



University of New Hampshire
InterOperability
Laboratory

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

Introduction to Broadband Forum WiFi Performance Testing

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Agenda

- Who, What, When, Why, Where?
- Broadband Forum Test Plan Scope
- Implementation of testing
 - Avoiding common mistakes
- Looking to the future

Setting the Stage

- Why performance testing? Why Broadband Forum?
Why now?
- WiFi has become the defacto connection for devices in the home and small business
- Making WiFi performance a direct impactor on customer QoE
- Service providers need industry tools to performance WiFi devices

Wireless at the Edge

- Challenge:

- Service providers must improve the QoE for risk of losing customers

- Solutions:

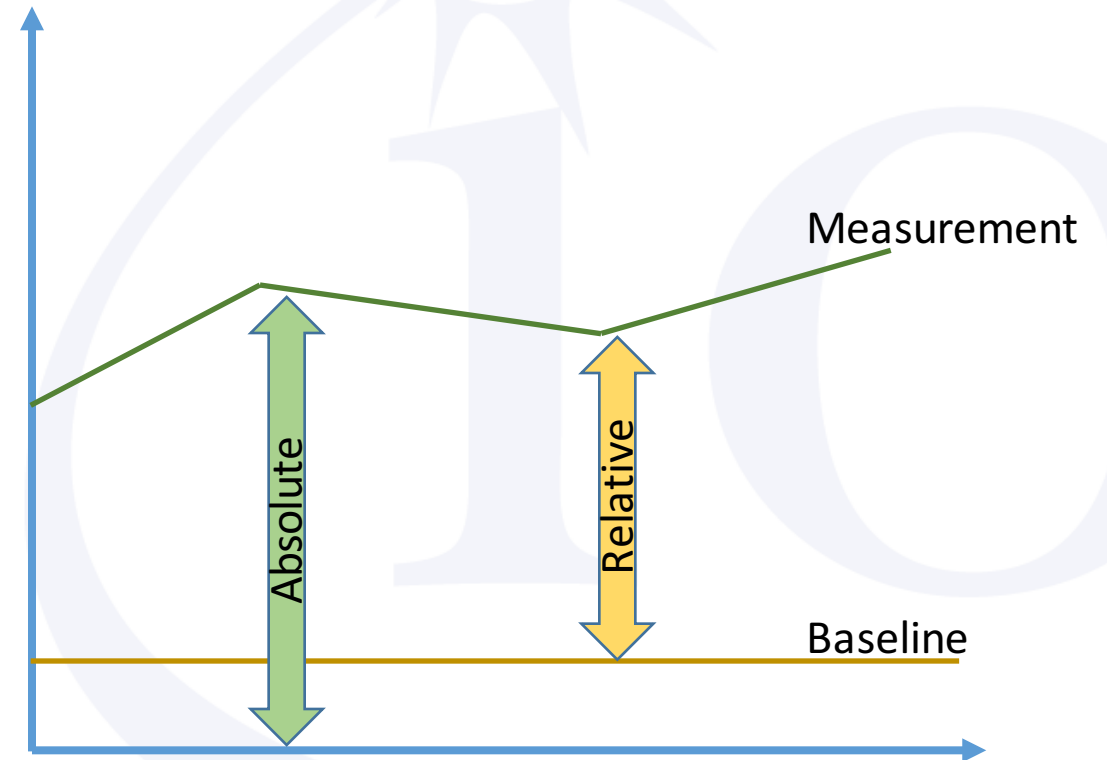
- Provide customers with well known (tried & tested) solutions
 - Cooperate with manufacturers to test WiFi equipment before field deployment
 - Repeatability testing to easily set baselines and find deviations caused by software or hardware changes

Test Plan Scope

- Scope:
 - Focused on testing of performance for AP devices (i.e. equipment provided by the service provider)
- Sections:
 - RF Capabilities
 - Baseline Performance
 - Coverage
 - Handling Multiple Stations
 - Stability & Robustness

Absolute vs Relative

- Broadband Forum test plan includes absolute performance requirements
 - Relative requirements are pass/fail metrics based on previous measurements for the same DUT
 - Absolute requirements are metrics relative to “zero”
- Broadband Forum test plan is unique in this aspect



