TEST REPORT

Tolly.

#213122

March 2013

Commissioned by
Ubiquiti Networks, Inc.

Ubiquiti Networks UniFi-AP AC

802.11n & 802.11ac Rate/Range Comparative Performance Evaluation Versus Aruba Networks, Cisco Systems and Ruckus Wireless

EXECUTIVE SUMMARY

Wireless networking has become the de facto standard endpoint connectivity in the workplace. Now, 802.11ac is the first Wi-Fi technology that can enable wireline performance in a wireless environment. Widespread deployment of 802.11ac could eliminate the need for wired clients of any type (outside of the data center) – enabling "utility networking" for the first time. With the advent of next-generation 802.11ac, users enjoy faster performance and network architects can expect higher client density per AP.

Ubiquiti Networks, Inc. commissioned Tolly to evaluate their next-generation UniFi UAP-AC access point, which leverages the 802.11ac architecture, against three leading 802.11n competitive offerings from Aruba Networks, Cisco Systems and Ruckus Wireless. (The other vendors do not yet offer systems leveraging 802.11ac technology.)The Ubiquiti Networks UniFi-AP AC delivered significantly greater throughput using 802.11ac technology as well as up to 10% greater throughput than the other offerings when running 802.11n (5GHz). See Fig. 1.

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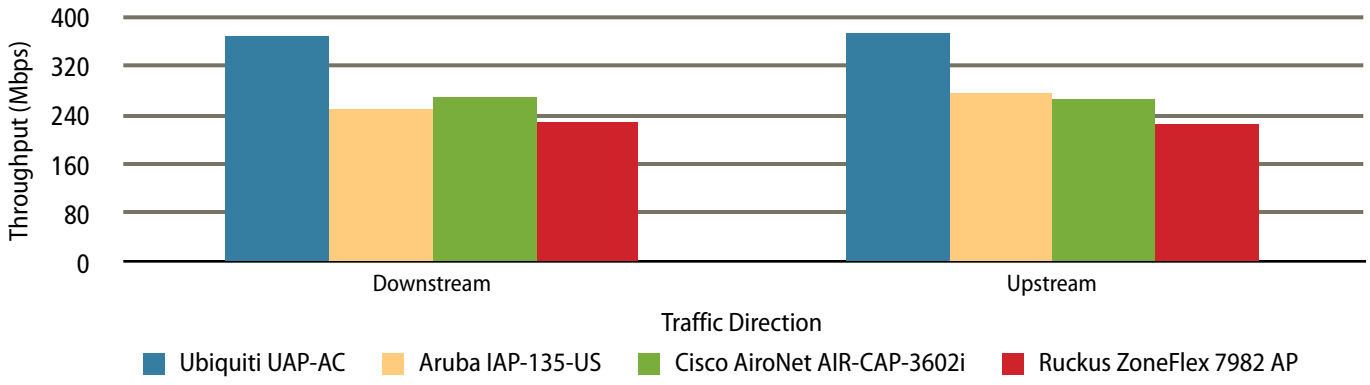
THE BOTTOM LINE

The Ubiquiti UniFi 802.11ac Access Point (UniFi-AP AC):

1. Delivers up to 46% faster upstream throughput, and up to 48% downstream throughput on average, using 802.11ac, than offerings tested from Aruba, Cisco and Ruckus
2. Leverages the leading-edge 802.11ac architecture, which allows for better performance and room for future growth
3. Offers up to 10% faster throughput, on average, for wireless 802.11n clients
4. Delivers consistently faster performance at various distances

5GHz 802.11ac/802.11n Single Client Throughput
Average Across all Distances Tested
(As reported by Ixia IxChariot 7.30 EA)



Note: Using WD MyNet AC Client Bridge with GbE connection to client. Results averaged over all distances. Ruckus was not able to associate with client at location 3, Location 1 & 2 average used. Distances tested: 24, 35 and 50ft. Ubiquiti communicated via 802.11ac, the others via 802.11n.

Source: Tolly, March 2013

Figure 1

Test Results

Performance

802.11ac (5GHz) Client Throughput

Tolly engineers tested the Ubiquiti UniFi UAP-AC against leading enterprise 802.11n offerings from Aruba, Cisco and Ruckus.

