Miercom

Lab Testing Summary Report

January 2009

Report 090112B

Product Category:

802.11 Wireless Optimization

Vendor Tested:

CISCO

Products Tested:

Cisco AP1250 and AP1140 w/ ClientLink Beam Forming Feature

Miercom PERFORMANCE VERIFIED

Key findings and conclusions:

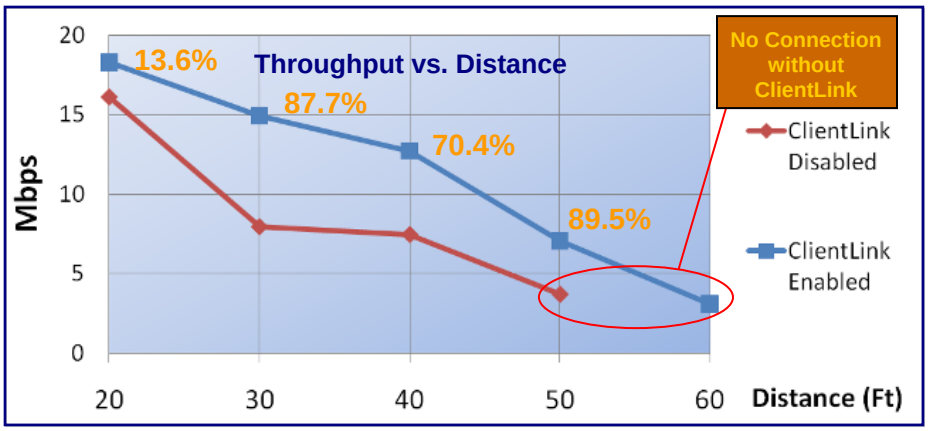
- **Cisco Client Link Feature increased the average throughput for 802.11a and 802.11g clients by 65%**
- **Increased the overall channel capacity by 27%**
- **Extended RF signal range to penetrate through obstacles and reduced coverage holes**
- **Easily deployed without hardware or software modifications required for the client**

Cisco submitted 802.11n access points AP1250 and AP1140 equipped with ClientLink beam forming technology for performance evaluation by Miercom. The focus of the evaluation was the performance enhancement that the ClientLink feature enables for legacy Wi-Fi 802.11a/g clients. We analyzed the overall benefit of ClientLink by comparing the performance improvement before and after enabling this feature. We measured the downstream throughput, reduction of application transaction time, and reduction of coverage holes, particularly at the outer edges of the access points.

ClientLink is a beam forming technology which enables legacy 802.11a/g clients to experience an overall improvement in throughput. Our testing proved that with ClientLink enabled, 802.11a/g clients could experience comparable performance to that of the latest 802.11n client technology. Tests proved that with ClientLink enabled there was an overall extended signal reach through obstacles, improved signal-to-noise ratio, and increased throughput at the outer points of an access point's coverage area. Application transaction times and coverage holes were also reduced. *(continued on page 3)*

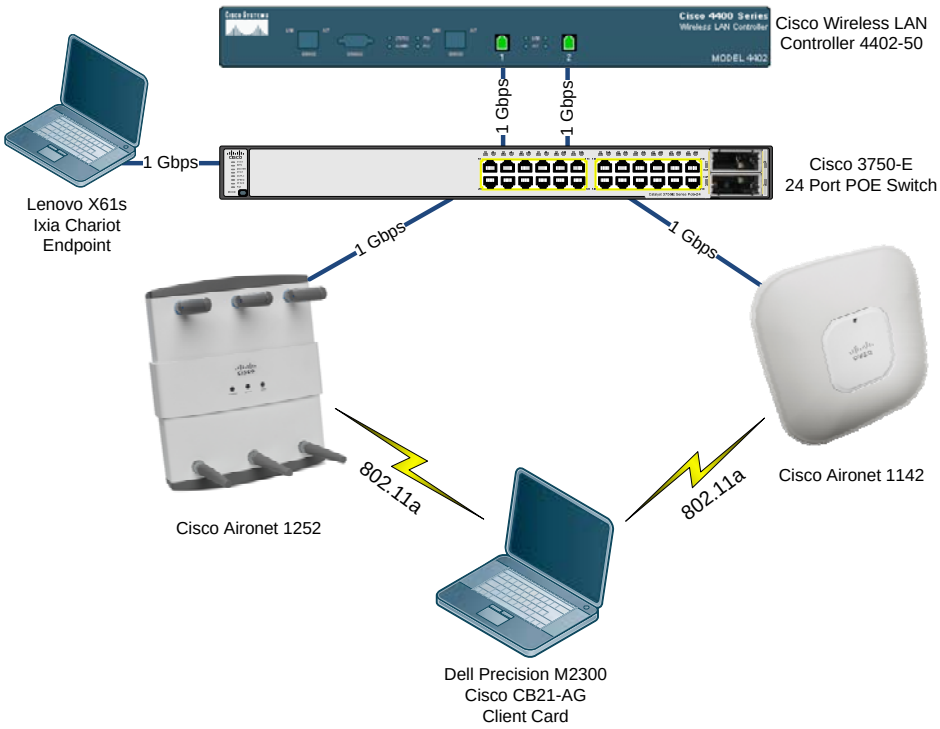
Figure 1 ClientLink Throughput Improvement

