Miercom

Lab Testing Summary Report

January 2015

Report 141212

Product Category:

Wireless Access Points

Vendor Tested:

CISCO

Products Tested:

Cisco Aironet 1570 Series

Aruba Networks AP-275

Ruckus Wireless T300

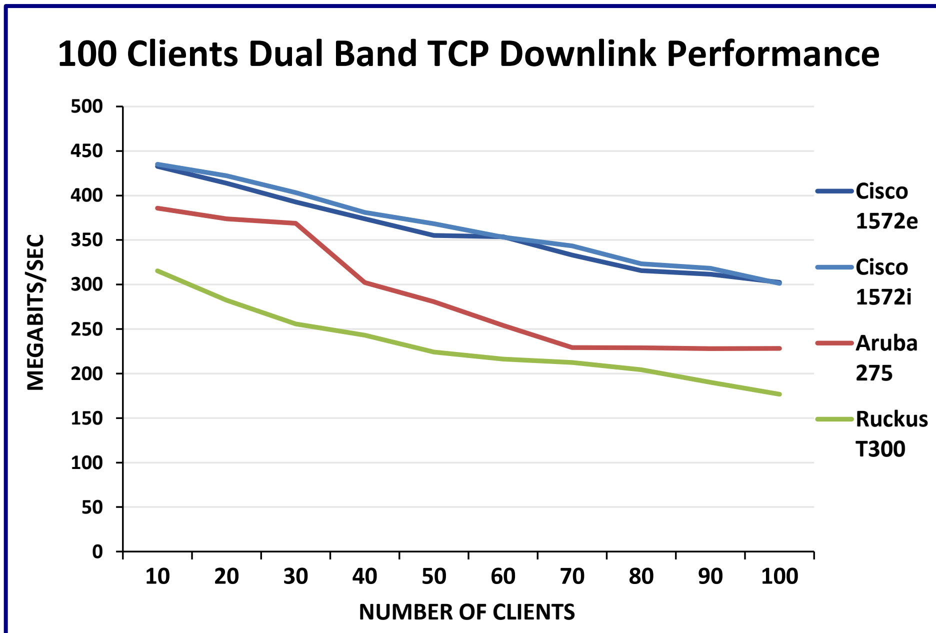
Key findings and conclusions:

- **Cisco's Aironet 1572 AP delivers from 40 and 58 percent more downlink bandwidth to a Samsung Galaxy S4 smartphone at 300 feet than the Aruba 275 and the Ruckus T300, respectively. At 1,000 feet the Cisco AP delivers more than five times the bandwidth of either the Aruba or Ruckus AP to a Galaxy S4.**
- **Cisco 1572 delivered a substantially consistent performance in a multi-iPhone 6 environment with more than two times the downlink bandwidth of either Aruba or Ruckus AP when traffic to all 10 iPhone 6 devices passed at the same time.**
- **In a backhaul test, Cisco 1572s delivered 600 Mbps of wireless throughput between wired networks 1,000 feet apart. Neither Aruba nor Ruckus APs supported such backhaul configurations due to lack of mesh at the time of testing.**
- **Cisco 1572 consistently outperforms both Aruba and Ruckus in a high-client density environment serving from 10 to 100 mixed clients (see below chart).**

Cisco engaged Miercom to compare the performance of Cisco's Aironet 1570 Series wireless access points (APs) with products from Aruba Networks, the AP-275, and Ruckus Wireless' T300 AP. Most of the throughput and performance tests for this comparative analysis were conducted outdoors in the fall of 2014.

In a high-client density test (see below graph), the Cisco Aironet 1570 outperformed the Aruba and Ruckus APs by delivering consistent, linear throughput performance as client load grew from 10 to 100.

Figure 1: High Client Density Performance



Source: Miercom, January 2015

Consistent winner. *The throughput delivered by the Cisco 1572i (with internal antenna), and 1572e (with external antenna) is compared with the Aruba AP-275 and Ruckus T300 APs for 10 to 100 802.11n/ac mixed-device clients. The Cisco AP consistently outperformed the Aruba and Ruckus APs in all environments.*

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The tests employed various real-world clients, including Samsung Galaxy S4, S5, and Apple iPhone 6 smartphones, along with iPads, Apple MacBooks, and Dell laptops. This assorted mix of client devices supported from one to three spatial streams, supporting 802.11n and the latest 802.11ac IEEE wireless standards.

Cisco Aironet 1572 has built-in support for both 802.11ac and the predecessor 802.11n spec, as well as earlier 802.11a/b/g. Models of the Aironet 1570 Series come with internal antennas or external antennas, and support various AC, DC and cable/Power-over-Cable (PoC) options.

All 1570 models also support dual-band operation – the ability to operate on both the 2.4-GHz and 5-GHz frequency bands concurrently. The Aironet 1570 Series supports the maximum radiated RF power allowed by law, which likely contributed to the Cisco AP's superior performance over Aruba and Ruckus, especially at longer distances – we tested at up to 1,000 feet (300 meters).

