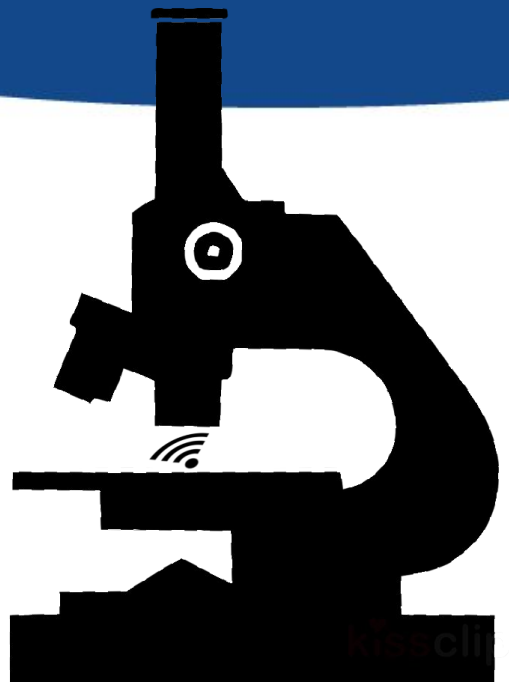
University of New Hampshire InterOperability Laboratory

Boost Broadband Satisfaction Through Wi-Fi Testing

TR-398 Issue 2 Explained



Lincoln Lavoie, UNH-IOL
Mike Talbert, Verizon

Please type any questions you have into the
"questions" window at anytime – we will address these at the end.

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Your Presenters

Lincoln Lavoie

UNH-IOL Principal Engineer, Broadband Technologies

Broadband Forum Technical Chair

20 years of experience in testing broadband technologies

Mike Talbert

Verizon

Associate Fellow

Broadband Forum President

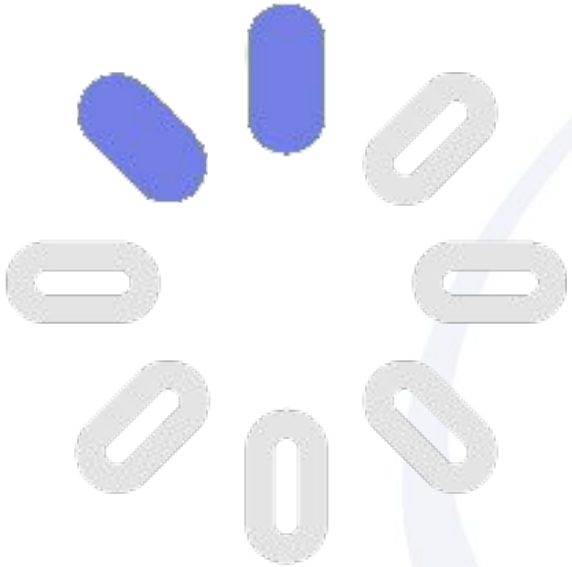
Vice Chair - BBF Service Provider Action Council (SPAC)

verizon

Agenda

- Wi-Fi & broadband, broadband & Wi-Fi, or the Internet
- What is TR-398 Issue 2
- TR-398 Issue 2 test coverage
- How to implement repeatable TR-398i2 testing
- A peak of the first results

The experience killers ...



Importance of Customer Experience

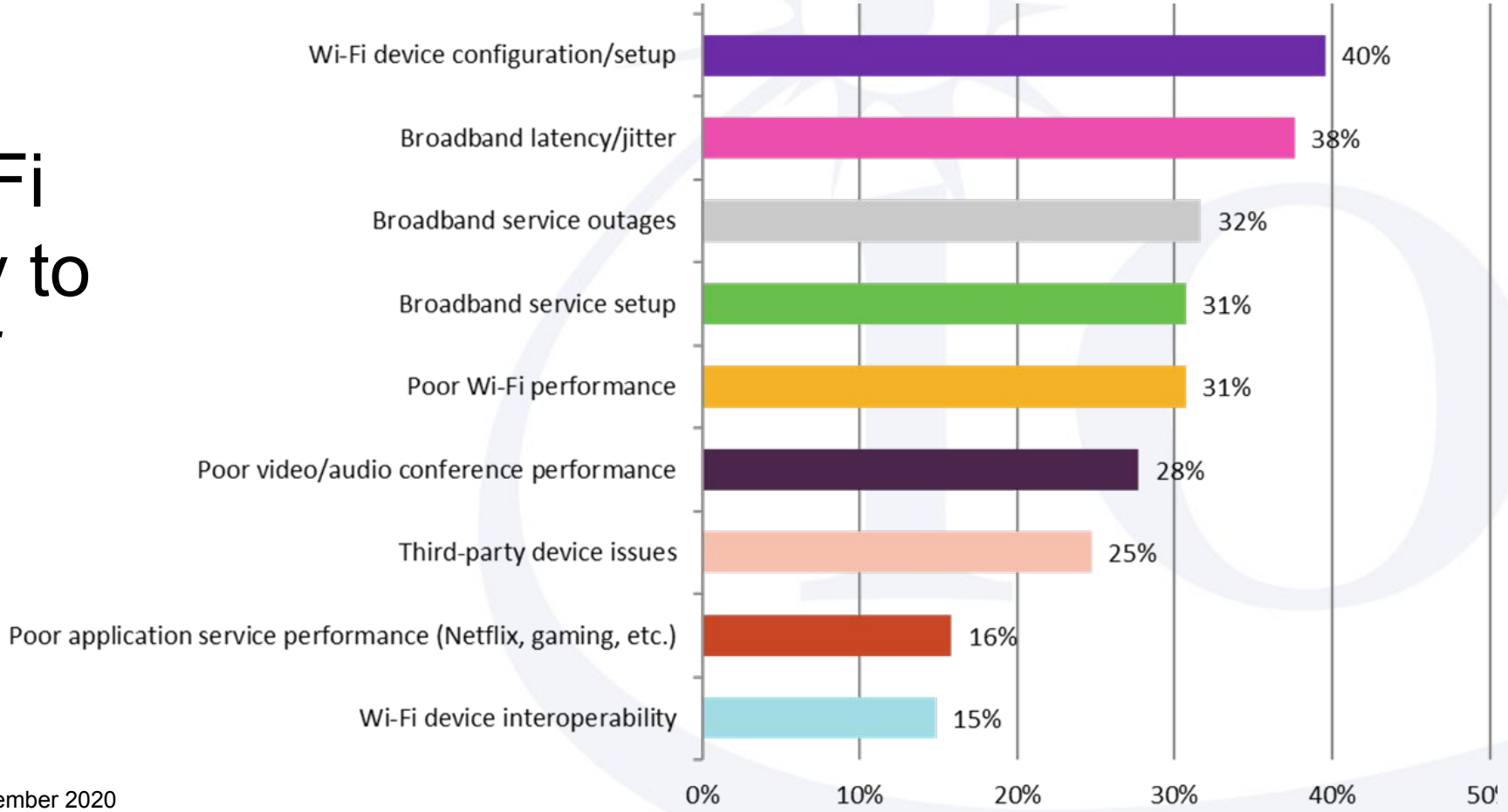
- Consumers expect transparent coverage in and outside the home
- No one wants to be bothered with the how or the why, they just want it to **work**