ClientLink Offers Higher Throughput per 802.11a/g Device



*Performance test of Cisco's ClientLink feature **proved up to a 65% average increase in throughput** for 802.11 a/g devices. ClientLink also provided coverage in hard to reach areas that otherwise had no wireless connectivity.*

Test Bed Diagram



How We Did It

ClientLink was evaluated for the performance benefits it provides in a mixed client environment by measuring the effect on throughput, and coverage with the beam forming feature on and off.

We utilized Ixia's Chariot 6.50 (www.ixiacom.com) to generate bi-directional TCP traffic between the wireless client and a wired endpoint. Ixia is an industry leader in providing testing tools for networking equipment. Ixia's unique approach provides realistic real-world session based traffic from tools such as Chariot. The wired endpoint which generated the traffic was a Lenovo X61s notebook connected via Gigabit Ethernet to our switch. The Ixia script utilized was 'Throughput.scr' which sends a 100KB of random, non-compressible TCP data as many times as possible during our 1 minute test duration. Each test run was repeated twice to ensure results were repeatable. Testing was performed at each distance from the access point first with ClientLink disabled, and then with ClientLink enabled, before moving client laptop to the next location, to ensure identical client orientation for both modes.

For site survey data we utilized AirMagnet's Survey 6.0 tool (www.airmagnet.com) in active Iperf survey mode which sends TCP traffic during the walkabout to measure signal strength, packet loss and uplink/downlink transmissions speeds in real-time. In this manner, the survey data is representative of a real client actively associated to the Access Point and transmitting data frames.

We utilized a Cisco 4402 Wireless LAN Controller supporting 50 Access Points running software release 6.0.37, a beta version of the official 6.0 software. Both the Cisco AP1252 and AP1142 in lightweight mode were tested and each was powered via PoE or ePoE in the case of the 1252. Interconnecting the entire test bed was a Cisco Catalyst 3750-E running IOS version 12.2(44)SE2. The wired connection between the Controller, Access Points and traffic generating endpoints were all Gigabit Ethernet. The wireless client was a Dell Precision M2300 (www.dell.com) laptop with a Cisco CB21-AG card with version 4.2.0.297.

(continued from page 1)

The introduction of 802.11n wireless technology offers several performance advantages over earlier Wi-Fi standards for improving network efficiency. However, to achieve full advantage of 802.11n technology, both the clients and the Access Points must be 802.11n compliant. However, in real-world deployments, a mixed client environment will continue to exist for the next several years. This is due to corporate refresh cycles, with an increased demand to further the longevity and increase the ROI of existing technology investments. In this mixed environment, legacy clients (802.11a/g) utilize a disproportionate amount of network resources due to lower throughput performance in the downlink direction, which comprises the majority of traffic flow. This slows down the speed of the network for all clients, including those which are 802.11n. In addition, legacy clients may experience coverage holes due to poor Wi-Fi reception, particularly in obstructed environments.

Cisco's ClientLink is an innovative feature designed to address this environment. It is an 802.11n infrastructure solution which improves access point to client (downlink) performance for legacy clients (802.11a/g), through a signal optimization process called transmit beam forming. This beam forming process improves the signal-to-noise ratio at the client, and reduces or eliminates coverage holes seen in the initial site survey. ClientLink does not require any changes to 802.11a/g client hardware or software to achieve these benefits. The management GUI allows easy control to enable or disable the beam forming feature through a simple check box.

ClientLink does not extend the overall range of the access points, but improves downstream connection performance within the existing coverage area.

