



## Lab Testing Summary Report

November 2013

Report 131101

Product Category:

### Wireless Access Point

Vendor Tested:



Products Tested:

Cisco Aironet 3702i

Aruba Networks AP-225



### Key findings and conclusions:

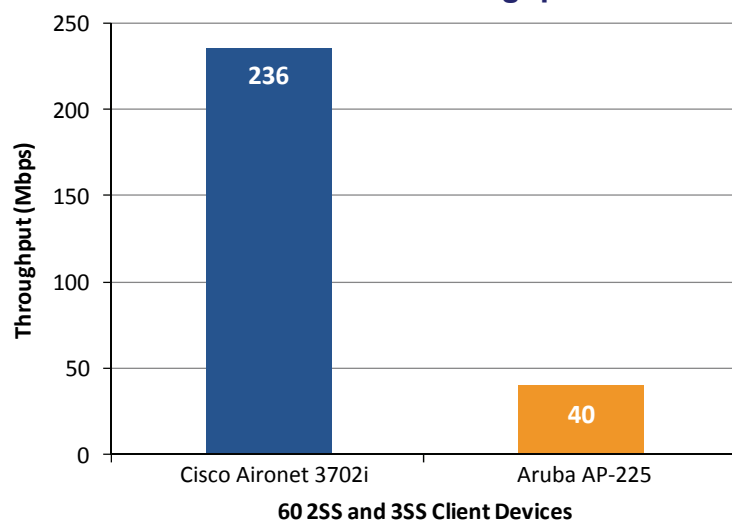
- Cisco Aironet 3702i is 6x faster than Aruba AP-225 in a high density test of 60 clients
- Cisco High-Density Experience, a suite of Cisco features that utilizes a purpose-built chipset with best-in-class RF architecture, enabled superior performance and coverage for 802.11ac deployments
- Aironet 3702i outperformed the Aruba AP-225 with both 802.3af and 802.3at power
- Greater performance was demonstrated using 4x4:3 802.11ac support and ClientLink 3.0 in rate versus range testing
- AP3702i had minimal impact on 802.11ac throughput when subjected to interference from another nearby AP transmitting in 802.11n 5 GHz mode

Cisco engaged Miercom to evaluate the performance of the Aironet 3702i indoor wireless access point and the AP-225 from Aruba Networks. Throughput/performance was tested to determine the impact of increased client devices, increased distance and/or physical obstructions, RF interference from devices on the same channel and functionality of operating with reduced power.

Cisco Aironet 3702i has built-in 802.11ac Wave 1 functionality as well as 802.11n functionality. This AP has internal antennas and is controller-based. As part of the 3700 Series, this model also includes:

- Updated ClientLink technology that supports 802.11a/g/n/ac and improves downlink performance by optimizing the signal-to-noise (SNR) ratio

Figure 1: Cisco Aironet 3702i vs. Aruba Networks AP-225 Multi-Client 802.11ac Throughput



Source: Miercom, November 2013

The Cisco Aironet 3702i delivered greater throughput than the Aruba AP-225 in all 12 scenarios in multi-client performance testing. The difference in throughput ranged from a low of 16.6% to one client to a high of 83.2% to the maximum population, 60 clients supporting 2 or 3 spatial streams, shown here.

- Cisco High-Density Experience (HDX), a feature set that alleviates the negative impact on throughput/end-user experience when there is an introduction of more clients, bandwidth-intensive applications and high-density concentrations of clients. HDX features include CleanAir 80Mhz for interference mitigation, ClientLink 3.0 for improved rate vs. range, Smart Roam for intelligent roaming handoff and Turbo Performance for high client scalability

The Aruba AP-225 access point has a software-configurable dual radio with a maximum data rate of 450 Mbps in the 2.4GHz band and 1.3 Gbps in the 5GHz band. Also, each omni-directional down-tilt antenna in the 3x3 MIMO design supports three spatial streams. The Aruba AP-225 is designed to connect with a dedicated mobility controller.

The APs operated in 802.11ac mode in three of the tests. One test validated the throughput in an environment where the number of client devices increased.

As shown in [Figure 1](#) on [page 1](#), the AP3702i provided more than 83.2% greater throughput per client than Aruba AP-225 with 60 devices supporting 2 or 3 spatial streams.

## 802.11ac Rate at Range Tests

Three sets of tests were conducted to determine the impact on throughput when increasing the distance and/or physical obstructions between the access point and the clients. During testing, the access points operated in the 802.11ac radio band, 5 GHz.