“It needs to be easy”
“It needs to be convenient”
“I shouldn’t have to worry about it”

Service providers need adequate tools manage, control and to proactively understand and ensure the **Quality of Experience** for their subscribers

Customer Support Calls

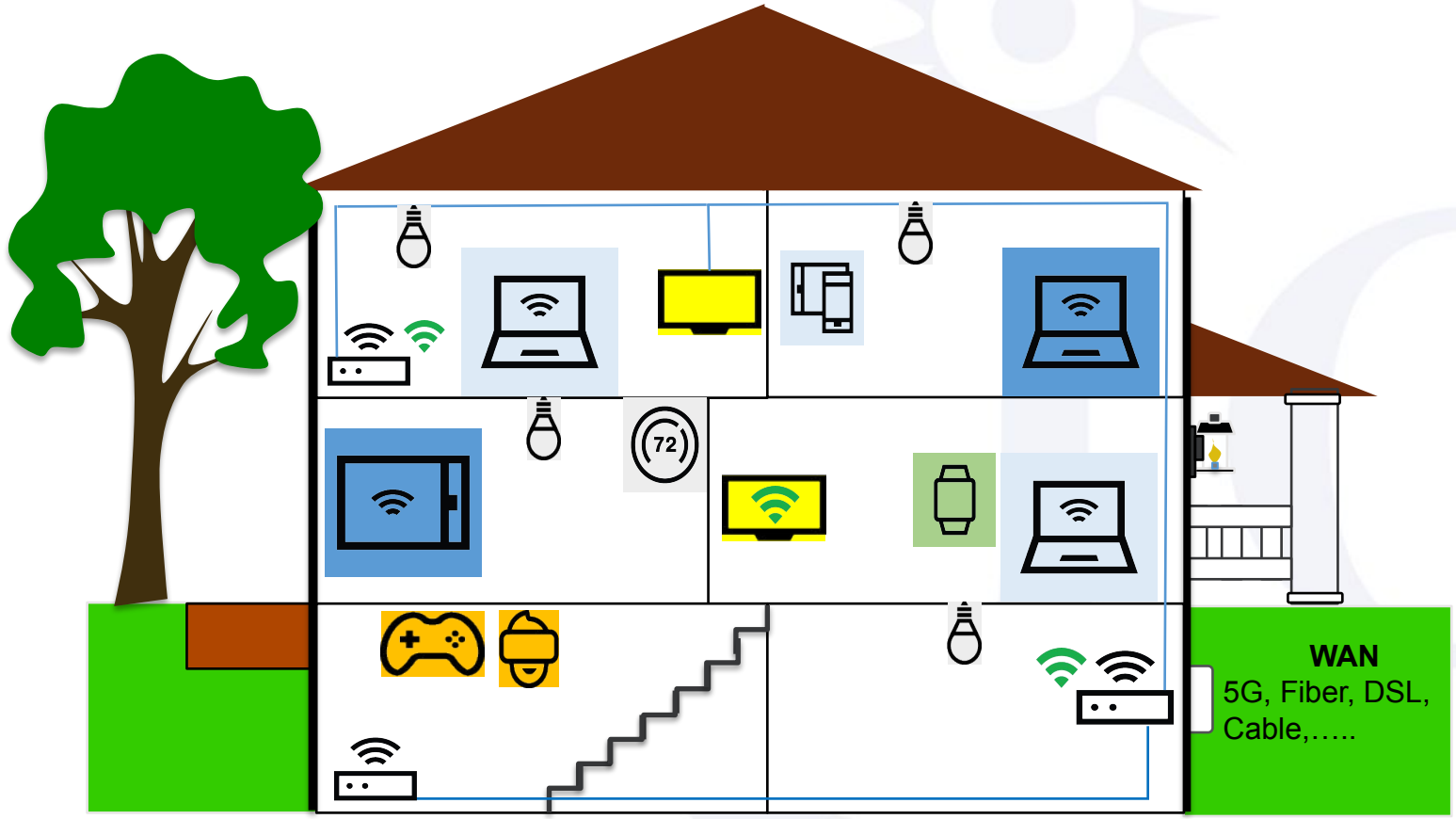
The importance of understanding Wi-Fi performance is key to ensuring Quality of Experience!



