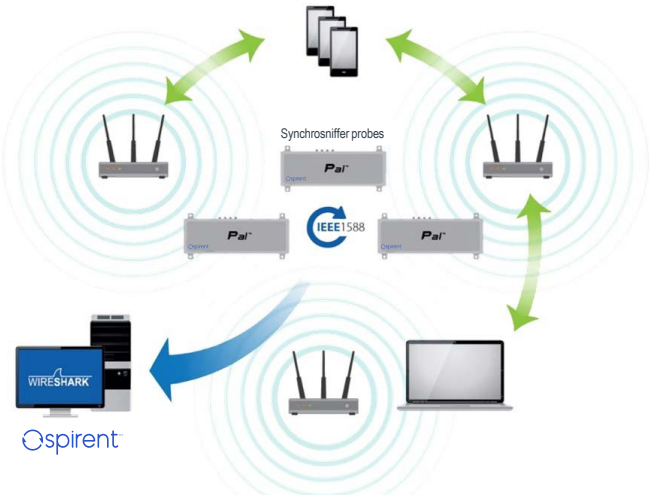
Octobox Software shows throughput, statistics and performance analysis plots

Octobox Synchrosniffer

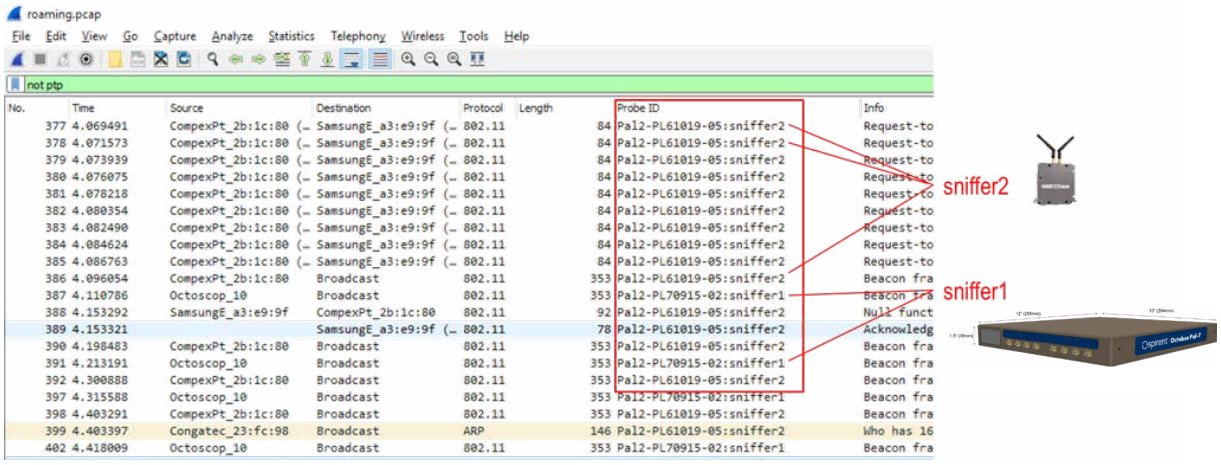
Pal-7 can capture and stream packets in PCAP format to Wireshark in real-time. All the Pal radios are synchronized via the Precision Time Protocol (PTP).

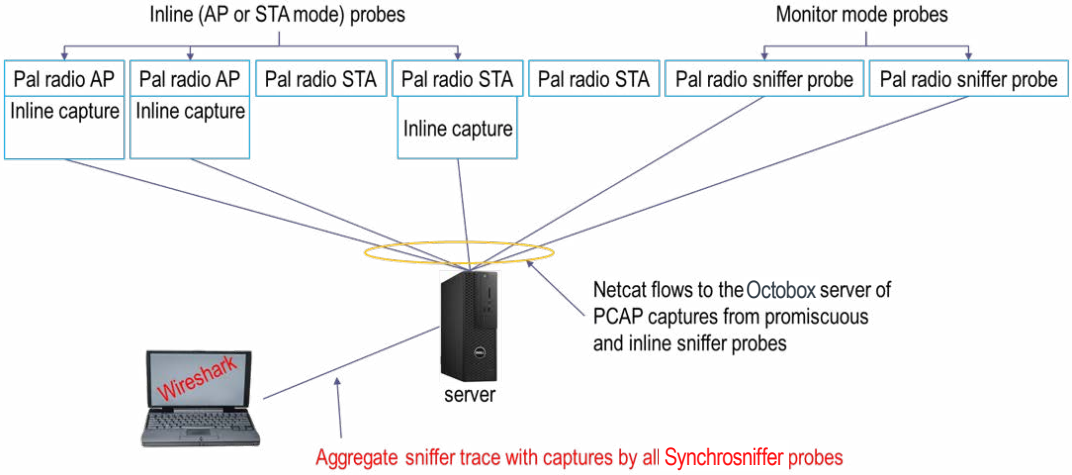
The captures from each radio in the Octobox testbed are combined by the Synchrosniffer engine running on the server into a common PCAP stream viewable in the Octobox-customized Wireshark for easy analysis. In this custom Wireshark application, you can identify captures by probe (i.e. Pal radio).