Throughput to Legacy Clients

For this test, the environment contained numerous RF obstacles between the AP and the wireless client. The obstacles consisted of closed metal fire doors between work areas, multiple walls (including one concrete), and pallets of stored equipment, which affected wireless network coverage and throughput. Output power of the AP was 8dBm.

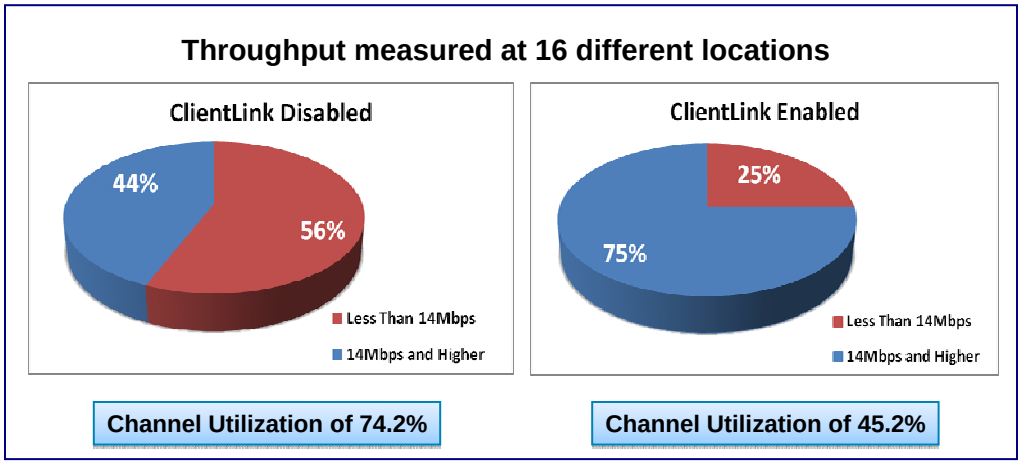
Our first test location was 20 feet from the AP, with a closed metal fire door between the AP and the legacy client. With beam forming disabled, receive signal level was -79dBm, and throughput was 16Mbps. When ClientLink was enabled, receive signal strength increased to -75dBm as measured at the client, and throughput increased to just over 18Mbps, an increase of 13.6%.

The second test was conducted at 30 feet with a obstacles including a wall and metal doors to impede the radio signal. Here, with beam forming disabled, receive signal level was -83dBm and throughput was 7.9Mbps. Enabling ClientLink boosted receive signal level by 3dBm, and increased throughput to 14.9Mbps, a performance increase of 87.7%.

The 40 foot location consisted of a small utility room separated by 2 walls from the AP. Here, with beam forming disabled, receive signal level

Figure 2 ClientLink System Capacity Improvement

ClientLink Offers Consistently Higher Throughput over Coverage Area



Performance test of Cisco's ClientLink feature ***proved up to a 27% average increase in Channel Capacity****.*

ClientLink allows clients to connect at consistently higher data rates. Faster data transmission with less retries = overall more efficient use of RF channel.

Faster 802.11a/g transactions opens airtime for 802.11n devices, allowing them to also improve performance.

was -85dBm, and throughput was 7.4Mbps. Enabling ClientLink boosted receive signal level by 2dBm, and increased throughput to 12.7Mbps, a 70% improvement.

The 50 foot test location changed the multipath again by placing another wall and door between the AP and the client. The advantage of ClientLink beam forming was 1dBm improvement in receive signal level, from -87 to -86, and a 89.5% improvement in throughput.

Perhaps the most dramatic display of ClientLink's benefit was seen when we performed our test at the 60 foot location. With beam forming disabled, the legacy 802.11a client was unable to maintain a stable Wi-Fi connection with the AP, due to extremely low receive signal level, resulting in zero throughput. However, when ClientLink was turned on, receive signal level was boosted to -85dBm, and receive throughput was 3Mbps. This represented a 100% improvement over the non-beam formed connection, and provided roughly the same throughput as the non-beam formed connection had done at the 50 foot location. This showed the improvement in performance at the edge of the access point's coverage area.