RF Capabilities

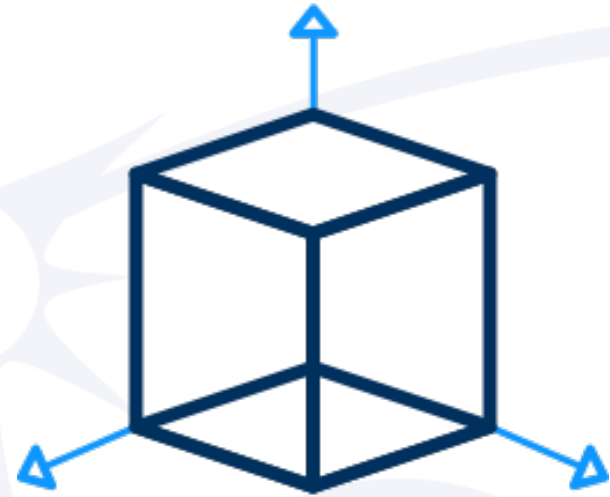
- Receiver Sensitivity – Measurement of DUT's ability to receive weak (small) signals
 - Impacted by: Chipset, Antenna Design, Internal Noise

Baseline Performance

- Maximum Throughput Test – Measure the DUT's maximum throughput under ideal conditions
 - Impacted by: Chipset, Antenna Design, System Software, CPU, Internal Noise
- Maximum Connection Test – Verify the DUT supports a minimum number of concurrently connected stations (STA)
 - Impacted by: Chipset, System Software, CPU
- Airtime Fairness – Verify the DUT fairly allocates “airtime” when multiple stations are actively passing traffic
 - Impacted by: Chipset, System Software, CPU

Coverage Testing

- Range Verse Rate – Measure the average throughput supported at different ranges (attenuation) between he DUT and STA
 - Impacted by: Chipset, Antenna Design, System Software, CPU
- Spatial Consistency – Measure the average throughput as a function of DUT orientation to the STA
 - Impacted by: Antenna Design



Handling Multiple Stations

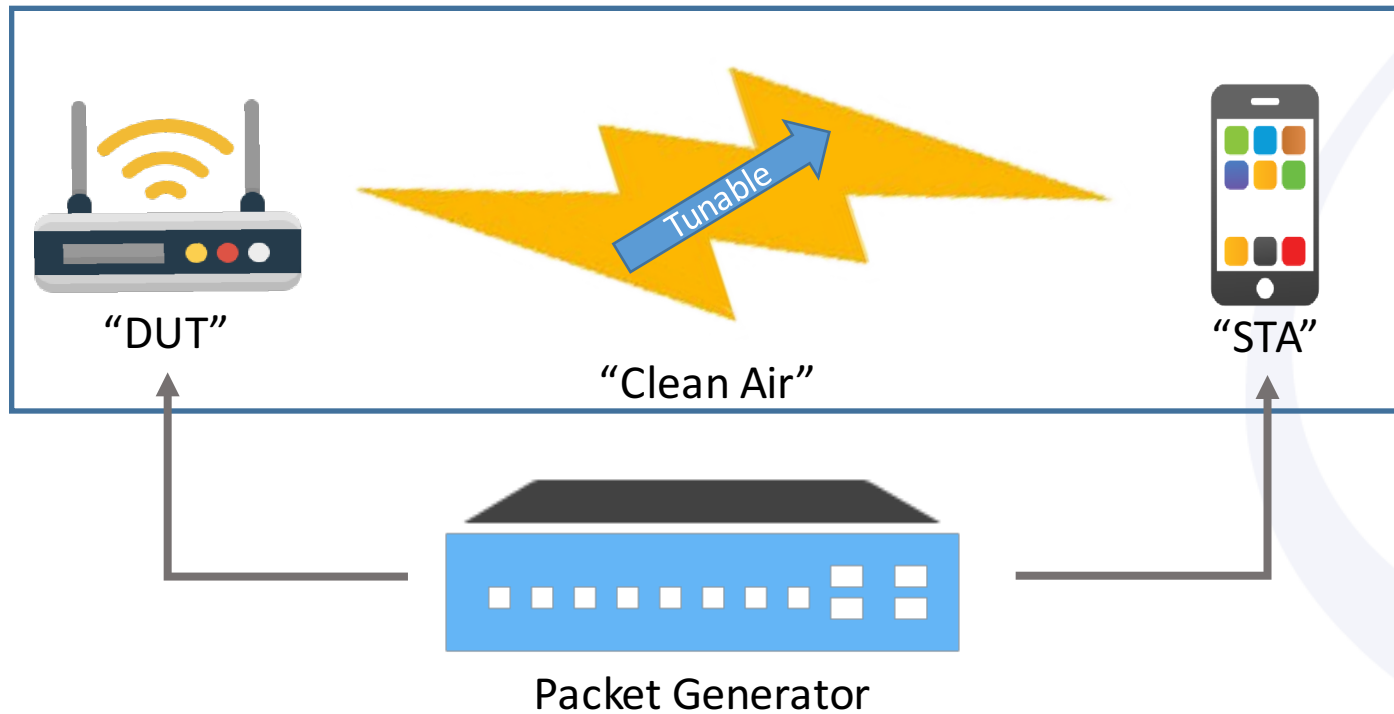
- Multiple Stations Performance – Measures the throughput between DUT and STA, when other STA are associated to the network
 - Impacted by: Chipset, Antenna Design, System Software, CPU
- Associations / Dissociations Stability – Verifies “non-impact” on throughput while other stations leave / join the network
 - Impacted by: Chipset, System Software, CPU
- Downlink MU-MIMO Performance – Measures throughput for systems implementing 802.11ac MU-MIMO for downlink (AP to STA)
 - Impacted by: Chipset, Antenna Design, System Software, CPU