Aruba Networks' AP-275 and Ruckus Wireless' T300 APs were each tested with the internal antennas. Cisco 1572 models with internal and external antennas were both employed in our testing.

Measuring Throughput

The best metric for comparing wireless performance, which we applied throughout this testing, is down-link throughput. That is the amount of data that a user with a mobile device actually realizes, and this is largely dependent on the characteristics of the data and wireless connection – signal strength, distance, frequency band, channel bandwidth, modulation, protocol, application, and a host of other factors including weather and interference.

Down-link throughput can be TCP-based – the connection-oriented transport protocol used for Web browsing and FTP file downloads – or connectionless UDP, popularly used for audio, VoIP and video streaming. Our testing for this report used both but most of the results shown are based on TCP.

The main tool that assured consistency of our down-link throughput measurements was a powerful tool from Ixia called IxChariot, which simulates real-world applications to predict device, system, and network performance.

Every effort was made to ensure the same conditions were applied with each Access Point. But even during the same test with the same AP, performance measurements varied. Subsequently all tests were conducted multiple times and averages were calculated. All the values shown in this report are the average of multiple test runs.

Test Cases

Four sets of tests were devised to exercise the Access Points' comparative performance:

1. Outdoor Rate vs Range: Single and multiple spatial streams 802.11ac devices – Samsung Galaxy S4s and S5s – were tested at 300, 600 and 1,000 feet from the Access Points.

2. Outdoor Multi Client Performance and Consistency: A total of 10 of Apple's 802.11ac capable latest iPhone 6 smartphones were tested simultaneously.

3. Outdoor Mesh Backhaul Test: Wireless throughput between two APs, linking two wired networks that are 1,000 feet apart.

4. High-Client Density Performance Test: The average throughput per client, with a mix of 802.11n and 802.11ac devices, measured in increments up to 100 clients.

Outdoor Rate vs Range Tests

A bird's-eye view of the outdoor test range is shown on the next page. The four access points – two Cisco 1572 models, one with internal antenna and one with external antenna, and the Aruba and Ruckus APs – were mounted on the roof of the building at the far right. The distance across two parking lots was marked at 100-foot intervals.

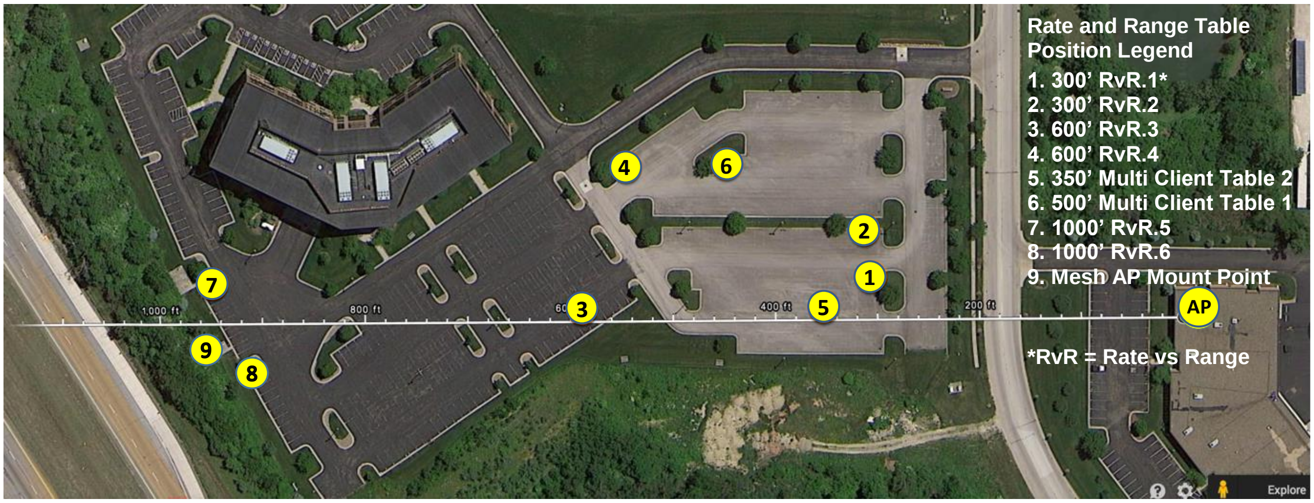
In addition, for the backhaul test, a 30-foot tower at the far left supported another Cisco AP, with local wired subnet, 1,000 feet from the rooftop APs.

The clients for these tests were placed on tables that were positioned at the required distances, all with a clear line of sight to the rooftop APs. See *How We Did It* on *page 8* for more details on the test set-up.

For the rate-vs-range tests, two different clients were employed, both supporting the latest IEEE 802.11ac wireless specification:

- Samsung Galaxy S4, a widely deployed Android smartphone that employs the Broadcom WLAN chipset supporting a single 802.11ac spatial stream.
- Samsung Galaxy S5, a newer Android smart-phone model, supporting two spatial streams.

