

Ruijie Networks X-Sense Smart Antenna Technology

802.11n & 802.11ac Rate/Range Comparative Performance Evaluation

Versus Apple, Cisco Systems, H3C and Ruckus Wireless

EXECUTIVE SUMMARY

The advent of high-availability wireless as has led to an increase in personal devices such as smartphones, tablets and of course, the portable computer, which all allow users to connect from anywhere within the office. All these different ways to connect ultimately means that there are many devices - usually several per person - competing for the same wireless bandwidth. High demands on the network combined with coverage issues, such as dead zones, pose a problem for enterprises operating a traditional antenna-based infrastructure.

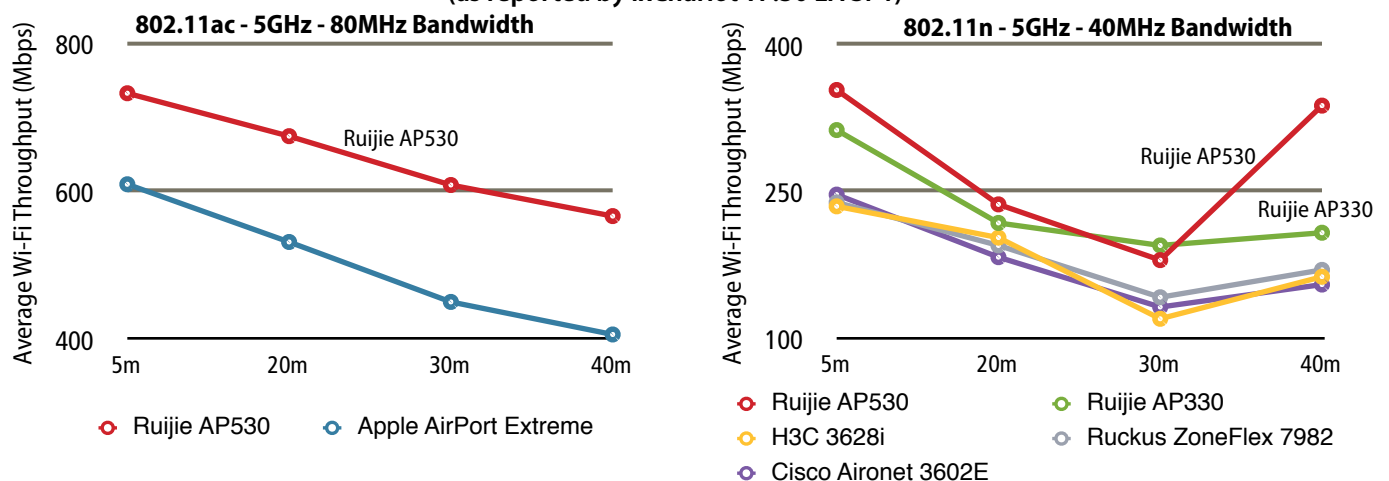
Ruijie Networks Co., Ltd. commissioned Tolly to evaluate their patented X-Sense Smart Antenna technology which is designed to reduce or eliminate dead zones of traditional antennas. In addition to Ruijie's 802.11ac Gigabit WiFi performance benefits, Ruijie's 802.11n performance also benefited from X-Sense - outperforming Cisco Systems, H3C and Ruckus Wireless. See Figure 1. ...<continued on next page>

THE BOTTOM LINE

The Ruijie Networks' APs with X-Sense Smart Antenna Technology:

- 1 Deliver the highest throughput numbers Tolly has validated thus far, with up to 928 Mbps downstream and 908 Mbps upstream WLAN 802.11ac throughput in the 5GHz band
- 2 Deliver up to 567 Mbps WLAN 802.11ac downstream throughput at long range (40m) in the 5GHz band
- 3 Deliver up to 3X 802.11n throughput at long range (40m) with obstacles using the 2.4GHz band compared to competitors
- 4 Deliver up to 1.5X faster 802.11n performance in high-density environments (50 concurrent users) in the 5GHz band, compared to competitors

Coverage Tests - 802.11ac and 802.11n Line-of-Sight Performance
Single-client, 5GHz, Downstream Throughput
(as reported by IxChariot v7.30 EA SP1)



Note: There were no obstacles between the AP and the client. Fat AP mode was used for all APs under test. 802.11ac tests used a Windows 7 laptop with a Broadcom BCM4360 3-stream 802.11ac Gigabit transceiver. 802.11n tests used a Windows 7 laptop with an Atheros AR9380 3-stream 802.11n adapter.