This aggregate multiprobe view helps analyze complex band steering, roaming and mesh behavior in the presence of motion, interference, path loss, multipath and device under test (DUT) orientation. Synchrosniffer is required for OFDMA to simultaneously capture traffic on multiple AIDs (association IDs) that are assigned to different RUs (resource units).

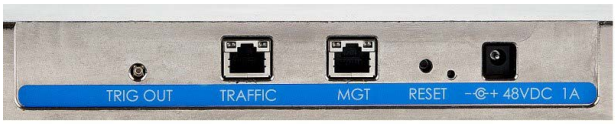


In addition to conventional monitor mode sniffing, Pal-7 radios can also work as in-line sniffer probes when configured as an AP or a STA. These Pal-7 radios can be Synchrosniffer probes in two modes: monitor (capturing all packets) or inline AP/STA (capturing packets addressed to the AP/STA).





Octobox Multiperf Managed Traffic Endpoints



Spirent's Multiperf traffic tool:

- Supports multipoint-to-multipoint traffic
- Automatically recovers from disconnections that are common when testing the dynamic range to a point of disassociation due to low signal level; restarts traffic after reconnection
- Supports iperf2, iperf3, and ping
- Synchronized endpoints for one-way delay measurements and for correlating sniffer captures to the performance metrics plots
- Supports bridging traffic for video, audio and other application-layer metrics

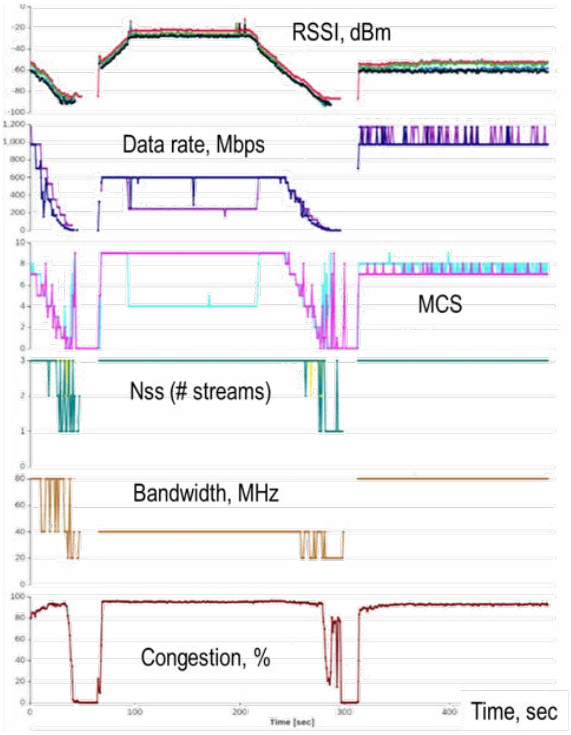
Each Multiperf traffic endpoint is controlled and monitored via an out-of-band management link. Both traffic and management Ethernet networks in the Octobox testbeds are 10 Gbps and have enough capacity to support multipoint traffic, sniffer captures and status reporting.

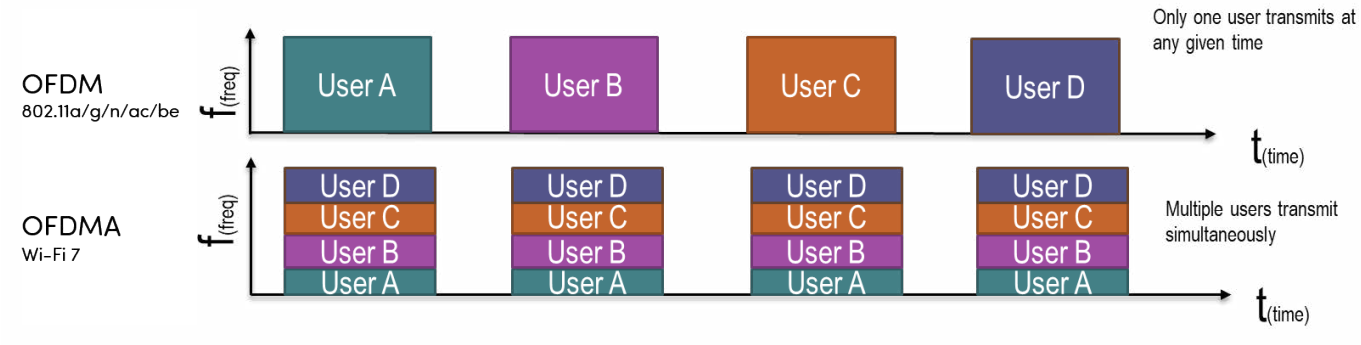
Multiperf is compatible with Windows, Linux, Android, iOS, and macOS devices, and all Pal test instruments can be configured as Multiperf endpoints.

