

## TR-398 WiFi Testing with LANforge

### i TR-398 Issue 3 available.

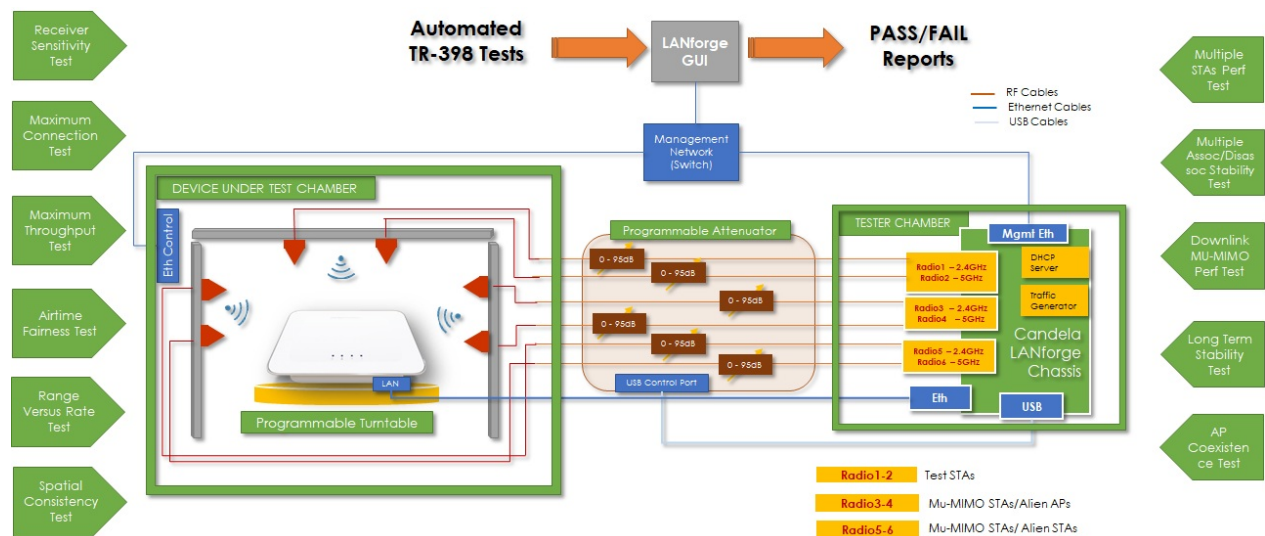
Candela Technologies has TR-398 Issue 3 support in LANforge 5.4.6 and higher.

The TR-398 WiFi 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. Radio performance, throughput, connection stability, airtime fairness and long-term stability are some of the test areas covered in this test plan. The test plan is designed for **service providers** deploying in home WiFi APs to qualify the APs in the lab before deployment and for equipment makers to test during the development of the APs.

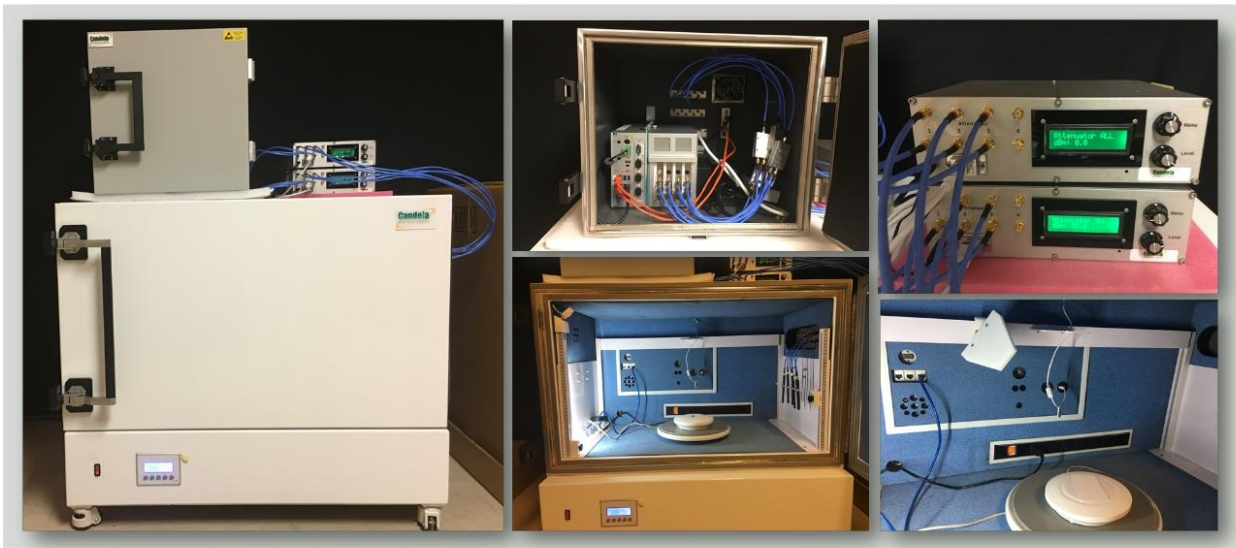
See an example report auto-generated by Candela's LANforge test suite: [HTML](#) | [PDF](#)