For this test, a wired laptop was used as the client with the GbE port of the laptop connected to a wireless 802.11ac bridge. The client communicated to the Ubiquiti product using 802.11ac and to the others using 802.11n (as they did not support 802.11ac).

In both upstream and downstream traffic scenarios, the Ubiquiti UniFi UAP-AC provided significantly higher throughput using 802.11ac, than the other APs under test. In downstream scenarios, the UniFi demonstrated 368 Mbps of throughput compared to to 248 Mbps for Aruba, 268Mbps for Cisco and 227 Mbps for Ruckus.

In upstream scenarios, the Ubiquiti UniFi-UAP-AC provided 46% faster throughput, on average, than the 802.11n solutions under test. The result shown is the average from tests at 24, 35 and 50 ft. See Figure 1.

Ubiquiti Networks, Inc.

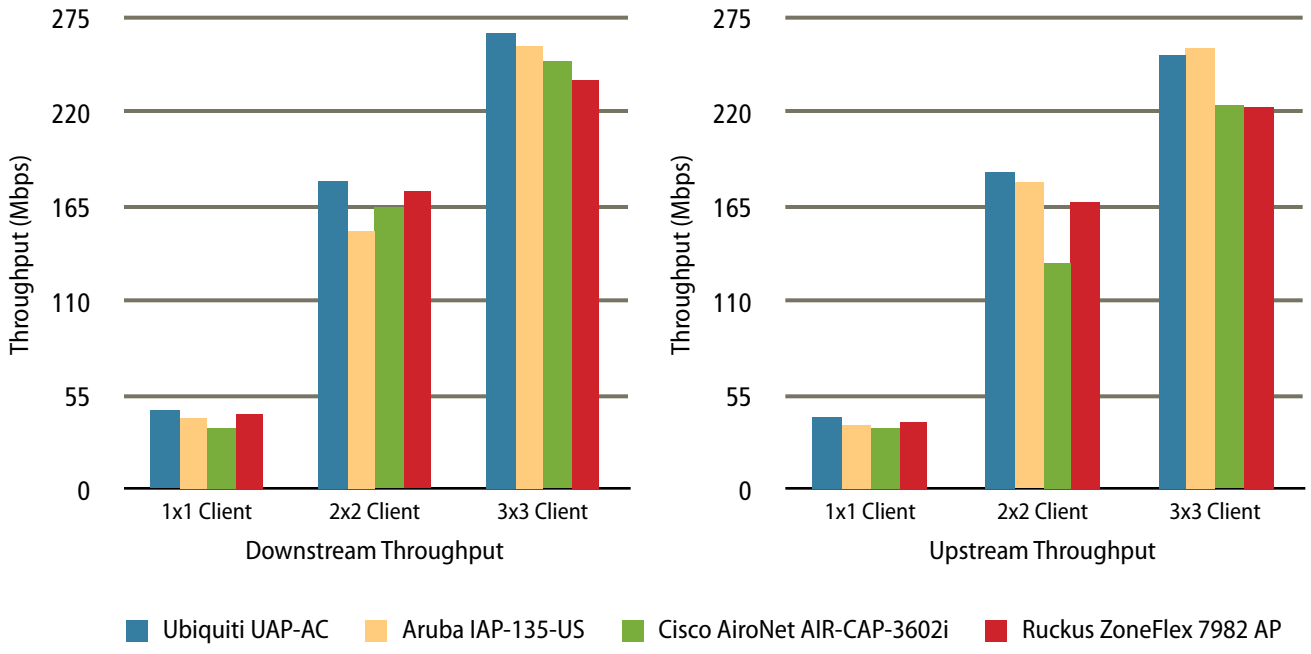
UniFi UAP-AC

802.11ac Single Client Performance Evaluation

Tolly Certified

Tested March 2013

5GHz 802.11n Downstream and Upstream Throughput for Various Clients
Average Across all Distances Tested
(As reported by Ixia IxChariot 7.30 EA)



Notes: For the purposes of this evaluation "1x1"denotes an Apple iPad 3, "2x2" denotes an Acer Aspire 4830-T with Intel 6200N Chipset and "3x3"indicates an Apple MacBook Pro with a Broadcom BCM43XX Chipset.

