# Table of Contents

- Table of Contents ..................................................................................................................... 2
- Modification Record .................................................................................................................. 3
- Acknowledgments ...................................................................................................................... 4
- Introduction ............................................................................................................................... 5
- Group 1: Performance in the 2.4 GHz Band ............................................................................. 7
  - Test 1.1: Open Air Baseline ...................................................................................................... 8
    - 1.1.1: Downstream Traffic .................................................................................................... 8
    - 1.1.2: Upstream Traffic ....................................................................................................... 8
  - Test 1.2: Throughput vs. Range .............................................................................................. 9
    - 1.2.1: Downstream Traffic .................................................................................................. 9
    - 1.2.2: Upstream Traffic ..................................................................................................... 10
- Group 2: Performance in the 5 GHz Band .............................................................................. 11
  - Test 2.1: Open Air Baseline .................................................................................................. 12
    - 2.1.1: Downstream Traffic .................................................................................................. 12
    - 2.1.2: Upstream Traffic ...................................................................................................... 12
  - Test 2.2: Throughput vs. Range ............................................................................................. 13
    - 2.2.1: Downstream Traffic ................................................................................................. 13
    - 2.2.2: Upstream Traffic ..................................................................................................... 14
Modification Record

- October 20, 2014 – Version 1.0 Release
  - Daniel Mareck/Auderien Monareh: Original Document creation.
- November 6, 2014 – Version 1.1 Release
  - Craig Chabot: Revision
- October 6, 2015 – Version 2.0 Release
  - Craig Chabot/Daniel Mareck/Auderien Monareh/Michael Schoerner: Revision
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Craig Chabot       University of New Hampshire  
Daniel Mareck      University of New Hampshire  
Auderien Monareh  University of New Hampshire  
Michael Schoerner  University of New Hampshire
Introduction

Overview
The University of New Hampshire’s InterOperability Laboratory (UNH-IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard.

Note: Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other compliant devices. However, combined with satisfactory operation in the IOL’s interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function well in most environments.

Organization of Tests
The tests contained in this document are organized to simplify the identification of information related to a test and to facilitate in the actual testing process. Each test contains an identification section that describes the test and provides cross-reference information. The discussion section covers background information and specifies why the test is to be performed. Tests are grouped in order to reduce setup time in the lab environment. Each test contains the following information:

Test Number
The Test Number associated with each test follows a simple grouping structure. Listed first is the Test Group Number followed by the test’s number within the group. This allows for the addition of future tests to the appropriate groups of the test suite without requiring the renumbering of the subsequent tests.

Purpose
The purpose is a brief statement outlining what the test attempts to achieve. The test is written at the functional level.

References
The references section lists cross-references to the IEEE 802.11 standards and other documentation that might be helpful in understanding and evaluating the test results.

Resource Requirements
The requirements section specifies the test hardware and/or software needed to perform the test. This is generally expressed in terms of minimum requirements, however in some cases specific equipment manufacturer/model information may be provided.

Last Modification
This specifies the date of the last modification to this test.

Discussion
The discussion covers the assumptions made in the design or implementation of the test, as well as known limitations. Other items specific to the test are covered here.

Test Setup
The setup section describes the initial configuration of the test environment. Small changes in the configuration should be included in the test procedure.

Procedure
The procedure section of the test description contains the systematic instructions for carrying out the test. It provides a cookbook approach to testing and may be interspersed with observable results.
Observable Results
This section lists the specific observables that can be examined by the tester in order to verify that the DUT is operating properly. When multiple values for an observable are possible, this section provides a short discussion on how to interpret them. The determination of a pass or fail outcome for a particular test is often based on the successful (or unsuccessful) detection of a certain observable.

Possible Problems
This section contains a description of known issues with the test procedure, which may affect test results in certain situations. It may also refer the reader to test suite appendices and/or whitepapers that may provide more detail regarding these issues.

Legend
For reasons of brevity, the following abbreviations have been used in this test suite:

AP  802.11 Access Point
APUT Access Point under test
DUT Device under test
ETH Ethernet endpoint on the wired side of the network
OB-MPE octoBox and Multi-Path Emulator
OOB Out of Box Settings
SS Spatial Stream
STA 802.11 Station
STAUT Station under test
TS Testing Station
Group 1: Performance in the 2.4 GHz Band

**Overview:** This group of tests uses IxChariot and Ixia Performance Endpoint to send TCP traffic from the TS to the DUT or through the DUT to an additional Ethernet endpoint (ETH2) running Ixia Performance Endpoint. Increasing degrees of attenuation via the octoScope quadAtten™ RF Attenuation module emulates increasing distance between the two endpoints. A “baseline” throughput measurement also will be taken in an open-air RF-isolated environment to serve as a point of comparison.

