

Xirrus XN8 Wi-Fi Array

Wireless Performance and Functional Evaluation vs Cisco Aironet 3502e & 5508 Controller

Executive Summary

Today's enterprises face growing challenges in supporting the increasing user density and capacity required to deliver acceptable end user experience in wireless network deployments. Wi-Fi is experiencing strong growth with the roll out of high speed IEEE 802.11n and the proliferation of wireless client devices. In deployments that encounter medium to high wireless user density and/or flash user traffic scenarios, traditional Wi-Fi deployments built on a coverage-based model will strain and potentially fail. The tests conducted for this report focused on the performance, capacity, and feature support required to handle the expanding requirements of tomorrow's wireless networks.

Performance tests showed a single Xirrus XN8 Wi-Fi Array (referred to as 'Array' or 'XN8 Array' hereafter) delivered higher user density and better rate/range compared to a Cisco Wi-Fi solution using a centralized 5508 Wi-Fi controller and four dual-radio 3502e access points (APs). The XN8 Array also demonstrated faster roaming time between two devices compared to the Cisco APs. Tests were designed to compare both solutions operating with an equal number of radios.

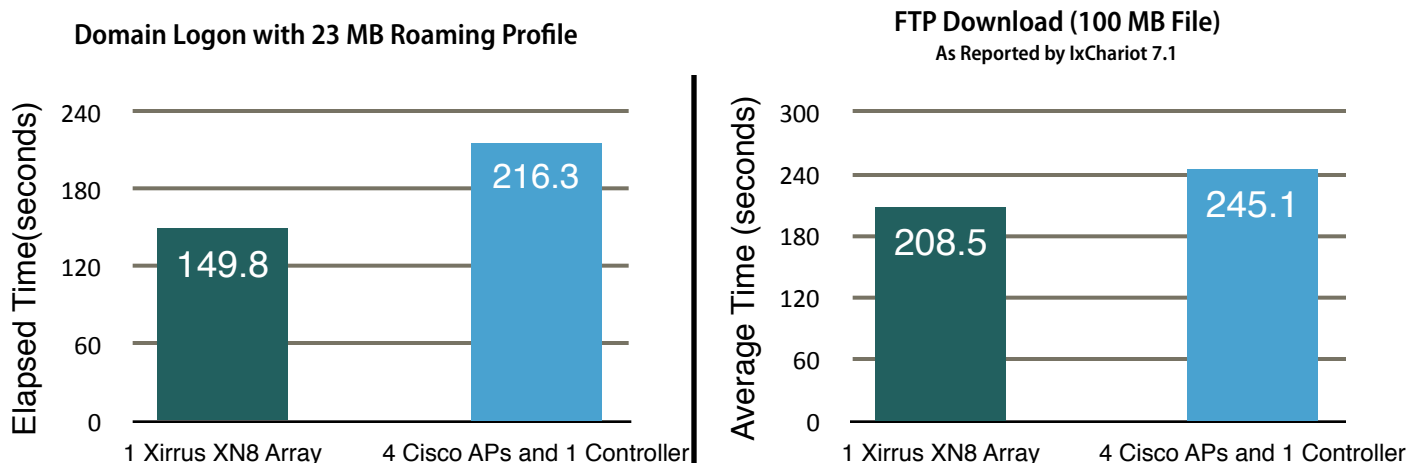
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The Bottom Line

In comparison to a 4-AP Cisco Aironet Wi-Fi solution, a single Xirrus XN8 Wi-Fi Array:

- 1 Delivered significantly higher user density and performance, while requiring significantly fewer devices per deployment
- 2 Provided greater coverage area per device in both 2.4 GHz and 5 GHz modes of operation
- 3 Completed Microsoft domain logon with 100 concurrent users 30% faster than Cisco
- 4 Completed file download of 100 MB files for 100 concurrent users 15% faster than Cisco
- 5 Implemented a distributed architecture that obviated the need for AP-controller traffic to transit the backbone

1 Xirrus XN8 Array vs 4 Cisco Aironet 3502e Access Points and 5508 Controller 100-User Task Completion Time Scenarios (Lower numbers are better)



Note: Elapsed time required for all clients to complete the Domain Logon. Average time required for each client to complete the 100MB Download. Load balancing active for Cisco APs. AES encryption active.