Source: Tolly, March 2013

Figure 2

802.11n (5GHz) Upload/Download Throughput for Mixed Clients

Tolly engineers evaluated how well the APs under test handled traffic in three different client types: 1x1, 2x2 and 3x3. For the purposes of this evaluation "1x1" denotes an Apple iPad 3, "2x2" denotes an Acer Aspire 4830-T with Intel 6200N Chipset and "3x3" indicates an Apple MacBook Pro with a Broadcom BCM43XX Chipset. (The first number represents the number of transmit streams and the second number represents the number of receive streams.)

Tolly engineers found that the 802.11ac Ubiquiti AP delivered comparable or better upstream/downstream throughput than the other three competing 802.11n APs in all three client configurations.

In five out of six scenarios tested, the Ubiquti UAP-AC delivered the fastest throughput of all APs under test. Only in the upstream MacBook Pro (3x3) test, did Ubiquiti come in a close second at 253 Mbps to Aruba's 257 Mbps. See Figure 2.

802.11n (5GHz) Upload/Download Throughput at Various Distances

Tollly engineers tested the Ubiquiti Uni-Fi UAP-AC versus comparable APs from Aruba, Cisco and Ruckus at various distances to determine the impact of proximity to the AP on the performance of three different types of clients, an Apple iPad 3, a MacBook Pro, an Acer Aspire 4830-T with Intel 6200N Chipset and a MacBook Pro.

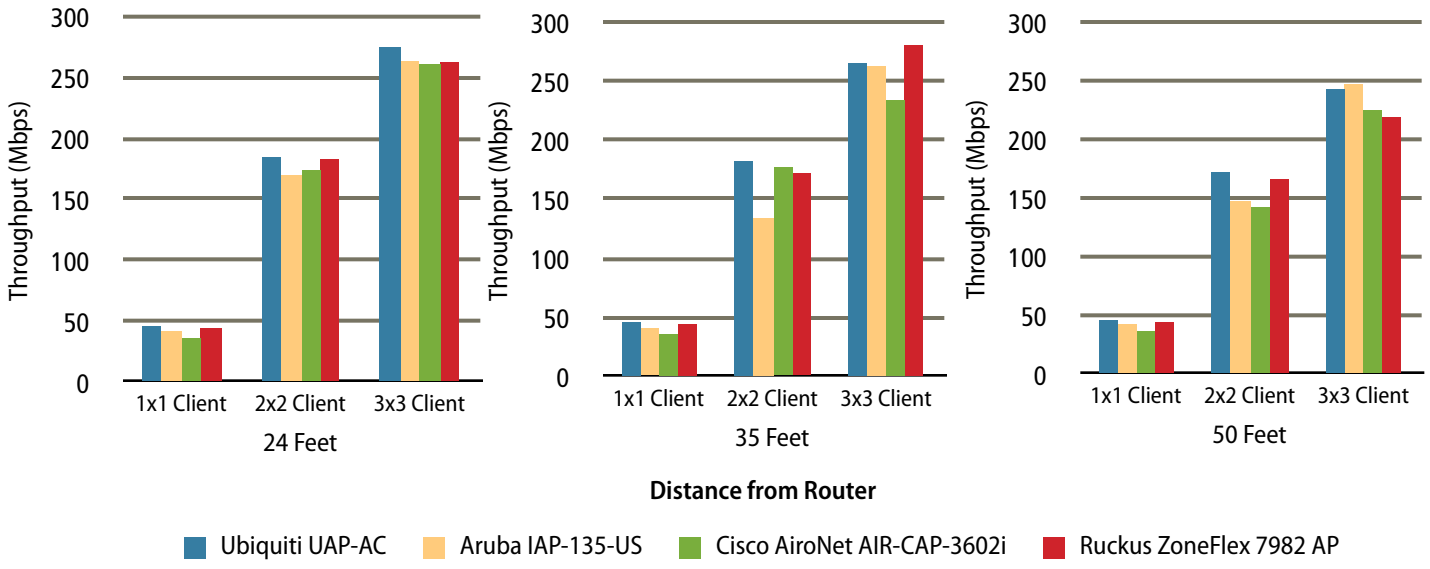
Distances were set at 24, 35 and 50 feet.

At 24 feet, Ubiquti's 802.11ac-based AP demonstrated the highest downstream throughput of all APs tested.

At 35 feet, the Ubiquiti UniFi UAP-AC again demonstrated the fastest downstream throughput for the iPad 3 (1x1) and Acer (2x2), but came in second to Ruckus for the MacBook Pro (3x3) scenario.