Figure 2: Outdoor Test Area Aerial View



***Long-distance calls**. An aerial view of the outdoor test area in suburban Ohio is shown above, with 300, 600 and 1,000-foot distances. The Access Points (APs) are mounted on the roof of the building on the far right. The test area, across two parking lots, was marked off in 100-foot intervals.*

Both of these wireless clients were placed on a table positioned at 300, 600 and 1,000-foot distances from the access point. Multiple test runs with multiple rotations from each location were conducted to acquire the average throughput representing closest-to-accurate real-world performance.

We observed in setting up the test bed that rain and vehicular traffic or parked cars between the clients and the AP could impact performance. So, for consistency, all for-the-record testing was conducted in dry weather and after hours with no cars in the parking lot and minimum vehicular traffic.

The maximum data rates that clients can theoretically achieve in the 802.11ac WiFi environment are outstanding. Client-device and AP support for two or three spatial streams can double or triple the throughput. The maximum ***theoretical*** data rates are:

- With three spatial streams = 1,300 Mbps
- With two spatial streams = 867 Mbps
- With a single spatial stream = 433 Mbps.

These theoretical maximum data rates, the physical layer (PHY) speed at which client devices communicate with the AP, assume perfect transmit conditions and do not take into account the many factors that can reduce throughput when passing actual data traffic, including application and protocol.

The connection-oriented TCP, for example, can reduce throughput drastically due to protocol overhead. An FTP download, which uses TCP, for example, can easily reduce a theoretical maximum throughput in half.

Figures 3 and 4 on the next page show the resulting average throughput by client. Results for the two different smartphones are shown in separate charts. The throughput values shown are an average of four test runs for each client at each location. It should also be noted that, due to inconsistent results, additional test runs were needed for the Aruba AP to achieve a proper average in almost all test cases.

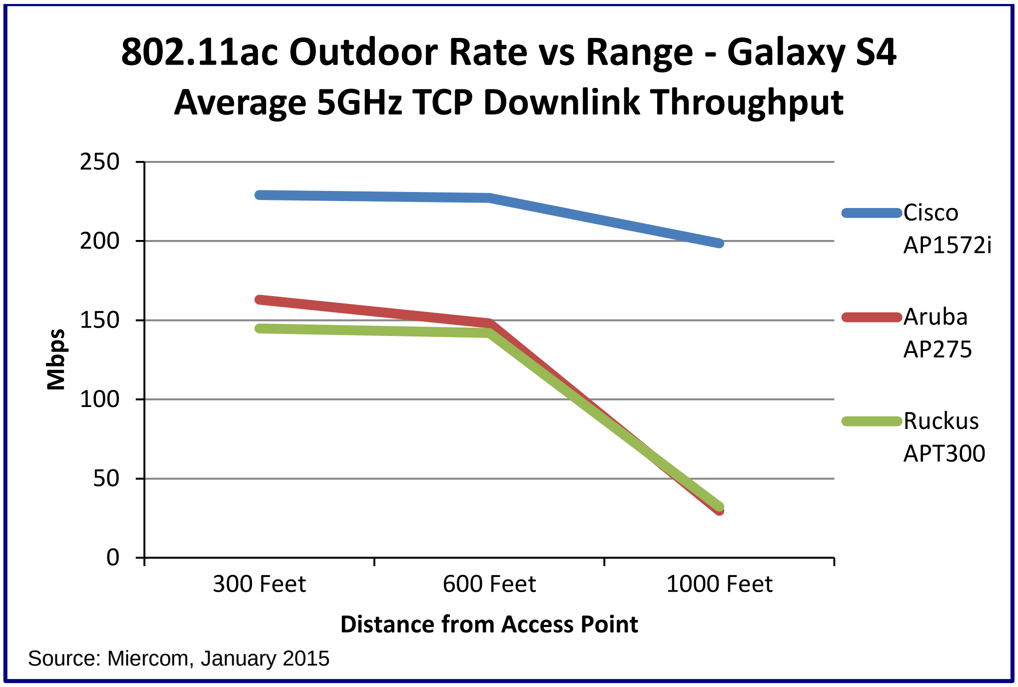
As expected, throughput declines as the client distance from the access point increases. *Figure 3* shows that Samsung's Galaxy S4 smartphone, which supports just one spatial stream, could achieve a down-link throughput of 229 Mbps at 300 feet with the Cisco AP1572.

Comparatively, though, the throughput delivered by Cisco at 300 feet is significantly more than could be obtained by the Galaxy S4 user from either the Aruba or Ruckus APs tested.

- At 300 feet, the Cisco 1572 delivers 40 percent more throughput to a Galaxy S4 than Aruba's AP-275, and 58 percent more than the Ruckus T300.

