

TR-398 Issue 2 WiFi Testing with LANforge: Virtual STA

The TR-398 WiFi Issue 2 Performance test plan by the Broadband forum provides a comprehensive set of tests to qualify the performance of WiFi access points (APs) to be deployed in residential and small office indoor environments. The TR-398 Issue 2 includes new test cases as compared to TR-398 Issue 1. The new test cases included in TR-398 Issue 2 are Dual Band Throughput, Bi-directional Throughput, 802.11ax-Peak performance and Automatic Channel Selection Tests. TR-398 Issue 2 includes 802.11ax station mode for all the test cases along with the existing 802.11n/ac modes.

See example reports auto-generated by this testbed:

- 6.1.1 RX Sensitivity at different angles and encodings.
- 6.2.1 Max Connection 32 station throughput
- 6.2.2 Max TCP Throughput
- 6.2.3 Airtime Fairness
- 6.2.4 Dual Band Throughput
- 6.2.5 TCP Bi-directional Throughput
- 6.2.6 Latency under Load Test
- 6.2.7 Quality of Service
- 6.3.1 Rate vs Range
- 6.3.2 Spatial Consistency
- 6.3.3 Peak Performance
- 6.4.1 Multiple Stations Performance
- 6.4.2 Multiple Association Stability
- 6.4.3 Downlink MU-MIMO, implemented but need example reports. Requires that AP must be able to disable/enable MU-MIMO.
- 6.4.4 Multicast Multi-Station
- 6.5.1 Long Term Stability.
- 6.5.2 AP Coexistence
- 6.5.3 Automatic channel selection.
- 8.1.1 Mesh Roam
- 8.2.1 Mesh Backhaul Rate vs Range
- 8.2.2 2-hop Mesh Backhaul Rate vs Range

1st May 2017 12:44:57 UTC

Test Setup Information		
Device Under Test	Name	2428-DUT
	RFCA	RFCA-1
	RFPower	Powerdown
	RFPath	RFPath-1
	RFPort	RFPort-1
Estimated Run Time	1:21:34	
Actual Run Time	4:23:48	

Objective

The TR-398 issue 2 full testbed is designed to be used to test the performance of a competitive set of WiFi products in a real-world environment. The test plan is designed to measure the performance of a set of WiFi products in a real-world environment. The test plan is designed to measure the performance of a set of WiFi products in a real-world environment. The test plan is designed to measure the performance of a set of WiFi products in a real-world environment. The test plan is designed to measure the performance of a set of WiFi products in a real-world environment. The test plan is designed to measure the performance of a set of WiFi products in a real-world environment.

Summary Results

Test	Setup	Concluded Scope	Passed	Failed	Info
Category 11/14/16/18/20/22/24/26/28/30/32/34/36/38/40/42/44/46/48/50/52/54/56/58/60/62/64/66/68/70/72/74/76/78/80/82/84/86/88/90/92/94/96/98/100	RFCA-1	0	0	0	
RFCA-1	RFCA-1	0	0	0	
A1 Bandwidth Sensitivity Test	RFCA-1	0	0	0	
A2.1 Maximum Connection Test (32 STA)	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 101 Mbps DL, 18 Mbps UL Throughput: 2.4GHz AC 18, 102 Mbps DL, 21.7 Mbps UL Throughput: 5GHz AX 18, 64.7 Mbps DL, 45.6 Mbps UL Power: 18 / 35 / 58
A2.2 Maximum TCP Throughput Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 114 Mbps DL, 14.2 Mbps UL Throughput: 2.4GHz AC 18, 117 Mbps DL, 20.6 Mbps UL Throughput: 5GHz AX 18, 138 Mbps DL, 50.4 Mbps UL
A2.3 AX Flow Latency Test	RFCA-1	0	0	0	AC 2.4GHz Power: 17.7 AX 2.4GHz Power: 17.7 AC 5GHz Power: 17.7 AX 5GHz Power: 17.7