Source: Tolly, July 2013

Figure 1

Executive Summary (con't...)

Ruijie AP330 (802.11n) and AP530 (802.11ac) leveraging Ruijie's X-Sense smart antenna technology were chosen for the comparable analysis against leading wireless manufacturers including Apple, Cisco Systems, H3C and Ruckus Wireless. The Ruijie APs outperformed all competing products in all WLAN single client and multiple client throughput test scenarios,

and provided 3 times the downstream throughput of the Cisco Aironet 3602E at long range (40 meters) distance in obstructed environments with the 2.4GHz band.

Test Results

Coverage Tests

Single client downstream throughput from 5 meters to 40 meters was tested to evaluate each access point's coverage

Ruijie Networks

X-Sense Smart Antenna Technology

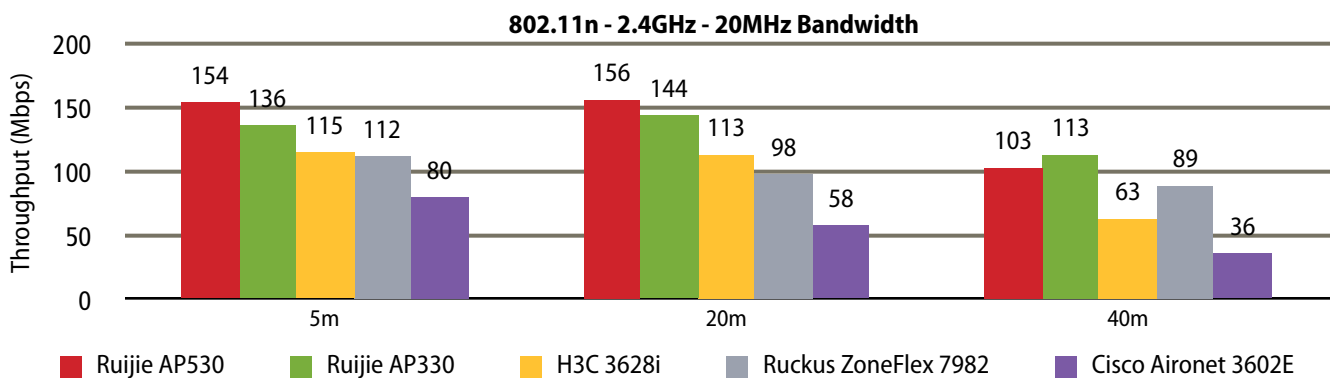


802.11n and 802.11ac Performance/Coverage Evaluation

Tested July 2013

Coverage Tests - 802.11ac and 802.11n Non-Line-Of-Sight Performance
Single-client Downstream Throughput
(as reported by IxChariot v7.30 EA SP1)

	DUT	5m	20m	30m	40m
802.11ac - 5GHz - 80MHz Bandwidth	Ruijie AP530	558	457	462	306
	Apple AirPort Extreme	388	265	194	123
802.11n - 5GHz - 40MHz Bandwidth	Ruijie AP530	199	271	211	202
	Ruijie AP330	201	199	198	131
	H3C 3628i	112	111	111	108
	Ruckus ZoneFlex 7982	146	120	141	114
	Cisco Aironet 3602E (external antennas)	153	118	117	102



Note: There were obstacles such as walls and pillars between the AP and the client. See Figure 4 for test environment. Fat AP mode for all APs under test. 802.11ac tests used a Windows 7 laptop with a Broadcom BCM4360 3-stream 802.11ac Gigabit transceiver. 802.11n tests used a Windows 7 laptop with a Atheros AR9380 3-stream 802.11n adapter. 802.11ac tests used 5GHz band with 80MHz bandwidth. 802.11n tests used 5GHz band with 40MHz bandwidth.

