TEST REPORT

Tolly.

#213128

September 2013

Commissioned by
Ubiquiti Networks, Inc.

Ubiquiti Networks UAP-Outdoor+ Access Point

802.11n WLAN Performance Evaluation

Versus Aruba Networks, Cisco Systems and Ruckus Wireless

EXECUTIVE SUMMARY

Wireless networking has become the standard method for providing indoor endpoint connectivity. Now Wi-Fi is becoming available practically everywhere; from stadiums to schools to trains and buses, retail outlets and branch offices. In high-density environments such as these, performance can suffer as several WLAN access points (APs) compete for the same operating band and interfere with each other.

Ubiquiti Networks commissioned Tolly to evaluate its UAP-Outdoor+ Access Point with Multi-Lane RF Technology against comparable APs from Aruba Networks, Cisco Systems and Ruckus Wireless, in high-interference 2.4GHz WLAN environments. The design of the Ubiquiti UAP-Outdoor+ allows the AP to perform effectively in noisy, high-density, high-interference deployments. Tolly found that the design provides excellent noise rejection of adjacent channel interference, thus achieving outstanding performance even in a saturated environment. See Figure 1.

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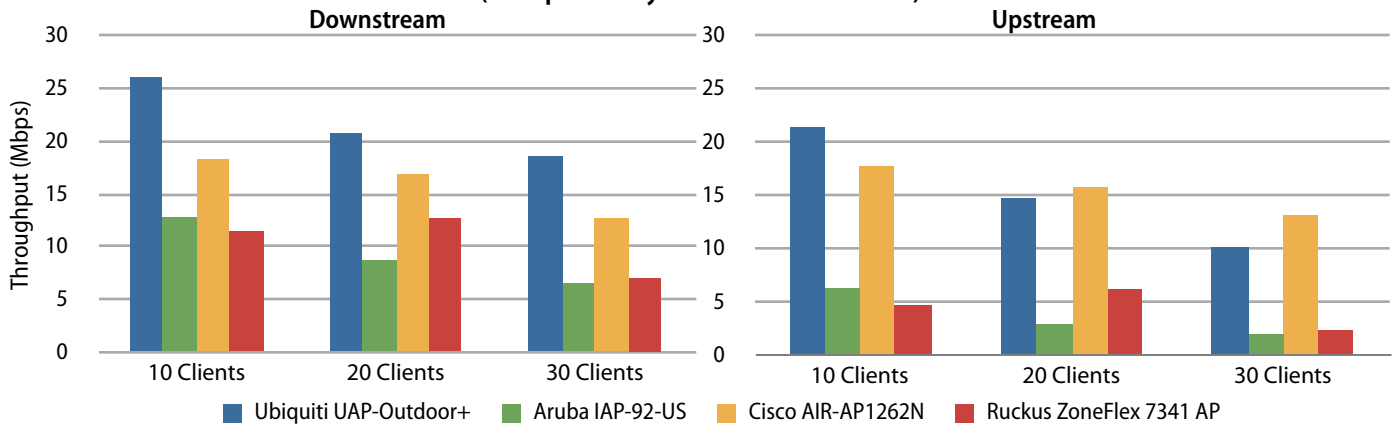
THE BOTTOM LINE

The Ubiquiti UAP-Outdoor+ Access Point:

1. Delivers up to 112% more downstream throughput and up to 124% greater upstream throughput, with interference, on average than offerings tested from Aruba, Cisco and Ruckus
2. Delivers up to 90% faster average upstream throughput and up to 95% faster average downstream throughput than Ruckus without interference
3. Provides up to 65% faster upstream throughput with interference and 1.8X faster downstream throughput than Aruba with interference

802.11n WLAN (2.4GHz) Aggregate Throughput With Adjacent Channel Interference at Various Client Densities

(As reported by Ixia IxChariot 7.30 EA)



Note: All clients were ~35 feet from the associated AP. 10 clients consisted of Apple iPads, the 20 client scenario added 5 iPhone/iPod Touch and 5 Android devices. 30 clients added 10 Android devices. All devices were running latest available OS and latest Ixia Performance Endpoint.

Source: Tolly, April 2013

Figure 1

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Background

Though 5GHz high-performance Wi-Fi is gaining in popularity, 2.4GHz is still the standard for legacy client and long-range deployments.

In theory, there are three non-overlapping channels (channels 1, 6 and 11) in the US 2.4GHz band. Typically, network architects alternate these channels for nearby APs to attempt to avoid channel interference. But in reality, because bandpass filters are not ideal, these three channels can still interfere with each other.