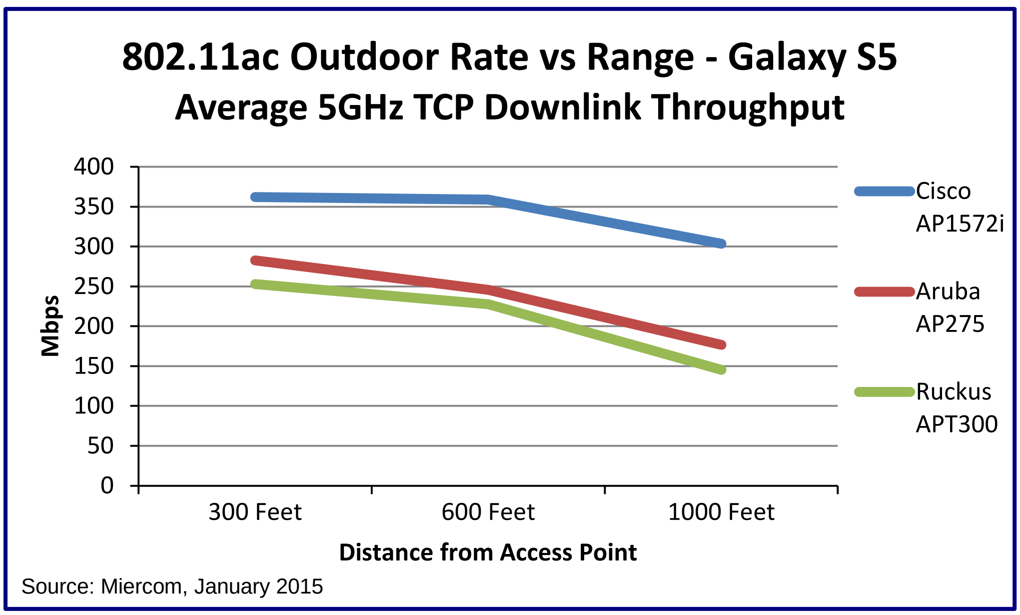
- At 1,000 feet, the Cisco 1572 delivers more than five times the down-link throughput to a Galaxy S4 than either the Aruba AP-275 or the Ruckus T300.

Figure 3: Galaxy S4 Throughput at 300, 600 and 1,000 Feet



***Galaxy S4**. At 300 feet, the Cisco 1572 delivers 40 percent more throughput to a Galaxy S4 than Aruba's AP-275, and 58 percent more than the Ruckus T300. At 1,000 feet, the Cisco 1572 delivers more than five times the down-link throughput to a Galaxy 4S than either the Aruba AP-275 or the Ruckus T300.*

Figure 4: Galaxy S5 Throughput at 300, 600 and 1,000 Feet



***Galaxy S5.** At 300 feet, the Cisco 1572 delivered 28 percent more throughput to a Galaxy S5 than Aruba's AP-275, and 43 percent more than the Ruckus T300. At 1,000 feet the Cisco 1572 AP delivers 71 percent more to a Galaxy S5 than Aruba's AP-275, and double – 109 percent more than – the Ruckus T300.*

The newer Galaxy S5 smartphone, supporting two spatial streams, achieved its best downlink throughput average of 362 Mbps, at 300 feet, with the Cisco 1572 AP. Again, the performance delivered by the Cisco AP was considerably better than the competition:

On analyzing the Rate vs Range data, it was clearly apparent that the smartphone clients, when connected to Aruba or Ruckus, start struggling to maintain the higher data rates beyond the mid-range of 600 feet.

At 1000 feet, Cisco 1572 AP managed to keep up with the higher data rate connections which allowed for a much higher average throughput performance for both the devices even at longer distances.

We observed that the average throughput performance for both of the Galaxy devices at 1,000 feet with the Cisco AP1572 was more than the average performance with either the Ruckus or Aruba APs at 300 feet.

Multi-Client Performance & Consistency

The next set of tests assessed outdoor performance with multiple smartphone clients of the same type, concurrently connected in different locations and with different orientations.

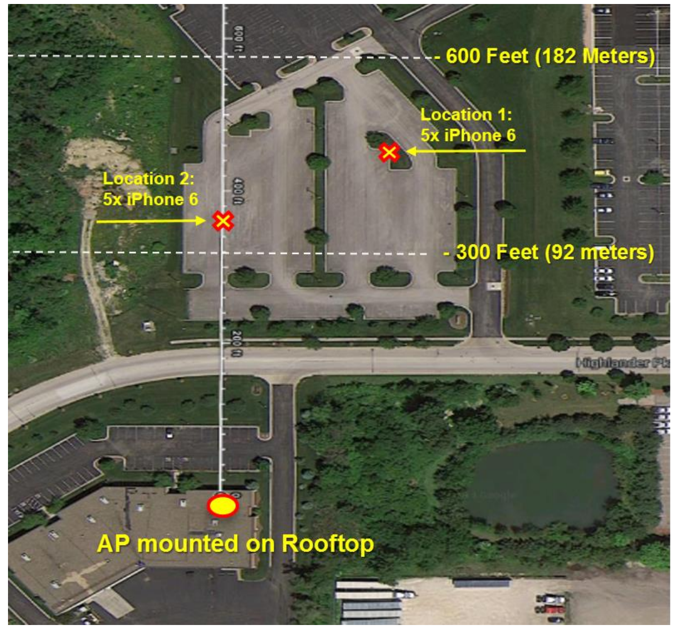
The clients were all Apple's latest iPhone 6. Ten of the iPhone 6 phones were deployed outside on two tables, five per table, with a good line-of-sight access to the AP. One table was situated at 350 feet from the AP, the other at 500 feet, as shown in the diagram to the right.