Source: Tolly, September 2010

Figure 1



Executive Summary

Continued ...

The feature verification tests on the XN8 Array and the Cisco APs validated elements of wireless RF design, integration with the wired network infrastructure and interoperability testing with the clients and backend systems in terms of access control, authentication and data encryption, VLAN support, high availability, etc.

The distributed architecture of the XN8 Wi-Fi Array, combining an integrated Wi-Fi controller, multiple radios and high-gain directional antennas in one device, delivered powerful performance and extensive feature support to meet the requirements of tomorrow's enterprise wireless networks.

Introduction

Each Xirrus XN8 Wi-Fi Array consisted of eight integrated Wi-Fi access points (IAPs), a Wi-Fi controller, a Wi-Fi threat sensor and two Gigabit Ethernet uplinks.

The Cisco Wi-Fi solution consisted of a 5508 Wi-Fi controller and four 3502e dual-radio thin APs.

The results of various performance and feature validation tests are summarized in the following sections.

Findings

Performance Tests

User Density - Domain Login

In this test, engineers configured 100 client laptops logging into a domain, downloading a 23 MB file as part of their user profile. The XN8 Array was configured to use its eight radios and built-in Wi-Fi controller. The Cisco Wi-Fi solution used a centralized Wi-Fi controller connected to four dual-radio APs.

As shown in Figure 1, the domain login process with 100 users connecting using the XN8 Array completed in less time than the Cisco Aironet solution over AES-encrypted wireless connections.

Download Performance

Tolly engineers used Ixia's IxChariot to measure the time required for the simultaneous FTP download of a 100 MB file by 100 Laptop clients.

Figure 1 illustrates the results of that test. The Xirrus solution completed the test in 208.5 seconds, 15% faster than Cisco's 245.1 seconds.


Inter-Device 802.11n Wi-Fi Roaming

Tests measuring the time a client takes to roam from one device to another showed that roaming between two XN8 Arrays completed within 16 ms when configured for open authentication/unencrypted Wi-Fi connections, compared to 160 ms using the Cisco Wi-Fi solution. Configured to use WPA2 authentication/AES encrypted Wi-Fi connections, the XN8 Array again demonstrated faster roaming time at

Xirrus

XN8 Wi-Fi Array

Performance and Feature Evaluation

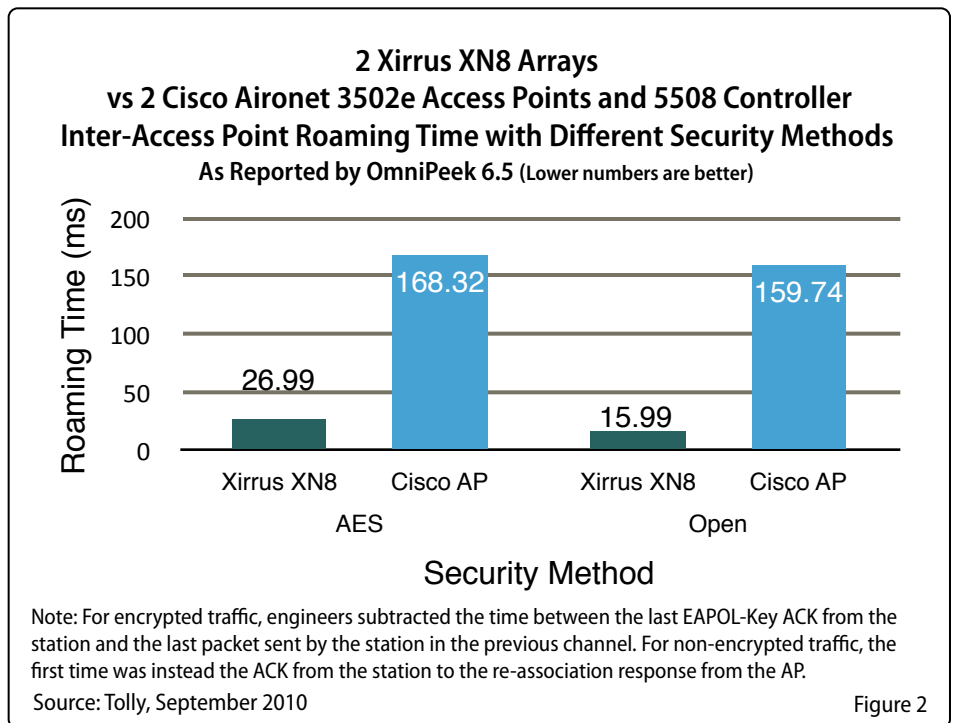


Tested September 2010

approximately 27 ms compared to 168 ms time for the Cisco Wi-Fi solution.