Stability & Robustness

- Long Term Stability – Verifies the link is stable over long duration testing (24 hours)
 - Impacted by: Chipset, System Software
- AP Coexistence – Measures the system performance when other WiFi networks are in operation within the same “air space”
 - Impacted by: Chipset



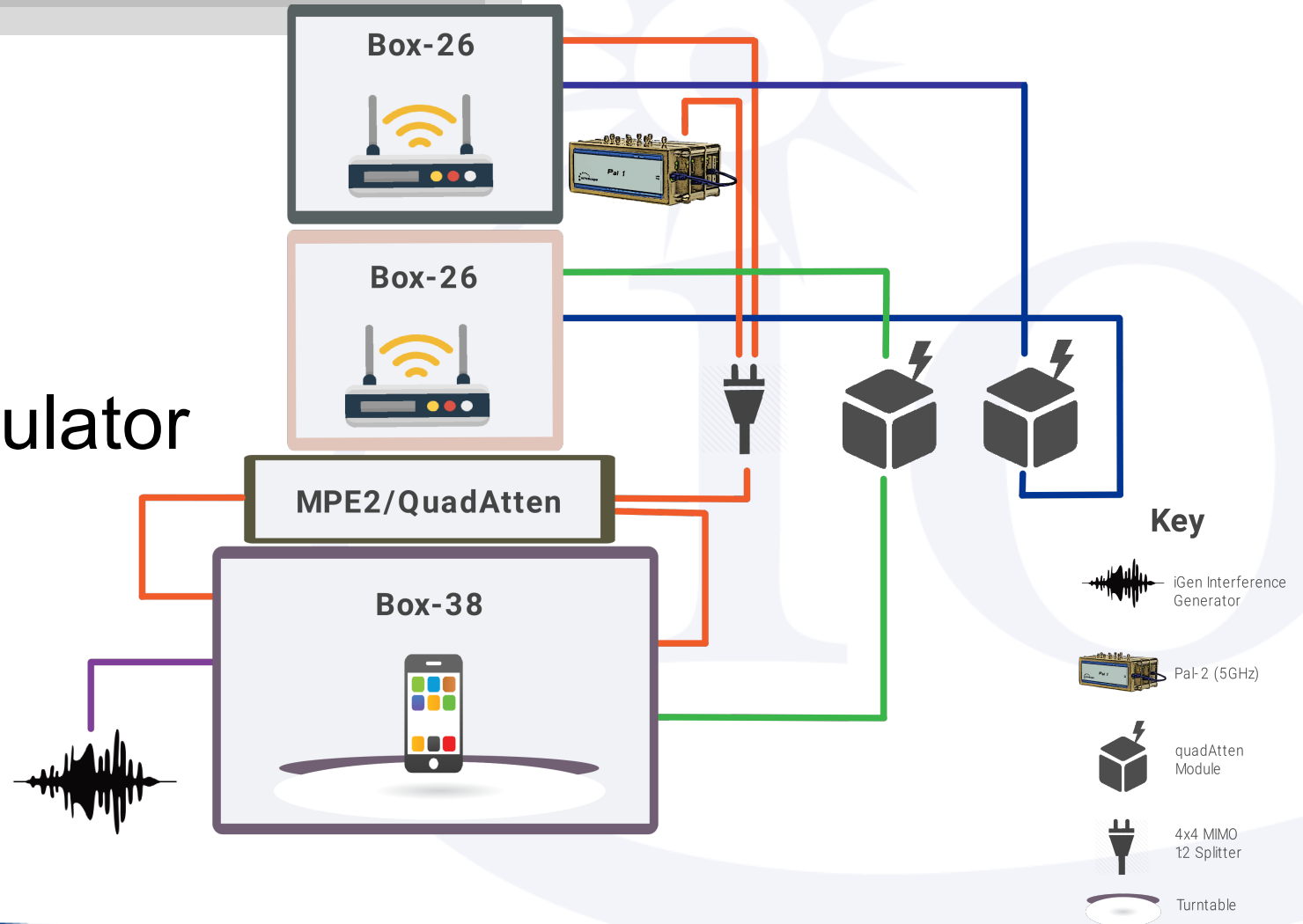