The iPhones were set at vertical and horizontal orientations (see below). The tables and phones were positioned at various angles to mimic a real world scenario, with fairly good signal conditions at each location.

Figure 6: Table on Location 1 with Five iPhone 6 Phones in Multiple Orientations

Figure 7: Table on Location 2 with Five iPhone 6 Phones in Multiple Orientations

Figure 5: Outdoor Multi-Client Performance and Consistency Aerial View

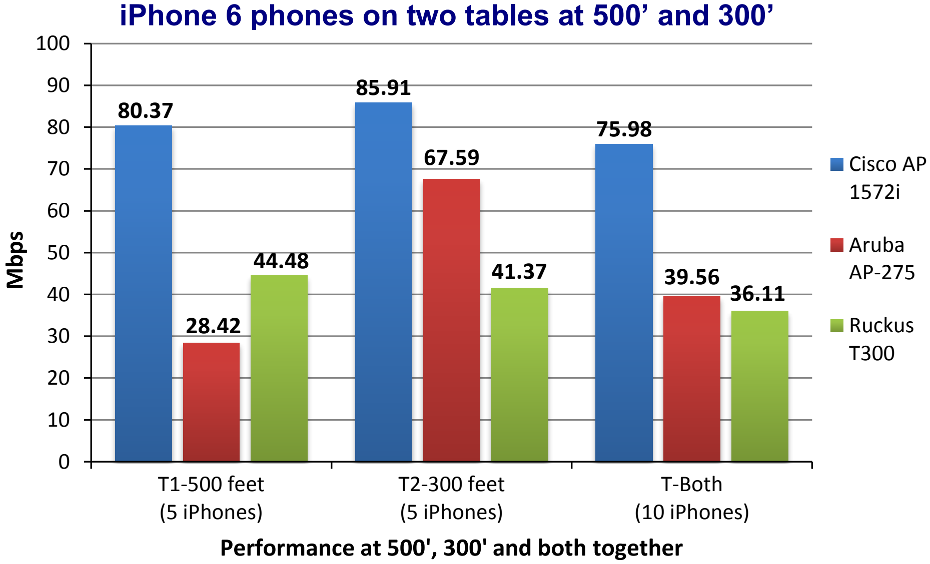


***iPhone 6 testing**. Five Apple iPhone 6s were placed on a table at Location 1 – 500 feet down-range from the APs. Five more iPhones were placed on a table at Location 2, 350 feet.*

Multiple test runs were conducted to measure the throughput performance of all the phones.

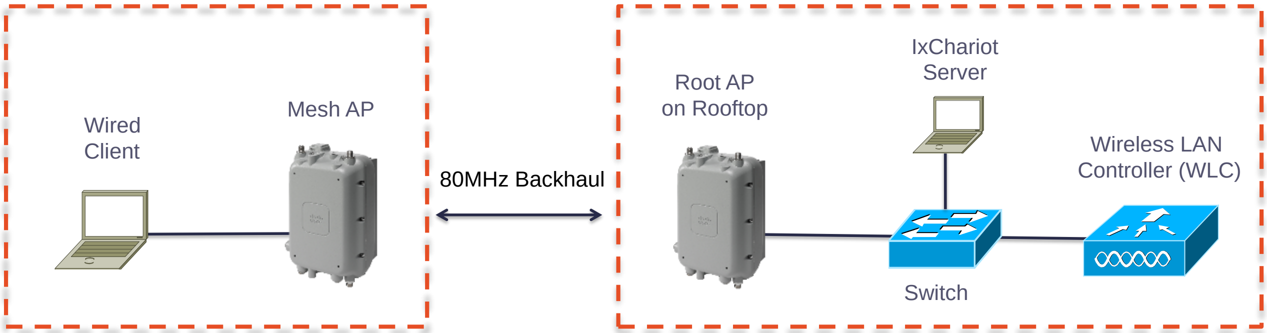
The average was taken of two test runs, per AP, for each of the five phones at one table. This was then repeated with the five phones at the second table. Then an average of two test runs for all ten phones was taken.