Throughput values for three types of 802.11ac-capable client devices were recorded. Six different distance and/or obstruction scenarios were used. The distance between the access point and the client device ranged from 10 feet to 150 feet. See [How We Did It](#) on [page 6](#) for specific details on the variations deployed.

There were two variations for each of the six client locations. In the first four scenarios, the client was located in a cubicle office environment. In the 100 and 150 feet scenarios, the access point and the client were in different rooms.

The maximum theoretical throughput possible for each device in each test varied based on the type of 802.11 functionality and/or radio band being utilized.

Each client device was tested in each set one at a time. Also, each device had different spatial stream (SS) capacity.

- a *Dell Latitude E6430* laptop, 3SS
- a *MacBook Air* notebook, 2SS
- a *Samsung Galaxy S4* smartphone, 1SS

As expected, throughput declined as the distance or physical obstructions increased between the access point and each client device.

The throughput values are an average of six runs, three runs at the two variations for each location.

The maximum theoretical data rate that could be achieved by spatial stream is as follows:

3SS = 1,300 Mbps

2SS = 867 Mbps

1SS = 433 Mbps

Results for each client at each location are shown in separate charts, [Figures 2-4](#) on the next page.

The AP3702i exhibited an advantage over the Aruba AP-225 in average throughput in all 18 scenarios of three client devices tested individually at six different locations.

The Aironet 3702i continued to provide robust throughput as difference increased between it and the client device. The two greatest differences in throughput were recorded with the 1SS *Samsung Galaxy* smartphone, 51.9% at 150 feet LOS and 45.5% at 100 feet LOS.

The two smallest differences in throughput were observed using the 2SS *MacBook Air* notebook, 5.5% at both 25 feet Non-LOS and 100 feet LOS.

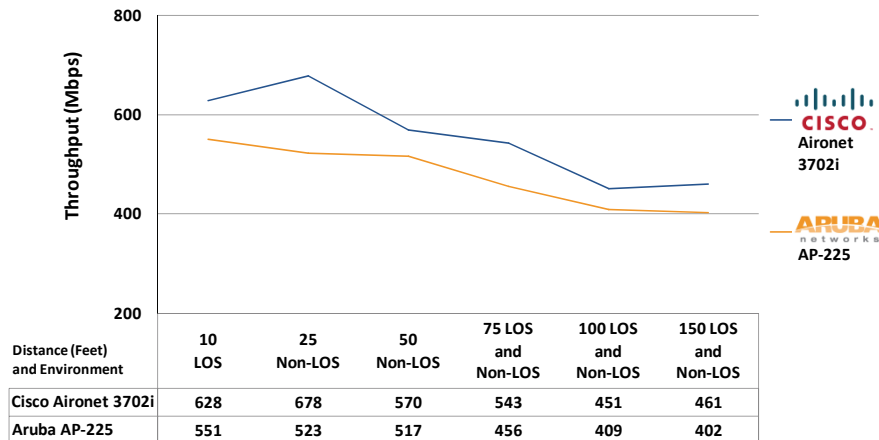
The difference in percentage from low to high for each client device was as follows:

- 3SS *Dell Latitude E6430* laptop: low of 10.3% for both 50 feet Non-LOS and 100 feet LOS, high of 29.6% for 25 feet Non-LOS
- 2SS *MacBook Air* notebook: low of 5.5% for both 25 feet Non-LOS and 100 feet LOS, high of 10.8% for 75 feet Non-LOS
- 1SS *Samsung Galaxy S4* smartphone: low of 12.5% for 50 feet Non-LOS, high of 51.9% for 150 feet LOS.

## Multi-Client Throughput

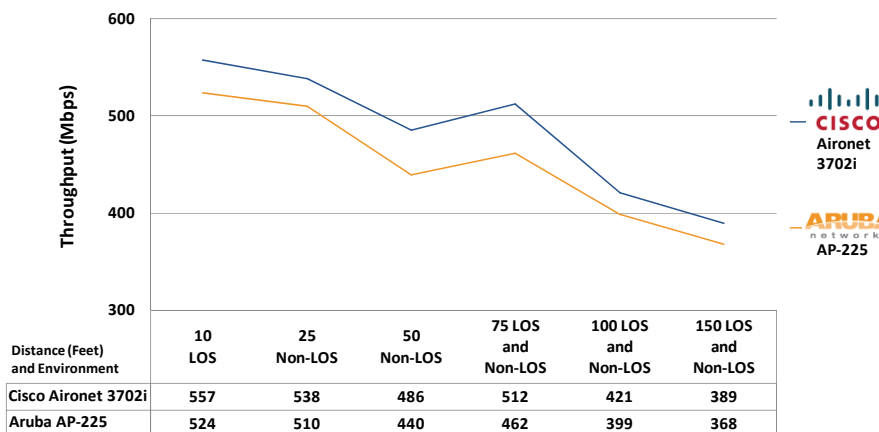
The Aironet 3702i and the Aruba AP-225 are designed to provide gigabit Wi-Fi performance to 802.11ac-capable mobile devices deployed in