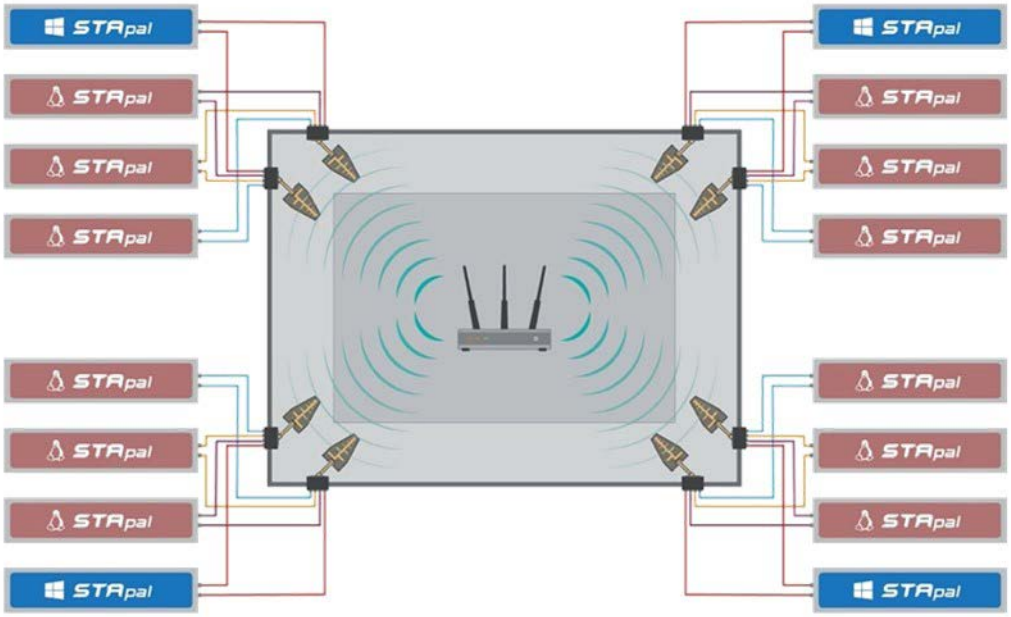
Octobox KPIs and Deep Performance Metrics Plots

The Octobox system produces most of its Layer 1 and Layer 2 statistics from the underlying Wi-Fi chipset operating in the test instrument. There are up to 56 individual KPIs available for tracking and plotting. Examples are: RSSI, data rate, MCS, Nss (# of streams), and bandwidth. As long as a test scenario involves at least one test instrument, statistics for both directions of the RF link (uplink and downlink) can be obtained, even if the Spirent test instrument was only one endpoint in the link.

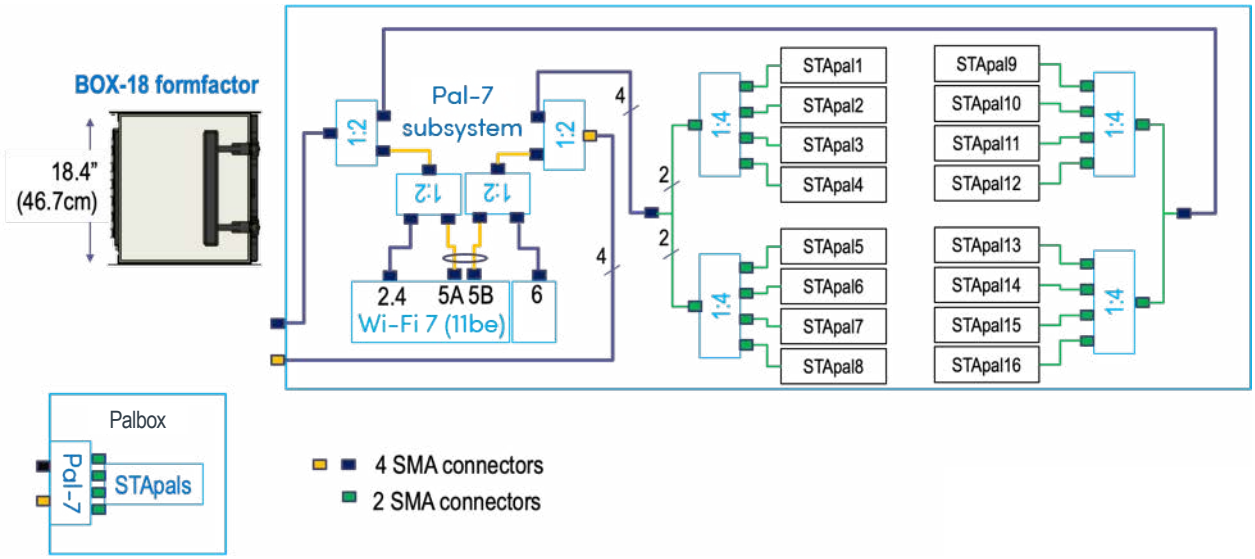
In scenarios where Spirent Octobox Wi-Fi test instruments aren't part of an RF link, such as a Wi-Fi capable cell phone connected to an off-the-shelf Access Point, OCTOBOX Software provides deep performance metrics for Layers 1 and 2. However, with the new Deep Performance Metrics feature, this changes. By configuring an Octobox as a sniffer to monitor the RF link's channel in the chamber where the RF link takes place, a subset of these KPIs can be generated.