Figure 8: 802.11ac Outdoor Performance and Consistency iPhone 6 phones on two tables at 500' and 300'



***Outperforming outdoors.** The average downlink throughput per iPhone 6 is shown for: 1) five phones at 500 feet, 2) five phones at 350 feet and 3) all ten phones operating at the same time. The Cisco Aironet 1572 effectively delivers double the per-client throughput of the Aruba AP-275 and the Ruckus T300 for the phones at 500 feet, and with all phones operating concurrently.*

Figure 9: Outdoor Mesh Network Diagram



Backhaul topology. *Two Cisco 1572 Access Points were set-up in a 'mesh backhaul' configuration, where a single 80-MHz WiFi (802.11ac) channel was used to link two wired networks 1,000 feet apart. Tests validated throughput over 300 Mbps for TCP traffic and 600 Mbps for UDP. Neither Aruba nor Ruckus supported Mesh on their outdoor 802.11ac APs at the time of testing.*

Outdoor Mesh Backhaul Test

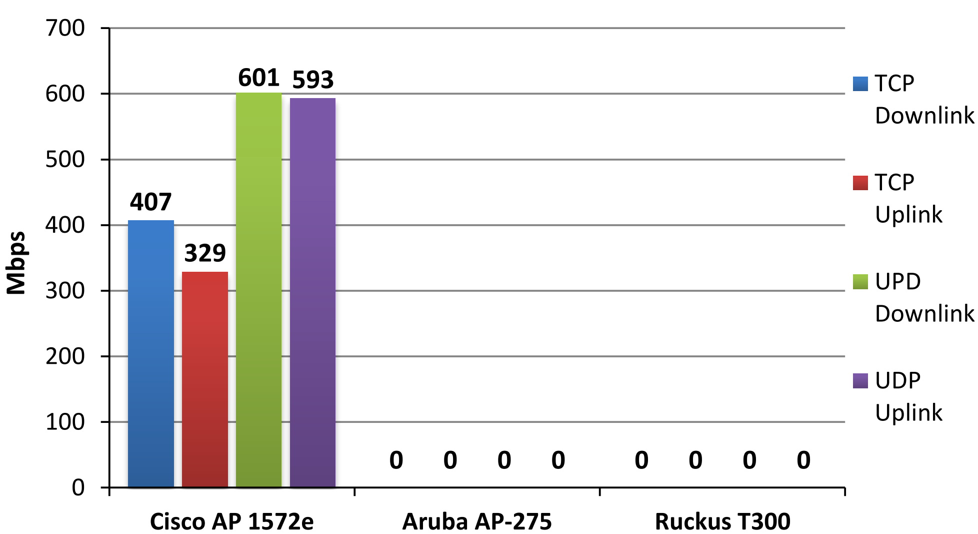
Backhaul generally refers to the extension of network services across a user organization's multiple sites. Connecting private-network sites via a wireless Access Point is not something many network designers would consider viable today. But in certain topologies, it can be an effectively workable solution.

The Cisco Aironet 1572 Access Point was developed to also serve a backhaul role. That was what the next test was designed to verify – how much bandwidth can be delivered over a single 80-MHz, IEEE 802.11ac channel to another 1572 AP up to 1,000 feet away.

The benefit to being able to link two sites 1,000 feet apart, quickly with two relatively inexpensive WiFi APs is clearly apparent. Where connectivity in a hurry is needed, or traversing a public roadway or other thorny right-of-way issue, this can be an invaluable alternative to an underground cable or licensed microwave link.

In the test configuration (see diagram above), the rooftop Cisco AP 1572 connected wirelessly across 1,000 feet to a second Cisco AP 1572, mounted on a 30-foot tower. Ixia's IxChariot was again used to measure the throughput – from a server cable-connected to the rooftop AP, across the wireless mesh-backhaul connection, to the remote AP, which is connected by wire to a client machine.

Figure 10: Outdoor 802.11ac Mesh Backhaul Performance



Source: Miercom, January 2015

Backhaul a la WiFi. *A pair of Cisco 1572 APs can be readily used for linking two wired networks 1,000 feet apart. Down-link throughput over the single-80-MHz WiFi channel was 329 Mbps for TCP and 600 Mbps for UDP. Neither the Aruba AP-275 nor the Ruckus T300 supported such a backhaul capability as mesh feature was not available for either of the vendors' 802.11ac APs at the time of testing.*

High-Client Density Test: 100 Clients

In another test, we sought to load the APs with a mixed set of real world clients and see how well they scale, performance-wise, under heavy stress as the number of clients contending for airtime on the same AP grows.

Shown on the right is the assortment of clients included in this test. The client mix was applied in increments of 10 and each new increment (20, 30, 40 etc.) was tested separately. The clients' distribution operating over 5GHz and 2.4-GHz frequency bands was 70 and 30 percent, respectively, and was maintained throughout the testing.

To assess the difference in performance between the Cisco AP with external antenna (1572e) and the AP model with internal antenna (1572i), both were separately tested.

As the results in *Figure 1* on *page 1* of this report show, both Cisco AP models worked at basically the same level of performance with each incremental increase in clients.

To summarize, the Cisco 1572 access points consistently out-performed the Aruba AP-275 and the Ruckus T300.