Test	Setup	Concluded Scope	Passed	Failed	Info
A3 Range Versus Rate Test	RFCA-1	0	0	0	AX 5GHz A: 14, 114 Mbps DL, 14.1 Mbps UL AX 5GHz A: 17, 138 Mbps DL, 17.7 Mbps UL AC 5GHz Power: 17.7 AX 5GHz Power: 17.7
A3.1 Spatial Consistency Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 101 Mbps DL, 18 Mbps UL Throughput: 2.4GHz AC 18, 102 Mbps DL, 21.7 Mbps UL Throughput: 5GHz AX 18, 64.7 Mbps DL, 45.6 Mbps UL Power: 18 / 35 / 58
A3.2 AX Peak Performance TCP Throughput Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 114 Mbps DL, 14.2 Mbps UL Throughput: 2.4GHz AC 18, 117 Mbps DL, 20.6 Mbps UL Throughput: 5GHz AX 18, 138 Mbps DL, 50.4 Mbps UL
A3.3 Multiple STA Performance Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 101 Mbps DL, 18 Mbps UL Throughput: 2.4GHz AC 18, 102 Mbps DL, 21.7 Mbps UL Throughput: 5GHz AX 18, 64.7 Mbps DL, 45.6 Mbps UL Power: 18 / 35 / 58
A4 Multiple STA Performance Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 101 Mbps DL, 18 Mbps UL Throughput: 2.4GHz AC 18, 102 Mbps DL, 21.7 Mbps UL Throughput: 5GHz AX 18, 64.7 Mbps DL, 45.6 Mbps UL Power: 18 / 35 / 58
A4.1 Multiple STA Performance Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 101 Mbps DL, 18 Mbps UL Throughput: 2.4GHz AC 18, 102 Mbps DL, 21.7 Mbps UL Throughput: 5GHz AX 18, 64.7 Mbps DL, 45.6 Mbps UL Power: 18 / 35 / 58
A4.2 Multiple STA Performance Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 101 Mbps DL, 18 Mbps UL Throughput: 2.4GHz AC 18, 102 Mbps DL, 21.7 Mbps UL Throughput: 5GHz AX 18, 64.7 Mbps DL, 45.6 Mbps UL Power: 18 / 35 / 58
A4.3 Executive Network Performance Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 101 Mbps DL, 18 Mbps UL Throughput: 2.4GHz AC 18, 102 Mbps DL, 21.7 Mbps UL Throughput: 5GHz AX 18, 64.7 Mbps DL, 45.6 Mbps UL Power: 18 / 35 / 58
A4.4 Latency Test	RFCA-1	0	0	0	Throughput: 2.4GHz AX 18, 101 Mbps DL, 18 Mbps UL Throughput: 2.4GHz AC 18, 102 Mbps DL, 21.7 Mbps UL Throughput: 5GHz AX 18, 64.7 Mbps DL, 45.6 Mbps UL Power: 18 / 35 / 58
A5 Long Term Stability Test	RFCA-1	0	0	0	AC 2.4GHz Power: 17.7 / 35 / 58 AC 5GHz Power: 17.7 / 35 / 58 AX 2.4GHz Power: 17.7 / 35 / 58 AX 5GHz Power: 17.7 / 35 / 58