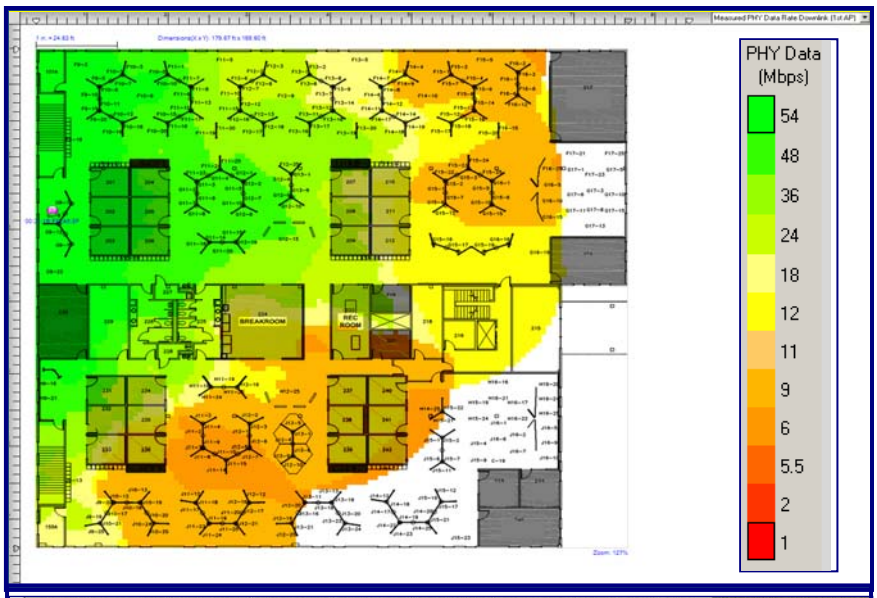
Reduction of Transaction Times

We performed a multi-location throughput test to evaluate the rate-changing advantage and beam forming which ClientLink provides, and its effect on throughput at different points around the circumference of the outer edge of the Access Point's coverage area.

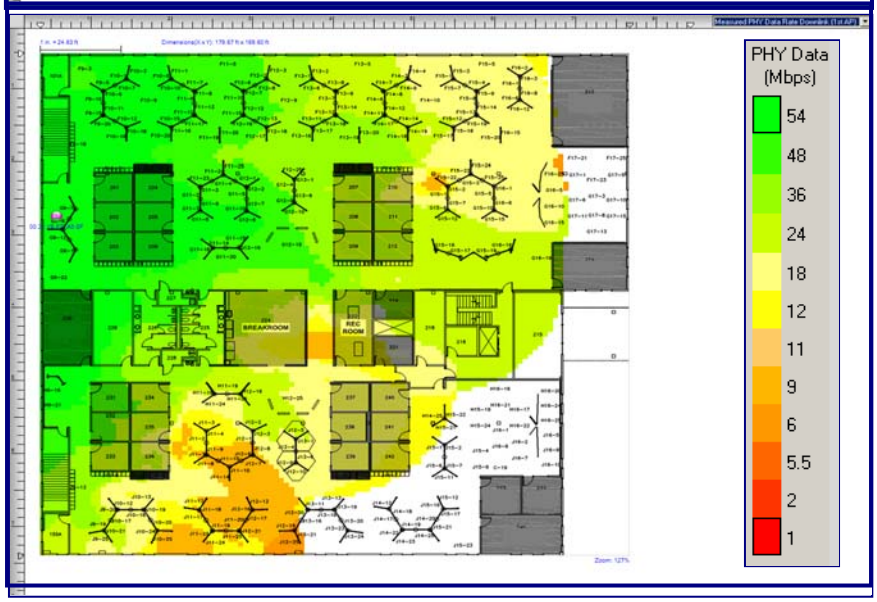
The client was tested in two locations, an office hallway and a break room, each 80 feet from the same AP. Measurements were taken at 0°, 90°,

Figure 3 ClientLink Data Rate Improvement

With ClientLink Disabled — Site survey output from AirMagnet Iperf tool shows areas of low downstream throughput experienced at outer edges of access point coverage range. Areas of white were outside the area of the survey and beyond the range of the access point.



With ClientLink Enabled — site survey results showing improved throughput rates at the outer edges of the AP coverage. Areas in white were outside the area of the survey and beyond the range of the access point.