For TCP down-link performance, the Cisco 1572 delivered from 15 to 50 percent better throughput per client, on average, than the Aruba AP-275.

Similarly, for TCP down-link performance, the Cisco 1572 delivered from 38 to 70 percent better throughput per client, on average, than the Ruckus T300.

Bottom Line

This testing exercised the Cisco, Aruba and Ruckus Access Points for throughput performance in a broad range of outdoor scenarios. In every test, the Cisco 1572 outperformed the competitive APs from Aruba and Ruckus.

***100 client mix**. A potpourri of popular wireless client devices was included in the high-client density test. When fully populated, all 100 real-world connected with the same AP. The MacBook Pro and the iPad Air devices supported 802.11n; all the rest supported the latest 802.11ac.*

***Indoor venue**. Due to the difficulty of testing such a large number of devices outside, this testing was done indoors. Clients were all distributed 10 to 45 feet from the AP, which in the shot below was the Aruba AP-275.*

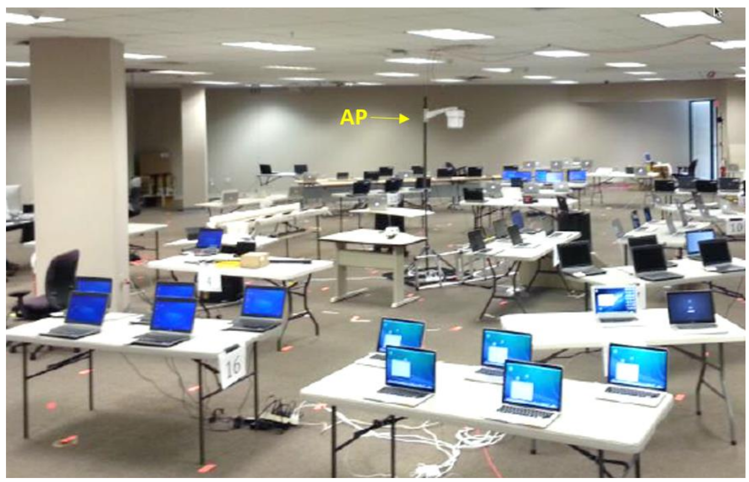
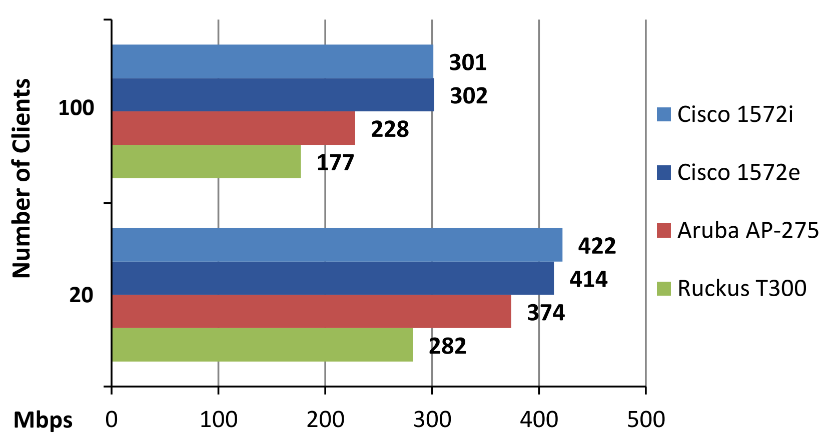
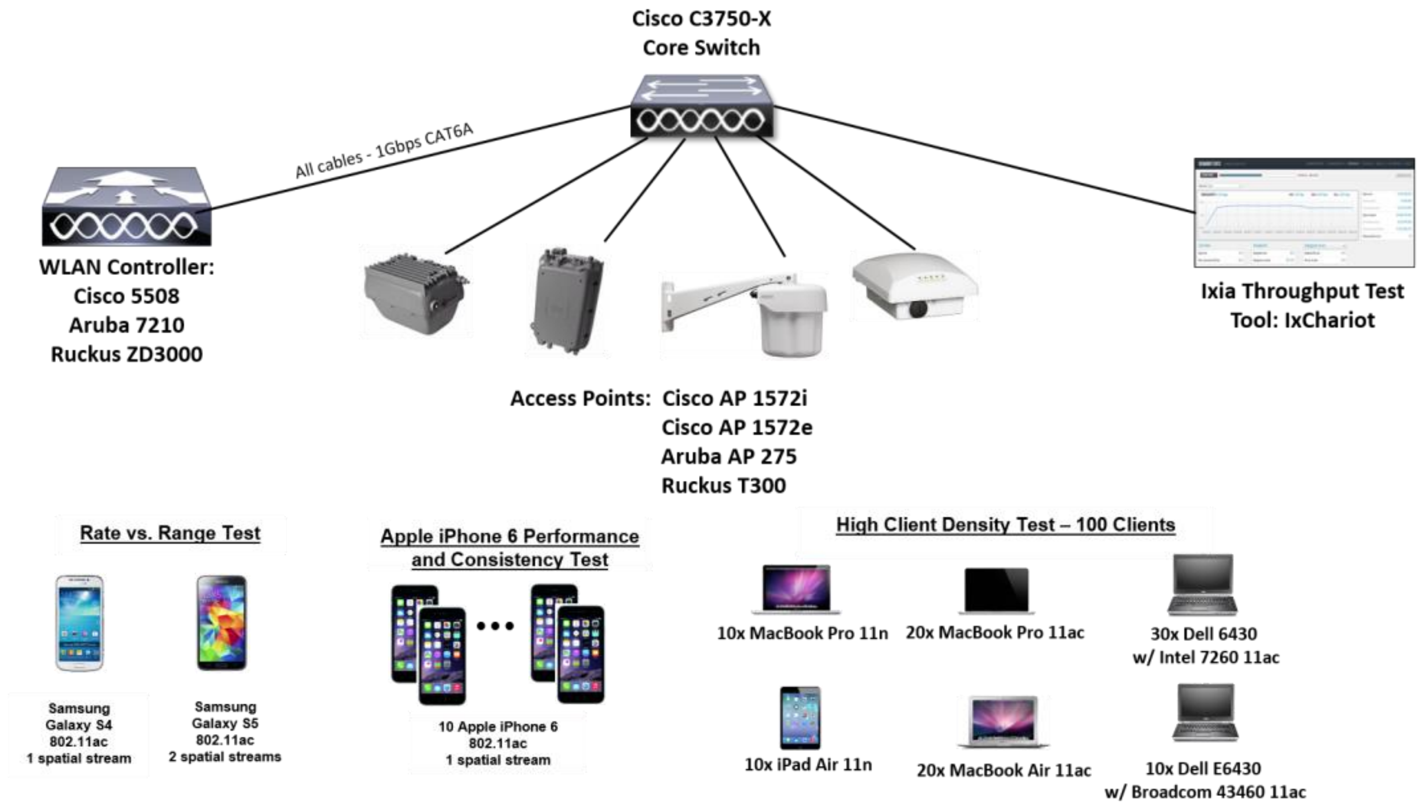