This test suite requires Ixia Performance Endpoint to be installed and running on the DUT or that a bridgeable Ethernet interface be available.

The following table shows the default settings for a 4SS 802.11abgnac certified AP Testing Station (TS). It operates as an AP for a STAUT and a STA (through the use of bridge mode) for an APUT. These configurations are to be used unless noted otherwise within a test case. The DUT should remain in its OOB settings unless noted otherwise within a test case.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>Channel Width</td>
<td>20 MHz</td>
</tr>
<tr>
<td>Channel</td>
<td>6</td>
</tr>
<tr>
<td>Security</td>
<td>WPA2-PSK</td>
</tr>
<tr>
<td>Encryption</td>
<td>AES-CCMP</td>
</tr>
<tr>
<td>SSID</td>
<td>rangeVthroughput</td>
</tr>
<tr>
<td>PSK</td>
<td>octoBox1</td>
</tr>
<tr>
<td>Short Guard Interval</td>
<td>Enabled</td>
</tr>
<tr>
<td>MPDU Aggregation</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

The following table specifies the default parameters for the OB_Throughput_TPTvsRange.tcl TCL script used to control IxChariot and the quadAtten™ RF Attenuator Module during testing. All other parameters should be set to `false` or left in its default value.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>attenEnable</td>
<td>True</td>
</tr>
<tr>
<td>attenStart</td>
<td>0</td>
</tr>
<tr>
<td>attenStop</td>
<td>60</td>
</tr>
<tr>
<td>attenStep</td>
<td>3</td>
</tr>
<tr>
<td>chariotEnable</td>
<td>True</td>
</tr>
<tr>
<td>stopOnError</td>
<td>True</td>
</tr>
<tr>
<td>Timeout</td>
<td>75</td>
</tr>
<tr>
<td>testMaskEnable</td>
<td>True</td>
</tr>
<tr>
<td>testMaskDelay</td>
<td>45</td>
</tr>
</tbody>
</table>
Test 1.1: Open Air Baseline

Purpose: To test throughput values between the DUT and TS in an open-air environment within a walk-in wireless isolation chamber.

References:
- IEEE Std 802.11-2012 Edition

Resource Requirements
- 802.11a/b/g/n/ac Testing STA (TS) that can be used as link partner with APUT or STAUT
- Ethernet endpoint (ETH) running IxChariot Console and Performance Endpoint
- additional Ethernet endpoint (ETH2) running Ixia Performance Endpoint (if needed)
- OB_Throughput_TPTvsRange.tcl TCL script
- IxChariot test file running a high throughput TCP traffic script
- walk-in wireless isolation chamber

Last Updated: October 6, 2015

Discussion: This test verifies that all components of the test setup can interoperate and provides a baseline against which the attenuated testing results gathered in test 1.2 can be compared.

Test Setup: Place the DUT and TS within range of each other in a wireless isolation chamber. Connect the TS to ETH. For APUT, connect the DUT to ETH2. For STAUT, confirm that Ixia Performance Endpoint is running on the STAUT. If the DUT does not support installation of Ixia Performance Endpoint, connect the DUT to ETH2.

Table – TvR TCL Script

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>attenEnable</td>
<td>false</td>
</tr>
</tbody>
</table>

1.1.1: Downstream Traffic

Procedure:
1) Verify that the endpoint pair defined in the IxChariot test file is set up so that Endpoint 1 is the IP address of ETH and Endpoint 2 is the IP address of ETH2 or the DUT running Ixia Performance Endpoint
2) Allow the DUT and TS to Authenticate, Associate, and complete the 4-way Handshake
3) Open a Command Prompt window in the same directory as the TCL script and issue the command:
   >tclshOB_Throughput_TPTvsRange.tcl
4) Record the observed throughput from the IxChariot console
5) Repeat step 3 three times
6) Average the results to obtain the downstream throughput baseline

1.1.2: Upstream Traffic

Procedure:
1) Swap the endpoint pair defined in the IxChariot test file is set up so that Endpoint 1 is the IP address of ETH2 or the DUT running Ixia Performance Endpoint and Endpoint 2 is the IP address of ETH
2) Allow the DUT and TS to Authenticate, Associate, and complete the 4-way Handshake
3) Open a Command Prompt window in the same directory as the TCL script and issue the command:
   >tclshOB_Throughput_TPTvsRange.tcl
4) Record the observed throughput from the IxChariot console
5) Repeat step 3 two more times
6) Average the results to obtain the upstream throughput baseline
Test 1.2: Throughput vs. Range

**Purpose:** To test throughput values between the DUT and TS connected at varying attenuation levels utilizing the octoBox and Multi-Path Emulator.