The Palbox also incorporates a Pal-7 subsystem that connects to the same 8 antennas as the STApal-6Es. The figure below shows a detailed block diagram of the Palbox and its symbol as used in the Octobox testbed diagrams.



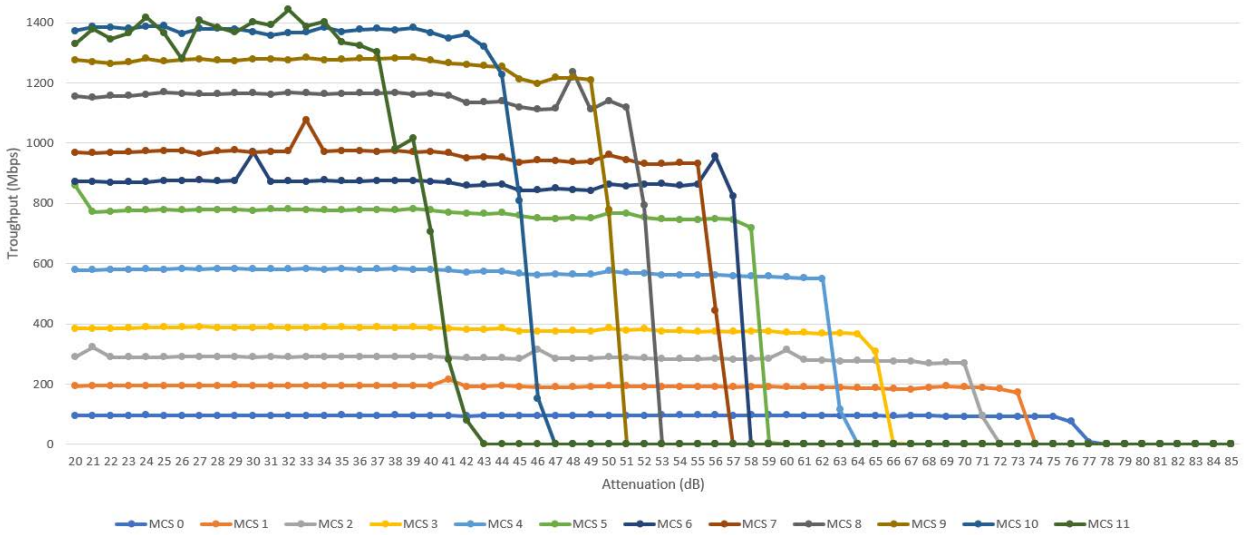
If you are testing with a reasonable number of OFDMA STAs and need dedicated Synchrosniffer probes, you can use multiple Palboxes in a testbed. The photo to the right shows a testbed with 2 Palboxes with their doors open.

The Palbox incorporates a Pal-7 subsystem that can be used to emulate up to TBD vSTAs for testing an access point under a heavy load.

With a Palbox, you can generate OFDMA and MU-MIMO traffic simultaneously, plus traffic load from up to TBD virtual stations – a lot of parallel traffic and analysis power in a small space.

Using Pal-7 to Test Rate Adaptation

When debugging early stage devices with rate adaptation issues, it is necessary to force DUT operation at some fixed parameters including fixed MCS, fixed Nss, etc. Here's an example of a test with a Pal-7 using fixed MCS one by one and observing throughput operation for each MCS setting vs. attenuation. The ideal rate adaptation would result in a throughput plot at the top perimeter of this waterfall curve.