Figure 11: High Client Density Test Results Summary
Average per-client TCP downlink throughput (Mbps)



Test Bed Configuration



Source: Cisco

How We Did It

The test scenarios applied for this report were as varied as their objectives. Details are included in the descriptions and results for each test throughout this report.

All the outdoor tests were conducted over the same outdoor test range. At that location the Access Points were mounted and tested, one at a time, on the roof-top of a building. All APs and controllers were configured using similar configurations (same channels, SSID, Cat-6A cable length) with the individual vendors' best practices applied. For 5GHz, channel 149+ on 80MHz bandwidth, and for 2.4GHz, channel 1 on 20MHz bandwidth were set with the Tx power set to max on both bands for all three vendors. Distances from the building were marked off in 100-foot gradations. In the first test, of rate vs range, a mix of handheld client devices was tested for down-link throughput at 300, 600 and 1,000 feet. In the second test, groups of Apple iPhone 6 smartphones were tested at 350 and 500 feet, and then their throughput compared with all ten Apple iPhones downloading concurrently from both locations to assess overall consistency of the network. A third test checked the throughput of two Cisco APs connected over 1,000 feet in a backhaul arrangement. The last test was performed inside the building to compare how throughput scaled under heavy stress when the client load on the AP grew from 10 to 100. All the latest controller codes available at the time of testing were deployed: Cisco 8.0 MR1, Aruba 6.4.2.2, and Ruckus 9.8.1.0

Miercom recognizes IxChariot by Ixia (www.ixiacom.com) as a leading test tool for simulating real-world applications for predicting device and system performance under practical load conditions. Consisting of the IxChariot Console, Performance Endpoints and IxProfile, the IxChariot product family provides network performance assessment and device testing by testing hundreds of protocols across several kinds of network endpoints. IxChariot is used to accurately access the performance characteristics of any application running on wired and wireless networks. IxChariot v7.30 was used for all the test cases.

Miercom recommends customers conduct their own needs analysis study and test specifically for the expected environment for product deployment before making a product selection. Miercom engineers are available to assist customers for their own custom analysis and specific product deployments on a consulting basis. Contact Miercom Professional Services via reviews@miercom.com for assistance.

Miercom Performance Verified

Cisco Aironet 1572 delivered superior results in all of the wireless performance tests. A mix of popular smartphones and other WiFi client devices all achieved a higher performance in all environments, at all distances, with the Cisco Aironet 1572 than with either the Aruba AP-275 or the Ruckus T300 AP.

Featuring a 4x4 MIMO design and supporting three spatial streams, the Cisco Aironet 1572 also operates at the maximum radiated strength allowed by law, assuring superior performance for a high density of clients out to 1,000 feet and beyond.

These comparative and competitive test results substantiate award of this Miercom Performance Verified Certification to the Cisco Aironet 1572.

Cisco Aironet 1572e Access Point

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