

# ***Interoperability Test Summary***

## ***Atheros Communications***

## ***Broadcom Corporation***

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### **Overview**

This document describes the tests that were performed to establish interoperability between Atheros and Broadcom 802.11n draft 1.0 chipsets. The testing focused on measuring the throughput in multi-vendor arrangements. Testing was performed using mandatory features of the IEEE 802.11n draft specification version 1.0. Testing included assessment of the devices' ability to associate and pass TCP/IP traffic.

### **System Requirements to Achieve Interoperability**

The 802.11n specification (currently at Draft 1.0 status) contains a large number of mandatory and optional features. Interoperability is not trivial due to the complexity of the standard as well as the number of mandatory elements. It is particularly important that devices support the mandatory elements as their presence is assumed by other vendors, and omitting them can prevent interoperability between vendors. The results reported in this document were obtained while using the following mandatory elements of the 802.11n 1.0 draft:

- 2-stream MIMO
- Legacy compatible mixed-mode preamble
- PHY level spoofing
- A-MPDU aggregation
- A-MPDU length and density limits
- Immediate Block ACKs

In addition, one optional element, the use of 40 MHz channel bandwidths, was also employed. The solutions tested, based on Atheros and Broadcom chipsets, implement each of these features according to the draft, thereby enabling interoperation between the tested devices at high data rates.

## Products Tested

<b>Table 1</b>			
<b>List of Atheros Products Submitted for Interoperability Testing</b>			
<b>Chipset</b>	<b>Reference Design on which the Hardware is Based</b>	<b>Software/Firmware Release number</b>	<b>Product Description</b>
XSPAN™ AR5008 chipset (AR5133 with AR5416)	MB71 040	Firmware revision 6.0.0.244	2.4 GHz draft 11n access point
XSPAN™ AR5008 chipset (AR5133 with AR5416)	CB71 050	SW driver revision 6.0.0.160	2.4 GHz draft 11n cardbus card

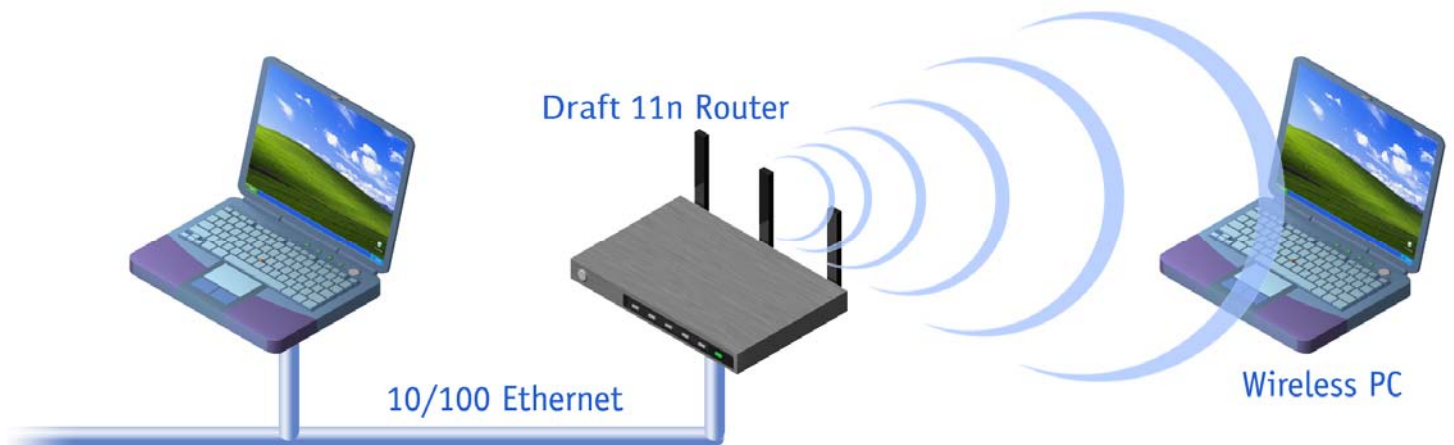
<b>Table 2</b>			
<b>List of Broadcom Products Submitted for Interoperability Testing</b>			
<b>Chipset</b>	<b>Reference Design on which the Hardware is Based</b>	<b>Software/Firmware Release number</b>	<b>Product Description</b>
Intensi-fi™ Chipset (BCM2055 with BCM4321)	BCM94321CB2 Hardware revision 4.2	Software revision 1.0.6.17_60518	2.4/5 GHz draft 802.11n cardbus reference design
Intensi-fi™ Chipset (BCM2055 with BCM4321)	BCM94704NR Hardware revision 2.4	Software revision 0.93.2	Draft 802.11n router/gateway reference design [Note: This system will host a BCM94321CB2 NIC of the revision specified above]

