TEST REPORT

Tolly.

#214124

June 2014

Commissioned by
Meru Networks, Inc.

Meru Networks WLAN Performance vs. Aruba Networks & Cisco Systems

802.11ac WLAN Systems: Meru Networks AP832i vs. Aruba Networks AP-225 and Cisco Systems Aironet 3702i

EXECUTIVE SUMMARY

Wireless LAN (WLAN) solutions built on the recent 802.11ac standard provide unprecedented performance for business networks, with WLAN solutions now rivaling the Gigabit speeds of wired LANs.

Meru Networks commissioned Tolly to evaluate the performance of its high-speed, 802.11ac AP832i access point (AP) and compare that to the Aruba Networks AP-225 and Cisco Systems Aironet 3702i WLAN solutions. Tests included multiple-AP and single AP tests handling data, VoIP and video traffic.

The Meru Networks AP832i consistently outperformed the other 802.11ac WLAN solutions across a range of tests using both 40MHz and 80MHz channel bonding.

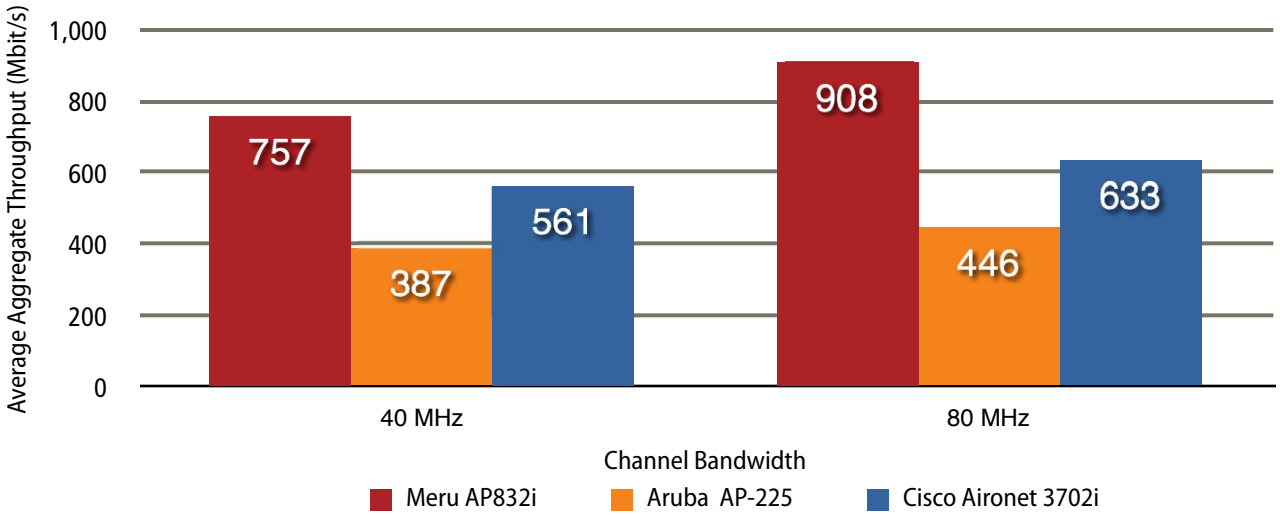
...<continued on next page>

THE BOTTOM LINE

The Meru Networks AP832i access point:

1. Consistently outperformed Aruba Networks and Cisco Systems solutions with data, VoIP and video
2. Delivered 2X the throughput of Aruba Networks when handling data/video at 40/80MHz
3. Exhibited significantly lower latency streaming video traffic than Aruba Networks and Cisco Systems

802.11ac WLAN Multi-AP, Multi-Client Aggregate Data/Video 40/80MHz Channel Bonding Throughput
(as reported by IxChariot 7.30 EA)



Notes: 6 APs with 5 clients associated with each AP. In each group of 5 clients, 1 client was 3x3, the others 2x2. 15 bidirectional data clients and 15 video clients. All video was downstream only. For bidirectional traffic, the 2x2 clients transmitted downstream and the 3x3 clients transmitted upstream.