Source: Tolly, July 2013

Table 1, Figure 2



performance. For each distance, all devices were tested at one line of sight location (no obstructions between the AP and the client) and one non-line-of-sight location (with obstructions between the AP and the client).

Line-Of-Sight Coverage Test

In 802.11ac tests, the Ruijie AP530 outperformed the Apple AirPort Extreme at all test locations with a 20% to 39% advantage. See Figure 1 for details.

In 802.11n tests, the Ruijie AP530 and Ruijie AP330 outperformed the H3C WA3628i-AGN, Ruckus Zoneflex 7982 and Cisco Aironet 3602E at all test locations. The AP530's advantage to all competitors varied from 17% to 118%. The AP330's advantage to all competitors ranged from 7% to 63%. See Figure 1.

Non-Line-Of-Sight Coverage Test

Hardware-based smart antenna technologies are designed to provide better performance for dead zones than traditional software-based antennas.

In 802.11ac tests, the Ruijie AP530 provided constantly higher throughput than the Apple AirPort Extreme at all test locations with a 44% to 149% advantage. Ruijie's "X-Sense" smart antenna technology showed a significant advantage when there were obstructions between the AP and the client. See Table 1.

Although all 802.11n APs under test have smart antenna or equivalent technologies, the Ruijie AP530 and AP330 still provided consistently higher 802.11n throughput than the H3C 3628i, Ruckus 7982 and Cisco 3602E at all test locations, in both the 5GHz and the 2.4GHz bands. The AP530's advantage across the range of competitors

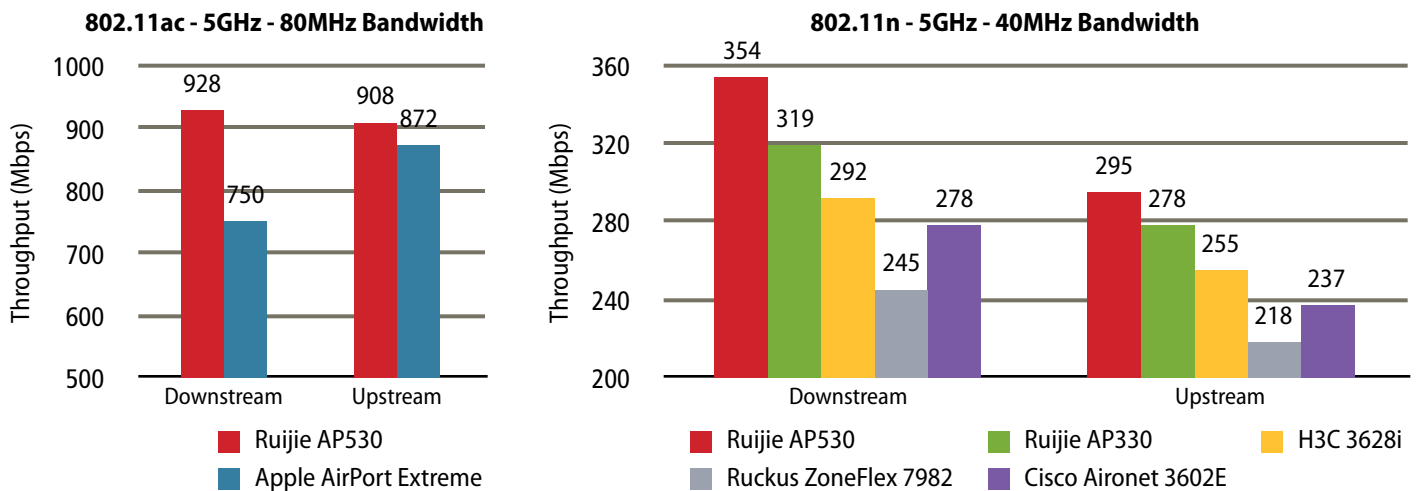
was from 30% to 144% in the 5GHz band and from 16% to 186% in the 2.4GHz band. The AP330's advantage across the range of competitors was from 15% to 79% in the 5GHz band and from 18% to 214% on the 2.4GHz band. See Table 1 and Figure 2 for detail.

