

Linksys EA8500 Max-Stream AC2600 MU-MIMO Gigabit Router

Comparative Wireless LAN Performance

EXECUTIVE SUMMARY

Busy home networks are now the rule rather than the exception with multiple clients demanding multiple high-bandwidth services - like video streaming - simultaneously. New multi-user MIMO (MU-MIMO) technology can deliver significantly more throughput to multiple users than the prior generation single-user MIMO (SU-MIMO). The Linksys EA8500 Max-Stream AC2600 MU-MIMO Gigabit Router is the first production device to offer this new, multi-user MIMO technology.

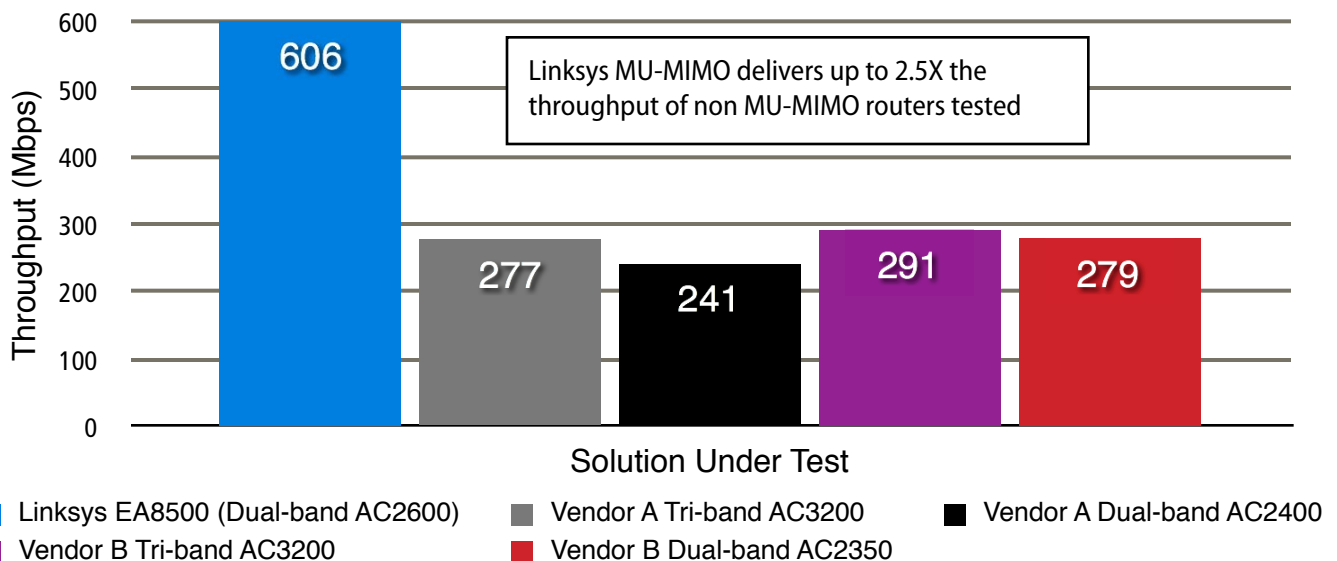
Linksys, Inc. commissioned Tolly to benchmark the multi-client throughput of the Linksys EA8500 and compare that to the aggregate throughput of several prominent 4x4 and tri-band wireless LAN (WLAN) solutions. The Linksys solution can deliver up to 2.5X aggregate throughput than earlier 802.11ac technology. See Figure 1. ...<continued on next page>

THE BOTTOM LINE

Linksys EA8500 Max-Stream AC2600 MU-MIMO Gigabit Router provides:

- 1 The first-to-market MU-MIMO router
- 2 Up to 2.5X aggregate increase in multi-client performance vs non MU-MIMO offerings
- 3 Up to 4.6X single-client performance than non MU-MIMO solution in multi-client, diverse location testing

Wireless LAN MIMO Multi-Client Downstream Performance
Three Clients, Line-of-Site Aggregate Performance,
(as reported by Ixia IxChariot v7.10 SP3)



Notes: Linksys running MU-MIMO. Tri-band devices provide a single 2.4GHz radio and two 5GHz radios. All testing using 5GHz band.