Source: Tolly, May 2014

Figure 1

Overview

To simulate an Enterprise office environment, 6 APs were deployed for simultaneous testing. A total of thirty client stations were used - 5 for each AP. Each group included 4 clients implementing 802.11ac 2x2 and 1 802.11ac 3x3 client.

The testing varied the traffic by type and direction. It included downstream and bidirectional data, VoIP (bidirectional) and video streaming (unidirectional/downstream). Additional testing was also conducted with just a single AP for each vendor.

Test Results

Multi-AP Data & Video, 40/80MHz Throughput

As the 802.11ac standard provides for both 40MHz and 80MHz channel bonding, both provide important insights into the overall performance of the WLAN solution.

In tests that consisted of traditional data traffic and streaming video, the Meru Networks solution outperformed the competing solutions with both 40MHz and 80MHz channel bonding

In both channel configurations, the Meru Networks AP832i configuration delivered throughput approximately 2X that of the Aruba Networks AP-225 configuration.

The Meru Networks configuration delivered 1.35X the throughput of the Cisco Systems Aironet 3702i configuration at 40MHz and 1.43X that of Cisco in the 80MHz test. See Figure 1.

Meru Networks, Inc.

AP832i

802.11ac WLAN Performance

Tolly. Certified

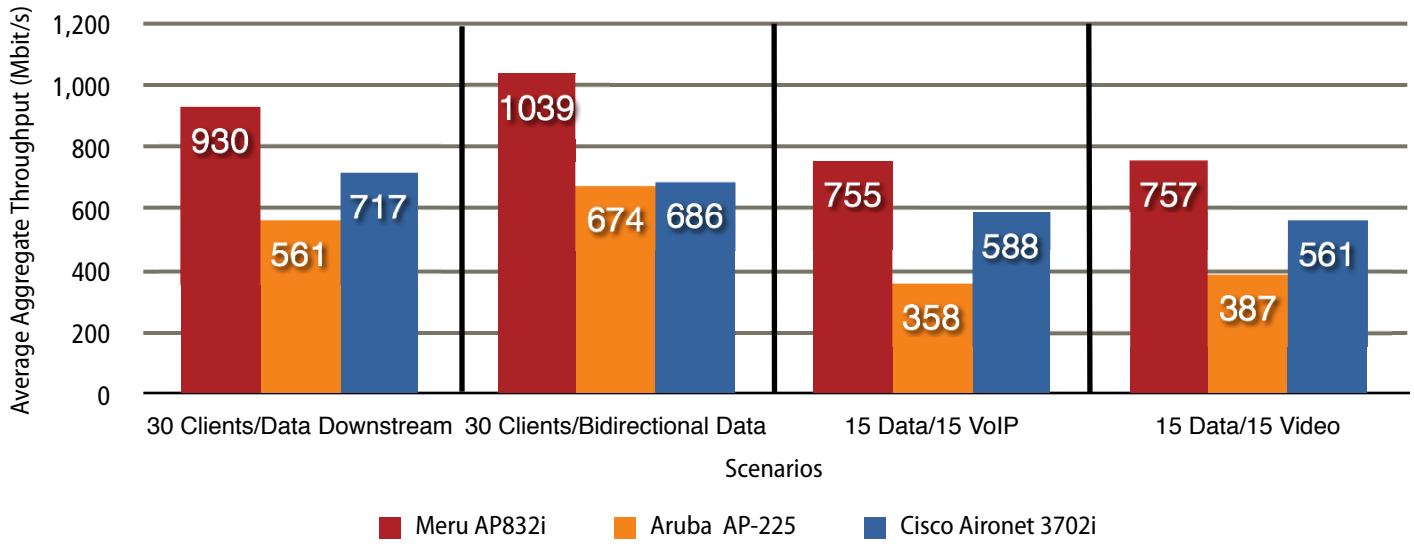
Tested May 2014

Multi-AP 40MHz Throughput - Various Traffic Scenarios

Configured to use 40MHz channel bonding, Tolly engineers ran a series of tests with different characteristics. The Meru Networks AP832i solution outperformed the competing solutions in all scenarios. See Figure 2.