Maximum Throughput

With a single client, Tolly engineers tested the maximum upstream and downstream throughput that each AP could provide - choosing the best result of three runs at either 1m or 5m distance.

In 802.11ac tests with the 5GHz band, the Ruijie AP530 provided 928 Mbps downstream throughput and 908 Mbps upstream throughput. These results are the highest downstream and upstream throughput results in all WLAN tests Tolly has performed to date (August 2013).

Maximum Throughput Tests - 802.11ac and 802.11n
Single-client, 5GHz, Distance of 1m, Three Runs, Best Result
(As reported by Ixia IxChariot 7.30 EA SP1)



Notes:

- Maximum throughput was tested with 1 meter distance from the client to the AP. However, Ruijie AP530 802.11n, Ruijie AP330 802.11n and Ruckus ZoneFlex 7982's downstream throughput was better at 5 meters than 1 meter distance. So the better results were used here.
- Fat AP mode for all APs under test. Average throughput in the 1 minute test is reported. 20 streams were used for IxChariot.
- 802.11ac tests used a Windows 7 laptop with a Broadcom BCM4360 3-stream 802.11ac Gigabit transceiver. 802.11n tests used a Windows 7 laptop with an Atheros AR9380 3-stream 802.11n adapter.

Source: Tolly, July 2013

Figure 3



In 802.11n tests, the Ruijie AP530 provided 354 Mbps downstream throughput and 295 Mbps upstream throughput while the AP330 provided 319 Mbps downstream throughput and 278 Mbps upstream throughput. Both Ruijie APs provided higher maximum throughput than the Apple, H3C, Ruckus and Cisco devices under test. In particular, the Ruijie AP530 provided 44% higher downstream throughput and 35% higher upstream throughput than Ruckus Zoneflex 7982. The Ruijie AP330 provided 30% higher

downstream throughput and 28% higher upstream throughput than Ruckus Zoneflex 7982. See Figure 3.

Multi-client Test

Multi-client tests were run with 3x3 and 2x2 clients to evaluate the aggregated throughput that each AP can provide with multiple devices.

In 802.11ac tests, with 10 and 20 3x3 802.11ac clients, the Ruijie AP530 provided

449 Mbps and 370 Mbps aggregated throughput, outperforming the Apple AirPort Extreme in both configurations. See Table 2.

In 802.11n tests, 10 3x3 802.11ac clients (802.11n compatible) and 50 2x2 802.11n clients were used to test. In all test cases, the Ruijie AP330 provided higher aggregated throughput than H3C, Ruckus and Cisco devices under test. See Figure 4.

Multi-client Test - 802.11ac Performance
Aggregate Downstream Throughput, 5GHz
 (as reported by IxChariot v7.30 EA SP1)