### TR-398 Demonstration Video

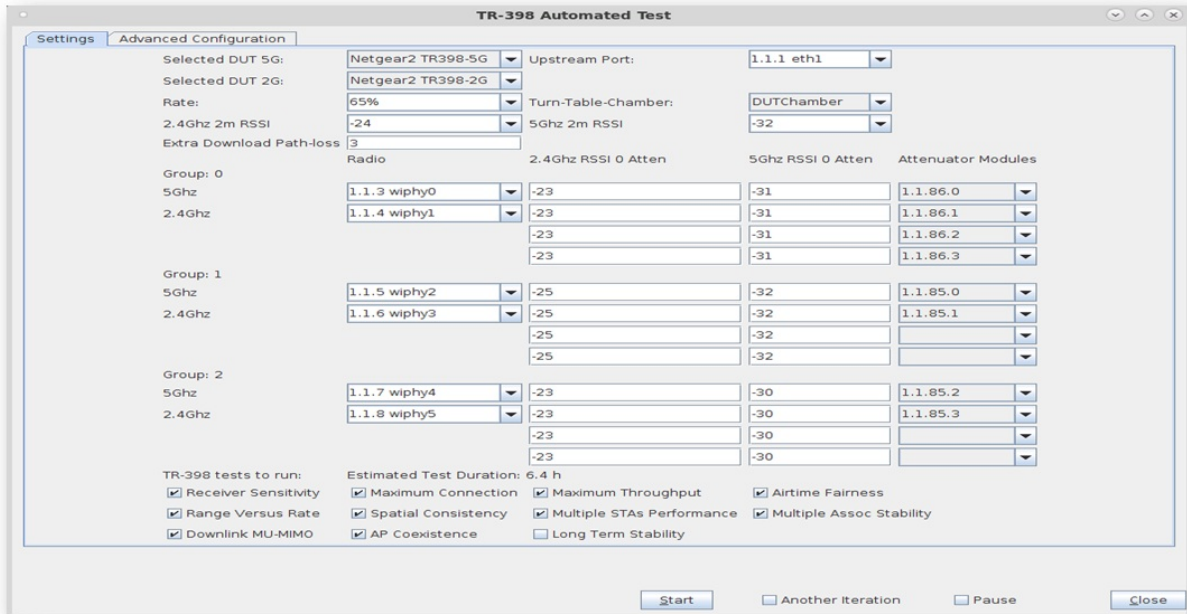
Candela Technologies offers a fully automated TR-398 test system. All the required test hardware including multi station emulator, traffic generator, RF enclosures, turntable, programmable attenuators and fully automated test software along with PASS/FAIL results are provided in a fully packaged, easy to use and affordable solution.



The test setup, testbed components and environment are all created as per the requirements in Section 5 of the TR-398 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 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 wave-2 radios (3x 2.4GHz, 3x 5GHz NICs), 2-eth ports (optional 10gE Ports).
- CT820a-Medium RF Chamber.
- CT840a or CT850a Large RF Chamber with Programmable Turntable.
- CT704b or CT714 4 Port Programmable Attenuators.
- RF Splitters/Combiners.
- Directional Antennas (optional).
- RF Cables.

- **Software**

- TR-398 Automation Software

- o Normal LANforge WiFi testing features are included at no additional charge.

## Key Tests from TR-398 Document

- 6.1 RF capability
  - o 6.1.1 Receiver Sensitivity Test
- 6.2 Baseline performance
  - o 6.2.1 Maximum Connection Test
  - o 6.2.2 Maximum Throughput Test
  - o 6.2.3 Airtime Fairness Test
- 6.3 Coverage
  - o 6.3.1 Range Versus Rate Test
  - o 6.3.2 Spatial Consistency Test
- 6.4 Multiple Stations Performance
  - o 6.4.1 Multiple Stations Performance Test.
  - o 6.4.2 Multiple Association/Disassociation Stability Test.
  - o 6.4.3 Downlink MU-MIMO Performance Test.
- 6.5 Stability/Robustness
  - o 6.5.1 Long Term Stability Test
  - o 6.4.2 AP Coexistence Test

## Key Measurements

- PASS/FAIL results table for each test per the TR-398 document.
- Detailed per test measurements.
- See an [example report](#).