802.11n Wi-Fi Rate/Range

These tests focused on the Wi-Fi range and throughput of each solution communicating with a single client. The XN8 Array, using a high-gain directional antenna system, consistently delivered stronger (better) signal levels and higher throughput at various distances compared to the Cisco Wi-Fi solution that used omnidirectional antennas. (see Figures 3 and 4.)





The RSSI ¹ (Received Signal Strength Indicator) measurements found in Figure 3 show that the XN8 Wi-Fi Array was able to maintain a given RSSI (dBm) value at over 2X the distance (longer range) from the AP compared to the Cisco Wi-Fi solution. Note that 2X range translates to 4X the coverage area.

In 5GHz rate/range tests, a single radio of the XN8 averaged greater than 2X the throughput of a single radio of the Cisco AP. At 112.5 feet from the Array, where Cisco had no recordable signal, the XN8 Wi-Fi Array delivered a steady-state throughput of 46 Mbps.

In both the 2.4 GHz and 5 GHz modes of operation, the XN8 Array delivered better signal and throughput at all but one test point compared with the Cisco Wi-Fi AP, and significantly higher throughput at greater distances.

Wi-Fi Mesh / WDS (Wireless Distribution System)

The XN8 Wi-Fi Array demonstrated a unique capability in the Wi-Fi arena. The multi-radio design allows for inter-Array mesh connections over dedicated radio links. In the event that Ethernet connectivity is not widely available, an Array can be utilized to provide mesh access for up to three additional Arrays.

Tests show that in the case where two Arrays form a single-radio mesh, twenty IxChariot clients associated with either of two Xirrus Arrays were capable of 155 Mbps of bidirectional throughput. The Cisco solution tested did not support meshing - a separate product is required to provide this functionality for Cisco.

VoIP Voice Quality (MOS)

Engineers configured IxChariot to emulate 100 bidirectional VoIP (RTP encapsulated G.711u) calls, measuring the MOS (Mean Opinion Score) over the course of two

minutes, and repeated the test for a total of three times to ensure accuracy.

The XN8 Array delivered a higher average MOS of 4.07 with no failed calls, while the Cisco solution averaged 3.87, with an