802.11ac WLAN Multi-AP, Multi-Client Aggregate 40MHz Channel Bonding Throughput

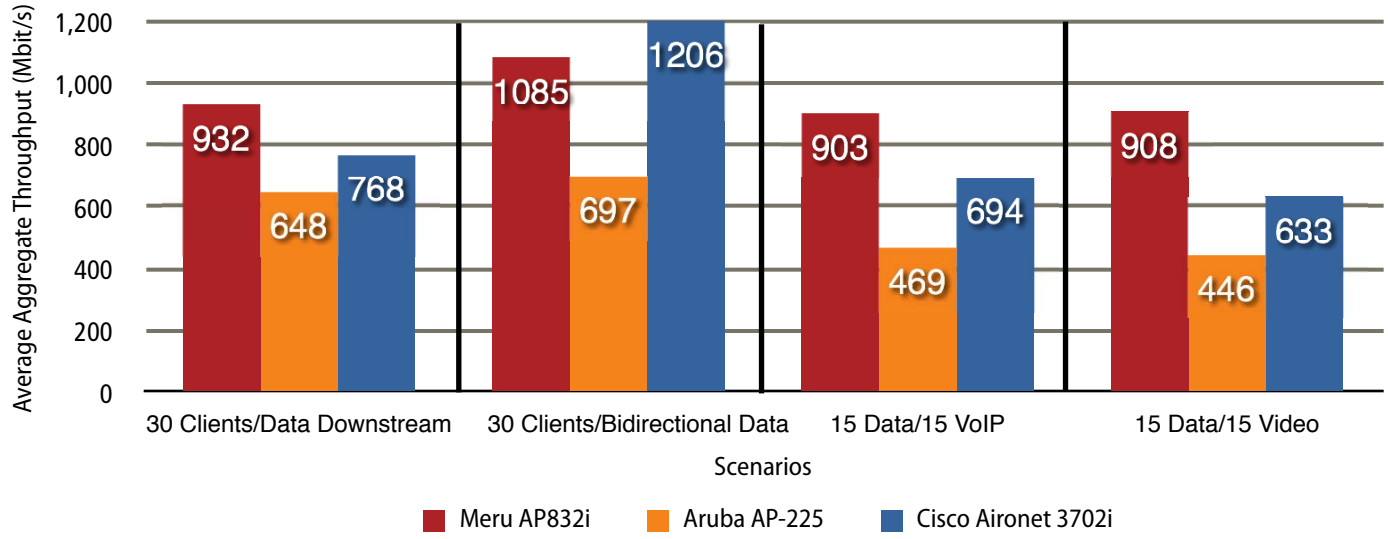
(as reported by IxChariot 7.30 EA)



Notes: 6 APs with 5 clients associated with each AP. In each group of 5 clients, 1 client was 3x3, the others 2x2. 15 data clients and 15 VoIP or video clients. All video was downstream only.

Source: Tolly, May 2014

Figure 2



Notes: 6 APs with 5 clients associated with each AP. In each group of 5 clients, 1 client was 3x3, the others 2x2. 15 data clients and 15 VoIP or video clients. All video was downstream only.

Source: Tolly, May 2014

Figure 3

The throughput results were most significant in the tests that included VoIP and video traffic. In those tests, the Meru Networks system throughput was roughly double that of the Aruba Networks AP-225 solution.

Across the range of tests, the Meru Networks system throughput was anywhere from 1.28X to 1.51X that of the Cisco Systems Aironet 3702i configuration.

Multi-AP 80MHz Throughput - Various Traffic Scenarios

The same series of tests was run with each of the solutions configured to use 80MHz channel bonding, Tolly engineers ran a series of tests with different characteristics. The Meru Networks AP832i solution outperformed the competing solutions in all scenarios save one. See Figure 3.

Here again, the Meru Networks solution outperformed the Aruba Networks offering by approximately 2X in the tests involving VoIP and video streaming.

With the exception of the bidirectional data test, the Meru Networks AP832i solution performance was anywhere from 1.21X to 1.32X that of the Cisco Systems Aironet 3702i solution.