Source: Tolly, May 2015

Figure 1



Tests were conducted in a residential environment and benchmarked two different client configurations. All tests were run against two other WLAN 802.11ac solutions running 3x3 MIMO and two running 4x4 MIMO. The competing products offer only single-user (SU) MIMO.

In the first test, three clients were situated equidistant (12 feet) from the access point (AP) under test. This scenario illustrates the benefits that MU-MIMO can offer across a group of clients situated at similar distances.

In the second test, four clients were used and only two were near each other with the other two placed at a greater distance and one on another floor of the house. This

scenario illustrates performance with more diverse client locations.

Test Results


Multi-Client, Line-of-Sight

The per-client average for the Linksys EA8500 was 202Mbps with the aggregate throughput at 606Mbps. This was more than 2X the throughput of the nearest competitor and 2.5X the throughput of the slowest competitor.

By contrast, across the four 3x3 and 4x4 SU-MIMO solutions, not one of the solutions averaged over 100Mbps of per-client throughput. The highest average client throughput for the competing solutions was 97Mbps for Vendor B's Tri-band

Linksys, Inc.

EA8500 Max-Stream AC2600 MU-MIMO Gigabit Router



MU-MIMO Wireless LAN Performance

Tested May 2015

solution. This product also delivered the highest aggregate throughput of any competitor at 291Mbps. See Figure and Table 1.