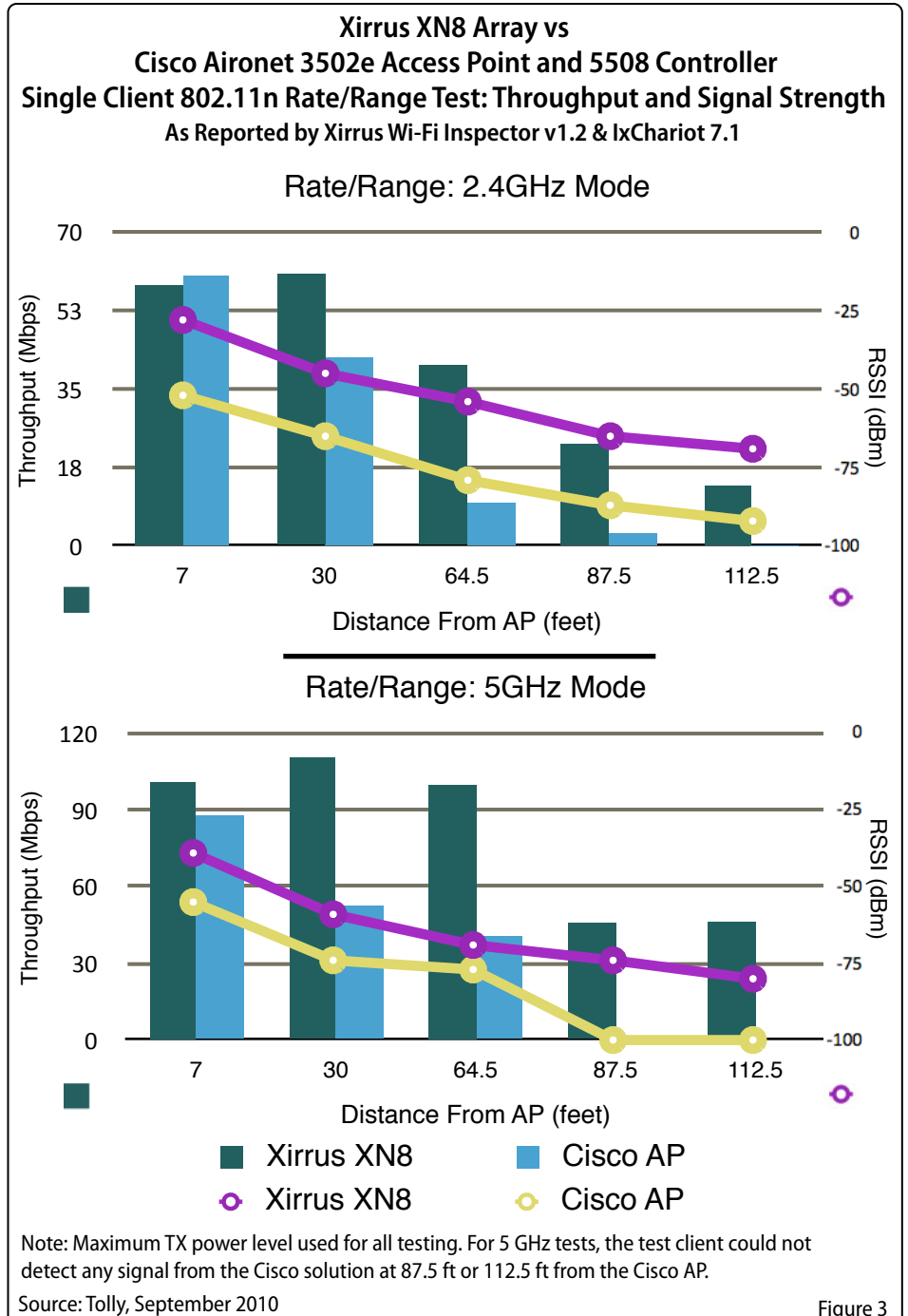
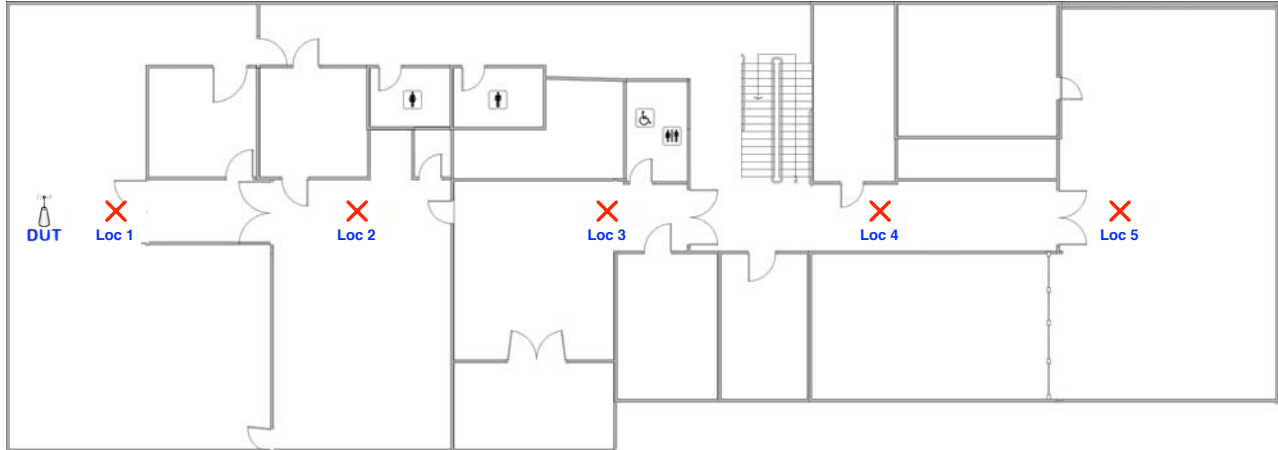


Figure 3

¹ According to Wikipedia, RSSI is the relative received signal strength in a wireless environment in arbitrary units.