Souce: Omdia's Service Provider Connected Home survey, November 2020

Complexity of the Home

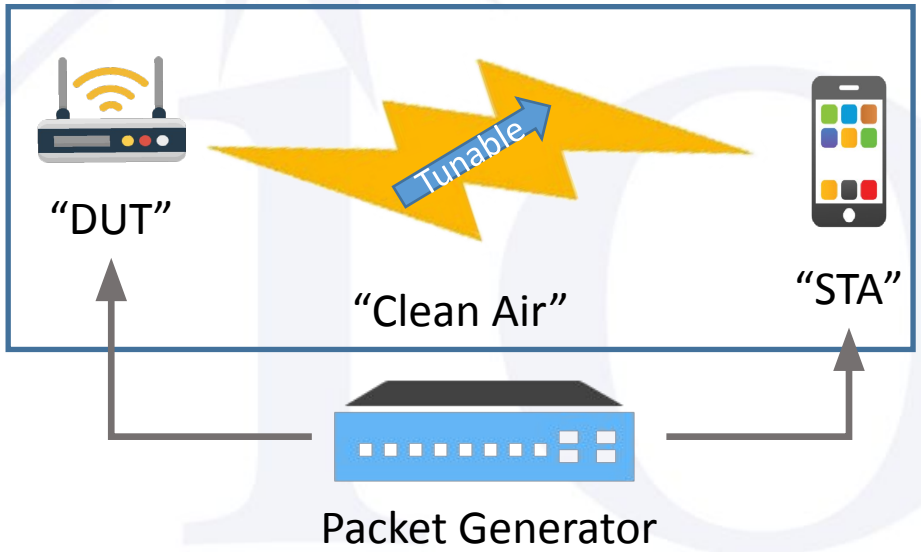
- Work from Home
- Streaming
- Wearables
- Home Access
- IOT Devices
- XR / Gaming
- Ethernet
- MoCA Multimedia over Coax Alliance
- 2.4Ghz Wi-Fi
- 5Ghz Wi-Fi
- 6Ghz Wi-Fi



What is TR-398i2?

A set of performance tests to evaluate the capability of an AP

Detailed test methodology ensures repeatability between labs, test runs, and devices