**Figure 2: Rate at Range, 802.11ac Throughput  
3SS Dell Latitude E6430 Laptop, Six Scenarios**



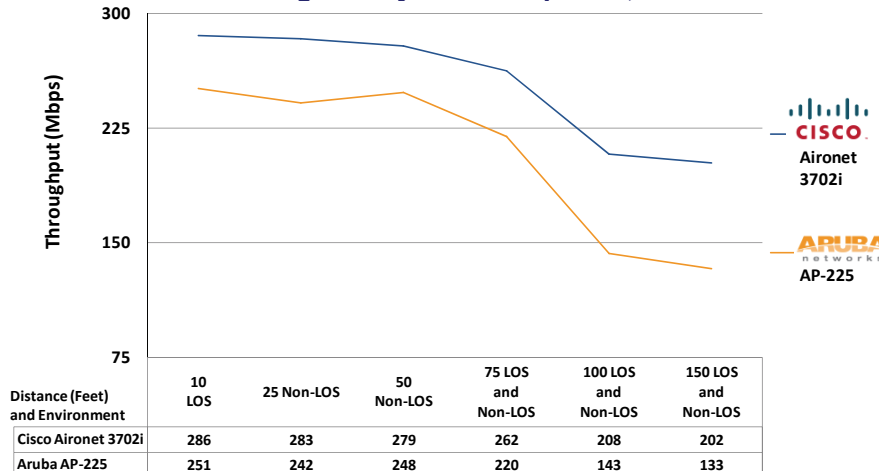
Source: Miercom, November 2013

**Figure 3: Rate at Range, 802.11ac Throughput  
2SS MacBook Air Notebook, Six Scenarios**



Source: Miercom, November 2013

**Figure 4: Rate at Range, 802.11ac Throughput  
1SS Samsung Galaxy S4 Smartphone, Six Scenarios**



Source: Miercom, November 2013

high-density wireless LAN environments.

Cisco High-Density Experience feature set is part of the 3702i AP. One of its key objectives is to reduce the negative impact on throughput caused by the increased clients.

This series of tests assessed the impact on throughput with a gradual increase of clients in a high-density single room environment.

There were 12 LOS test scenarios, starting with five clients. The number of clients was then successively increased by five until the maximum of 60 was reached.

The clients consisted of 10 *Dell Latitude E6430* 3SS laptops. The other clients were 2SS devices, 30 *E6430* laptops and 20 *MacBook Air* notebooks. The access point was suspended from the ceiling.

The AP3702i provided greater throughput as shown in *Figure 5* on *page 4*.

The difference started at 11.9% for five devices.

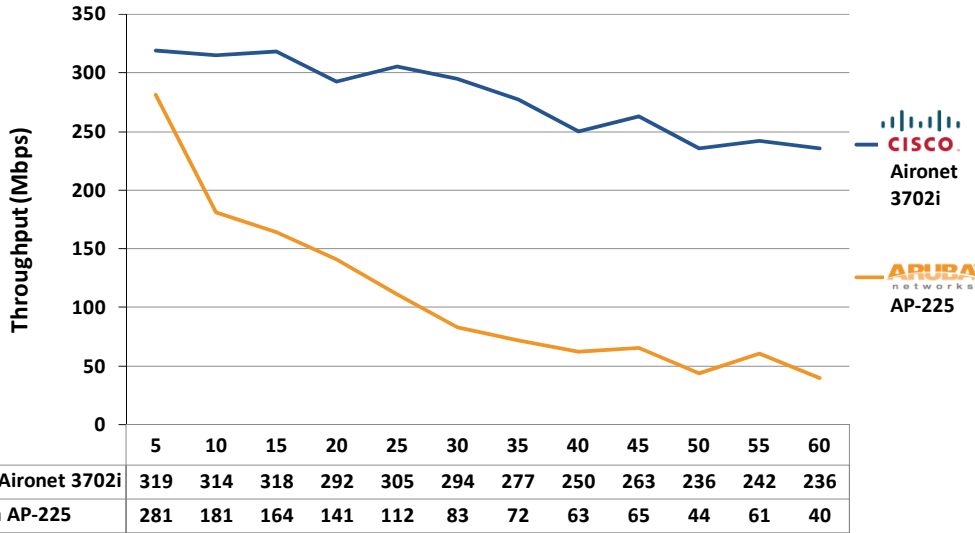
In the remaining 11 scenarios, the difference ranged from a low of 42.4% for 10 devices to a high of 82.8% for the maximum population, 60 devices.