Single-AP, Single-Client 40/80MHz Throughput

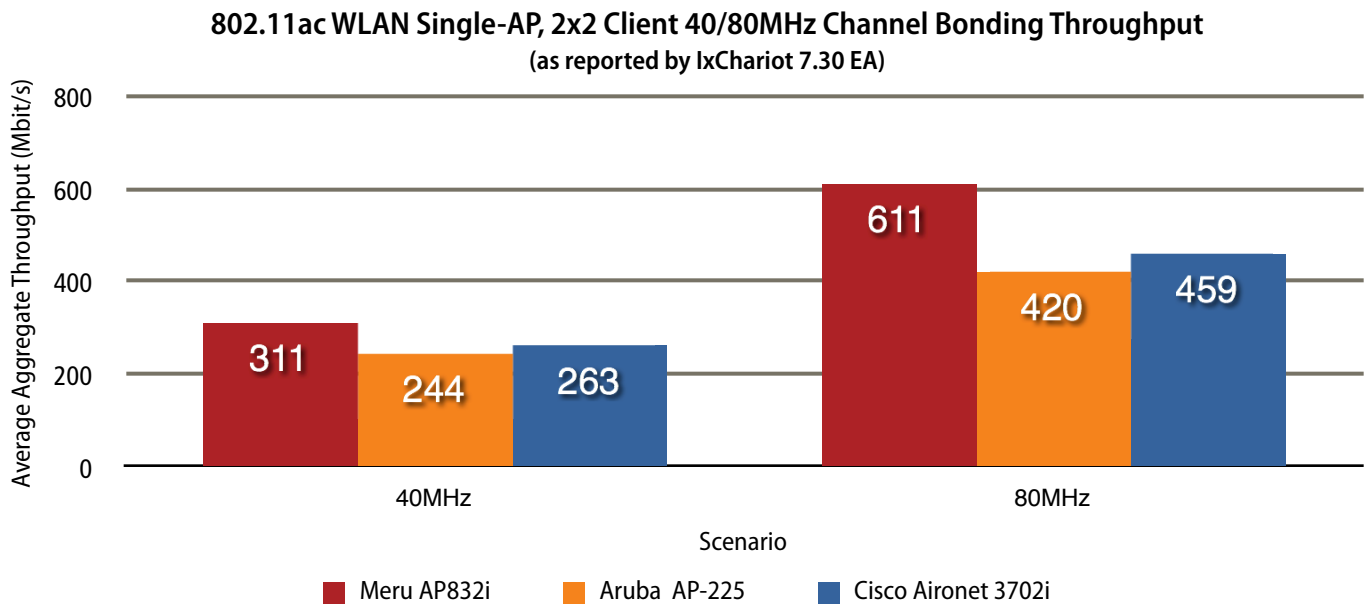
To establish the performance of an single client, Tolly engineers conducted tests where a single 802.11ac (2x2) client was associated with a single AP in both 40MHz and 80MHz channel bonding scenarios.

In both scenarios, the Meru Networks solution delivered higher throughput than either of the competing solutions. See Figure 4.

Single-AP, Single Legacy Client 80MHz Throughput

For those environments where legacy 802.11n clients are present, the single-client throughput was benchmarked for a single 802.11n (3x3) client with 80MHz channel bonding.

