

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

Test Set Information
Name: TR398-DUT
SDS: Home & Home Wi-Fi
Passwd: Network 192.168.1.1
SSID: Home-2.4GHz
WiFi: (802.11a) 802.11n
Channel: (802.11n)
Estimated Run Time: 10.57h
Actual Run Time: 8.25h

Objective

The TR-398 Issue 2 WiFi Performance Testbed by the Embedded Testbed provides a comprehensive set of tests to verify the performance of WiFi access points (AP) designed for residential and small office environments. Basic performance, throughput, connection stability, off-air channel, and Co-existence with 2.4GHz performance. Spatial Consistency are long term stability are some of the test areas covered in this testbed. The testbed is designed to stress device throughput from 800 Kbps to 240 Mbps to verify the AP's ability to support 802.11n or 802.11ac deployment used for equipment manufacturers. The testbed by Candela Technologies offers a fully automated TR-398 Issue 2 test system. The user can select from the testbed to run a test or all tests at once. The test results are displayed on the testbed interface. Measurements are made and compared to the specified PASS/FAIL criteria in the TR-398 Issue 2 test plan and throughput will show the summary PASS/FAIL results followed with detailed results for each test.

Summary Results

Test	Setup	Compliance Scope	Passed	Failed	Info
Coverage B21 11AC Zen Antenna RSSI	Passed	-	-	-	-
Coverage B21 11AC Zen Antenna RSSI	Passed	-	-	-	-
A1 180-degree Sensitivity Test	Passed	-	-	-	-
A2.1 Maximum Connector Test (32 STA)	Passed	2.4GHz AX	-	-	Throughput: 2.4GHz AX 11.101 Mbps DL, 18.945 Mbps UL Throughput: 2.4GHz AX 11.102 Mbps DL, 19.218 Mbps UL Throughput: 2.4GHz AX 11.625 Mbps DL, 16.426 Mbps UL Power: 16.156 dBm
A2.2 Maximum TCP Throughput Test	Passed	2.4GHz AX	-	-	Throughput: 2.4GHz AX 18.550 Mbps DL, 16.295 Mbps UL Throughput: 2.4GHz AX 11.439 Mbps DL, 10.025 Mbps UL Throughput: 2.4GHz AX 11.065 Mbps DL, 10.818 Mbps UL Throughput: 2.4GHz AX 18.845 Mbps DL, 16.465 Mbps UL
A2.3 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7

Test Name	Setup	Compliance Scope	Passed	Failed	Info
A3 180-degree Sensitivity Test	Passed	2.4GHz AX	-	-	AX 2.4GHz AX 11.102 Mbps DL, 18.945 Mbps UL AX 2.4GHz AX 11.102 Mbps DL, 19.218 Mbps UL AX 2.4GHz AX 11.625 Mbps DL, 16.426 Mbps UL Power: 16.156 dBm
A3.1 Spatial Consistency Test	Passed	2.4GHz AX	-	-	Throughput: 2.4GHz AX 18.550 Mbps DL, 16.295 Mbps UL Throughput: 2.4GHz AX 11.439 Mbps DL, 10.025 Mbps UL Throughput: 2.4GHz AX 11.065 Mbps DL, 10.818 Mbps UL Throughput: 2.4GHz AX 18.845 Mbps DL, 16.465 Mbps UL
A3.2 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A3.3 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A3.4 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A3.5 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A3.6 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A3.7 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A3.8 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A3.9 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A3.10 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7

Test Name	Setup	Compliance Scope	Passed	Failed	Info
A4 180-degree Sensitivity Test	Passed	2.4GHz AX	-	-	Throughput: 2.4GHz AX 18.550 Mbps DL, 16.295 Mbps UL Throughput: 2.4GHz AX 11.439 Mbps DL, 10.025 Mbps UL Throughput: 2.4GHz AX 11.065 Mbps DL, 10.818 Mbps UL Throughput: 2.4GHz AX 18.845 Mbps DL, 16.465 Mbps UL
A4.1 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.2 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.3 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.4 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.5 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.6 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.7 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.8 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.9 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7
A4.10 AX High Throughput Test	Passed	2.4GHz AX	-	-	AC 2.4GHz Passed 11.7 AX 2.4GHz Passed 11.7

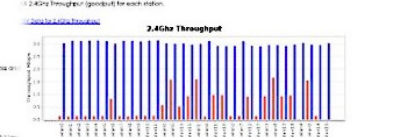
5.2.1 Maximum Connection Test (32-STA)

Summary
 Maximum Connection Test: To verify that the AP can support 32 STA (simultaneously) connected with minimal performance or connection stability issues.

Test Procedure
 Test steps are done for 2.4GHz and then for 5GHz bands.
 1. Establish the LAN connection, create 32 stations and allow the 32 stations to associate with the EUT.
 2. Measure the download TCP performance, using a test time of 120 seconds and a traffic rate of 2 Mbps for BQ2.1 in 8 Mbps for BQ2.1.
 3. Repeat the test in 2.4GHz and 5GHz for BQ2.1 in 8 Mbps through each STA consecutively. Record the number of packets transmitted and received to calculate the packet error rate.
 4. Do some test in the speed direction.

Pass/Fail Criteria
 1. For each of the test configuration, Packet Error Rate (PER) for each STA (BQs), achieve less than 1%.
 2. For 2.4GHz, summed download throughput shall be at least (32Mbps * 0.9).
 3. For 5GHz, summed download throughput shall be at least (32Mbps * 0.9).
 4. For 5GHz, summed upload throughput shall be at least (32Mbps * 0.9).
 5. For 5GHz, summed download throughput shall be at least (32Mbps * 0.9).
 6. For 2.4GHz, AX, summed download throughput shall be at least (32Mbps * 0.9).
 7. For 5GHz, AX, summed download throughput shall be at least (32Mbps * 0.9).