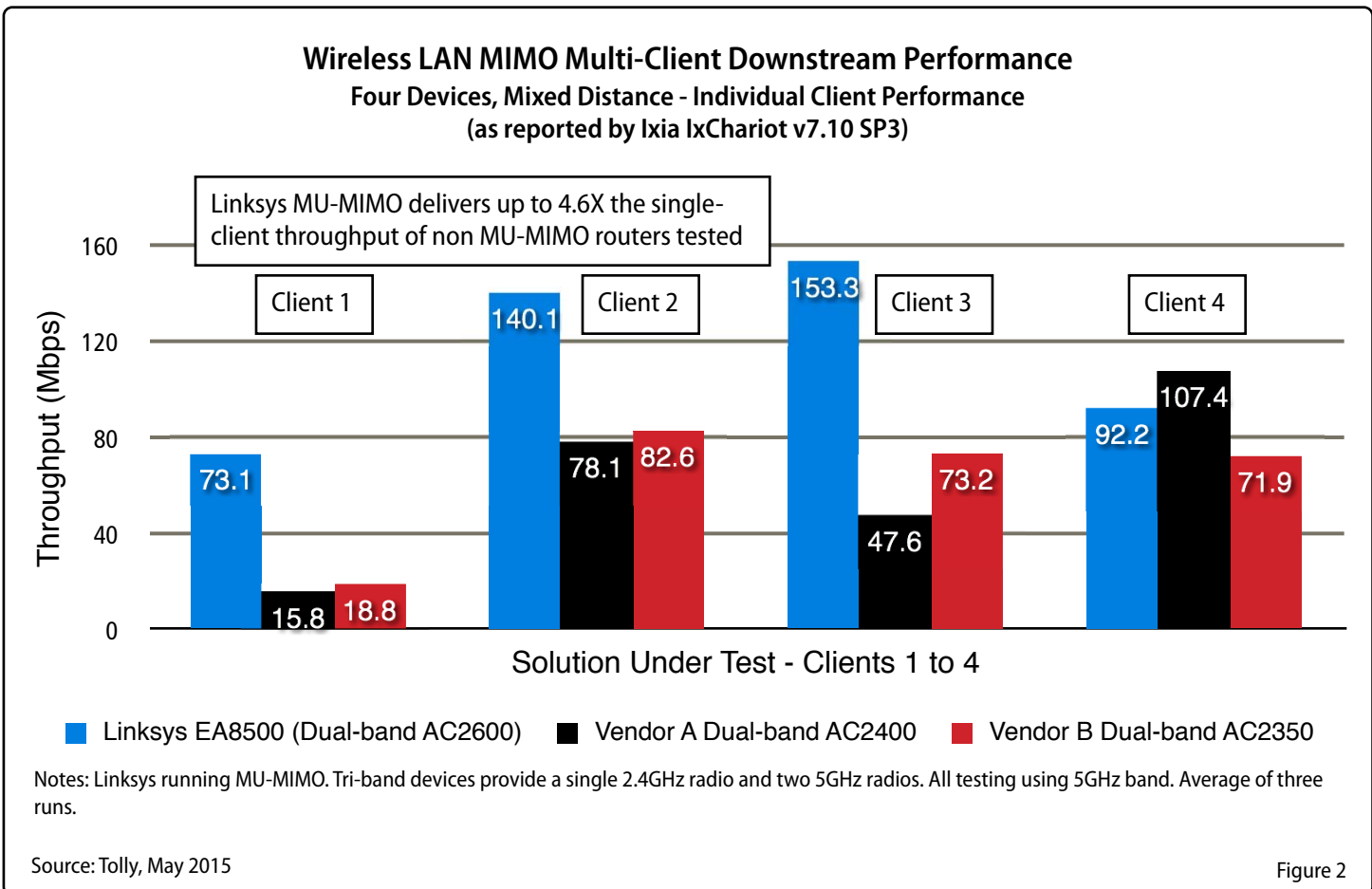


Figure 2



Multi-Client, Mixed Distance

This test of four clients in a different set of locations in the residence again showed the benefit of MU-MIMO. Run only against the competing 4x4 solutions, this test focused on examining the average throughput for a single physical client across the three test runs.

Across the tests, the Linksys solution delivered the highest results for a single client at 153Mbps. This was significantly greater than the 107Mbps of the nearest competitor.

In relative terms, the Linksys solution delivered per-client throughput that was

4.6X that of the Vendor A solution delivering throughput of 73.1Mbps compared with 15.8Mbps. See Figure 2.

Test Setup & Methodology

Objective

The objective of the test was to benchmark the wireless LAN (WLAN) access points (APs) to determine their downstream throughput using MU-MIMO only and SU/MU-MIMO clients.

Systems Under Test

All systems provided access point functionality and were marketed as commercial grade devices. All devices were upgraded to the most current firmware available at time of test. Wherever possible,

WLAN Downstream Throughput Test Result Details (Data for Figure 1)

Wireless LAN MIMO Multi-Client Downstream Performance Three Devices, Line-of-Site Aggregate Performance, (as reported by Ixia IxChariot v7.10 SP3)					
	Linksys EA8500 (Dual-band AC2600)	Vendor A Tri-band AC3200	Vendor A Dual-band AC2400	Vendor B Tri-band AC3200	Vendor A Dual-band AC2350
Client 1	202.50	99.89	96.42	108.60	92.83
Client 2	196.55	79.74	73.14	104.10	96.84
Client 3	206.78	97.66	71.40	78.50	89.25
Per-Client Average	201.94	92.43	80.32	97.07	92.98
Total	605.830	277.290	240.966	291.200	278.925

Notes: Linksys running MU-MIMO. Tri-band devices provide a single 2.4GHz radio and two 5GHz radios. All testing using 5GHz band.

Source: Tolly, May 2015

Table 1



SUTs were configured with identical settings with respect to bandwidth, channels, transmit power and security. The SUT was connected to a router via a wired Ethernet connection and Gigabit Ethernet switch. The router provided DHCP addressing services for the test clients and was not used during the test runs. The security settings were turned off on each of the systems under test.

All systems were running current firmware. The Linksys EA8500 was running firmware 1.1.3.166845. For additional details about the systems under test and the test clients, see Tables 2 and 3.

Environment & Setup

All testing was conducted using 5GHz.

Three Client - Line of Sight Test

This test used 3 Dell Inspiron 13 7000 Series systems. Each system was outfitted with a 1x1 miniPCI MU-MIMO card. For all test client information see Table 3.

