

University of New Hampshire InterOperability Laboratory

The University of New Hampshire InterOperability Laboratory (UNH-IOL)

New & Expanded WiFi Test & Measurement Assures Performance at the Network Edge

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Agenda

- Wireless at the Network Edge
- •Creating a Test Environment
- Testing

Range, Fairness, Operations, Noise, Interop, Roaming, Mesh

Industry Directions

Nearly all edge network access utilizes a wireless technology, making the wireless a key driver in the user's quality of experience (QoE)

QoE is the user's perception of the network performance

Poor wireless performance \rightarrow Poor QoE

Poor QoE \rightarrow User complaints

•Challenge:

 Service providers must improve the QoE for risk loosing customers

•Solutions:

Provide customers with well known (tried & tested) solutions

- Cooperate with manufacturers to test WiFi equipment before field deployment
 - Repeatable testing to easily set baselines and find deviations caused by software or hardware changes

 A typical broadband home **o 4 Family Members** 0 1 Access Point ₀ 1 laptop _o 4 Smart Phones °2 tablets ° 2 TVs (w/ media player) This list is growing



Generations of technology

IEEE 802.11a/g
IEEE 802.11n
IEEE 802.11ac Wave 1
IEEE 802.11ac Wave 2

Access Point technology dominates performance setting Wave 2 AP out performs a/g AP Maximum performance when all stations match AP capabilities



Performance Impactors

AP Location (range)
Number of stations (fairness)
Other wireless systems (noise)
Network changes/association/beacons (operations)
Other device types (interoperability)

Predicting QoE

 Testing for the above categories can ensure deployed equipment will perform adequately to prevent low QoE scores

Creating a Test Environment

- UNH-IOL performance testing environment building upon octoScope octoBox personal test bed
- Addresses testing for the 4 key categories: range, noise, operational, interoperability

 Additional Testing: roaming, mesh



Creating a Test Environment

Control

° One variable under test

Repeatability

- $_{\circ}$ Low noise
- Automation capabilities
- Flexibility / Future Proof

- Cabled path between DUT and partner(s)
- Controlled path using attenuators and channel emulator
- Chambers eliminate external noise sources
- Support for 4 spatial streams, future up to 8
- Nearfield antenna simplify test setup

Creating a test Environment

- Isolation Chambers

 Turntable
 Nearfield antennas
- •MPE2 Multi-path emulator
- Attenuator(s)
- •PAL Partner Device(s)
- •Noise Generator



Testing: Range

- Controlled channel between two devices (DUT & Partner)
 - Partner can be real device or emulated endpoint
- Multi-path emulator and Quad-Attenuator create the "distance" between AP / Station
- Measure total throughput between DUT and Partner
- DUT is rotated to ensure uniform spatial performance



Testing: Range

- Test results indicate performance:
 - Bit-rate / Throughput
 Latency
- Test setup / design ensures repeatability

 Can be used to set absolute performance requirement

Throughput vs. Range in the 2.4 GHz Band (Downstream)



Testing: Fairness

- Test for AP device under load from multiple stations
 Pre-Wave2 devices can not talk in multiple directions
- Emulated stations perform simultaneous throughput measurements
 - $_{\circ}\,$ Can be mix of technologies (e.g. 802.11g and 802.11n)
- Ideally, all stations granted similar access to "airtime" resulting in similar performance
 - Can be used to verify functionality provided by QoS functions (Wi-Fi Alliance WMM for example)
 - Complex cases vary the "distance" (power) to from each station



Testing: Operations

 Test for AP device under stress from other operations:

 Association / Authentication / Disassociation
 Mixed Stations (802.11 standard)

Mixed Data Rates (fixed MCS)



Testing: Noise

- Test for AP or Station operating under noise environment
- •Noise sources include:
 - $_{\circ}$ Other 802.11 systems
 - Other technologies: Bluetooth, Zigbee, etc.
 - External Sources: Microwave Oven, etc.
 - o Regional Sources: Radar



- Key use cases when Dynamic Frequency / Channel selection is enabled.
 - AP / Station adjust to avoid interference or congested channels
 - Can measure adjustment / convergence timing or performance impact(s)
- Radar avoidance is mandatory feature from 802.11 specification

Testing: Interop

- Verify performance against a variety of common devices (AP or Station)
 - Typical test partners (AP):Netgear N7500 & Nighthwak, Linksys 2600; (Stations): iPhone, iPad, Apple TV, Google Pixel, Chromecast



Testing: Roaming

- Test station transitions
 between multiple AP
 - Can be used with and without active control (i.e. enterprise applications)
- New applications enabling AP to AP communication optimize station transition / associations



Testing: Mesh

- Similar to roaming testing, but with Wireless only path between APs
- Becoming increasingly important with multi-AP solutions
 - Cross vendor solutions on the horizon



Industry Directions

- Service Provider Challenge:
 Improving customer QoE with better WiFi
- Answer: Broadband Forum Test Plan
 - First industry accepted performance test plan
 - Stated 2017, expected to complete (publish) during 2018
 - Considerations given for repeatable testing, with performance requirements
 - Service providers can use the test plan and results to evaluate potential equipment (levels the playing field)



Industry Directions

- •UNH-IOL is continuing to augment test plans • Available to UNH-IOL member companies • Testing tends to lead ahead of standardized testing
- Strong partnerships with T&M equipment provides ensures cutting edge testing
- •On our roadmap:
 - Range testing with fine-gain rotation
 - Additional fairness testing
 - Receiver/stress testing



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#WiFiwebinar

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References & Contacts

- Lincoln Lavoie
 - UNH-IOL Senior Engineer, Broadband Technologies
 lylavoie@iol.unh.edu
- UNH-IOL WiFi Testing Services: <u>https://www.iol.unh.edu/testing/mobile/wifi</u>
- octoScope Test Equipment:
 - o <u>https://www.octoscope.com/</u>
- Broadband Forum Test Plan:
 - <u>https://issues.broadband-forum.org/browse/CONTRIB-20265</u> (draft, members only)