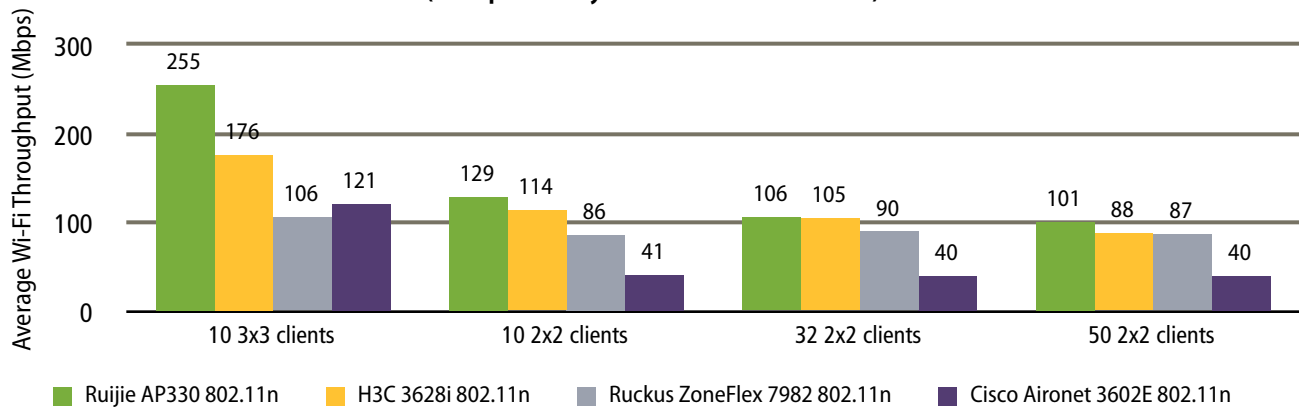
DUT	10 3x3 802.11ac clients	20 3x3 802.11ac clients
Ruijie AP530	449 Mbps	370 Mbps
Apple AirPort	429 Mbps	360 Mbps

Note: Fat AP mode for all APs under test. 802.11ac 5GHz band with 80MHz bandwidth was used for all tests. 3x3 clients tests used Windows 7 desktops with ASUS 802.11ac Dual-band Wireless-AC1750 PCI-E Adapters.

Source: Tolly, July 2013

Table 2

Multi-client Test - 802.11n Performance
5GHz, Downstream Throughput
 (as reported by IxChariot v7.30 EA SP1)



Note: Fat AP mode used for all APs under test. 802.11n 5GHz band with 40MHz bandwidth was used for all tests. 3x3 clients tests used Windows 7 desktops with ASUS 802.11ac Dual-band Wireless-AC1750 PCI-E Adapters. 2x2 clients tests used Windows 7 netbooks (20 with TP-Link TL-WDN3321 USB wireless adapters, 20 with Belkin F7D4101 V1 USB wireless adapters, 10 with Netgear WNDA3100 USB wireless adapters).