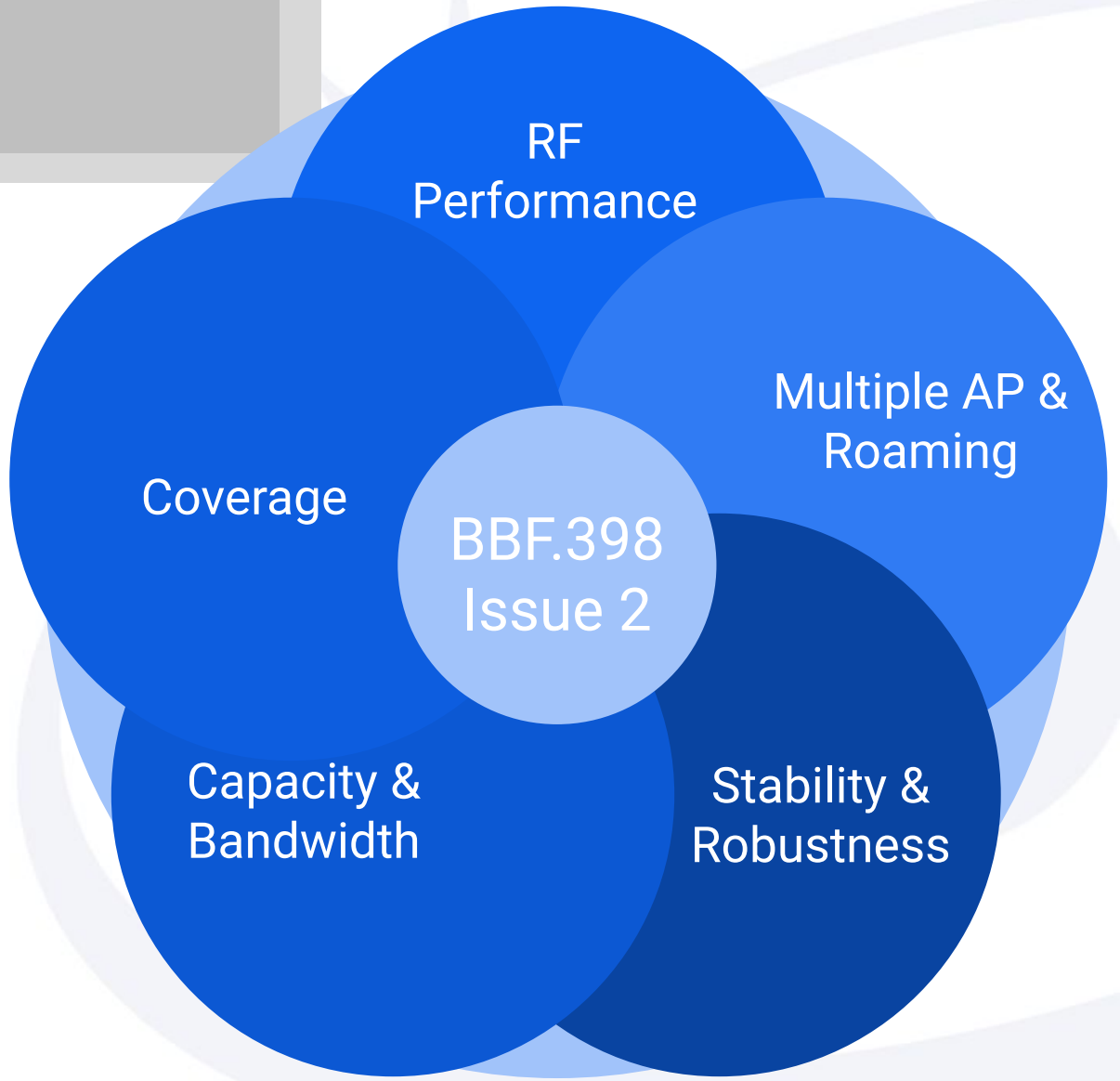
BBF.398i2 Test Coverage

Focused on operator requirements for Carrier Grade Wi-Fi

Wi-Fi 5 & Wi-Fi 6

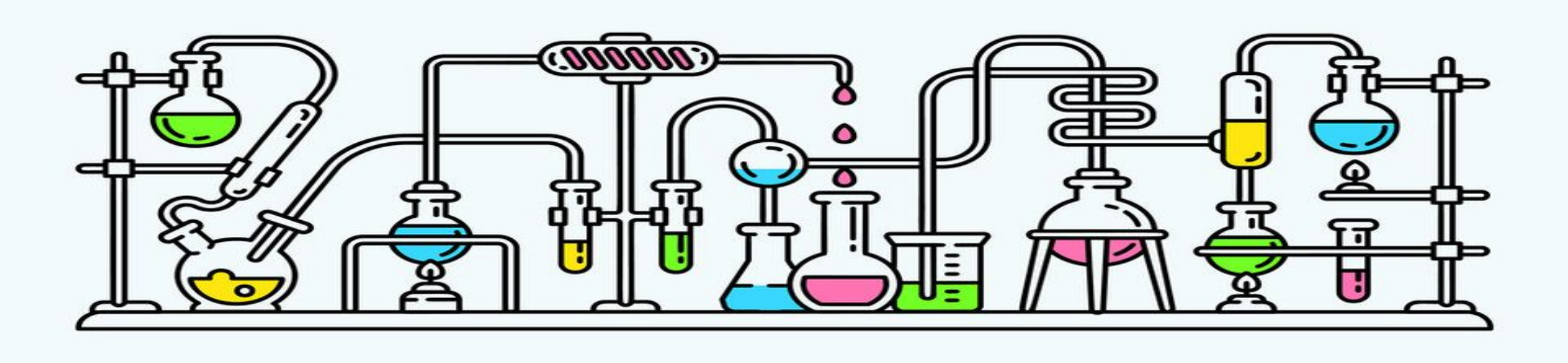
(802.11n, ac, and ax)