Per-client throughput was also calculated. The difference in per-client throughput with 60 devices was 3.93 Mbps for the AP3702i versus 0.66 Mbps for the Aruba AP-225.

## RF Interference on Throughput

This series of tests assessed the impact on throughput of RF interference caused by other nearby access points transmitting

**Figure 5: Multi-Client 802.11ac Throughput**  
**1 to 60 2SS and 3SS Client Devices, 14 LOS Scenarios**



The AP3702i access point with the Cisco High-Density Experience feature set delivered greater throughput in all test sets than the Aruba AP-225. The difference was significant in the scenarios starting with 10 devices through the maximum population. The difference ranged from a low of 42.4% with 10 devices to a high of 82.8% with 60.

Source: Miercom, November 2013

on the same channel. This test is especially important because of 802.11ac's wider channel bandwidth, which can be negatively impacted if any section of the 80MHz-wide channel is in use.

The Cisco Access Point was developed to ensure optimum spectrum re-use, and leverages CleanAir for 80MHz to minimize the impact of the signal from other access points located nearby a high-density coverage area. This feature operates automatically and allows Cisco to send an 80MHz-wide 802.11ac transmission even when

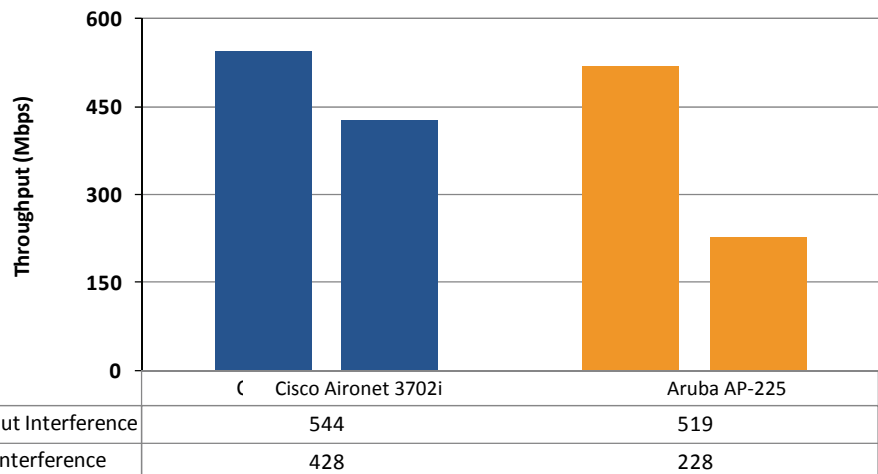
Wi-Fi interference is operating on a portion of that channel.

The AP under test operated in 802.11ac mode and was paired with a 2SS MacBook Air notebook. The interfering access point, a Cisco SMB WAP561, operated in 802.11n 5 GHz mode and was paired with a 1SS iPhone5 client.

The maximum theoretical data rate for MacBook Air notebook was 866 Mbps.

Baseline throughput value was verified with and without interference.

**Figure 6: 802.11ac Throughput**  
**With and Without 802.11n 5 GHz Interference**



Source: Miercom, November 2013

The Cisco AP3702i outperformed the Aruba AP-225 without and with interference from an access point operating in 802.11n 5 GHz mode heard at -80 dBm. The difference in throughput was just 4.8% without interference. It increased to 87.7% with interference.

The AP3702i outperformed the Aruba AP-225 in both scenarios as shown in *Figure 6* on *page 4*. The advantage for the AP3702i was 4.8% without 802.11n 5 GHz interference (544 Mbps versus 519 Mbps). The gap increased to 87.7% (428 Mbps versus 228 Mbps) with interference.