## TR-398 Sample Test Results and Reports

**Summary Results**

Test	Result	Notes
6.1.1 Receiver Sensitivity Test	Pass	
6.2.1 Maximum Connection Test (32-stations)	Pass	
6.2.2 Maximum TCP Throughput Test	Pass	
6.2.3 Airtime Fairness Test	Pass	
6.3.1 Range Versus Rate Test	Pass	
6.3.2 Spatial Consistency Test	Pass	
6.4.1 Multiple STAs Performance Test	Pass	
6.4.2 Multiple Association/Disassociation Stability Test	Pass	
6.4.3 Downlink MU-MIMO Performance Test	Pass	
6.5.2 AP Coexistence Test	Pass	
6.5.1 Long Term Stability Test	Skipped	

**6.2.1 Maximum Connection Test (32-stations)**

Type	Result	Notes
6.2.1.1 Assumptions	INFO	This test does not specify RSSI, so calibration is difficult.
6.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.2.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	

**6.5.2 AP Coexistence Test**

Type	Result	Notes
2.4GHz 6.5.2.4.4 Baseline download rate	INFO	119.53 Mbps
2.4GHz ch. 11:6.5.2.4.4 Side AP	INFO	Req: 121.36 Req: 118.73
2.4GHz ch. 11:6.5.2.4.7 Co-Channel Interferer AP	INFO	Req: 47.81 Req: 58.26
2.4GHz ch. 33:6.5.2.4.7 Overlapping Channel Interferer AP	INFO	Req: 47.81 Req: 49.15
2.4GHz ch. 6:6.5.2.4.7 Adjacent Channel Interferer AP	INFO	Req: 113.56 Req: 21.15
5GHz 6.5.2.4.4 Baseline download rate	INFO	697.49 Mbps
5GHz ch. 157:6.5.2.4.4 Side AP	INFO	Req: 655.84 Req: 692.39
5GHz ch. 157:6.5.2.4.7 Co-Channel Interferer AP	INFO	Req: 279.00 Req: 312.47

**6.4.3 Downlink MU-MIMO Performance Test**

Type	Result	Notes
6.4.3.4.3 2x MU-MIMO Sta-1 Baseline	INFO	697.97 Mbps
6.4.3.4.4 3x MU-MIMO Sta-2 Baseline	INFO	348.63 Mbps
6.4.3.4.5 3x MU-MIMO Sta-3 Baseline	INFO	311.95 Mbps
6.4.3.4.6 MU-MIMO Sta-1 - 3 Total	INFO	312.77 378.70 217.08 Mbps
6.4.3.4.7 3x MU-MIMO Sta-1 - 3 Total	INFO	311.95 Mbps
MU-MIMO Throughput	INFO	Req: 611.35 Req: 55
6.4.3.5.3 MU-MIMO Throughput Comparison	INFO	50-MIMO Total: 2108.55

**6.3.1 Range Versus Rate Test**

Type	Result	Notes
6.3.1.1 Assumptions	INFO	This test does not specify RSSI, so calibration is difficult.
6.3.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.1.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	

**6.2.2 Maximum TCP Throughput Test**

Type	Result	Notes
Total 2.4GHz download throughput	Sum-total download: 112.33 Mbps Requested: 100Mbps	
Total 2.4GHz upload throughput	Sum-total upload: 112.36 Mbps Requested: 100Mbps	
Total 5GHz download throughput	Sum-total download: 700.68 Mbps Requested: 650Mbps	
Total 5GHz upload throughput	Sum-total upload: 701.46 Mbps Requested: 650Mbps	

**6.3.2 Spatial Consistency Test**

Type	Result	Notes
6.3.2.1 Assumptions	INFO	This test does not specify RSSI, so calibration is difficult.
6.3.2.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	
6.3.2.1.1.1 2dRx rx wlan1:11:0a:60:00:1:0:0	Download: 49K	

**Comprehensive PDF Test Reports**

### TR-398 Test

Wed Jul 10 06:41:16 PDT 2014

**Test Report Information**

Report Name	Report 1
Device Under Test	Model: 7840-50-1088-010
Operator	lanforge@lanforge.com