Absolute metrics / requirements for pass/fail test outcomes

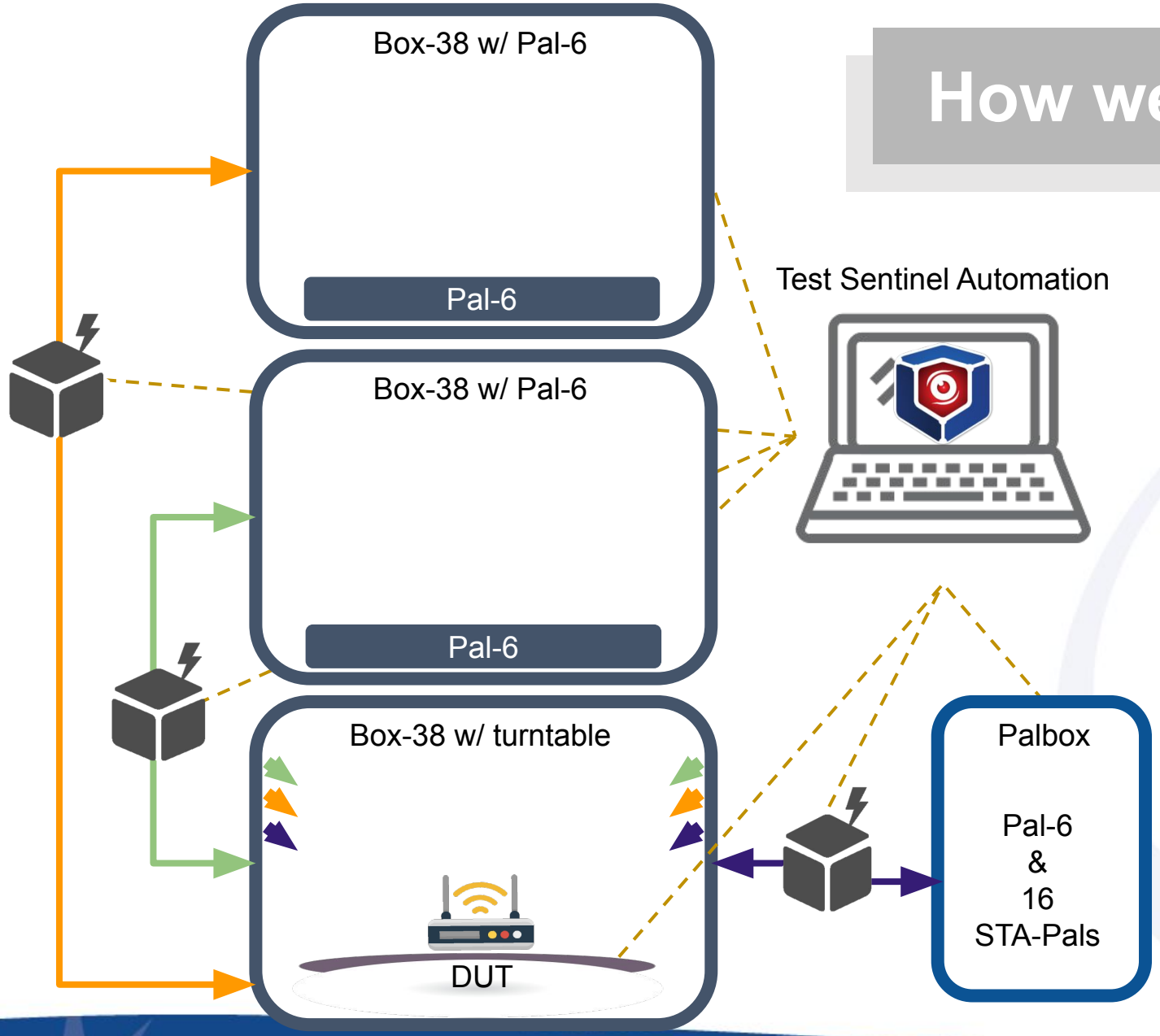


Test Environment

- Repeatability is key
- Clean “air” environment
- Controlled RF path
- Control of the STA operating modes
- Instrumented traffic generation