Testing was conducted in a residence with no other WLAN access points enabled in

Vendor	Model	MIMO Streams	Antenna Location
Linksys, Inc.	EA8500 (1.1.3.166845)	4x4	4 External
A	N/A	Twin 3x3	6 External
A	N/A	4x4	4 External
B	N/A	Twin 3x3	6 External
B	N/A	4x4	4 External

Source: Tolly, May 2015 Table 2

5GHz band. All testing was line of sight (LOS). SUTs were positioned 12 feet from the Dell clients. All systems used Channel 153 with a bandwidth on auto.

Clients were situated at the same distance from the AP under test and were situated at table level. The AP under test was placed at approximately three feet above the floor.

Test traffic was generated using the Ixia IxChariot v 7.10 SP3 benchmarking system. All testing used the IxChariot High Throughput script. Three WLAN clients running the IxChariot Endpoint software communicated with a single IxChariot Endpoint that was connected via wired Ethernet connection to the test network via the aforementioned Gigabit Ethernet

Function	Wired Chariot Endpoint & Console	Wireless Chariot Endpoint	Wireless Chariot Endpoint
Quantity	1	3	1
Computer Brand	HP	Dell	Dell
Model	Envy 17	Inspiron 13 7000 Series	XPS P54G
CPU	Intel i7 2630QM	Intel i5 5200U	Intel i5 5200U
Operating System	Windows 7	Windows 8.1 Professional	Windows 8.1
LAN/WiFi Card	Ethernet Realtek PCIe GBE Family Controller	Qualcomm Atheros QCA9377	Qualcomm Atheros QCA9377
Driver	7.23.623.2010	11.0.0.526	11.0.0.526
Chariot Version	Console & Endpoint 7.10 SP3	Endpoint 8.1.49.17	Endpoint 8.1.49.17

Source: Tolly, May 2015 Table 3



switch. Run time for each test was one minute at each test location. Tests were run at least three times and the best result for each SUT was used. Tolly engineers monitored the AP under test to be certain that three clients were communicating with the appropriate SSID/radio being tested.

engineers monitored the AP under test to be certain that four clients were communicating with the appropriate SSID/radio being tested.

Four Client - Mixed Distance

For the four client test, which used 3 Dell Inspiron 13 7000 Series clients and one Dell XPS P54G client, engineers placed two clients in the living room, which were 12 feet from the access point. The third client was located in the living room on the first floor which was 30 feet from the access point. The final client was located on the second floor in the master bedroom, which was 55 feet from the access point.

Test traffic was generated using the Ixia IxChariot v 7.10 SP3 benchmarking system. All testing used the IxChariot High Throughput script. Four WLAN clients running the IxChariot Endpoint software communicated with a single IxChariot Endpoint that was connected via wired Ethernet connection to the test network via the aforementioned Gigabit Ethernet switch. Run time for each test was one minute at each test location. Tolly

Background & Benefits: 802.11ac MU-MIMO

The most significant advancement in 802.11ac is MU-MIMO technology, which provides a dramatic breakthrough in the performance and flexibility available to WLAN users. In SU-MIMO, a device transmits multiple spatial streams at once, but only to one device at a time. MU-MIMO allows multiple spatial streams to be assigned to different clients simultaneously, increasing the total throughput and capacity of the WLAN system.

MU-MIMO builds upon the transmit beamforming capabilities to establish up to four simultaneous directional Radio Frequency (RF) links.

In MU-MIMO operation, an AP uses enhanced beamforming techniques to maximize transmission in the desired client direction while simultaneously minimizing transmission in the direction of undesired clients through null steering. Known as spatial reuse, this technique provides each of the four users with its own dedicated full-bandwidth channel in much the same way cellular phone networks use small cell nodes and spectrum reuse techniques to increase system capacity.


Benefits

- More traffic over the network
- Increased throughput and reduced latency
- Increased spectral efficiency
- Benefit to legacy clients: enhanced airtime efficiency with MU-MIMO clients makes more airtime available to legacy clients giving a perceived performance boost

Source: Qualcomm Atheros, Inc.

Test Equipment Summary

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

Vendor	Product	Web
Ixia	IxChariot v7.10 SP3	 http://www.ixiacom.com



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