Compliance Score
 Compliance score for this CA test is calculated with 1% of the score coming from the percentage of stations meeting the pass criteria. If all the stations meet the test throughput, the test throughput compliance will be considered as a percentage of the actual



10K-CA-Test: Snapshot AX 2.4GHz Download

Port	Rate	Mode	Channel	Mode	Power	AP	IP	MAC
1.17	44.5	802.11n	2.412	TX	15dBm	772.18.101.144	192.168.1.33	aa:aa:aa:aa:aa:aa
1.18	54	802.11n	2.412	TX	15dBm	772.18.101.144	192.168.1.35	aa:aa:aa:aa:aa:aa
1.19	41.2	802.11n	2.412	TX	15dBm	772.18.101.144	192.168.1.36	aa:aa:aa:aa:aa:aa
1.20	34	802.11n	2.412	TX	15dBm	772.18.101.144	192.168.1.36	aa:aa:aa:aa:aa:aa
1.21	46	802.11n	2.412	TX	15dBm	772.18.101.144	192.168.1.36	aa:aa:aa:aa:aa:aa

Key Measurements

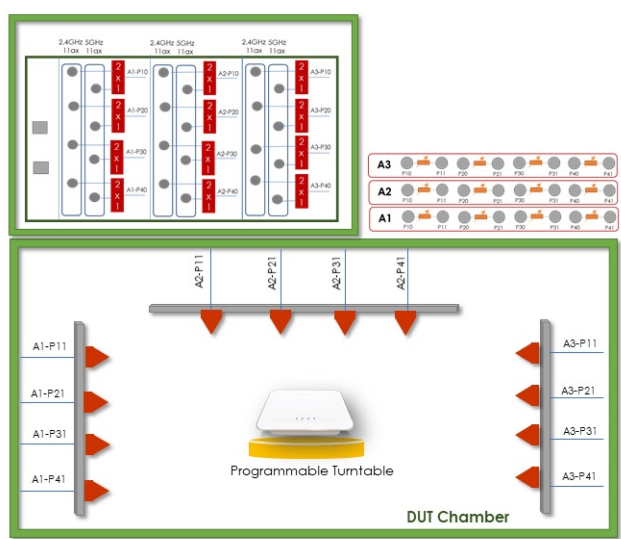
- PASS/FAIL results table for each test per the TR-398 Issue 2 document.
- Detailed per test measurements.

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.

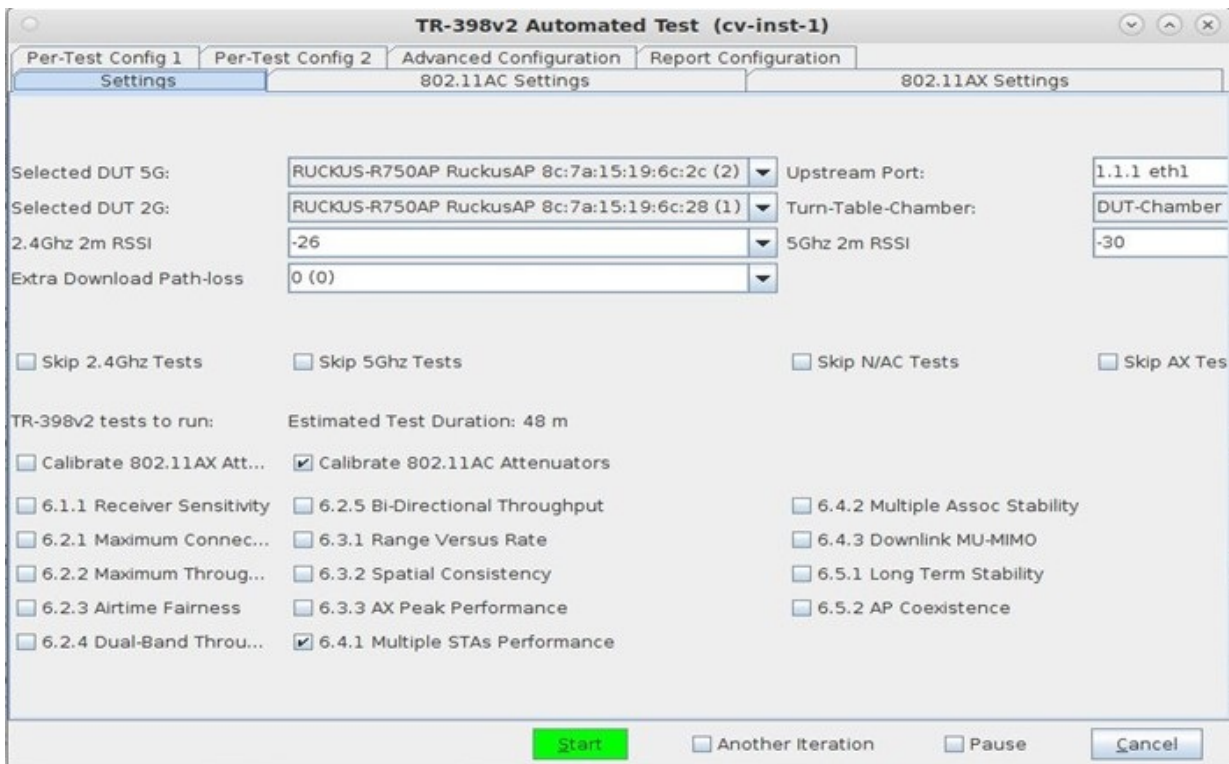
TR-398 Issue2 Full Testbed Wiring Diagram – Virtual AX STA



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:

 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