Test	Setup	Concluded Scope	Passed	Failed	Info
A6 Throughput (Average)	RFCA-1	0	0	0	
A6.1 AC 2.4GHz Downlink	RFCA-1	0	0	0	
A6.2 AC 2.4GHz Uplink	RFCA-1	0	0	0	
A6.3 AC 5GHz Downlink	RFCA-1	0	0	0	
A6.4 AC 5GHz Uplink	RFCA-1	0	0	0	
A6.5 AX 2.4GHz Downlink	RFCA-1	0	0	0	
A6.6 AX 2.4GHz Uplink	RFCA-1	0	0	0	
A6.7 AX 5GHz Downlink	RFCA-1	0	0	0	
A6.8 AX 5GHz Uplink	RFCA-1	0	0	0	
A6.9 AX 2.4GHz Downlink	RFCA-1	0	0	0	
A6.10 AX 2.4GHz Uplink	RFCA-1	0	0	0	
A6.11 AX 5GHz Downlink	RFCA-1	0	0	0	
A6.12 AX 5GHz Uplink	RFCA-1	0	0	0	
A6.13 AX 2.4GHz Downlink	RFCA-1	0	0	0	
A6.14 AX 2.4GHz Uplink	RFCA-1	0	0	0	
A6.15 AX 5GHz Downlink	RFCA-1	0	0	0	
A6.16 AX 5GHz Uplink	RFCA-1	0	0	0	
A6.17 AX 2.4GHz Downlink	RFCA-1	0	0	0	
A6.18 AX 2.4GHz Uplink	RFCA-1	0	0	0	
A6.19 AX 5GHz Downlink	RFCA-1	0	0	0	
A6.20 AX 5GHz Uplink	RFCA-1	0	0	0	
A6.21 AX 2.4GHz Downlink	RFCA-1	0	0	0	
A6.22 AX 2.4GHz Uplink	RFCA-1	0	0	0	
A6.23 AX 5GHz Downlink	RFCA-1	0	0	0	
A6.24 AX 5GHz Uplink	RFCA-1	0	0	0	
A6.25 AX 2.4GHz Downlink	RFCA-1	0	0	0	
A6.26 AX 2.4GHz Uplink	RFCA-1	0	0	0	
A6.27 AX 5GHz Downlink	RFCA-1	0	0	0	
A6.28 AX 5GHz Uplink	RFCA-1	0	0	0	
A6.29 AX 2.4GHz Downlink	RFCA-1	0	0	0	
A6.30 AX 2.4GHz Uplink	RFCA-1	0	0	0	
A6.31 AX 5GHz Downlink	RFCA-1	0	0	0	
A6.32 AX 5GHz Uplink	RFCA-1	0	0	0	

5.2.1 Maximum Connection Test (32 STA)

Summary

- Maximum Connection Test verifies that the WiFi AP can support 32 STAs simultaneously connected with minimal performance or responsiveness degradation.

Test Procedure

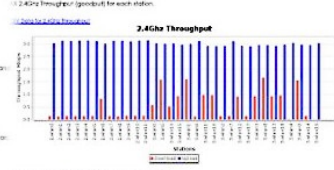
- Test prep steps are done for 2.4GHz and then for 5GHz bands.
- Establish the LAN connection, create 32 stations and allow the 32 stations to associate with the DUT.
- Measure the download TCP performance, using a test time of 30 seconds and a traffic rate of 2 Mbps for 802.11n or 8 Mbps for 802.11ac. Wait for 802.11n or 802.11ac to stabilize for 10 seconds before starting the test. Record the number of packets transmitted and received to calculate the packet error rate.
- Do some tests in the opposite direction.

Pass/Fail Criteria

- For each of the test configurations, Packet Error Rate (PER) for each STA (SAs), achieve less than 1%.
- For 2.4GHz, summed download throughput should be at least (SAs*100 * 2 Mbps).
- For 5GHz, summed download throughput should be at least (SAs*100 * 8 Mbps).
- For 802.11ac, summed download throughput should be at least (SAs*100 * 8 Mbps).
- For 802.11n, summed download throughput should be at least (SAs*100 * 2 Mbps).
- For 802.11n, summed download throughput should be at least (SAs*100 * 2 Mbps).
- For 802.11ac, summed download throughput should be at least (SAs*100 * 8 Mbps).

Conclude Score

- Conclude score for this CA test is calculated with 1/5 of the score coming from the percentage of stations meeting the pass/criteria and 4/5 of the score coming from the throughput. The throughput component will be considered as a percentage of the actual.



10K CA Test: Snapshot AX 2.4GHz Downlink

Port	Tx Rate (Mbps)	Rx Rate (Mbps)	% Util (%)	% STA Busy (%)	Mode	Channel	Load CF (Mbps)	QoS (Mbps)	AP	IP	MAC
117	45	28.641	0	0	802.11ac	36	0	117	8-102-144	802.11ac	8-102-144
118	54	23.021	0	0	802.11ac	36	0	118	8-102-144	802.11ac	8-102-144
119	212	101.547	0	0	802.11ac	36	0	119	8-102-144	802.11ac	8-102-144
120	184	97.881	0	0	802.11ac	36	0	120	8-102-144	802.11ac	8-102-144
121	158	80.020	0	0	802.11ac	36	0	121	8-102-144	802.11ac	8-102-144
122	148	81.842	0	0	802.11ac	36	0	122	8-102-144	802.11ac	8-102-144