## Test Configuration

In all of the testing, the following equipment was used:

Hardware/Software	Model/Mode
PC1	Dell D610
PC2	Dell D600
Chariot V3.2	High Performance Throughput Script

Chariot by Ixia is a standard software tool used by the industry to measure network performance. For all tests the physical configuration shown in figure 1 was used.



Two tests with multiple runs were performed. One was performed in an isolation chamber, and the other in an open air environment. The open air environment was free of interference from other devices. Be aware that the throughput of a wireless network can be affected by the presence of other wireless networks operating in the same area. Some draft 11n devices have the ability to use a second wireless channel if it is available in order to increase their throughput. Therefore, the performance of some draft 11n devices can be degraded not only by other networks operating on the same channel, but also by devices operating in one of the adjacent channels.

The APs that were tested have 10/100 Fast Ethernet ports. These ports cannot exceed 100Mb/s in a single direction. However, they can pass traffic simultaneously in both directions. Therefore, in order to show wireless throughput above 100Mb/s, it is necessary to run traffic in both directions (uplink and downlink) simultaneously. The total of the uplink and downlink throughput represents the full bandwidth of the wireless link.

Two configurations were tested. In one, an Atheros-based AP was connected to a Broadcom-based client. In the other, a Broadcom-based AP was connected to an Atheros-based client.

## Test Results

### Configuration 1: Atheros-based AP, Broadcom-based Client

In this configuration a PC was connected to the Atheros-based AP with a single Ethernet cable. This PC ran the Chariot console. The client PC ran a Chariot end point. The client scanned and automatically associated to the AP since they had been configured to have matching SSIDs.

Chariot was configured to generate one logical connection in the downlink direction, and one logical connection in the uplink direction. The throughput was measured using Chariot's filesendl script.

The following parameters were modified in Chariot's filesendl.scr using the script editor:

File\_Size= 10M

send\_buffer\_size= 64k

receive\_buffer\_size= 64k

These modifications insured that Chariot produced enough data to fully load the wireless channel even at data rates greater than 100Mb/s. The Chariot filesendl script was run, and the throughput of the two logical connections (one uplink and one downlink) was totaled. This bi-directional total represents the total throughput of the wireless link, and allows the throughput to exceed the ~95Mb/s limitation of the 10/100 Ethernet port on the AP. The tests were run multiple times to establish consistency.

The bi-directional throughput consistently exceeded 100 Mb/s. The following table shows representative results.

Atheros based AP ↔ Broadcom based Client	
Test iteration	Bi-directional Throughput (Mb/s)
1	106.2
2	107.1
3	103.6

### Configuration 2: Broadcom-based AP, Atheros-based Client

The tests described above were repeated using the Broadcom-based AP connected to the Atheros-based client. The configurations and Chariot settings were identical.

The bi-directional throughput consistently exceeded 100 Mb/s. The following table shows representative results.

Broadcom based AP ↔ Atheros based Client	
Test iteration	Bi-directional Throughput (Mb/s)
1	106.3
2	105.6
3	106.4

**This is an independent test**

This is the first of a series of interoperability tests to be conducted by Atheros and Broadcom with a variety of silicon vendors. The testing is not associated with the Wi-Fi Alliance or any testing conducted by the alliance. The parties involved intend to conduct such testing only until the Wi-Fi Alliance has established an interoperability testing and certification program.

**For more information**

Please contact Henry Rael for Broadcom Corporation, [hrael@broadcom.com](mailto:hrael@broadcom.com), or Dan Munoz for Atheros Communications, [dmunoz@arpartners.com](mailto:dmunoz@arpartners.com)