Source: Tolly, July 2013

Figure 4

Test Setup & Methodology

Test Environment

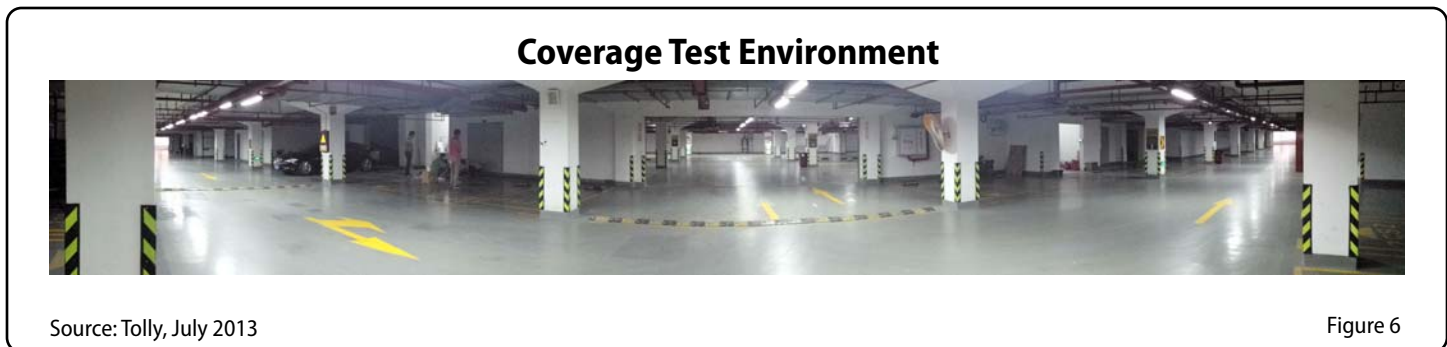
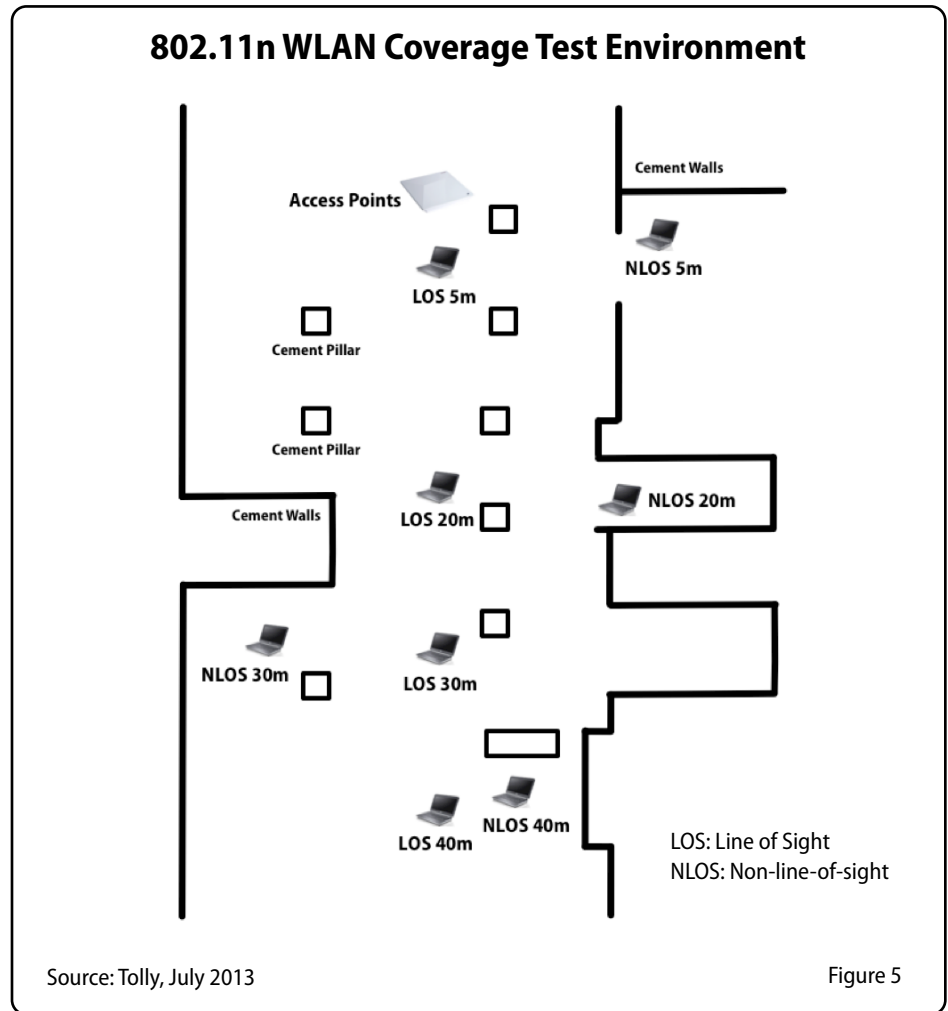
Single client coverage tests and maximum throughput tests were performed in an almost empty public indoor garage without cars passing through or parking changes. Walls and pillars were used as the obstructions in the non-line-of-sight tests. In 802.11n tests, all APs were hung on the ceiling side-by-side. In 802.11ac tests, as the Apple AirPort could not be mounted on the ceiling, both APs were placed on a chair and faced the client. 20 streams of Ixia IxChariot v7.30 EA SP1 traffic were used for the client. See Figure 5 and Figure 6 for the 802.11n test environment. 802.11ac tests were run at the same location. But the location of APs under test and clients were slightly different.

Multi-client tests were performed in an office. APs were hung on the ceiling in the middle side-by-side. The Apple Airport was placed on a table in the middle of the office. Clients were placed around the APs on and under tables. 2 streams of Ixia IxChariot traffic were used per client.