Key Measurements

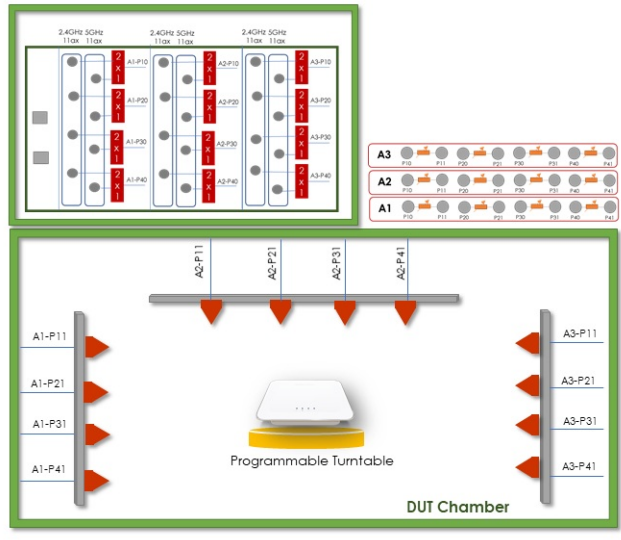
- PASS/FAIL results table for each test per the TR-398 Issue 2 document.
- Detailed per test measurements.

Overview

TR-398 Issue 2 Overview Video
Slide presentation for Candela Technologies' TR-398 issue 2 solution.

Candela Technologies offers a fully automated TR-398 Issue 2 test system. All the required test hardware including multi station emulator, traffic generator, RF enclosures, turntable, programmable attenuators, and fully automated test software along with PASS/FAIL results are provided in a fully packaged, easy to use and affordable solution. This testbed uses 6 4x4 dual-band radios supporting 19 virtual stations each. This performs better than 32 individual radios in some cases since there are fewer radios in a small volume, but virtual stations do not support OFDMA, so the AP must disable OFDMA. TR-398 assumes OFDMA is disabled, so using virtual stations does not invalidate this test. This virtual-station solution is also more affordable than the 32-station tri-band radio version of this testbed.

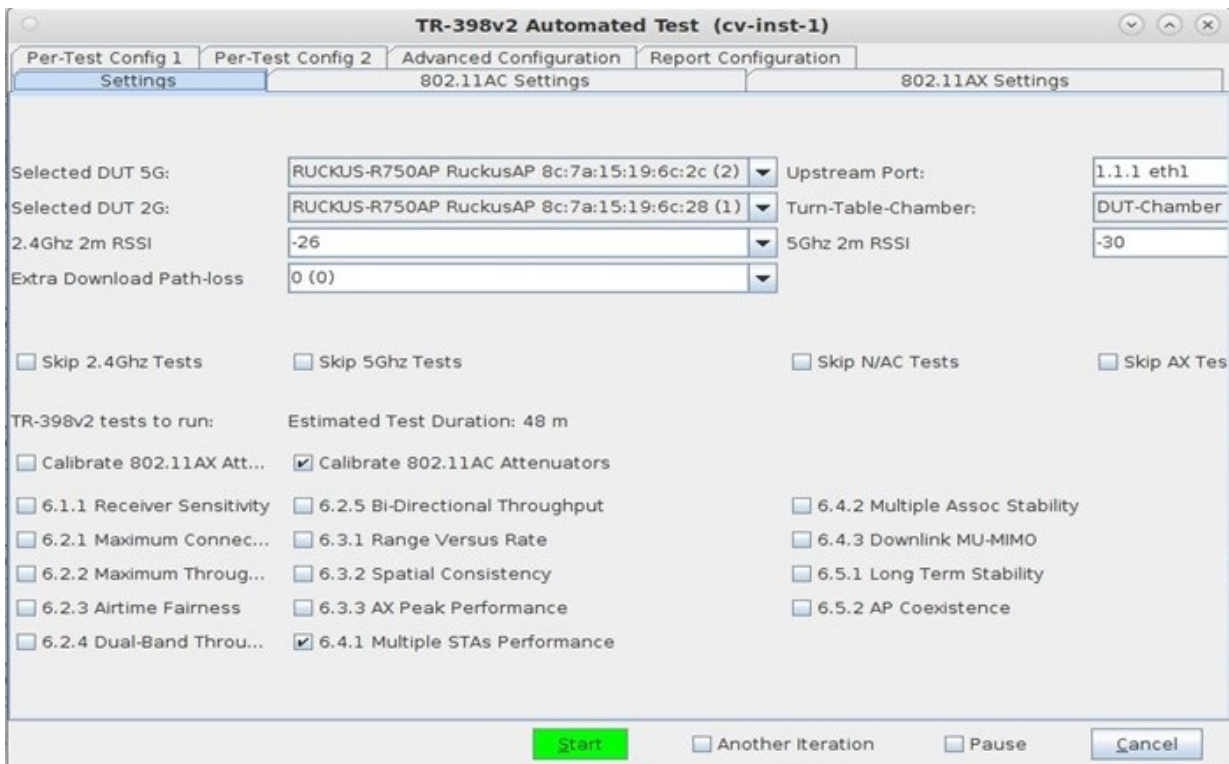
TR-398 Issue2 Full Testbed Wiring Diagram – Virtual AX STA