802.11n Signal Rate/Range Test Results and Environment

As Reported by Xirrus Wi-Fi Inspector v1.2 & IxChariot v7.1



Description	Metric	2.4 GHz Radio Distance from AP (Feet)					5 GHz Radio Distance from AP (Feet)				
		Loc 1	Loc 2	Loc 3	Loc 4	Loc 5	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5
		7	30	64.5	87.5	112.5	7	30	64.5	87.5	112.5
Xirrus XN8	RSSI (dBm)	-28	-45	-54	-65	-69	-39	-59	-69	-74	-80
	Throughput (Mbps)	58.1	60.6	40.2	22.7	13.5	100.9	110.4	99.8	45.7	46.2
Cisco 3502e AP	RSSI (dBm)	-52	-65	-79	-87	-92	-55	-74	-77	X	X
	Throughput (Mbps)	60.3	42.1	9.6	2.9	0.2	87.8	52.4	40.8	0.0	0.0

Note: "X" signifies no signal was detected and, thus, throughput was zero.

Source: Tolly, September 2010

Figure 4

average of two failed calls across all three test iterations.

Feature Verification Tests

The comprehensive list of all the features evaluated is listed in Tables 1 and 2. Some of the important results are discussed below.

Radio Features

The XN8 Array integrates eight radios with high-gain directional antennas, four of which operate in IEEE 802.11a/b/g/n modes and the remaining four supporting IEEE 802.11a/n.

The XN8 Array allowed Wi-Fi clients operating in different 802.11 modes to associate at the same time.

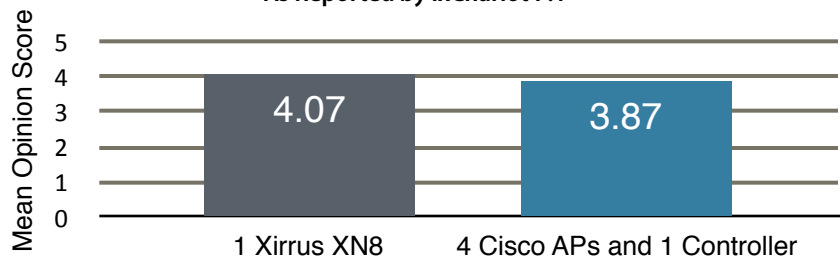
SSID Features

A Service Set Identifier (SSID) identifies a particular IEEE 802.11 WLAN. The XN8 Array supported several options for managing

service options based on SSIDs. The XN8 allows an SSID to be specified to be broadcast/advertised or not, or specify an SSID to be advertised in 2.4 GHz and/or 5 GHz bands simultaneously.

Bidirectional VoIP Call Quality - 100 Concurrent Users Best Effort QoS

As Reported by IxChariot 7.1



Note: Cisco does not recommend Best Effort QoS for VoIP.

Source: Tolly, September 2010

Figure 5



Feature Verification Checklist

Test Case	Xirrus XN8	Cisco Wi-Fi AP + Controller
RADIO		
Basic 802.11b-only Association	Pass	Pass
Basic 802.11g-only Association	Pass	Pass
Basic 802.11a Association	Pass	Pass
Basic 802.11bg Association	Pass	Pass
Mixed 802.11ag Association	Pass	Pass
Mixed 802.11ab Association	Pass	Pass
Mixed 802.11bg Association	Pass	Pass
Basic 802.11n Association	Pass	Pass
Mixed 802.11n and Legacy Association	Pass	Pass
SSID		
SSID Broadcast Settings	Pass	Pass
SSID Band Settings	Pass	Pass
SSID Traffic Shaping Settings	Pass	Pass
SSID Access Settings	Pass	Pass
UNICAST, MULTICAST AND BROADCAST		
Unicast, Multicast and Broadcast Traffic	Pass	Pass
AUTOMATIC CHANNEL ASSIGNMENT		
Automatic Channel Assignment	Pass	Pass
STATION LOAD BALANCING		
Station Load Balancing	Pass	Pass
ROAMING		
Inter-Device Roaming	Pass	Pass
NETWORK		
Basic Network Settings	Pass	Pass
VLANs	Pass	Pass
MESH/WDS		
Single Radio Mesh/WDS Link	Pass	N/A
Multi-Radio Mesh/WDS Link	Pass	N/A
HIGH AVAILABILITY		
Radio Resiliency	Pass	Pass
Uplink Resiliency	Pass	Pass
Device Resiliency	Pass	Pass