In all tests, the same clients were used at the same locations. The 802.11ac tests used the default high throughput script in IxChariot. All other tests used the default

throughput script in IxChariot. All tests were run with 1 minute. Average throughput for the 1 minute duration was reported.

For all 5GHz tests, channel 157 was used. 802.11ac tests used 80MHz bandwidth and 802.11n tests used 40MHz bandwidth. For 2.4GHz 802.11n tests, channel 11 with 20MHz bandwidth was used.



Client Device Configurations

Device	Make/Model	CPU/RAM	Operating System	Networking
802.11ac single client test device	Dell Latitude E5430	Intel Core i5 @ 3.2GHz / 2GB	Windows 7	Broadcom BCM4360 3-stream 802.11ac Gigabit transceiver
802.11n single client test device	Dell Latitude E5420	Intel Core i3 @ 2.2GHz / 2GB	Windows 7	Qualcomm Atheros AR9380 3-stream 802.11n
802.11ac 3x3 client for multi-client tests	Dell PC	AMD Athlon 64 X2 Dual-core @ 2.00GHz / 1GB	Windows XP	ASUS 802.11ac Dual-band Wireless-AC1750 PCI-E Adapter
802.11n 2x2 client for multi-client tests	ACER 255 Netbook	Intel Atom N2600 @ 1.50GHz / 2GB	Windows 7	20 with TP-Link TL-WDN3321 USB wireless adapters, 20 with Belkin F7D4101 V1 USB wireless adapters, 10 with Netgear WNDA3100 USB wireless adapters

Source: Tolly, July 2013

Table 3

Systems Under Test


Vendor	Model	Version
Ruijie Networks Co., Ltd.	AP530-I (802.11ac AP, internal antennas)	1T19p1
Ruijie Networks Co., Ltd.	AP330-I (802.11n AP, internal antennas)	1T19p1
Cisco Systems, Inc.	Aironet 3602E (802.11n AP, external antennas)	IOS Software, C3600 Software (AP3G2-K9W7-M), Version 15.2(2)JB, fc1
H3C Technologies Co., Ltd.	WA3628i-AGN (802.11n AP, internal antennas)	Comware version 5.20, release 1105
Ruckus Wireless, Inc.	Zoneflex 7982 (802.11n AP, internal antennas)	9.5.2.0.15.BL7
Apple Inc.	AirPort Extreme (802.11ac)	version 7.7

Source: Tolly, July 2013

Table 4

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 SP1	 http://www.ixiacom.com

About Ruijie Networks

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Ruijie Networks has over 38 branch offices with sales and service covering Asia, Europe, North America, and South America. Ruijie Networks is the only data communication company certified as an innovative enterprise in China. With continuous improvement on the innovative road of independent R&D, Ruijie Networks leads and promotes the development of cutting-edge network technologies worldwide.