**Objective**

This TR-398 Performance test plan for the LANforge test provides a comprehensive set of checks to identify the performance of 802.11n access points. LANforge is designed to simulate and generate test scenarios, including performance, throughput, connection stability, channel reuse, and coexistence. The LANforge Performance, Spatial Consistency, and Coexistence tests are based on the test plan. The test plan also describes the test plan's Coexistence Performance test which is designed to check the coexistence of multiple access points in the same area. The test plan also describes the test plan's Coexistence Performance test which is designed to check the coexistence of multiple access points in the same area. The test plan also describes the test plan's Coexistence Performance test which is designed to check the coexistence of multiple access points in the same area.

**Summary Results**

Test	Result	Notes
6.1.1 Receiver Sensitivity Test	Pass	
6.2.1 Maximum Connection Test (32-stations)	Pass	
6.2.2 Maximum TCP Throughput Test	Pass	
6.2.3 Airtime Fairness Test	Pass	
6.3.1 Range Versus Rate Test	Pass	
6.3.2 Spatial Consistency Test	Pass	
6.4.1 Multiple STAs Performance Test	Pass	
6.4.2 Multiple Association/Disassociation Stability Test	Pass	
6.4.3 Downlink MU-MIMO Performance Test	Pass	
6.5.2 AP Coexistence Test	Pass	
6.5.1 Long Term Stability Test	Skipped	

**6.1.1 Receiver Sensitivity Test**

**Test Procedure**

1. Select attenuation to starting value (0 dB) through the passing value.
2. Configure the LANforge test scenario to generate traffic at 40% of maximum rate.
3. Configure the LANforge test scenario to generate traffic at 40% of maximum rate.
4. Increase attenuation by 1.0 dB each step. For each attenuation step, run LANforge for 10 minutes.
5. Record the test results in the test results table.
6. Repeat the test procedure for each test scenario.
7. Test this step only for the MCS test for 2.4GHz on 2.4GHz and MCS test for 5GHz.

## TR-398 Test System Pricing

Test Case	LANforge Radio 1-2	Attenuator Unit 1	Tester Chamber	DUT Chamber	LANforge Radio 3-4	Attenuator Unit 2	LANforge Radio 5-6	Turntable in DUT Chamber
6.2.1 Maximum Connection Test	✓	✓	✓	✓				
6.2.2 Maximum Throughput Test	✓	✓	✓	✓				
6.3.1 Range Versus Rate Test	✓	✓	✓	✓				
6.4.2 Multiple Assoc/Disassoc Stability	✓	✓	✓	✓				
6.5.1 Long Term Stability	✓	✓	✓	✓				
6.2.3 Airtime Fairness Test	✓	✓	✓	✓	✓	✓		
6.4.3 Downlink MU-MIMO Performance	✓	✓	✓	✓	✓	✓	✓	
6.5.2 AP Coexistence	✓	✓	✓	✓	✓	✓	✓	
6.1.1 Receiver Sensitivity Test	✓	✓	✓	✓				✓
6.3.2 Spatial consistency test	✓	✓	✓	✓	✓	✓	✓	✓
6.4.1 Multiple STAs Performance Test	✓	✓	✓	✓	✓	✓	✓	✓

- Covers only 5 tests
- Needs single LANforge system with 2 radios, 1 4-port attenuator and 2 medium RF chambers
- **System Price: \$60K**

- Covers 8 tests
- Add 4 more LANforge radios and second attenuator
- **System Price: \$80K**

- Covers all 11 tests
- Change DUT chamber to a large chamber with Turntable
- **System Price: \$100K**

All System prices are approximate and include HW, SW, all accessories including RF cables, splitters etc... and 1 year customer support

Received your test-bed and need to put it together? Here are some [TR-398 Wiring Diagrams and Installation notes](#). Please contact [support@candelatech.com](mailto:support@candelatech.com) if you need any assistance.

**Lead Times:** Most LANforge systems can generally be shipped within a couple of days of customer PO. RF chambers and attenuators may need 2 or more weeks of lead time. Direct-from-the-factory shipping is available for the RF chambers to decrease shipping costs and lead times.

**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](mailto:sales@candelatech.com) or give us a call at: 1-360-380-1618

Candela Technologies, Inc., 2417 Main Street, Suite 201, Ferndale, WA 98248, USA  
[www.candelatech.com](http://www.candelatech.com) | [sales@candelatech.com](mailto:sales@candelatech.com) | +1.360.380.1618