Interference caused by nearby transmitters on distinct frequency channels "bleeding over" to another channel is called Adjacent Channel Interference (ACI)[1]. To provide an optimal Wi-Fi user experience, APs must be able to avoid ACI for channels 1, 6 and 11.

Multi-lane RF technology, present in the UAP-Outdoor+, optimizes the operating channel and rejects interference using specialized circuitry (the High Selectivity Receiver (HSR)), thus allowing multiple APs to operate in proximity to one another.

Tolly benchmarked the 2.4GHz upstream/downstream throughput performance of the Ubiquiti UAP-Outdoor+ compared to offerings from Aruba, Cisco and Ruckus in environments with and without interference.

Tolly found that the Ubiquiti UAP-Outdoor+ was able to successfully mitigate adjacent channel interference to provide the most upstream and downstream throughput. With interference, Ubiquti demonstrated up to 1.8X faster downstream throughput than Aruba and up to 95% faster throughput than Ruckus. See Figure 1.

Test Results

Performance

802.11n Client Throughput with Adjacent Channel Interference

To demonstrate average aggregate throughput in an environment with interference, Tolly engineers tested the Ubiquiti UAP-Outdoor+ against comparable enterprise 802.11n offerings from Aruba, Cisco and Ruckus with a varying load size of 10, 20 and 30 clients.

In both downstream and upstream scenarios, the Ubiquiti UAP-Outdoor+ provided consistently high throughput in a high-noise environment.

In the downstream scenario, Ubiquiti delivered the highest average throughput at 21.8 Mbps across the three load sizes, compared to 9.3 Mbps for Aruba, 15.9 Mbps for Cisco and 10.4 Mbps for Ruckus. See Figure 1.

In the upstream scenario, Ubiquiti and Cisco delivered the highest average throughput, at 15.4 Mbps and 15.5 Mbps, respectively. Ruckus provided the next highest at 4.4 Mbps, with Aruba demonstrating the least amount of average upstream throughput at 3.7 Mbps. See Figure 1.

The clients for this test included 10 Apple iPads, 5 Apple iPhone/iPod Touch devices and 15 Android devices.

Ubiquiti Networks, Inc.

UAP-Outdoor+ Access Point

802.11n Comparative Performance Evaluation

Tolly. Certified

Tested April 2013

802.11n Client Throughput Without Adjacent Channel Interference

Tolly engineers also evaluated the Ubiquiti UAP-Outdoor+ against the comparable access points under test in an environment without interference. APs were evaluated under the same load sizes of 10, 20 and 30 clients.

On average, the Ubiquiti UAP-Outdoor+ provided the highest throughput with both upstream and downstream traffic.

When uploading, the Ubiquiti UAP-Outdoor+ provides an average aggregate throughput of 18.3 Mbps, compared to 15.7 Mbps from Aruba, 16.9 Mbps from Cisco and 14.2 Mbps from Ruckus. See Figure 2.

For downstream traffic, Ubiquiti provides the fastest average throughput by up to 10Mbps. The Ubiquiti UAP-Outdoor+ provided 24.2 Mbps of downstream throughput without interference. This compares with 20.1 Mbps from Aruba, 16.9 Mbps from Cisco and 14.6 Mbps from Ruckus.

[1] For more information, see "The Impact of Adjacent Channel Interference in Multi-Radio Systems using IEEE 802.11, IEEE International Wireless Communications and Mobile Computing Conference, 2008".

