

# Wireless LAN Consortium

802.11abgnac

Range vs. Throughput Test Suite

*Version 2.0*

*Technical Document*



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## **Modification Record**

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

Parameter	Value
Band	2.4 GHz
Channel Width	20 MHz
Channel	6
Security	WPA2-PSK
Encryption	AES-CCMP
SSID	rangeVthroughput
PSK	octoBox1
Short Guard Interval	Enabled
MPDU Aggregation	Enabled

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 – TvR TCL Script

Parameter	Value
attenEnable	True
attenStart	0
attenStop	60
attenStep	3
chariotEnable	True
stopOnError	True
Timeout	75
testMaskEnable	True
testMaskDelay	45

## 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.tclTCL 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

Parameter	Value
attenEnable	false

### 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:  
>tc1shOB\_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:  
>tc1shOB\_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:  
>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

## 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 – TS Configuration

Parameter	Value
Band	5 GHz
Channel Width	20/40/80 MHz
Channel	149

## 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

Parameter	Value
attenEnable	false

### 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 step3 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

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**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