**References:**
- IEEE Std 802.11-2012 Edition

**Resource Requirements**
- 802.11a/b/g/n/ac Testing STA (TS) that can be used as link partner with APUT or STAUT
- Ethernet endpoint (ETH) running IxChariot Console and Performance Endpoint
- additional Ethernet endpoint (ETH2) running Ixia Performance Endpoint (if needed)
- octoBox Multi-Path Emulator with quadAtten™ RF Attenuator Module
- OB_Throughput_TPTvsRange.tcl TCL script
- IxChariot test file running a high throughput TCP traffic script

**Last Updated:** October 6, 2015

**Discussion:** This test discovers the DUT’s performance by evaluating its throughput levels while interoperating with the TS at varying simulated distances through the use of attenuation. Testing is performed utilizing octoScope's OB-MPE which provides the necessary environment to attain consistent and repeatable testing results in addition to emulating a Model B 802.11 channel for MIMO (or spatial streaming) devices.

**Test Setup:** Place the DUT in the top octoBox chamber with its antennas oriented closest to the near field antennas and connect it to the internal Ethernet port if necessary. Place the TS in the bottom octoBox chamber and connect it to the internal Ethernet port and antenna cabling. Connect ETH to the bottom octoBox chamber's external Ethernet port. If needed, connect ETH2 to the top octoBox’s external Ethernet port.

**1.2.1: Downstream Traffic**

**Procedure:**
1) Verify that the endpoint pair defined in the IxChariot test file is set up so that Endpoint 1 is the IP address of ETH and Endpoint 2 is the IP address of ETH2 or the DUT running Ixia Performance Endpoint
2) Allow the DUT and TS to Authenticate, Associate, and complete the 4-way Handshake
3) Open a Command Prompt window in the same directory as the TCL script and issue the command: >tclsh OB_Throughput_TPTvsRange.tcl
4) Record the observed throughput from the IxChariot console
5) Rotate the DUT 90° clockwise from the original position and repeat steps 1-3
6) Rotate the DUT 180° clockwise from the original position and repeat steps 1-3
7) Rotate the DUT 270° clockwise from the original position and repeat steps 1-3

**Possible Problems:** None
1.2.2: Upstream Traffic

Procedure:
1) Swap the endpoint pair defined in the IxChariot test file is set up so that Endpoint 1 is the IP address of ETH2 or the DUT running Ixia Performance Endpoint and Endpoint 2 is the IP address of ETH
2) Allow the DUT and TS to Authenticate, Associate, and complete the 4-way Handshake
3) Open a Command Prompt window in the same directory as the TCL script and issue the command: `>tclshOB_Throughput_TPTvsRange.tcl`
4) Record the observed throughput from the IxChariot console
5) Rotate the DUT 90° clockwise from the original position and repeat steps 1-3
6) Rotate the DUT 180° clockwise from the original position and repeat steps 1-3
7) Rotate the DUT 270° clockwise from the original position and repeat steps 1-3

Possible Problems: None
**Group 2: Performance in the 5 GHz Band**

**Overview:** This group of tests repeats the tests defined in Group 1, this time with the network configured to operate in the 5 GHz band.

The following table specifies the default settings for the TS for this group of tests. All other parameters should be set as specified in the Group 1 Overview or left in its OOB settings. Unless otherwise specified, the test setup should be left as it was for the Group 1 tests.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band</td>
<td>5 GHz</td>
</tr>
<tr>
<td>Channel Width</td>
<td>20/40/80 MHz</td>
</tr>
<tr>
<td>Channel</td>
<td>149</td>
</tr>
</tbody>
</table>
Test 2.1: Open Air Baseline

Purpose: To test throughput values between the DUT and TS in an open-air environment within a walk-in wireless isolation chamber.

References:
- IEEE Std 802.11-2012 Edition

Resource Requirements
- 802.11a/b/g/n/ac Testing STA (TS) that can be used as link partner with APUT or STAUT
- Ethernet endpoint (ETH) running IxChariot Console and Performance Endpoint
- additional Ethernet endpoint (ETH2) running Ixia Performance Endpoint (if needed)
- OB_Throughput_TPTvsRange.tcl TCL script
- IxChariot test file running a high throughput TCP traffic script
- walk-in wireless isolation chamber

Last Updated: October 6, 2015

Discussion: This test verifies that all components of the test setup can interoperate and provides a baseline against which the attenuated testing results gathered in test 2.2 can be compared.