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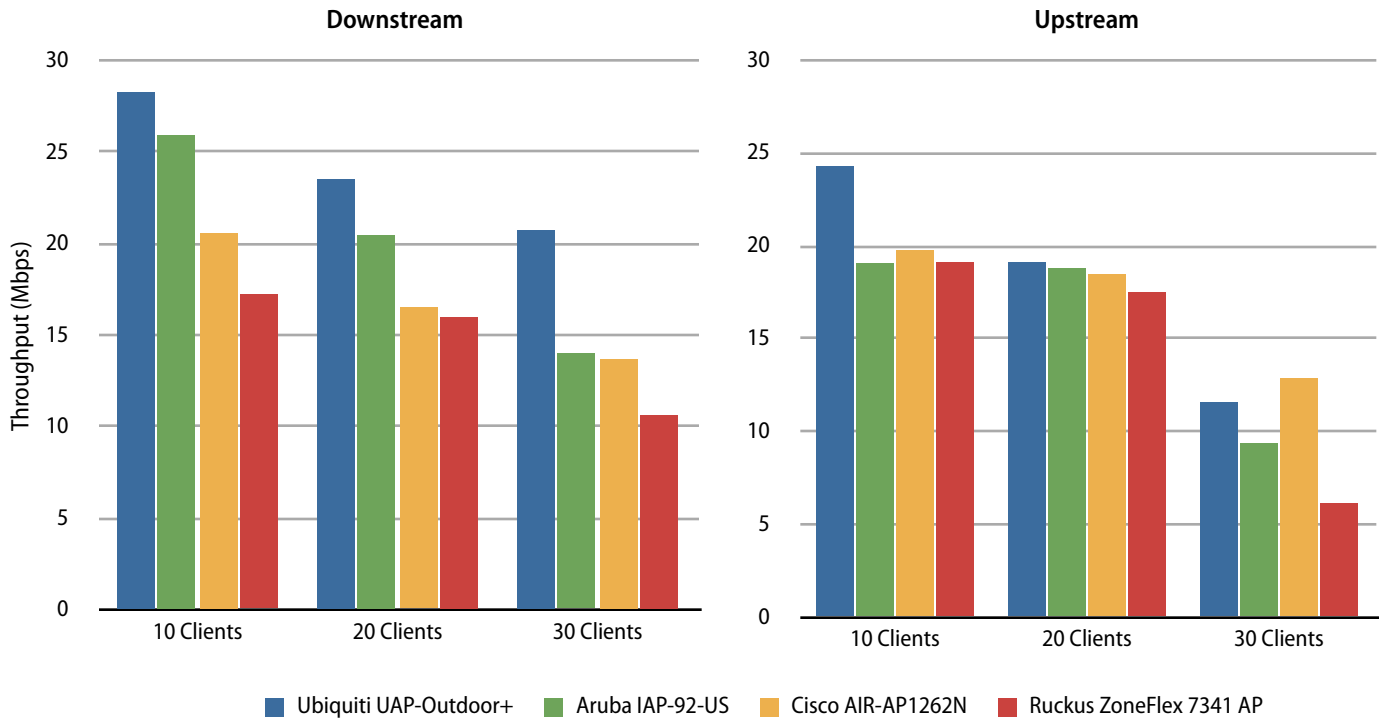
802.11n WLAN (2.4GHz) Aggregate Throughput Without Adjacent Channel Interference at Various Client Densities
(As reported by Ixia IxChariot 7.30 EA)



Note: All clients were ~35 feet from the associated AP. 10 clients consisted of Apple iPads, the 20 client scenario added 5 iPhone/iPod Touch and 5 Android devices. 30 clients added 10 Android devices. All devices were running latest available OS and latest Ixia Performance Endpoint.

Source: Tolly, April 2013

Figure 2

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 spaced out on the back two rows (~35ft). Prior to testing, engineers performed a site survey of the environment, and no signals greater than -90 dBm on the 2.4GHz channel 11, which was used for testing, were detected.

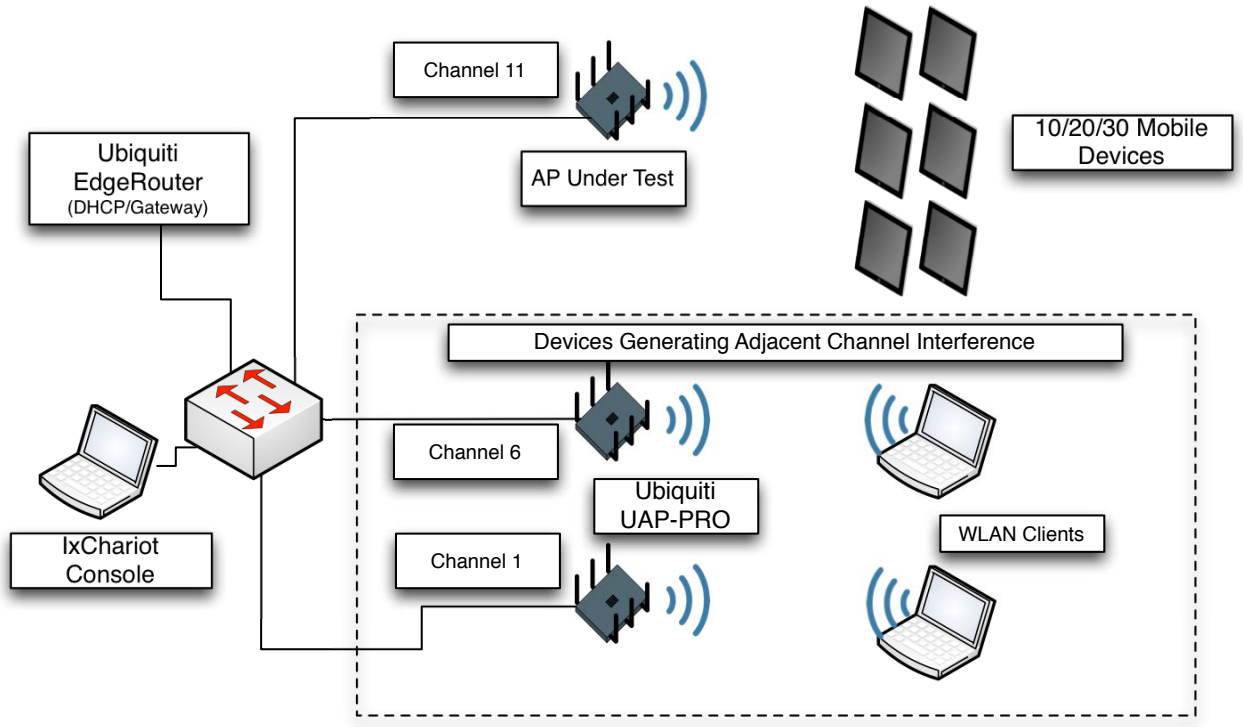
LAN connectivity and power were provided by a PoE switch (with separate injector where necessary), connected to an Ubiquiti EdgeRouter, which hosted the environment's DHCP server. Prior to testing, engineers verified that the latest firmware was installed on each solution, and that each solution was current as of April 17, 2013.