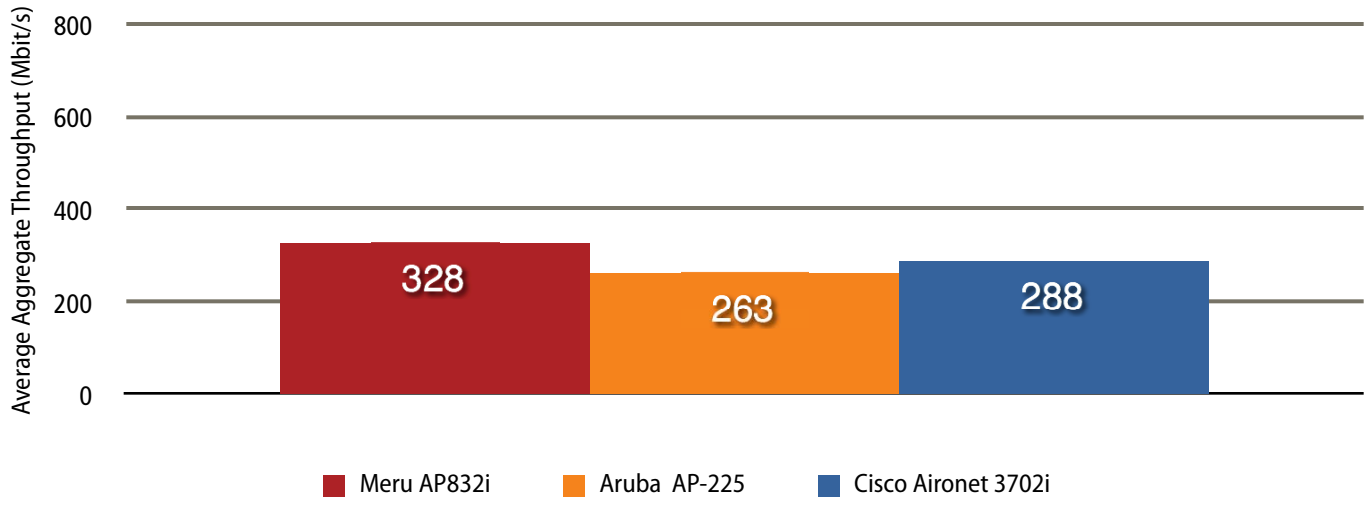
Again, the throughput using the Meru Networks solution was higher than when using the competing solutions. See Figure 5.



Notes: 1 AP. The 2x2 client was an Apple MacBook Air running 802.11ac.. Traffic profile was downstream TCP.

Source: Tolly, May 2014

Figure 4



Notes: 1 AP. The 3x3 client was an Apple MacBook Pro running 802.11n. Traffic profile was downstream TCP. AP configured in 80MHz mode.

Source: Tolly, May 2014

Figure 5

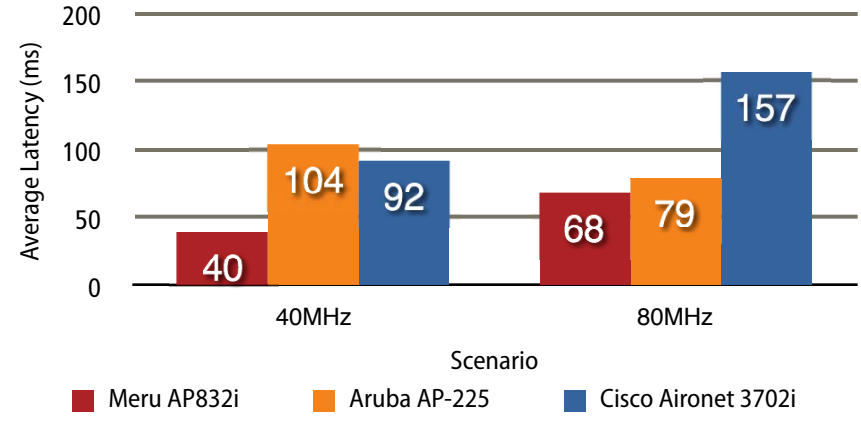
Multi-AP Video Streaming, 40/80MHz Latency

As excessive latency (delay) can degrade the quality of the streamed video - potentially causing interruptions to the video viewing experience, it is important to benchmark traffic latency.

Tolly engineers measured the video streaming latency across multiple APs in tests with both 40MHz and 80MHz channel bonding.

In all scenarios, the Meru Networks solution exhibited lower latency than both competitors.

In the 40MHz channel bonding test, the Meru Networks AP832i latency was less than half that of the others. In the 80MHz channel bonding test, the Meru Networks latency was less than half that of the Cisco Systems Aironet solution. See Figure 6.



Source: Tolly, May 2014 Figure 6

Test Setup & Methodology

Environment

The test environment consisted of a 20,000 sq.ft., single level office building. APs from each competitor were placed at equidistant locations around the interior of the building. Four Apple MacBook Air clients (2x2 802.11ac) and one Apple MacBook Pro client (3x3 802.11ac) laptops were placed on desks in the vicinity of each AP, for a total of thirty client machines.