Octobox Personal Testbeds

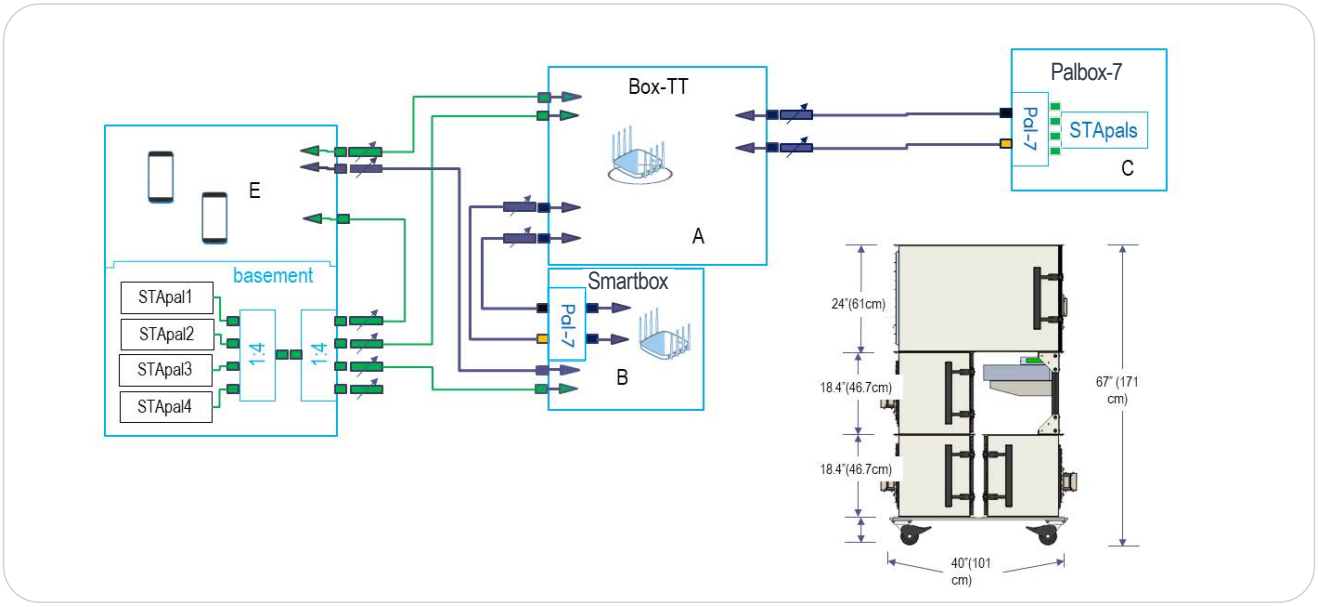
Octobox testbeds are available in three recommended configurations: Stack-Min, Stack-Mid, and Stack-Max.

A block diagram of the simplest Pal-7 based testbed, STACK-MIN, is shown below.

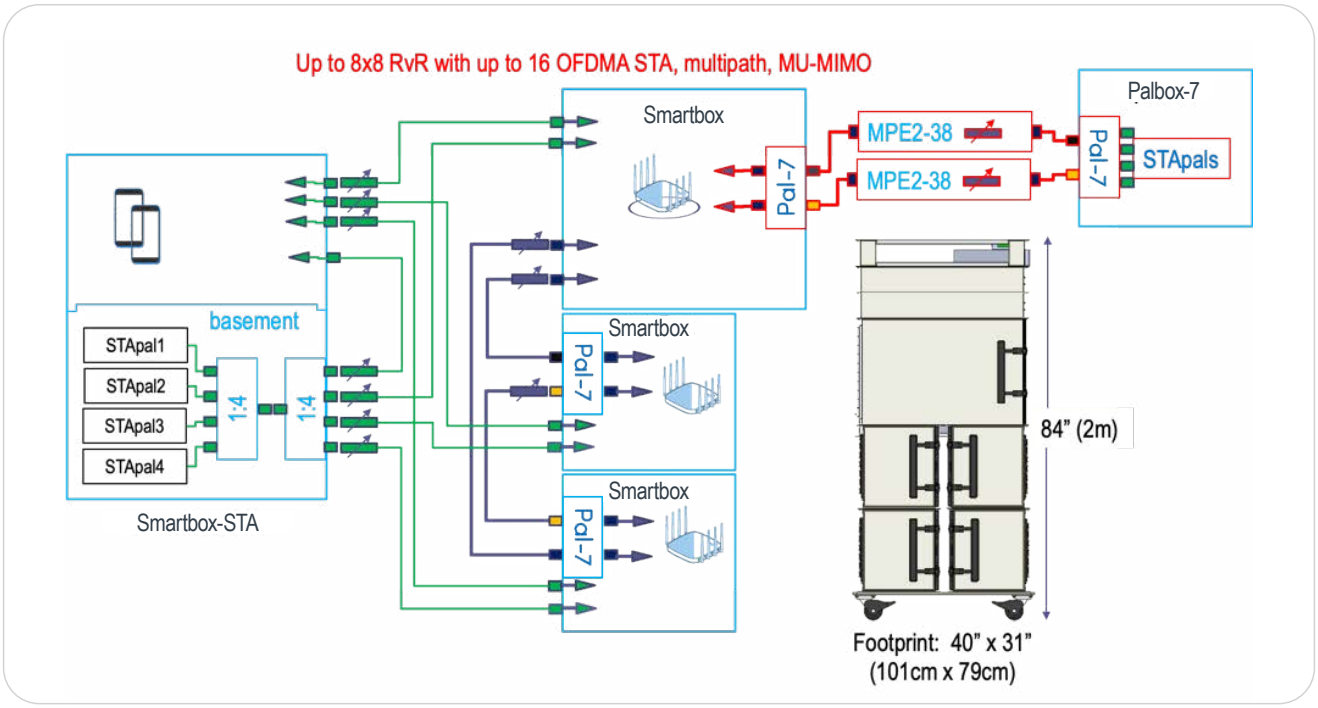
The Octobox Stack-Min testbed is capable of the following tests:

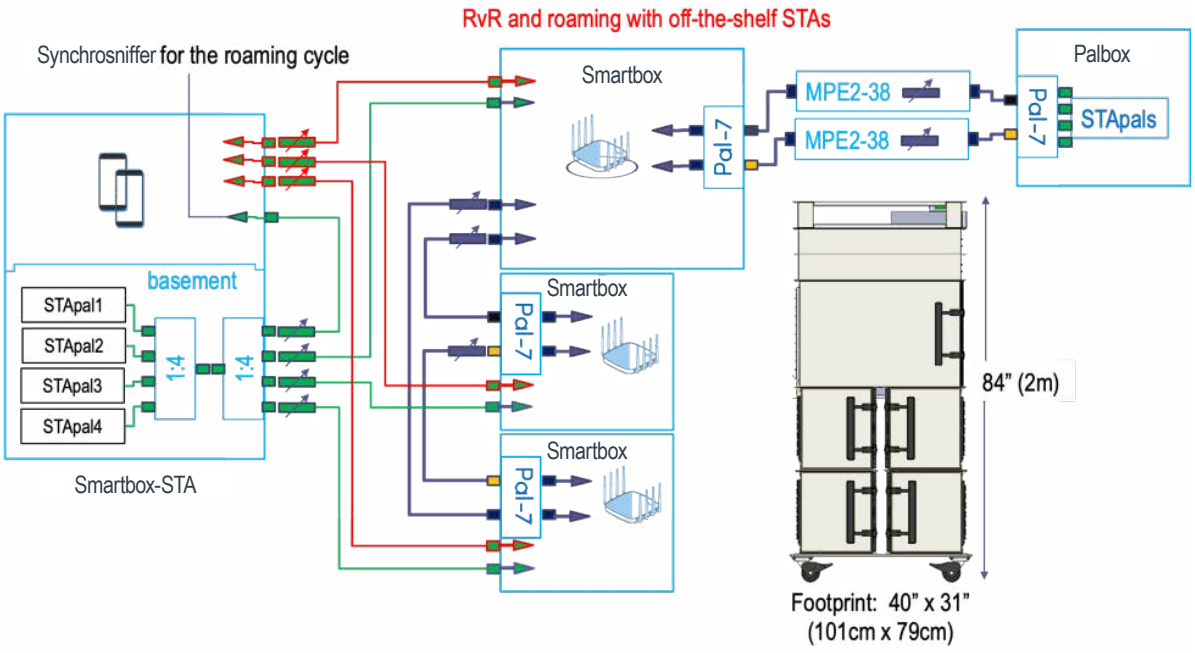
- RvR, RvR with rotation, RvRvO or RvOvR if a turntable is included
- Band steering
- Packet capture
- OFDMA testing with 16 STApal-6Es using a Palbox