The test setup, testbed components and environment are all created as per the requirements in Section 5 of the TR-398 Issue 2 test plan document. Some of the components may be different than pictured depending on the options purchased. Please ask your sales representative for details.



The LANforge GUI provides integrated configuration and automation control for all the components of the testbed including the station emulators, traffic generator, attenuators, and turntables. The entire set of TR-398 Issue 2 tests, or optionally a subset of these tests, can be run with a single push of a button. An HTML and PDF report can be generated with a second button click when the test completes.



Includes these Building Blocks

- **Hardware**
 - LANforge Multi station Emulation and Traffic Generation Hardware – minimum 6 4x4 dual-band AX capable radios, dual 1/2.5/5/10g Eth ports.
 - CT820a-Medium RF Chamber.

- CT840a Large RF Chamber with Programmable Turntable.
- CT714b 4 Port Programmable Attenuators.
- RF Splitters/Combiners.
- Directional Antennas (optional).
- RF Cables.
- **Software**
 - TR-398 Issue 2 Automation Software
 - Normal LANforge WiFi testing features are included at no additional charge.

Key Tests from TR-398 Issue 2 Document

- 6.1 RF capability
 - 6.1.1 Receiver Sensitivity Test
- 6.2 Baseline performance
 - 6.2.1 Maximum Connection Test
 - 6.2.2 Maximum Throughput Test
 - 6.2.3 Airtime Fairness Test
 - 6.2.4 Dual-band Throughput Test
 - 6.2.5 Bidirectional Throughput Test
 - 6.2.6 Airtime Fairness Test
- 6.3 Coverage
 - 6.3.1 Range Versus Rate Test
 - 6.3.2 Spatial Consistency Test
 - 6.3.3 802.11ax Peak Performance Test
- 6.4 Multiple Stations Performance
 - 6.4.1 Multiple Stations Performance Test.
 - 6.4.2 Multiple Association/Disassociation Stability Test.
 - 6.4.3 Downlink MU-MIMO Performance Test.
- 6.5 Stability/Robustness
 - 6.5.1 Long Term Stability Test
 - 6.5.2 AP Coexistence Test
 - 6.5.3 Automatic Channel Selection Test
- 8 Mesh test cases (TR398 issue-3) Requires additional testbed components.
 - 8.1.1 Mesh Roaming Test
 - 8.2.1 Mesh Backhaul Rate vs Range
 - 8.2.2 2-hop Mesh Backhaul Rate vs Range

Lead Times and Support:

i Please contact support@candelatech.com if you need any assistance.

Lead Times: Four to six weeks.

TaaS/Onsite Support: Customers with only occasional test needs can use our Test as a Service option. Candela engineers can do the testing for you in our fully equipped test lab and provide a detailed test report with recommendations.

For more information, please contact sales@candelatech.com or give us a call at: 1-360-380-1618