A single SSID was configured for each solution in the 2.4GHz band and was statically set to channel 11.

For the Ubiquiti solution, the controller role was installed on a separate laptop connected to the LAN.

The Ubiquiti, Aruba, and Ruckus solutions were all running default configurations, except for the radio-specific parameters. Cisco's configuration consisted of the following: CleanAir disabled, RRM disabled, TX Power default 1 (30dBm). See Table 1 for details.

WLAN 2.4GHz Adjacent Channel Interference Test Bed



Source: Tolly, April 2013

Figure 3

Adjacent Channel Interference

Two standalone Ubiquiti APs were configured on channels 1 and 6 with 20MHz bandwidth. Two separate client machines were associated with these APs, and iPerf was used to generate bidirectional traffic to saturate these two channels, simulating adjacent channel interference for each of the tests.

About Ubiquiti Multi-Lane RF Technology

Ubiquiti's patented Multi-Lane RF technology increases wireless capacity and throughput in high-density areas using specialized circuitry, the High-Selectivity Receiver (HSR). Our proprietary HSR filter isolates signals on the operating channel and removes adjacent channel interference.

Although theoretically channels 1, 6, and 11 of the 2.4 GHz operating band are distinct channels, in reality there is cross channel interference that affects performance, especially in noise, dense environments. The typical AP has a generic filter, so when it operates on channel 6, it also hears RF from channels 1 and 11. When the UniFi AP-Outdoor+ operates on channel 6, its HSR filter eliminates all non-channel 6 frequencies. With Multi-Lane RF technology, you truly have three high-speed channels (1, 6, and 11) available for superior capacity and throughput.

Source: Ubiquiti Networks

Systems Under Test

Vendor	Model	Version	Configuration
Ubiquiti Networks, Inc.	Ubiquiti UAP-Outdoor+	UniFi 2.4.1	Default - SSID Channel 11
Aruba Networks, Inc.	Aruba IAP-92-US	6.2.0.0-3.2.0.2_37339	Default - SSID Channel 11
Cisco Systems, Inc.	AIR-AP1262N-A-K9	12.4(25d)JA1	Default - SSID Channel 11
Ruckus Wireless, Inc.	Ruckus ZoneFlex 7341 AP	9.5.0.0.156	Default - SSID Channel 11

Note: All tests run using 2.4GHz spectrum.

Source: Tolly, April 2013

Table 1

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

Test Execution

Tolly engineers installed each client with the latest version of Ixia's IxChariot. Each client was configured with two unidirectional pairs running the high performance throughput script, such that traffic was either upstream or downstream. The size of the timing records was modified from 10MB to 1MB to allow for a shorter run time.

For each run, the appropriate number of clients were associated to the AP under test. A separate machine used MetaGeek Chanalyzer software in conjunction with a MetaGeek Wi-Spy USB spectrum analyzer to monitor the environment ensuring that 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. Engineers then introduced interference on the adjacent channels by means of the iPerf clients, and re-ran the IxChariot scripts.

About Tolly

The Tolly Group companies have been delivering world-class IT services for more than 20 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

Interaction with Competitors

In accordance with Tolly's Fair Testing Charter, Tolly personnel invited representatives from competing companies to participate. Only Ruckus responded to the invitation. Representatives from Ruckus reviewed and provided feedback on the test plan regarding the latest version of firmware, but provided no further feedback after reviewing their results.

For more information on the Tolly Fair Testing Charter, visit:

http://www.tolly.com/FTC.aspx

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