How we built the test setup



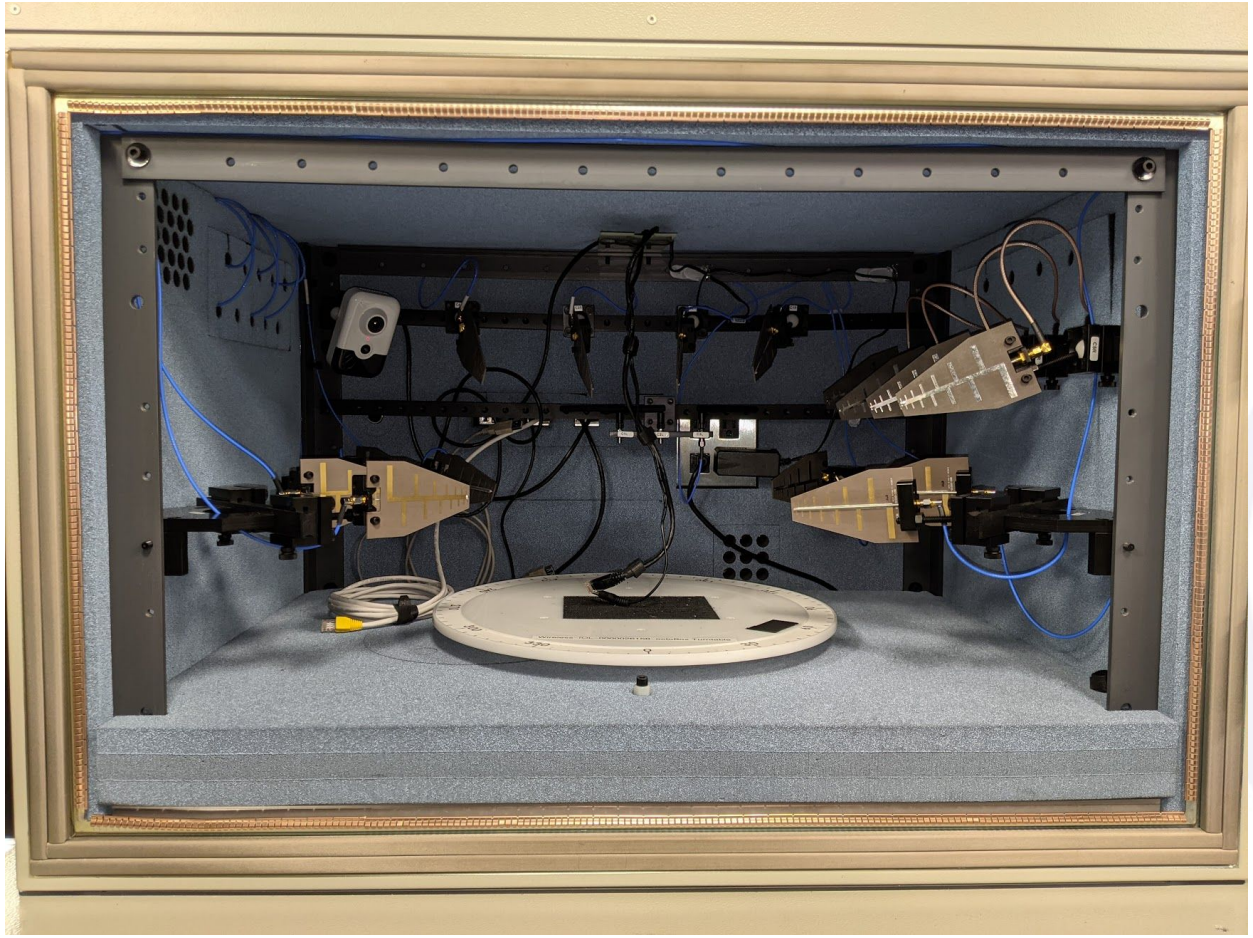
Test bed is based on octoScope

RF Path is controlled via programmable attenuators

Stations emulated by Pal equipment

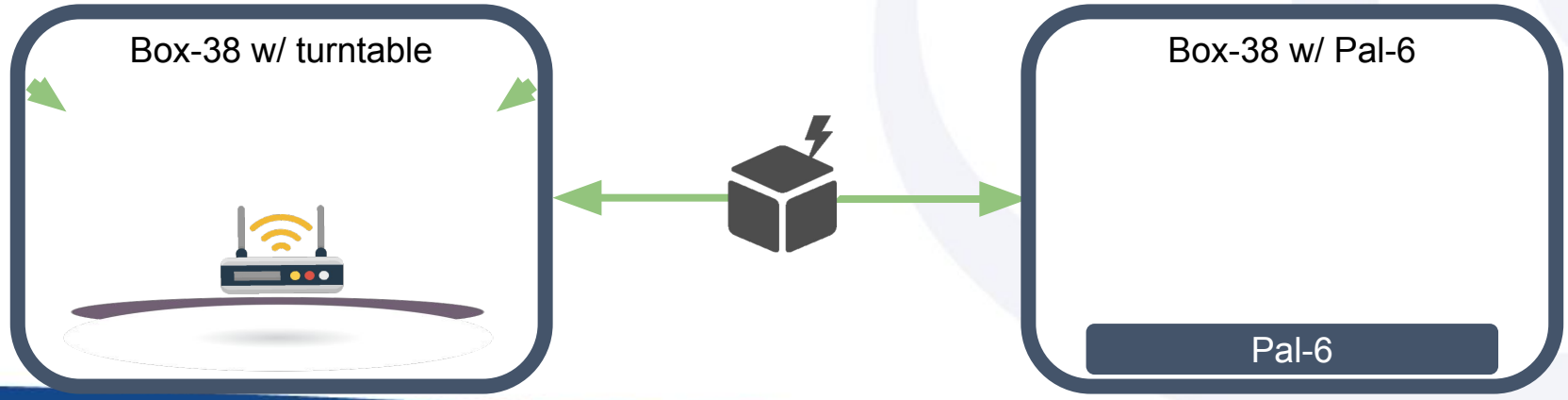
UNH-IOL Test Sentinel automation fully controls all components and collects results

What's under the hood?



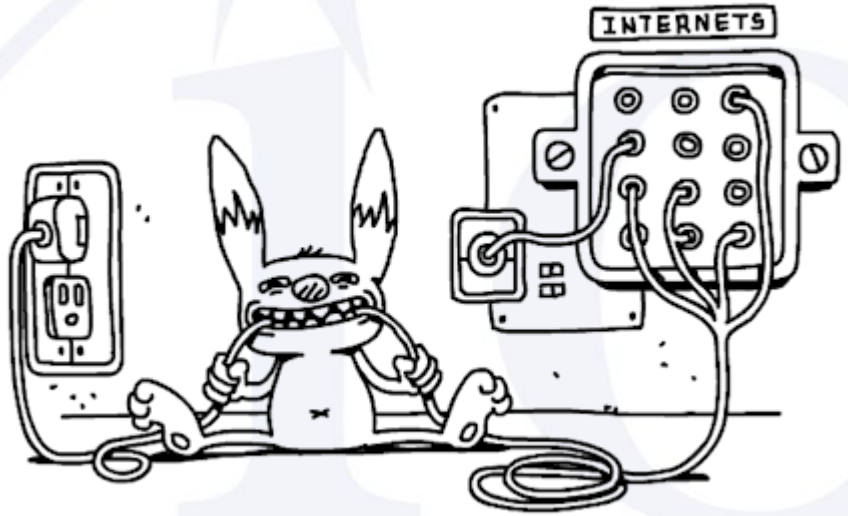
Basic Test Layout

- Coverage for the majority of test cases within TR-398i2
- Pal-6 configured as 1 or more STAs
- Tunetable and programmable attenuator define the test scenario
- One set of near-field antennas accommodate any device under test