Source: Tolly, September 2010

Table 1

Furthermore, the XN8 Array supported specification of traffic shaping rules per SSID and also specific time of day to enable or disable a chosen SSID.

Encryption/Authentication Features

The XN8 Array supported an extensive Array of encryption and authentication features: including open/WPA/WPA2/802.1x/RADIUS authentication methods, and unencrypted/WEP/AES/TKIP encryption for the Wi-Fi traffic.

Unicast/Broadcast/Multicast Features

The XN8 Array supported unicast, broadcast and multicast traffic.

Load Balancing Features

The XN8 Array boasts advanced load balancing features like automatically assigning a specific frequency channel based on the amount of congestion in various channels when a client associates with the Array. The XN8 Array also intelligently assigned newly associated clients (wireless stations) to a specific radio depending on the load on different radios, to ensure optimal performance to all clients.

Roaming Features

The XN8 Array supported Wi-Fi roaming between different radios on the same device (intra-device roaming) and/or between different controllers (inter-device roaming).

Access Control Features

The XN8 Array supported multiple access control options to limit access to a known wireless client/station, or based on MAC address or IP address or the of a station, or to limit access to clients based on the TCP/UDP port of its traffic.

Wi-Fi Mesh/WDS Features

The XN8 Array supported using single or multiple radios on the Array to connect wirelessly to other XN8 Arrays, forming a Wi-Fi Mesh using a WDS (Wireless Distribution System) link. This feature allows connecting various XN8 Arrays wirelessly, and



Security Feature Checklist

Test Case	Xirrus XN8	Cisco Wi-Fi AP + Controller
ENCRYPTION AND AUTHENTICATION		
Open Authentication with WEP Encryption	Pass	Pass
WPA/WPA2-PSK Authentication with AES/TKIP Encryption	Pass	Pass
802.1x (Internal RADIUS) Authentication with AES/TKIP Encryption	Pass	Pass
802.1x (External RADIUS) Authentication with AES/TKIP Encryption	Pass	Pass
RADIUS MAC Authentication	Pass	Pass
ACCESS CONTROL		
Station Access Control	Pass	Pass
Access Control Based on MAC Address	Pass	Pass
Access Control Based on TCP/UDP Port	Pass	Pass
ROGUE DETECTION/MITIGATION		
Detection of Rogue APs	Pass	Pass
Rogue AP Mitigation	Pass	Pass

Source: Tolly, September 2010

Table 2

minimizing the number of cables in the network. The Cisco solution tested did not support mesh links - a different solution is required.

Rogue AP Detection/Mitigation Features

The XN8 Array allowed specifying a single radio on the Array to scan the coverage area to detect and mitigate a rogue (unwanted) access point.

High Availability Features

The XN8 Array was configured with two Gigabit Ethernet uplinks to support uplink resiliency, and also demonstrated resiliency at a radio-level and at a Wi-Fi controller-level by reassigning clients associated with a specific radio or Wi-Fi controller to another radio or Wi-Fi controller when the original radio/Wi-Fi controller goes down.

Advantages of the Xirrus XN8 Wi-Fi Array

Distributed Architecture

By integrating a Wi-Fi controller on each XN8 Array, the burden of client authentication and data encryption/decryption can take place at the Wi-Fi access layer, closer to the user. Using this distributed architecture, the impact on the backbone network bandwidth is reduced, along with decreasing the effective latency.

More Radios per Cable Drop

The XN8 Array delivered more radios per device per cable drop compared to Cisco Wi-Fi access points (APs) that typically support only two radios per device. This results in fewer Wi-Fi devices required to deliver a particular user density, as well as significant savings in cabling costs.