At 50 feet, the Ubiquti UniFi UAP-AC's downstream performance is maintained, falling second to Aruba by a small margin (242Mbps to 247Mbps). See Figure 3.

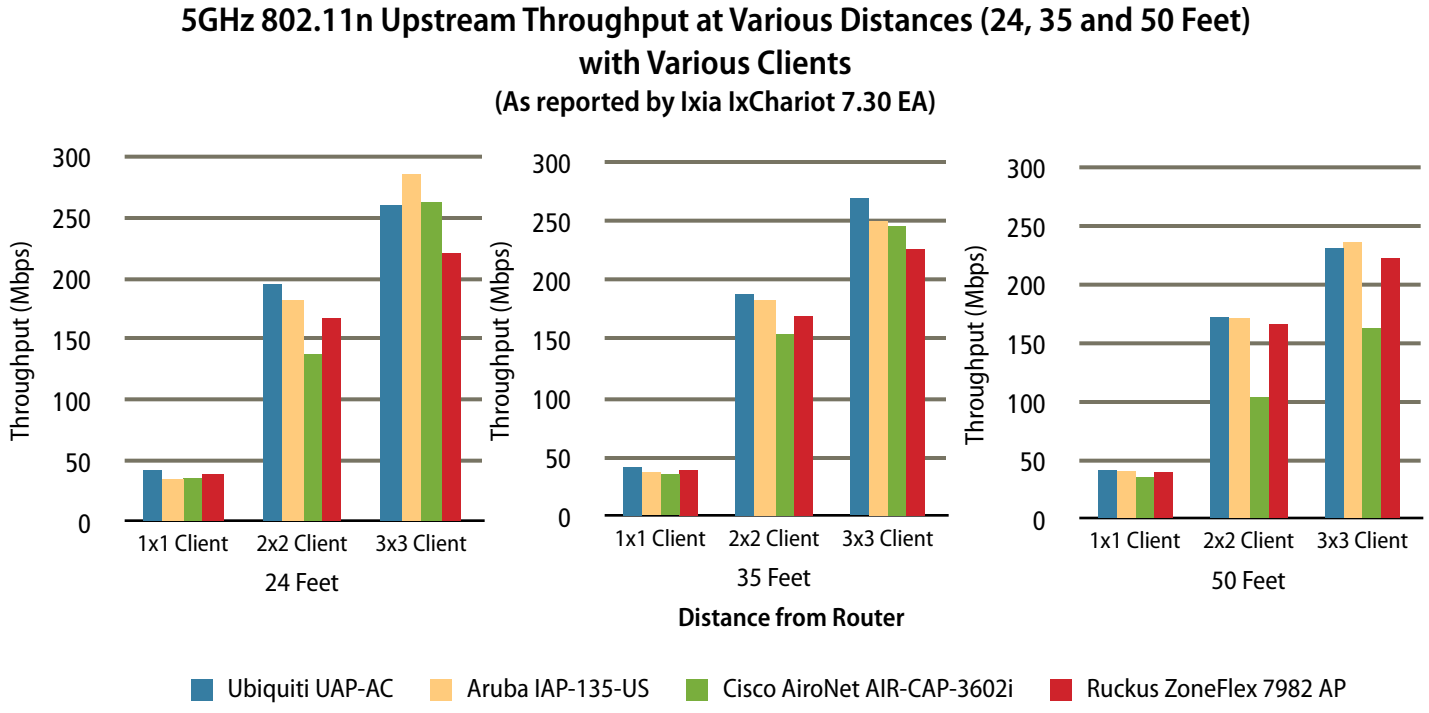
5GHz 802.11n Downstream Throughput at Various Distances (24, 35 and 50 Feet) with Various Clients
(As reported by Ixia IxChariot 7.30 EA)



Notes: For the purposes of this evaluation "1x1" denotes an Apple iPad 3, "2x2" denotes an Acer Aspire 4830-T with Intel 6200N Chipset and "3x3" indicates an Apple MacBook Pro with a Broadcom BCM43XX Chipset.

Source: Tolly, March 2013

Figure 3



Source: Tolly, March 2013

Figure 3

Tolly engineers repeated the distance test with upstream traffic and measured how each AP performed.