Where the gremlins are

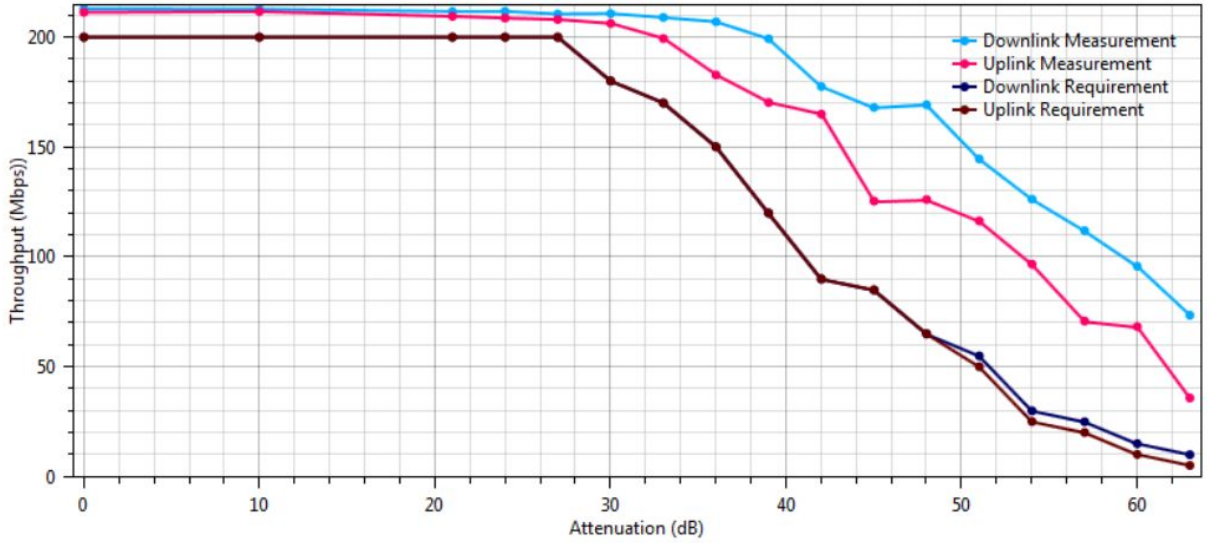
- Account for RF path losses in the test setup
- Watch out for STA impacts on the testing, use well know devices
- Device positions relative to near field antennas
- Mind the cables, don't touch the antennas



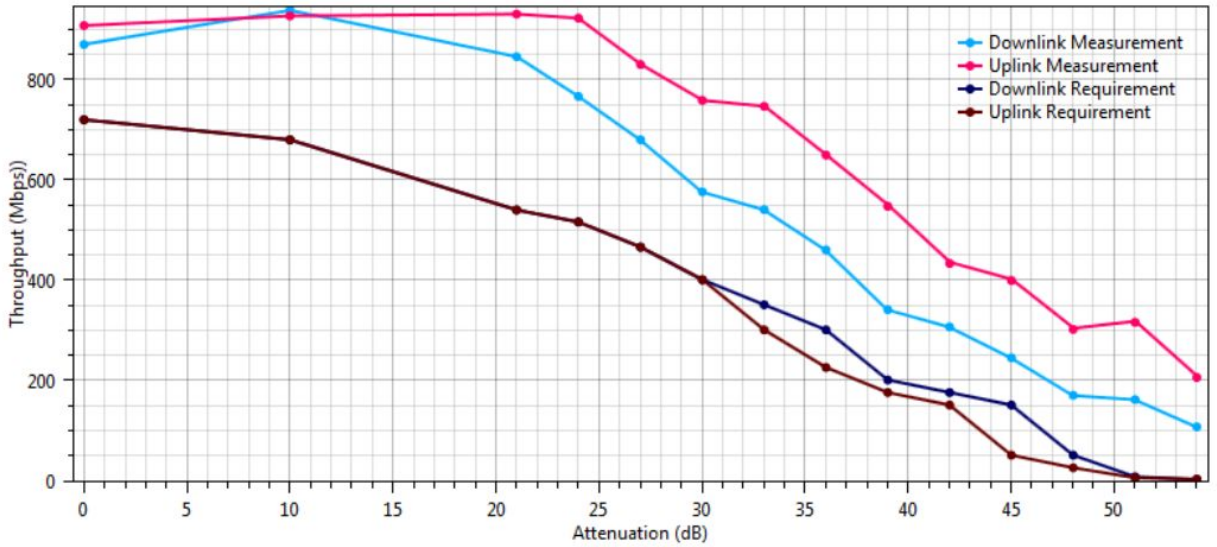
- Watch out for OS and CPU impacts on the traffic generator
- Automation is key to repeatability, humans are bad repeated tasks

Early Results

802.11ax 2.4 GHz Throughput vs Range



802.11ax 5 GHz Throughput vs Range



* Attenuation values are in addition to the “base” 2m test setup.

Early Results

802.11ax Dual-Band Throughput

2.4 GHz: 10 dB Downlink | 5 GHz: 10 dB Downlink			
2.4 GHZ		5 GHz	
Measurement	214.08	Measurement	725.28
Requirement	195	Requirement	700
2.4 GHz: 10 dB Uplink | 5 GHz: 10 dB Uplink			
2.4 GHZ		5 GHz	
Measurement	208.92	Measurement	730.52
Requirement	195	Requirement	700
2.4 GHz: 10 dB Downlink | 5 GHz: 10 dB Uplink			
2.4 GHZ		5 GHz	
Measurement	213.78	Measurement	921.65
Requirement	195	Requirement	700
2.4 GHz: 10 dB Uplink | 5 GHz: 10 dB Downlink			
2.4 GHZ		5 GHz	
Measurement	212.17	Measurement	934.1
Requirement	195	Requirement	700