Implementation of Testing



- AP (DUT)
- Station(s)
- Controllable RF Path
- Clean RF Environment
- Packet Generator

Implementation of Testing (2)

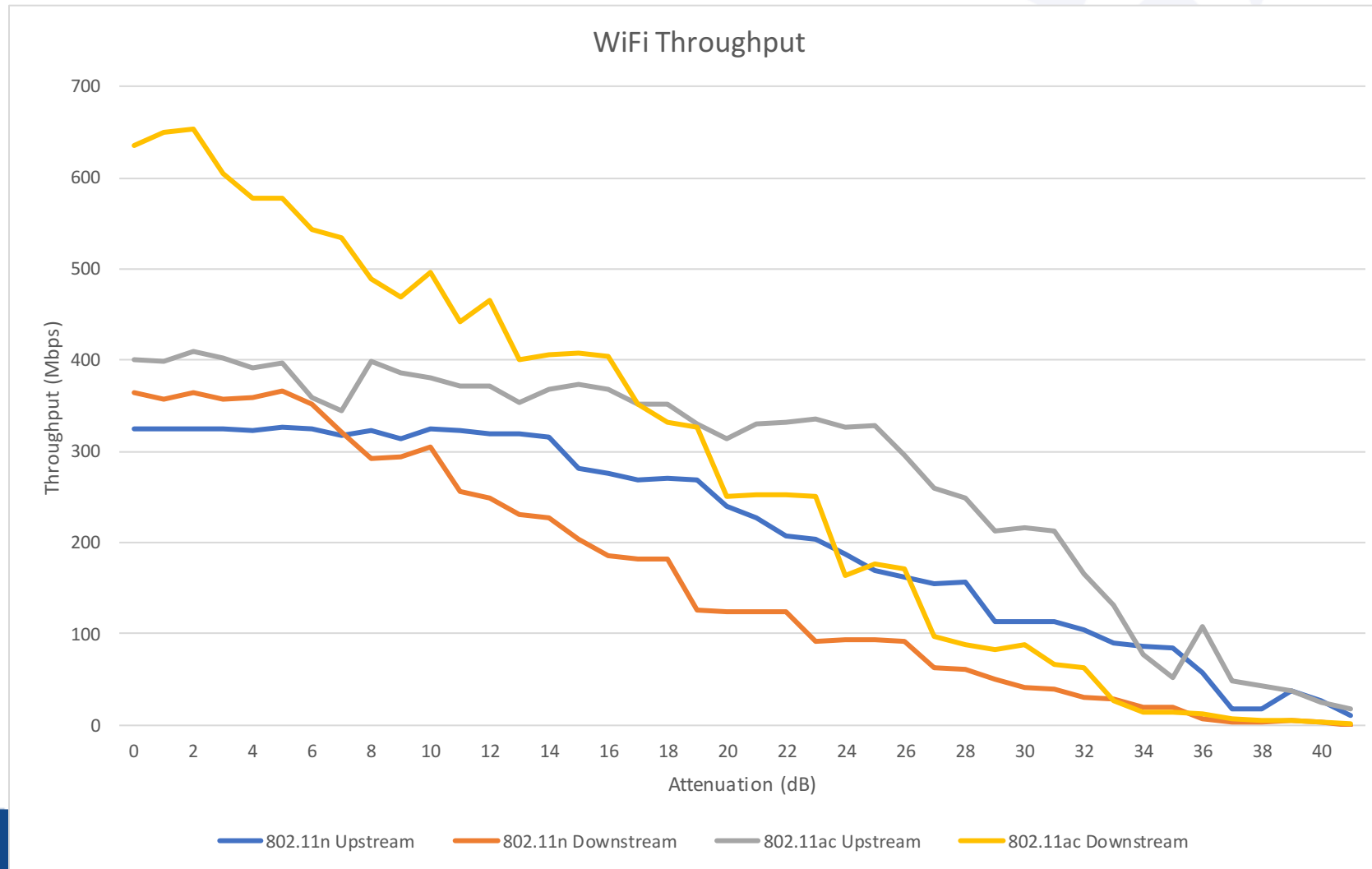
- Isolation Chambers
 - Turntable
 - Nearfield antennas
- MPE2 – Multi-path emulator
- Attenuator(s)
- PAL Partner Device(s)
- Noise Generator