At 24 feet, the Ubiquiti UniFi UAP-AC demonstrated a significant performance advantage in upstream throughput for the iPad 3 (1x1) and Acer (2x2), but came in third to Ruckus and Cisco, respectively, for the MacBook Pro (3x3) scenario.

At 35 feet, the Ubiquiti AP maintained its performance advantage, demonstrating the highest upstream throughput out of all APs tested for all three scenarios.

At 50 feet, the Ubiquiti UniFi UAP-AC demonstrated the highest throughput using the iPad 3 (1x1 scenario), tied with Aruba in the Acer scenario (2x2) and placed a close second to Aruba in the MacBook Pro (3x3) scenario. See Figure 3.

Test Setup & Methodology

Test Environment

Testing was performed in a typical classroom environment of roughly 1,200 sq. ft. Each AP was placed on a table at the front of the room, and clients were placed in alternating rows. Prior to testing, engineers performed a site survey of the environment, and no signals greater than -90 dBm in the channels used for testing.

LAN Connectivity and power was provided by PoE switch (with separate injector where necessary), connected to an Ubiquiti EdgeRouter, which hosted the environment's DHCP server. Prior to testing, engineers verified that the latest firmware was installed on each solution, and that each solution was current as of March 4, 2013.

A product-specific SSID was configured for each solution in the 5GHz band, and all solutions were set to use 40MHz channel bonding. Standalone APs were used for the Aruba and Ruckus configurations. For Ubiquiti, the controller role was installed on a virtual machine located on a separate laptop connected to the LAN. For the 802.11ac Ubiquiti test, channel bandwidth was 80MHz.

The Ubiquiti, Aruba, and Ruckus configurations were all default except for the radio-specific parameters. Cisco's configuration consisted of the following: CleanAir Disabled, RRM Disabled, TX Power Default 1 (30dBm). All client devices were

Device Configurations
Endpoints and Wireless AC Bridge

Device	Make/Model	CPU/RAM	Operating System	Networking	Driver
IxChariot Console	Dell Latitude E5420	Core i3, 4GB	Windows 7 SP1	Net Xtreme 57xx Gigabit Ethernet controller	N/A
802.11n 3x3 Client	Apple MacBook Pro Model 9,2	Core i5, 4GB	Mac OS X 10.8.2	Broadcom BCM43XX	5.166.98.100.14
802.11n 2x2 Client	Acer Aspire 4830T-6678	Core i3, 4GB	Windows 7 SP1	Intel Centrino Advanced-N 6205	15.1.1.1
802.11n 1x1 Client	Apple iPad 3 Model MD336LL/A	standard configuration	iOS 6.1.2	unspecified	unspecified
802.11ac Bridge (Connected to a wired Acer Aspire client for ac testing only.)	WD My Net AC Bridge Model 1813C - L2F	unspecified	N/A	4x1GbE ports	N/A

Systems Under Test

Vendor	Model	Version	Configuration
Aruba Networks, Inc.	Aruba IAP-135-US	6.2.0.0-3.2.0.2_37229	Default - 5GHz SSID
Cisco Systems, Inc.	Cisco AiroNet AIR-CAP3602I-A-K9	HW: v01, SW Ver 7.4.100.0	no CleanAir, RRM
Ruckus Wireless, Inc.	Ruckus ZoneFlex 7982 AP	SW ver: 9.4.0.0.110	Default - 5GHz SSID
Ubiquiti Networks, Inc.	Ubiquiti UAP-AC	v2.4.0	Default - 5GHz SSID

Source: Tolly, March 2013 Table 1

updated to the latest available firmware and drivers. See Table 1 for details.

Test Execution

Tolly engineers installed each client with the latest version of Ixia's IxChariot. IxChariot was configured with two unidirectional pairs of the High Performance Throughput script, such that traffic was either upstream or downstream.

For each run, only the client being tested was associated to the AP under test. A separate machine was using MetaGeek Chanalyzer software in conjunction with a MetaGeek Wi-Spy USB spectrum analyzer device to monitor the environment to ensure there was no interference and that each client was associating at its maximum rate. Traffic was then generated for one minute. Tests were repeated three times for accuracy. The 24 and 35 feet locations consisted of line-of-sight testing. The 50 foot test location included one wall obstruction.

About Tolly

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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 7.30 EA**	http://www.ixiacom.com

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