Source: Ruijie Networks, August 2013

Ruijie Patented Technology - X-Sense Smart Antenna Overview

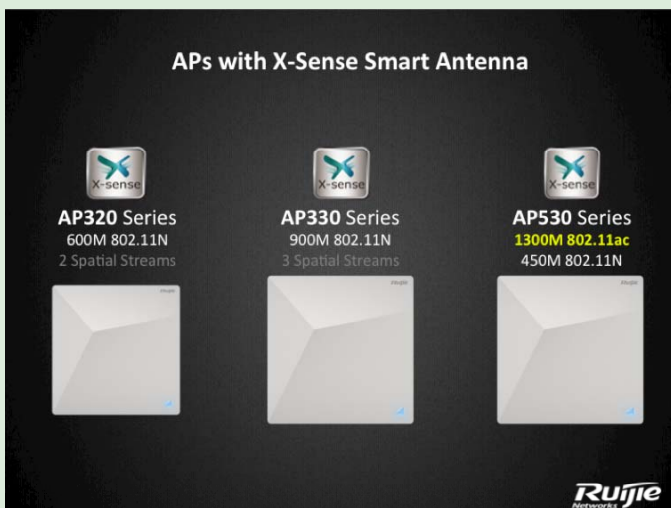
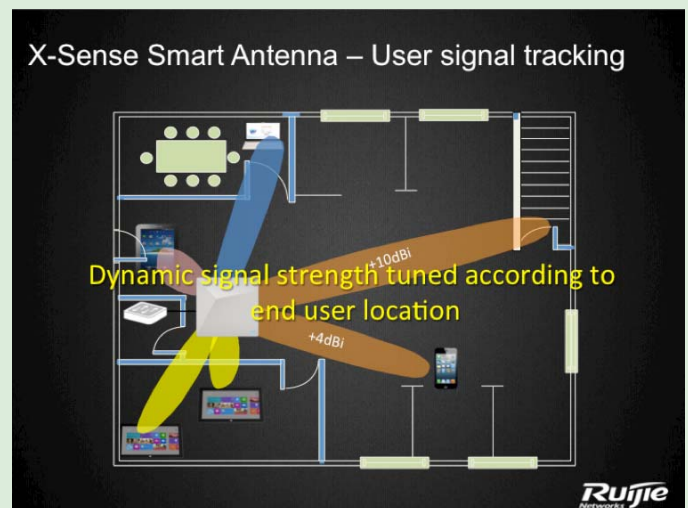
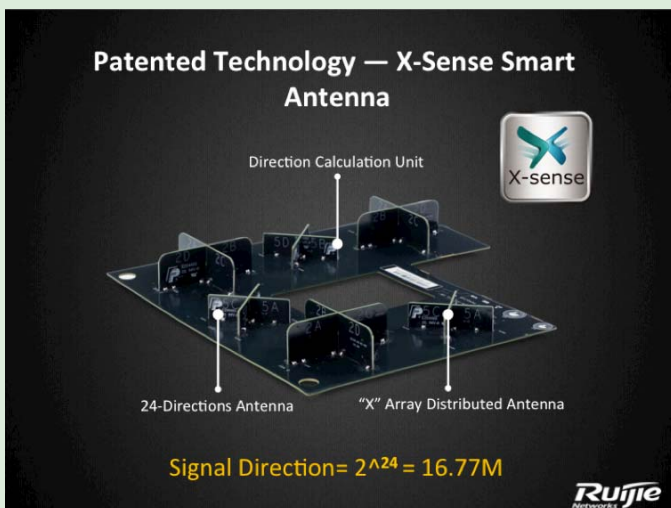
Information provided by vendor, not necessarily verified by Tolly

➤ **Full coverage based on 16.77 million signal paths**

In the X-Sense Smart Antenna matrix architecture, AP with 24 built-in array antennas dynamically selects up to 16.77 million different antenna combinations and effectively solves the weakness of coverage dead zones of traditional antennas. Regardless of the location of mobile intelligent terminal, the X-Sense Smart Antenna customizes and aligns the best signal path to achieve full coverage.

➤ **Automatic adjustment for best signals**

Regardless of the high mobility of end terminals, the AP always provides the best signal path all thanks to the revolutionary change brought by Ruijie X-Sense Smart Antenna technology. No manual adjustment required, the X-Sense Smart Antenna can automatically preform up to 300 signal path switchovers within 1 ms. Even if the terminal is moving fast, the X-Sense Smart Antenna can always trace the terminal and offer the best signal strength.



For more information on Ruijie Networks enterprise WLAN solution, please visit website:

<http://www.ruijienetworks.com/product/Wireless>



Source: Ruijie Networks, August 2013



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 Apple, Cisco Systems, H3C Technologies Co., Ltd., and Ruckus Wireless to participate in the testing. Apple, Cisco and H3C did not respond to the invitation. Representatives from Ruckus reviewed the test methodology and version levels. Ruckus reviewed its results but did not comment by publication date.

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

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



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