Test Setup: Place the DUT and TS within range of each other in a wireless isolation chamber. Connect the TS to ETH. For APUT, connect the DUT to ETH2. For STAUT, confirm that Ixia Performance Endpoint is running on the STAUT. If the DUT does not support installation of Ixia Performance Endpoint, connect the DUT to ETH2.

Table – Tvr TCL Script

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>attenEnable</td>
<td>false</td>
</tr>
</tbody>
</table>

2.1.1: Downstream Traffic

Procedure:
1) Verify that the endpoint pair defined in the IxChariot test file is set up so that Endpoint 1 is the IP address of ETH and Endpoint 2 is the IP address of ETH2 or the DUT running Ixia Performance Endpoint
2) Allow the DUT and TS to Authenticate, Associate, and complete the 4-way Handshake
3) Open a Command Prompt window in the same directory as the TCL script and issue the command:
   >tclsh OB_Throughput_TPTvsRange.tcl
4) Record the observed throughput from the IxChariot console
5) Repeat step 3 two more times
6) Average the results to obtain the downstream throughput baseline

2.1.2: Upstream Traffic

Procedure:
1) Swap the endpoint pair defined in the IxChariot test file is set up so that Endpoint 1 is the IP address of ETH2 or the DUT running Ixia Performance Endpoint and Endpoint 2 is the IP address of ETH
2) Allow the DUT and TS to Authenticate, Associate, and complete the 4-way Handshake
3) Open a Command Prompt window in the same directory as the TCL script and issue the command:
   >tclsh OB_Throughput_TPTvsRange.tcl
4) Record the observed throughput from the IxChariot console
5) Repeat step 3 two more times
6) Average the results to obtain the upstream throughput baseline
Test 2.2: Throughput vs. Range

Purpose: To test throughput values between the DUT and TS connected at varying attenuation levels utilizing the octoBox and Multi-Path Emulator.

References:
- IEEE Std 802.11-2012 Edition

Resource Requirements
- 802.11a/b/g/n/ac Testing STA (TS) that can be used as link partner with APUT or STAUT
- Ethernet endpoint (ETH) running IxChariot Console and Performance Endpoint
- additional Ethernet endpoint (ETH2) running Ixia Performance Endpoint (if needed)
- octoBox Multi-Path Emulator with quadAtten™ RF Attenuator Module
- OB_Throughput_TPTvsRange.tcl TCL script
- IxChariot test file running a high throughput TCP traffic script

Last Updated: October 6, 2015

Discussion: This test discovers the DUT’s performance by evaluating its throughput levels while interoperating with the TS at varying simulated distances through the use of attenuation. Testing is performed utilizing octoScope’s OB-MPE which provides the necessary environment to attain consistent and repeatable testing results in addition to emulating a Model B 802.11 channel for MIMO (or spatial streaming) devices.

Test Setup: Place the DUT in the top octoBox chamber with its antennas oriented closest to the near field antennas and connect it to the internal Ethernet port if necessary. Place the TS in the bottom octoBox chamber and connect it to the internal Ethernet port and antenna cabling. Connect ETH to the bottom octoBox chamber’s external Ethernet port. If needed, connect ETH2 to the top octoBox’s external Ethernet port.

2.2.1: Downstream Traffic

Procedure:
1) Verify that the endpoint pair defined in the IxChariot test file is set up so that Endpoint 1 is the IP address of ETH and Endpoint 2 is the IP address of ETH2 or the DUT running Ixia Performance Endpoint
2) Allow the DUT and TS to Authenticate, Associate, and complete the 4-way Handshake
3) Open a Command Prompt window in the same directory as the TCL script and issue the command:
   >tclsh OB_Throughput_TPTvsRange.tcl
4) Record the observed throughput from the IxChariot console
5) Rotate the DUT 90° clockwise from the original position and repeat steps 1-3
6) Rotate the DUT 180° clockwise from the original position and repeat steps 1-3
7) Rotate the DUT 270° clockwise from the original position and repeat steps 1-3

Possible Problems: None
2.2.2: Upstream Traffic

Procedure:
1) Swap the endpoint pair defined in the IxChariot test file is set up so that Endpoint 1 is the IP address of ETH2 or the DUT running Ixia Performance Endpoint and Endpoint 2 is the IP address of ETH
2) Allow the DUT and TS to Authenticate, Associate, and complete the 4-way Handshake
3) Open a Command Prompt window in the same directory as the TCL script and issue the command:
   `>tclsh OB_Throughput_TPTvsRange.tcl`
4) Record the observed throughput from the IxChariot console
5) Rotate the DUT 90° clockwise from the original position and repeat steps 1-3
6) Rotate the DUT 180° clockwise from the original position and repeat steps 1-3
7) Rotate the DUT 270° clockwise from the original position and repeat steps 1-3

Possible Problems: None