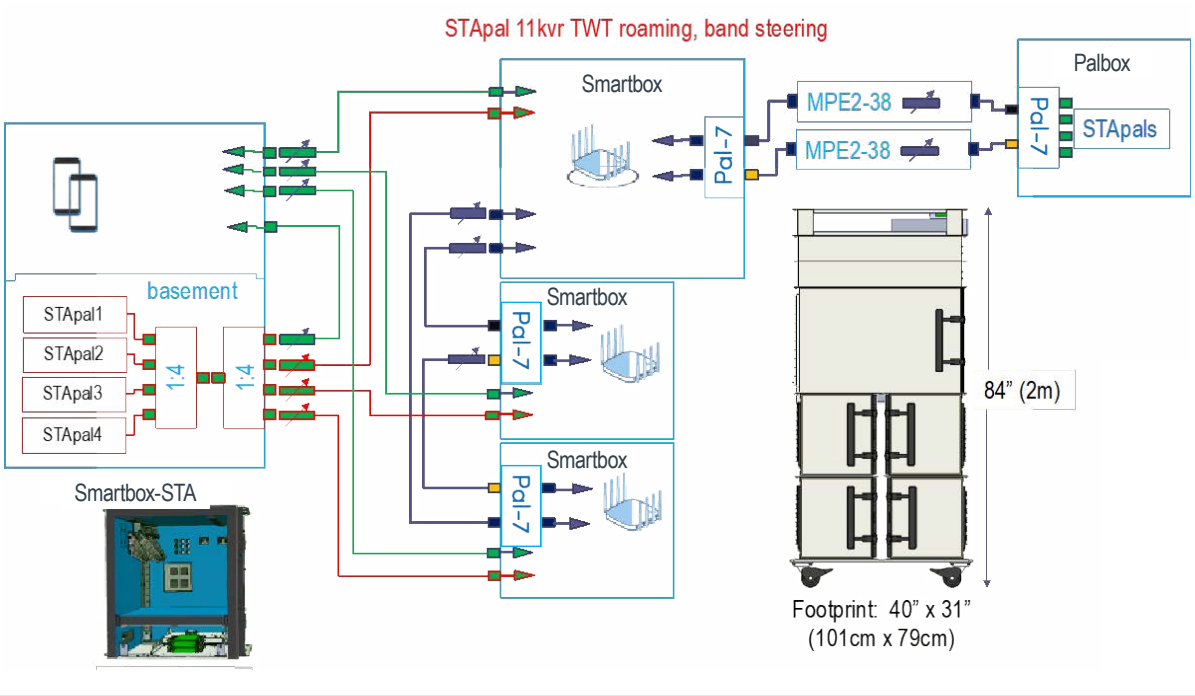
Octobox Stack-Mid is designed for communications service provider (CSP) to test and optimize home-focused Wi-Fi devices and solutions. A subset of Spirent's fully-featured Octobox Stack-Max testbed, Octobox Stack-Mid supports testing of all features and standards vital to home Wi-Fi devices, including the latest Broadband Forum TR-398 Issue 2 test cases for home router performance. It enables CSPs to test the latest Wi-Fi solutions for the home user, including the most recent technologies such as Wi-Fi 6, Wi-Fi 7, MU-MIMO and OFDMA. When combined with the Octobox Tracker Field-to-Lab replay capability, the testbed can also be used in the optimization of mesh networks, while features such as roaming, access point (AP) steering, band steering, and load balancing are also easy to test and optimize. Realistic deployment scenarios can be recorded in the field and replicated inside the testbed.



The following 6 block diagrams show the different RF paths in the Stack-Max and the functions they perform. The paths are highlighted in red and the functions are stated in red font.




RvR and roaming with off-the-shelf STAs
Synchrosniffer for the roaming cycle
Smartbox
Pal-7
MPE2-38
MPE2-38
Palbox
Pal-7
STApals
basement
STApal1
STApal2
STApal3
STApal4
1:4
1:4
Smartbox
Pal-7
Smartbox
Pal-7
Smartbox-STA
84" (2m)
Footprint: 40" x 31"
(101cm x 79cm)


STApal 11kvr TWT roaming, band steering
Smartbox
Pal-7
MPE2-38
MPE2-38
Palbox
Pal-7
STApals
basement
STApal1
STApal2
STApal3
STApal4
1:4
1:4
Smartbox
Pal-7
Smartbox
Pal-7
Smartbox-STA
84" (2m)
Footprint: 40" x 31"
(101cm x 79cm)