In the AP3702i, noise suppression works automatically. The RX Sensitivity Tuning-Based Channel Reuse Feature in the Aruba AP-225 must be manually set. The AP-225 was tested with the RX feature at various settings, without any improvement in throughput.

## Performance on Reduced Power

This test assessed the throughput and functionality of each AP while operating with regular and reduced power.

Both access points transmitted 802.11n 2.4 GHz and 802.11 5 GHz signal. The clients, two *Dell Latitude E6430* laptops, faced the access point, 10 feet LOS.

Two power supplies were used, the conventional 802.3at (PoE+) and reduced power 802.3af (PoE).

A drop in throughput was experienced by the Aruba AP-225 at 2.4 GHz, 148 Mbps for 802.3at to 55 for 802.3af, 169%.

In terms of functionality of the AP, there was no change for the AP3702i. Using an 802.3af power supply that provides up to 15.4 watts, it continued to transmit three spatial streams by backing down from 4x4 to 3x3 operation on both 2.4 GHz and 5 GHz. However, the functionality of the Aruba AP-225 dropped to only one spatial stream on the 2.4 GHz radio.

## Bottom Line

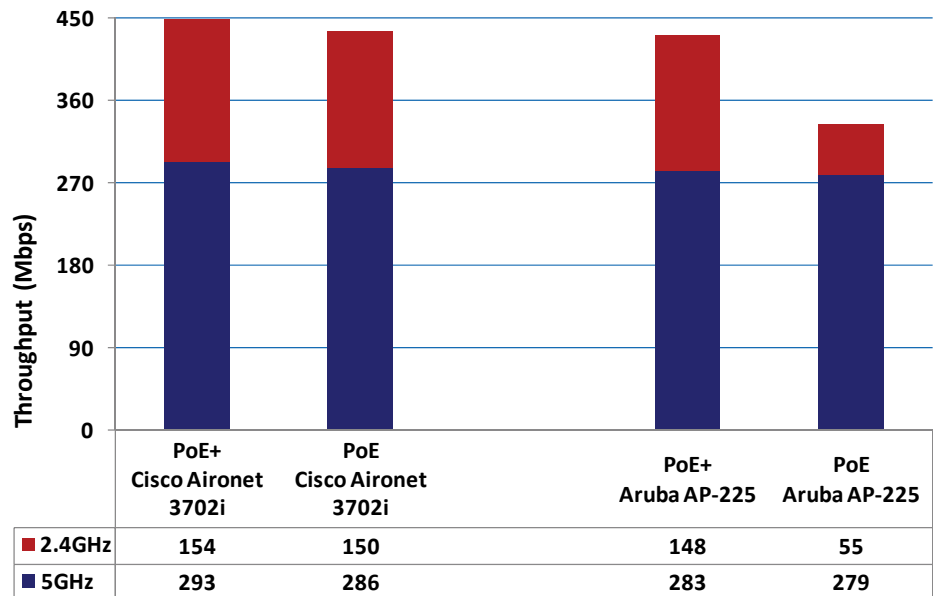
The Cisco Aironet 3702i is part of the Cisco Aironet 3700 Series, the first from Cisco with built-in 802.11ac functionality. It proved that it can add significant value to a real-world WLAN now and will continue to do so after the gigabit Wi-Fi standard is finalized in early 2014.

During rate at range tests, the AP3702i delivered a high level of 802.11ac throughput, beginning with 10 feet Line of Sight and ending with 150 LOS and Non-LOS. It maintained a high level of 802.11ac throughput in two series of tests that simulated real-world factors that can negatively impact throughput: a high-density environment and RF interference from a nearby access point.

While operating on reduced power, the AP3702i proved that it can retain full functionality while operating in each 802.11n mode, 2.4 GHz and 5 GHz.