Implementation of Testing (3)

- RF path is emulated with multi-path fading channel and attenuators
 - Drives repeatability & allows for automation
- Station(s) (STAs) are based on test & measurement equipment. Supporting latest 802.11 standards
- Test traffic can be generated using either iPerf or dedicated test & measurement equipment
 - Not yet fully specified in draft test plan

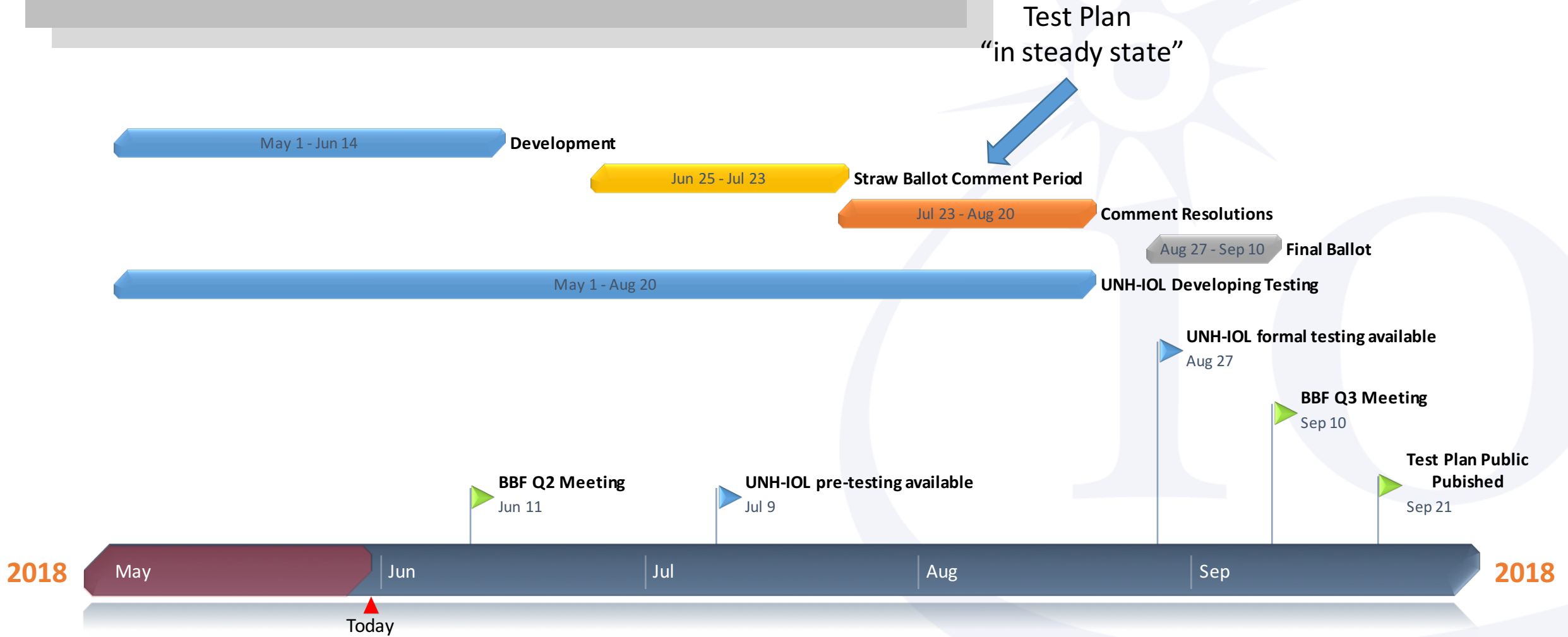
Some Initial Results



Common Pitfalls

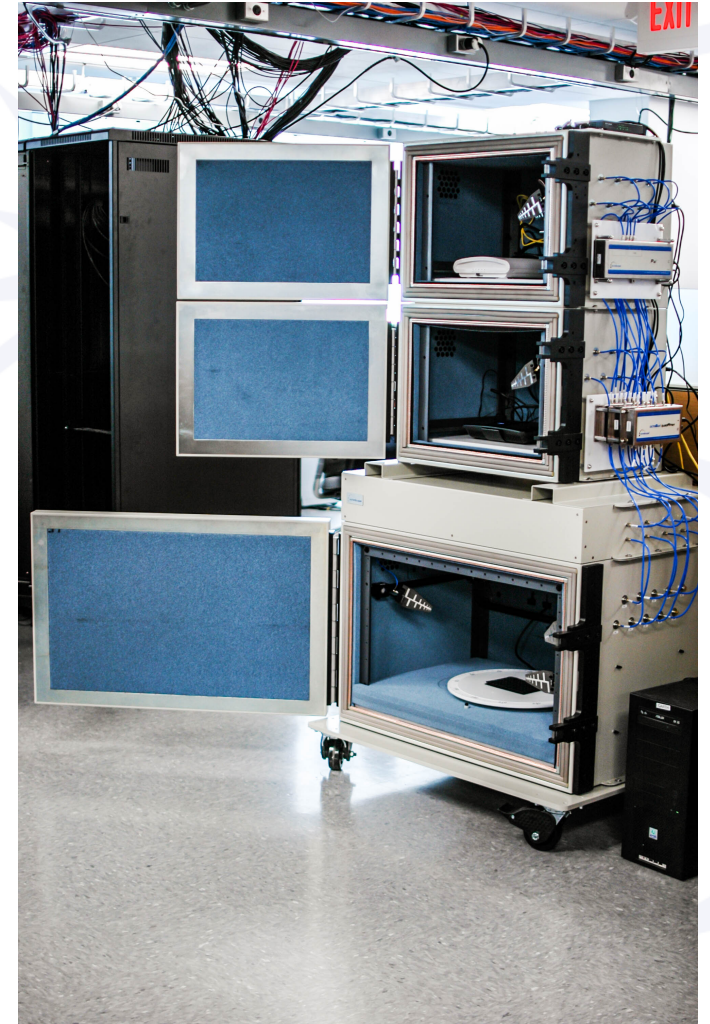
- Working with companies around to the world to develop and compare test results: we've seen many common mistakes.
- Noisy environment
 - Avoid any open air testing
 - Careful with RF connectors (i.e. proper tightness, etc.)
- Calibrated (controlled) RF path
 - Avoid purely flat paths (i.e. cable and attenuators only)
- Traffic measurement techniques
 - Configuration settings can have impact on measured results. Ideally, final test plan will provide very detailed requirements or iPerf command recipe.
- Dealing with number of spatial streams
 - Difference(s) between AP and STA
 - RF path impacts, number of channels, attenuators, etc.

Projected Timelines



Getting Tested

- UNH-IOL provides fully automated testing
- Testing performed in lab, Durham, NH, USA
 - Company engineers not required onsite (but welcome if they would like to attend testing)
 - Testing performed by UNH-IOL technicians
- Results owned directly by your company, not published by UNH-IOL or sent to 3rd party without authorization



In the Future

- Multi-AP Performance (client steering)
 - Station roaming between multiple AP
 - MAP protocol under development of WFA
 - AP Uplink is wired or wireless
- Mesh / Hybrid Networks
 - Links between APs provided by 802.11 only
 - Focus on performance through the mesh “uplink”
- QoE Testing
 - Impacts of Wireless channels on higher layer applications



#WiFiwebinar

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References & Contacts

- Lincoln Lavoie
 - UNH-IOL Senior Engineer, Broadband Technologies
 - lylavoie@iol.unh.edu
- 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://issues.broadband-forum.org/browse/CONTRIB-20265>
(draft, members only)