Testbed features and comparison

	Stack-			Notes
	Min	Mid	Max	
TR-398	•	•	•	Automated certification to the Broadband Forum TR-398 performance test standard. Full coverage on Stack-Max and Stack-Mid
RvR	•	•	•	Rate vs range test
RvRvO, RvOvR, RvRwR	•	•	•	Orientation or rotation tests require a turntable
Quad-band throughput	•	•	•	Aggregate throughput on up to 3 channels
Band Steering	•	•	•	
Roaming		•	•	
Mesh		•	•	
8x8 MIMO OTA	•	•	•	
8x8 with multipath			•	
160 MHz MIMO OTA	•	•	•	
MU-MIMO OTA	•	•	•	Beamforming based multi-user MIMO
DFS	•	•	•	
ACS	•	•	•	
Traffic replay	•	•	•	
Inline sniffing	•	•	•	Synchrosniffer probe while in STA or AP mode, reporting packets targeted for the STA or AP
Synchrosniffer probes	16	23	31	Palbox in Stack-Max has 16 STApal-6Es and a Pal-7 subsystem. Twelve out of the sixteen STApal-6Es have a 2x2 STA radio capable of sniffing on either 2.4, 5 or 6 GHz band
Total number of stations per band				
2.4 GHz	17	22	24	Pal-7 has one 2.4 GHz, two 5 GHz, and one 6 GHz radio. The two 5 GHz radios can be run separately or combined as a single 8x8 80MHz radio or a 4x4 160 MHz radio.
5 GHz	18	24	28	
6 GHz	17	22	24	
OFDMA-capable STAs	16	20	20	OFDMA Multiperf endpoints
vSTA				
2.4 GHz	240	480	960	Each vSTA can run its own traffic using the Octobox Multiperf mp2mp traffic; bridge via vSTAs to set up application layer traffic, e.g. voice/ video streams
5 GHz	256	512	1024	
6 GHz	80	160	320	
Total	576	1152	2304	

Octobox Pal-7 Open

Use the Octobox Pal-7 Open in a walk-in isolation chamber or in an open-air test environment, such as a test house. All the RF connectors for the Wi-Fi 7 radios and interference can be directly connected to the antennas. The open antenna subsystem supports all Spirent's antenna carriers, including high-gain antennas and dipole antennas for open air testing.

Open antenna system can be configured with any of the Octobox antennas

Pal-7 Open can also be placed inside an Octobox chamber as a portable Synchrosniffer or as traffic endpoints.

Pal-7 Open photo showing all the RF ports

Pal-7 Specifications

Wi-Fi	Pal-7
Channels	2.4 GHz, 5 GHz and 6 GHz
Bandwidth	20, 40, 80, 160, 320 MHz
Standards	801.11a, 802.11b, 802.11g, 802.11n, 802.11ac (wave 2), 802.11ax, 802.11be
Virtual stations	TBD per-radio
Traffic replay	From PCAP file
Monitor	Detailed statistics from the Wi-Fi chipset
Sniffer	Synchrosniffer Wireshark captures
802.11ax PHY	DL/UP OFDMA in AP mode DL MU-MIMO in AP mode and beamforming
802.11ax MAC	• Trigger frame support • Non-trigger based and trigger-based sounding for beamforming • Multi-user RTS and CTS • Buffer status report • UL-OFDMA Random Access • Multiple BSSID • Bandwidth query report
General	**Pal-7**
Traffic endpoints	Multiperf, iperf3, iperf2, ping
	Trigger out connector for triggering external RF instruments
Traffic Management	Two 10 Gbps Ethernet
Power	Power adapter
Dimensions	23” x 10.4” x 1.4” (58 √ 26 √ 3.5cm)
TX power	MCS, # streams, frequency and channel width dependent (see below)
Processor subsystem	Quad-core ARM Cortex-A73 at 2.2 GHz

Pal-7 Real-Time Radio Status

STA	AP	MON	Pal-7
√	√	√	Offline
√	√	√	Monitor
√			Scanning <CH #>
√	√		PHY mode <HT20, OFDMA, HE40, etc.>
√	√	√	Channel primary and secondary
√			Bandwidth
	√		Associated STAs <#> hover over to show list of STAs
√			MAC address
√	√		BSSIDs <list>
	√		SSID

About Spirent

Spirent Communications (LSE: SPT) is a global leader with deep expertise and decades of experience in testing, assurance, analytics and security, serving developers, service providers, and enterprise networks. We help bring clarity to increasingly complex technological and business challenges. Spirent's customers have made a promise to their customers to deliver superior performance. Spirent assures that those promises are fulfilled.

For more information visit: www.spirent.com

Glossary

A2DP	advanced audio distribution profile
ACS	automated channel selection
AFH	adaptive frequency hopping
AID	association ID
AP	access point
BE	best effort (priority)
BK	background (priority)
BLE	Bluetooth low energy
BT	Bluetooth
DFS	dynamic frequency selection
DL	downlink
HE	high efficiency
HFP	hands free profile
HID	human interface device profile
KPI	key performance indicator
MCS	modulation coding scheme
MIMO	multiple input multiple output
MP2MP	multi-point to multi-point (traffic generator)
MU	multi-user
Nss	number of spatial streams
OFDMA	orthogonal frequency domain multiple access
OPP	object push profile
OTA	over the air
RSSI	receive signal strength indicator
RU	resource unit
RvR	rate vs. range
RvRvO	rate vs. range vs. orientation
RvOvR	rate vs. orientation vs. range
RX	receive
STA	station (aka client)
TX	transmit
UL	uplink
VI	video (priority)
VO	voice (priority)
vSTA	virtual STA

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