Each client was running Mac OS 10.9.2, and installed with the Ixia IxChariot 7.30 performance endpoint.

Solutions Under Test

Tolly engineers tested enterprise 802.11ac solutions from three vendors. See Table 1.

The Meru Networks AP832 access points were deployed along with one MC4200 Controller, running software version 6.1-2-12. All APs were placed in bridge mode, and used vendor suggested best practices. See Figure 7.

The Aruba Networks solution consisted of AP-225 access points in conjunction with an Aruba 7210 Mobility Controller running ArubaOS 6.3.1.6. The APs were placed in bridge mode, with the fair access QoS policy and ARM as per vendor best practices.

The Cisco solution consisted of Cisco Aironet 3702i access points, with one Cisco 5508 Controller, running iOS 15.2.4.0. All

802.11ac WLAN Solutions Evaluated

Vendor	Controller		Access Points	
	Model	Version	Model	Version
Meru Networks, Inc.	MC4200	6.1-2-12	AP832i	6.1-2-12
Aruba Networks, Inc.	7210 Mobility Controller	6.3.1.6	AP-225	6.3.1.6
Cisco Systems, Inc.	5508 Wireless Controller	7.6.120.0 (May 2, 2014)	Aironet 3702i	IOS 15.2.4.0

Source: Tolly, May 2014 Table 1

APs were operating in FlexConnect local switching mode, with Silver QoS along with Adaptive Radio Management as per vendor best practices.

Default parameters were used where applicable, 2.4GHz disabled, using WPA2 security for all SSIDs.

All products used vendor-recommended settings. The Aruba and Cisco configurations were based on previous test configurations used in comparison tests published by Aruba Networks. [1]

Test Execution

All tests were run five times in sequence with a one minute runtime. All results reported are the average of 5 test runs. Except where otherwise noted, all IxChariot data tests utilized default High Performance Throughput script parameters. Reporting was set to "batch" for all IxChariot tests.

Single Client Throughput

For this test, an Apple MacBook Air and Apple MacBook Pro were each associated to a single AP. For each client, engineers configured an IxChariot stream with 8 downstream pairs to test the unidirectional performance.

5 Client Throughput

For this test, 5 Apple MacBook Air laptops were associated to a single AP. A total of six downstream pairs were created per client, and tests were run.

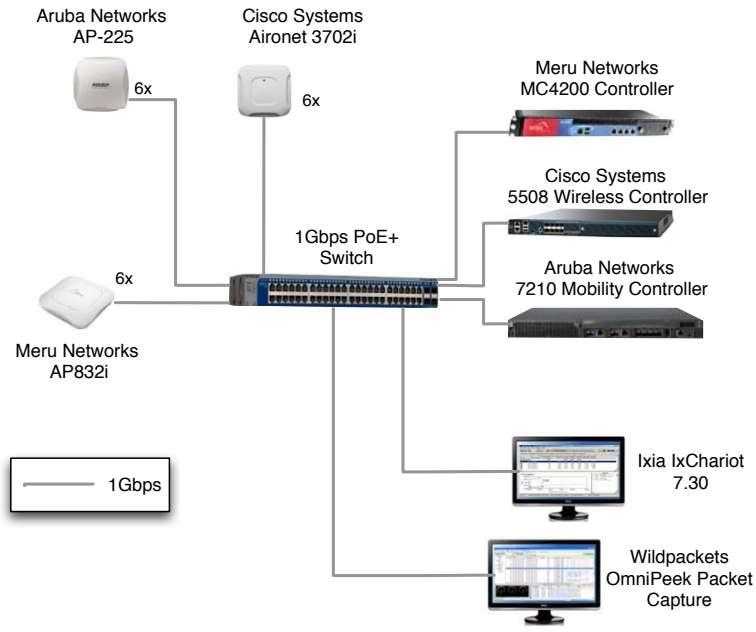
30 Client Tests

For this setup, all thirty 802.11ac clients (24 MacBook Air - 2x2, 6 MacBook Pro - 3x3 systems) were associated to the test network, and each vendor's load balancing algorithm was given time to distribute the clients across the six APs. For bidirectional traffic, the 2x2 clients transmitted downstream and the 3x3 clients transmitted upstream. Tolly validated that each AP had at least one client connected prior to running tests, though client-AP association was not the same for each vendor configuration, despite having the same physical test environment.