Higher User Density

By integrating more radios per device and by using additional channels in the less-congested 5 GHz (802.11a/n) band, along with automatic channel assignment and user load balancing, the XN8 Array delivers better user density than the Cisco Wi-Fi solution.

Longer Range

Compared to the Cisco Wi-Fi solution, the XN8 Array delivered better usable throughput at a longer range by using multiple high-gain directional antennas transmitting in 2.4 GHz and/or 5 GHz frequency bands. The XN8 Array delivered longer range than Cisco Wi-Fi solutions that use omni-directional antennas, thus requiring fewer devices to cover a given area. At approximately twice the range, the coverage area is four times greater per Array compared with the Cisco AP.



Test Bed Setup

The test bed for most tests consisted of up to two (in the case of roaming and mesh/WDS tests) Xirrus XN8 Wi-Fi Arrays (Running ArrayOS 5.0-1523) connected to a Cisco Catalyst 3750 switch for wired LAN backbone connectivity. The XN8 solution tested included eight Integrated Access Points (IAPs) built into a single device.



The test methodology used for this report relies upon test procedures, metrics and documentation practices as defined by:

Tolly Common Test Plan #1060:
Wi-Fi Infrastructure Devices.

To learn more about Tolly Common Test Plans, go to:

<http://www.CommonTestPlan.org>

A similar test bed was used for the Cisco Wi-Fi solution, consisting of four dual-radio thin APs (Model AIR-CAP3502E-A-K9) running IOS version 12.4(23c)JA, that were plugged back into the Cisco switch for providing connectivity to the centralized Wi-Fi controller (Model AIR-CT5508-12-K9).

For the range tests, a client laptop was configured with an AirMagnet 802.11a/b/g/n Wireless PC Card (driver version 7.4.2.122) and the Xirrus Wi-Fi Inspector version 1.2 application.

The location for the range tests was set in an office building (layout shown in Figure 4) and the test points were chosen at incremental distances from the Wi-Fi AP, and included physical obstructions like doors, wooden furniture, etc.

For the roaming tests, the monitoring laptop used WildPackets OmniPeek application to capture the Wi-Fi traffic on the chosen SSID.

For the domain login performance and client download tests, engineers used 100 client laptops - HP Mini 311 netbooks equipped with an Intel Atom N450 CPU @1.66 GHz, 2 GB RAM, running Microsoft Windows 7 Professional (32-bit) Operating System, and a built-in Broadcom 43224AG Wi-Fi adapter (driver version 5.60.350.6).

The 100 client laptops were divided into groups and placed on eight plastic-coated metal racks arranged in a semi-circle, with the four Cisco APs in the four corners of the lab. For Xirrus tests, a single Xirrus XN8 was placed in the center of the room for the complete set of testing. Cisco noted in its comments that the client configuration was not "real world". Tolly notes that the focus of the large-scale tests was the aggregate throughput of the SUT and not the throughput of any individual client or clients.

All tests were conducted using default configurations, only modifying settings when relevant to a given test scenario. Specifically, this included statically setting channels & SSIDs to assure all SUTs were equivalent, defining authentication methods, switching between 2.4 & 5 GHz radios, and balancing the number of clients across radios.

Test Methodology

The detailed test methodology for the various tests can be found in the "Tolly Common Test Plan #1060: Wi-Fi Infrastructure Devices". Information about the test plan is available online at:

<http://www.commontestplan.org/Plans/1060.html>.

Interaction with Cisco Systems

In accordance with our process for conducting comparative tests, The Tolly Group contacted Cisco Systems to notify them of the evaluation and invite their participation. Tolly provided Cisco with its results prior to publication and responded to Cisco's questions about the methodology and its results. Where necessary, this document has been updated to provide clarification for the reader.

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

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





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Test Equipment Summary

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

Vendor	Product	Web
NetSupport	NetSupport School v10.50.6	http://www.netsupportschool.com
WildPackets	OmniPeek 6.5a	http://www.wildpackets.com
Ixia	IxChariot 7.1 EA SP2	http://www.ixiacom.com
Xirrus	Xirrus Wi-Fi Inspector v1.2.0	http://www.xirrus.com

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