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Amsterdam, The Netherlands

Connected Home Broadband Acceleration Seminar

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IN COOPERATION WITH:

Broadband World Forum
Re-Defining Wi-Fi
Performance with TR-398

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The experience killers…
Do you have Internet?

- Subscribers associate Wi-Fi directly as the Internet
  - Poor Wi-Fi performance causes support calls and increased operational costs for operators
- Operators are facing growing demands on Wi-Fi services provided to their subscribers
  - Increased number of devices, demands for bandwidth, coverage requirements, lower latency
- Operators have responded:
  - Managed Wi-Fi offerings
  - Deploying proprietary multi-AP solutions
  - Cooperating in the BBF to develop TR-398 to enumerate their performance requirements
Introducing TR-398 Wi-Fi Performance Testing

- Focused on operator requirements to “Carrier Grade” Wi-Fi
- Testing coverage is for AP devices
- Pragmatic approach to testing, with emphasis on what is or will be deployed
  - Technologies: 802.11n & 802.11ac (2 spatial streams)
- First industry agreed absolute performance requirements
  - Pass / Fail decision points
TR-398 Issue 1 Development

- Strong focus on current and near term deployments and requirements
  - Test cases developed around key issues (performance / stability / coverage)
- Test metrics based on measurements of real devices
  - Across multiple vendors and chipsets
  - Final results selected to ensure the “bar” is reasonable, while delivering performance differentiation requested by operators
- Aims to define repeatable, well documented testing
  - Common language between vendors and operators on testing and results
- Some vocab
  - WT = “working text” (draft document)
  - TR = “technical report” (published document)
Test plan details requirements for the test infrastructure, without being prescriptive to tools or exact configuration.

Requirements:
- Noise / Interference less than -100 dBm total in an 80 MHz bandwidth
- RF path between STA and DUT is controllable & repeatable
- Test cases may specify additional requirements (i.e. impairments or additional stations)
Working Lab Example

- TR-398 Testing Environment, as implemented by University of New Hampshire InterOperability Lab
  - Provides full coverage for all TR-398 test cases
  - Well controlled RF path and environment, allowing for repeatable results
  - Controllable to full automation environment via Test Sentinel
  - Supports additional testing, including: roaming, mesh, 802.11ax, etc.
TR-398 Results (1)

TR-398 6.3.2: Spatial Consistency Test

AVERAGE THROUGHPUT IN 802.11ac AT MEDIUM RANGE (32 dB) (Mbps)

<table>
<thead>
<tr>
<th>Rotation (Degrees)</th>
<th>DL</th>
<th>UL</th>
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<tbody>
<tr>
<td></td>
<td>Required</td>
<td>Measured</td>
</tr>
<tr>
<td>0</td>
<td>200</td>
<td>374.957</td>
</tr>
<tr>
<td>30</td>
<td>200</td>
<td>356.937</td>
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<tr>
<td>60</td>
<td>200</td>
<td>322.858</td>
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<td>90</td>
<td>200</td>
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<tr>
<td>120</td>
<td>200</td>
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<td>150</td>
<td>200</td>
<td>263.707</td>
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<tr>
<td>180</td>
<td>200</td>
<td>332.086</td>
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<tr>
<td>210</td>
<td>200</td>
<td>208.182</td>
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<td>200</td>
<td>238.876</td>
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<tr>
<td>270</td>
<td>200</td>
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<td>300</td>
<td>200</td>
<td>365.213</td>
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<tr>
<td>330</td>
<td>200</td>
<td>367.012</td>
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<tr>
<td>Variation</td>
<td>&lt;40%</td>
<td>34.483</td>
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TR-398 Results (2)

For the RvR test, UNH-IOL typically performs test for 1dB “steps”

- Pass / Fail is determined based on points required by test plan
- Additional points provide best view of overall performance and provide additional debugging info

### TR-398 6.3.1: Range Versus Rate Test (802.11ac)

<table>
<thead>
<tr>
<th>Attenuation (dB)</th>
<th>Downlink Required</th>
<th>Measured</th>
<th>Uplink Required</th>
<th>Measured</th>
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<tbody>
<tr>
<td>0</td>
<td>560</td>
<td>610.237</td>
<td>560</td>
<td>687.181</td>
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<tr>
<td>10</td>
<td>530</td>
<td>588.026</td>
<td>530</td>
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<td>420</td>
<td>526.523</td>
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<td>709.012</td>
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<td>24</td>
<td>400</td>
<td>433.520</td>
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<td>54</td>
<td>1</td>
<td>19.785</td>
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<td>6.490</td>
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Why is TR-398 Important for ISPs?

- Customers’ perception of the overall QoS mostly based on Wi-Fi performance.

- Wi-Fi certification programs become a natural area of interest.

- Interoperability and security are key, but there’s more.
Example 1 – Performance Assessment

- Carriers assess the Wi-Fi performance of their devices.

- Not unusual to come across mismatch of observed results collected by different teams.

- Deceitful measurements? Poor testing? Not necessarily, lack of alignment.

- TR-398 provides a list of recommended test-cases, which promote more comparable results.
Example 2 – Same Feature Different Implementations

- Non-harmonized QoE across different devices.
- Time-consuming discussions to agree on the expected behaviour.
- TR-398 provides a clear set of expected outcomes.
Coming Up Next

- Work already underway within BBF for TR-398 Issue 2 - to address additional use cases within Wi-Fi deployments
  - Roaming, Client Steering, Channel Selection, Dual Band Operation, 802.11ax, multiple APs, Mesh, etc.
  - Testing methodology (TCP vs. UDP)
  - Advanced features: QoS, WMM

- Additional BBF Work:
  - Open Broadband Multi-AP (OB-MAP): Open source implementation of Wi-Fi Alliance EasyMesh
  - TR-069 / USP data model updates for 802.11ax and EasyMesh
  - Broadband Quality Experience Delivered (Broadband QED)
Getting Involved …

- **Broadband Forum**
  - [https://www.broadband-forum.org](https://www.broadband-forum.org)
  - Contribute to Issue 2 Test Plan: 4 face-to-face meetings & teleconference meetings
    - New input and test cases are always welcome

- **During the show**
  - Visit the BBF Interop Pavilion for a demo of QED or additional information on TR-398.

- **University of New Hampshire InterOperability Laboratory**
  - [https://www.iol.unh.edu/testing/mobile/wifi](https://www.iol.unh.edu/testing/mobile/wifi)
Re Defining Wi-Fi Performance with TR-398

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June 2-4, 2020
Den Haag, The Netherlands

THE DATE HAS BEEN SET!

An event by tech innovators for tech leaders!

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