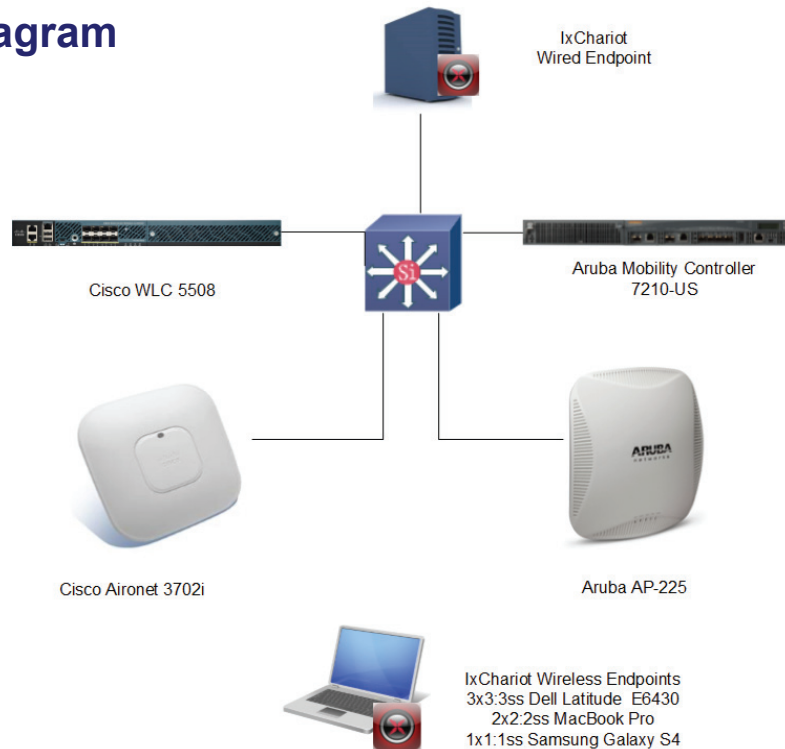
*The Cisco AP3702i did not experience a drop in throughput at either 802.11n 2.4 GHz or 5 GHz when dropping from conventional 802.3at (PoE+) power supply to a reduced power 802.3af (PoE). The Aruba AP-225 experienced a drop of 169% at 2.4 GHz.*

**Figure 7: 802.11n 2.4 GHz and 5 GHz Throughput, PoE+ vs PoE**



Source: Miercom, November 2013

## Test Bed Diagram



## How We Did It

Two spectrum analyzers were used to ensure that no outside radio traffic was present on the band used in testing, the Cisco Spectrum Wi-Fi and the inSSIDer Office from MetaGeek. The APs operated in 802.11ac mode in the tests for rate at range, multi-client and without and with 802.11n 5 GHz interference. The access points were tested using two 802.11n clients, one on 2.4GHz, one on 5GHz in testing for performance on reduced power.

In the test for throughput without and with interference, a Cisco SMB WAP561 AP operated in 802.11n 5 GHz mode provided interference, transmitting to a 1SS iPhone client.

In all tests, Layer 3 traffic was generated by Ixia IxChariot Server, running on a *Dell Latitude E6430* laptop. IX Chariot client was located on a 3SS *Dell Latitude* laptop, a 2SS *MacBook Air* notebook and a 1SS *Samsung Galaxy S4* Smartphone in rate at range testing.

3SS *Dell Latitude E6430* laptops, 2SS *Dell Latitude E6430* laptops and 2SS *MacBook Air* notebooks were used in multi-client testing and a 2SS *MacBook Air* notebook in without and with interference testing.

Each AP was managed by a separate hardware-based controller, the AP3702i by a Cisco WLC 5508, Version 7.6.1.106 (beta build) and the Aruba AP-225 by an Aruba 7210 Mobility Controller, Version 6.3.1.0.

In all tests, the AP3702i and the Aruba AP-225 were attached horizontally against a dropdown ceiling. Each rate versus range test used three different clients, each with a different spatial stream.

Testing was conducted in an office building with multiple rooms, partitions, walls and hallways.

Miercom recognizes IxChariot by Ixia ([www.ixiacom.com](http://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.

The tests in this report are intended to be reproducible for customers who wish to recreate them with the appropriate test and measurement equipment. Current or prospective customers interested in repeating these results may contact [reviews@miercom.com](mailto:reviews@miercom.com) for details on the configurations applied to the Device Under Test and test tools used in this evaluation. 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 Performance Verified

Designed for indoor, high-density use, the Cisco Aironet 3702i exhibited strength in all 802.11ac performance tests.

Multi-client testing spotlighted the new software- and hardware-based Cisco High-Density Experience feature set. Without and with interference testing highlighted CleanAir 80MHz, a function in the Cisco High-Density Experience.

The Cisco Aironet 3702i, part of the 3700 Series of access points, is an impressive product. It is the first purpose-built AP from Cisco with 802.11ac functionality.

Testing proved that the Aironet 3702i has earned the Miercom Performance Verified Certification.



**Cisco Aironet  
3702i  
Access Point**



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