2.4 GHz: 32 dB Downlink | 5 GHz: 25 dB Downlink			
2.4 GHZ		5 GHz	
Measurement	210.85	Measurement	727.81
Requirement	130	Requirement	400
2.4 GHz: 32 dB Downlink | 5 GHz: 25 dB Downlink			
2.4 GHZ		5 GHz	
Measurement	198.64	Measurement	740.93
Requirement	130	Requirement	400
2.4 GHz: 32 dB Downlink | 5 GHz: 25 dB Uplink			
2.4 GHZ		5 GHz	
Measurement	213.5	Measurement	895.24
Requirement	130	Requirement	400
2.4 GHz: 32 dB Uplink | 5 GHz: 25 dB Downlink			
2.4 GHZ		5 GHz	
Measurement	200.15	Measurement	864.38
Requirement	130	Requirement	400

2.4 GHz: 42 dB Downlink | 5 GHz: 35 dB Downlink			
2.4 GHZ		5 GHz	
Measurement	189.1	Measurement	565.89
Requirement	75	Requirement	250
2.4 GHz: 42 dB Uplink | 5 GHz: 35 dB Uplink			
2.4 GHZ		5 GHz	
Measurement	162.46	Measurement	734.78
Requirement	75	Requirement	250
2.4 GHz: 42 dB Downlink | 5 GHz: 35 dB Uplink			
2.4 GHZ		5 GHz	
Measurement	189.95	Measurement	743.71
Requirement	75	Requirement	250
2.4 GHz: 42 dB Downlink | 5 GHz: 35 dB Uplink			
2.4 GHZ		5 GHz	
Measurement	162.38	Measurement	567.44
Requirement	75	Requirement	250

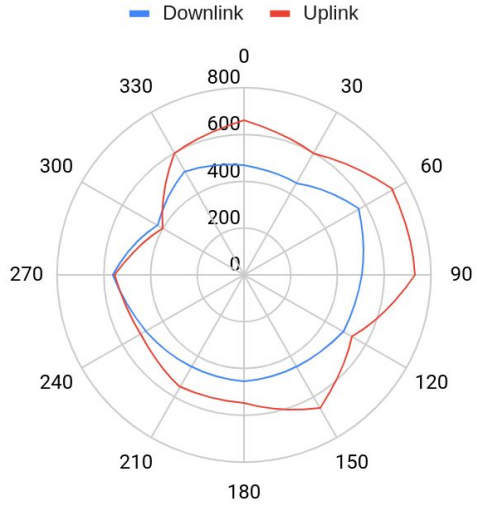
* All data rates are Mbps

Early Results

802.11ax 5 GHz Spatial Consistency

Rotation Angle	10 dB Attenuation		25 dB Attenuation		35 dB Attenuation	
	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink
0	867.277	936.19	689.06	902.211	467.059	657.593
30	931.316	919.052	698.966	846.389	452.934	597.485
60	940.465	927.958	865.133	930.447	570.103	733.291
90	940.636	927.335	761.488	931.648	504.488	733.291
120	937.094	926.976	763.856	850.483	489.043	530.005
150	940.872	922.707	700.182	908.93	452.205	653.296
180	937.598	933.404	738.294	908.93	452.651	547.148
210	939.745	933.684	743.557	840.379	449.791	550.813
240	940.406	923.073	755.539	828.192	481.003	510.156
270	937.49	930.467	758.815	828.192	561.719	550.941
300	866.754	926.317	686.598	721.069	429.527	398.538
330	866.754	926.317	758.802	721.069	512.396	595.787
Variation	5.84%	0.94%	7.64%	15.32%	11.48%	32.24%

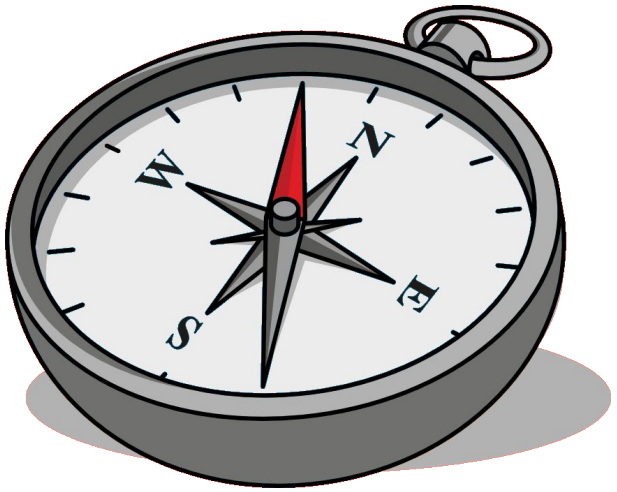
35dB Attenuation



35 dB attenuation (plus the 2m setup) represents about 100m free space

* All data rates are Mbps

Where to next



- Wi-Fi Technologies and deployments will continue to evolve
- BBF.398 development will continue, adding testing to meet growing needs of network operators (Issue 3 work kicked off during Q1-2021)

- Testing underway of devices meeting BBF.398 Grade Wi-Fi requirements

BBF.398 GRADE Wi-Fi

#WiFiwebinar

#UNHIOL

Continue your Wi-Fi Testing Journey

http://bit.ly/WiFiTestWeb

References & Contacts

- Lincoln Lavoie
  - UNH-IOL Principal Engineer, Broadband Technologies
  - lylavoie@iol.unh.edu
- Michael Talbert
  - Associate Fellow, Verizon
  - mike.talbert@verizon.com
- UNH-IOL WiFi Testing Services:
  - https://www.iol.unh.edu/testing/mobile/wifi
- octoScope Test Equipment:
  - https://www.octoscope.com/
- Broadband Forum Test Plan:
  - https://www.broadband-forum.org/technical/download/TR-398_Issue-2.pdf