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

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

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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 → Poor QoE

Poor QoE → 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

- 4 Family Members
- 1 Access Point
- 1 laptop
- 4 Smart Phones
- 2 tablets
- 2 TVs (w/ media player)

This list is growing
• Generations of technology
  o IEEE 802.11a/g
  o IEEE 802.11n
  o IEEE 802.11ac Wave 1
  o IEEE 802.11ac Wave 2

• Access Point technology dominates performance setting
  o Wave 2 AP outperforms a/g AP
  o Maximum performance when all stations match AP capabilities
Wireless at the Edge

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

• Predicting QoE
  o Testing for the above categories can ensure deployed equipment will perform adequately to prevent low QoE scores
• 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
  o One variable under test
• Repeatability
  o Low noise
  o 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)
  o 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
• Test results indicate performance:
  o Bit-rate / Throughput
  o Latency
• Test setup / design ensures repeatability
  o Can be used to set absolute performance requirement
Testing: Fairness

- Test for AP device under load from multiple stations
  - Pre-Wave2 devices cannot talk in multiple directions
- Emulated stations perform simultaneous throughput measurements
  - 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)
• Test for AP or Station operating under noise environment

• Noise sources include:
  o Other 802.11 systems
  o Other technologies: Bluetooth, Zigbee, etc.
  o 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
• Verify performance against a variety of common devices (AP or Station)
  • Typical test partners
    (AP): Netgear N7500 & Nighthawk, Linksys 2600;
    (Stations): iPhone, iPad, Apple TV, Google Pixel, Chromecast
• Test station transitions between multiple AP
  o Can be used with and without active control (i.e. enterprise applications)
• New applications enabling AP to AP communication optimize station transition / associations
• Similar to roaming testing, but with Wireless only path between APs
• Becoming increasingly important with multi-AP solutions
  o 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)
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
References & Contacts

• Lincoln Lavoie
  o UNH-IOL Senior Engineer, Broadband Technologies
  o lylavoie@iol.unh.edu

• UNH-IOL WiFi Testing Services:
  o https://www.iol.unh.edu/testing/mobile/wifi

• octoScope Test Equipment:
  o https://www.octoscope.com/

• Broadband Forum Test Plan:
  o https://issues.broadband-forum.org/browse/CONTRIB-20265
    (draft, members only)