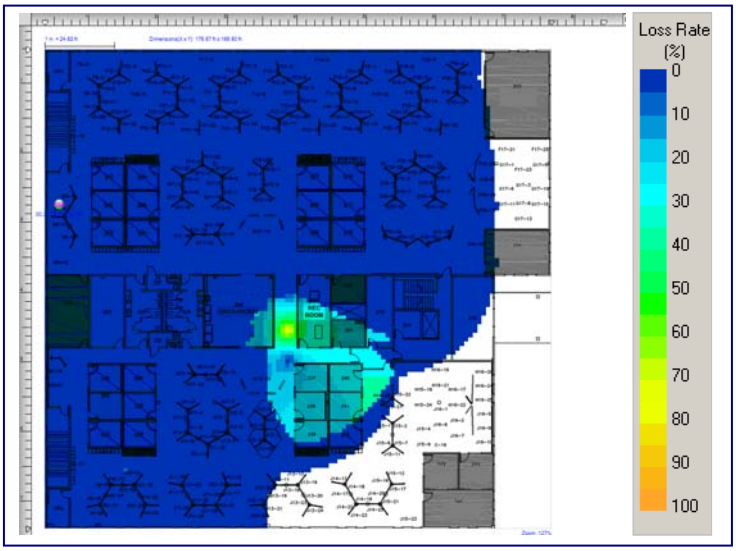


180°, and 270° from the AP. The test file was 100KB non-compressible TCP data.

With beam forming enabled, we observed using the AirMagnet tool a general upward trend in the frame size distribution versus with beam forming disabled. This reflected the protocol selecting higher frame rates based on the improved SNR. With beam forming disabled, only 44% of the traffic received at the client was received at a rate of 14Mbps or higher, with a significant portion being received at rates of less than 10Mbps. However, when beam forming was turned on, the amount of traffic received by the client at 14Mbps or above jumped to 75%, which is an impressive 31% increase. The improved throughput reduces transaction times for clients and allows for greater system capacity.

Extended Signal Range

Site surveys were conducted from 21 locations in a challenging (obstructed) environment, and then repeated from 83 locations in a larger open office environment, using the AirMagnet Iperf Tool. For the challenging environment, ClientLink provided a clear improvement in data rates, particularly near the outer edges of the AP's coverage area, where beam forming provided 6-15Mbps better throughput compared to when ClientLink was disabled. In the open office environment, beam forming provided a 9-12Mbps throughput advantage to clients located in the outer edges of the AP's coverage area. Areas where the client had experienced holes of high packet loss due to poor SNR were also eliminated when beam forming was enabled.



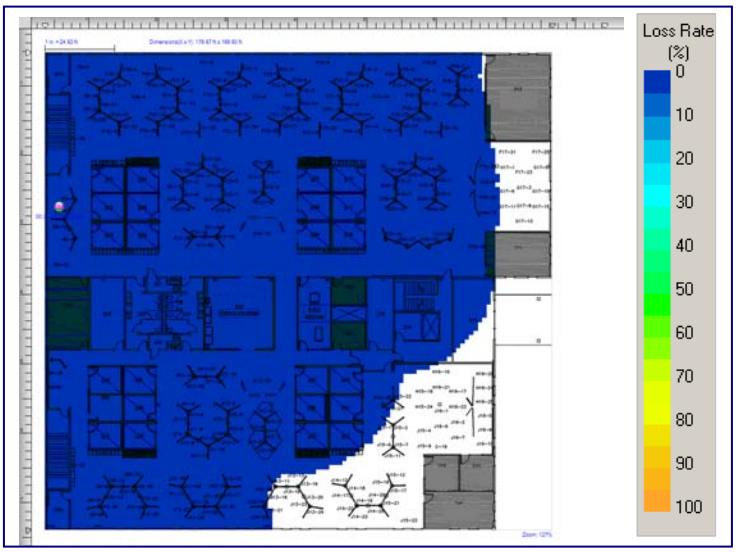


Figure 4 ClientLink Coverage Improvement

With ClientLink disabled — site survey of an open floor plan consisting of offices and cubicles shows a hole in coverage in workspaces adjacent to a break room. This is an area of high packet loss (up to 70%) in the access point's coverage area. Legacy clients would experience many retries here, slowing down the network performance for all users.

With ClientLink enabled — improved signal quality provided by beam forming eliminates the hole seen in the previous site survey, ensuring continuous coverage for all clients.

Miercom Performance Verified

Based on lab testing of the Cisco AP1250 and AP1140 Access Points with ClientLink feature, Miercom verifies that their performance capabilities offer superior throughput and extended coverage for legacy 802.11a/g clients.

Hands on testing confirmed that Cisco's Client Link Feature can greatly enhance the end user experience in today's mixed wireless environments. Customers can further protect initial investments made in pre-802.11n technology by using the Client Link feature in Cisco Access Points.

The Cisco AP 1250 and AP1140 Access Points with ClientLink earned the Miercom Performance Verified Certification.

Cisco AP 1250 & AP1140 Access Points

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