Using four IxChariot pairs per client, engineers initiated the downstream performance test with all thirty client machines. The IxChariot script was updated with the "timing records" set to 10MB. For this test, all traffic was generated from the wired IxChariot station. Upon completing, engineers modified the test such that the six MacBook Pro clients (3x3 ac) were now sending data upstream to the AP, while the remaining 24 MacBook Air clients were still in downstream mode. Tests were re-run and results recorded.

For the VoIP and video tests, engineers modified the test configuration such that half of the clients were passing bidirectional VoIP traffic or unidirectional video streams. 12 MacBook Air clients and three MacBook Pro clients were configured to make a bidirectional G.711u VoIP call, while the remaining 15 clients were passing downstream traffic. For the video test, the 15 VoIP clients were each reconfigured to receive a 1.5Mbps MPEG-2 video stream, while the remaining 15 clients were passing downstream traffic.

Test Bed Topology



Source: Tolly, May 2014 Figure 7

[1] http://www.arubanetworks.com/pdf/technology/TR_Aruba_WiFi_Performance_APPENDIX.pdf

About Tolly

The Tolly Group companies have been delivering world-class IT services for more than 25 years. Tolly is a leading global provider of third-party validation services for vendors of IT products, components and services.

You can reach the company by E-mail at sales@tolly.com, or by telephone at +1 561.391.5610.

Visit Tolly on the Internet at: http://www.tolly.com

Test Equipment Summary

The Tolly Group gratefully acknowledges the providers of test equipment/software used in this project.

Vendor	Product	Web
Ixia	**IxChariot v7.30 EA**	http://www.ixiacom.com

Terms of Usage

This document is provided, free-of-charge, to help you understand whether a given product, technology or service merits additional investigation for your particular needs. Any decision to purchase a product must be based on your own assessment of suitability based on your needs. The document should never be used as a substitute for advice from a qualified IT or business professional. This evaluation was focused on illustrating specific features and/or performance of the product(s) and was conducted under controlled, laboratory conditions. Certain tests may have been tailored to reflect performance under ideal conditions; performance may vary under real-world conditions. Users should run tests based on their own real-world scenarios to validate performance for their own networks.

Reasonable efforts were made to ensure the accuracy of the data contained herein but errors and/or oversights can occur. The test/audit documented herein may also rely on various test tools the accuracy of which is beyond our control. Furthermore, the document relies on certain representations by the sponsor that are beyond our control to verify. Among these is that the software/hardware tested is production or production track and is, or will be, available in equivalent or better form to commercial customers. Accordingly, this document is provided "as is," and Tolly Enterprises, LLC (Tolly) gives no warranty, representation or undertaking, whether express or implied, and accepts no legal responsibility, whether direct or indirect, for the accuracy, completeness, usefulness or suitability of any information contained herein. By reviewing this document, you agree that your use of any information contained herein is at your own risk, and you accept all risks and responsibility for losses, damages, costs and other consequences resulting directly or indirectly from any information or material available on it. Tolly is not responsible for, and you agree to hold Tolly and its related affiliates harmless from any loss, harm, injury or damage resulting from or arising out of your use of or reliance on any of the information provided herein.

Tolly makes no claim as to whether any product or company described herein is suitable for investment. You should obtain your own independent professional advice, whether legal, accounting or otherwise, before proceeding with any investment or project related to any information, products or companies described herein. When foreign translations exist, the English document is considered authoritative. To assure accuracy, only use documents downloaded directly from Tolly.com. No part of any document may be reproduced, in whole or in part, without the specific written permission of Tolly. All trademarks used in the document are owned by their respective owners. You agree not to use any trademark in or as the whole or part of your own trademarks in connection with any activities, products or services which are not ours, or in a manner which may be confusing, misleading or deceptive or in a manner that disparages us or our information, projects or developments.

214124nfs-3 wt-2014-06-12-VerG