CARNet Wi-Fi Independent Test Results

Access Points Comparison

May 2015

Key Takeaways

AP Performance via Stress Testing

- World's top 802.11ac and 802.11n Access Points (APs) were tested by the Croatian Academic and Research Network (CARNet) within a real world high-capacity, high interference classroom environment

- 19 APs were stressed within several progressive testing scenarios using industry standard test tools

- The results found that Ruckus Smart Wi-Fi APs consistently outperformed all devices under test (DUTs) in almost every test scenario

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Overall Vendor Performance

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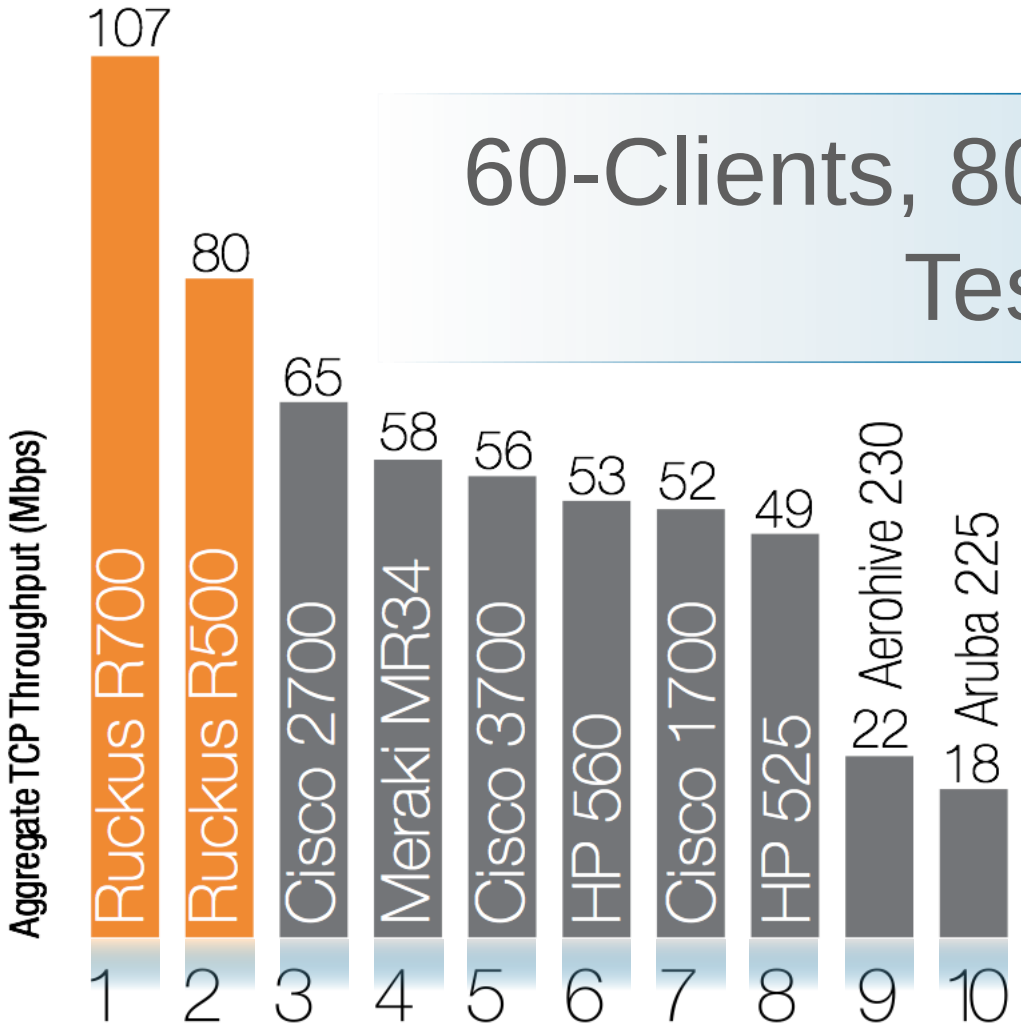

60-Clients, 802.11/802.11ac Testing

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Croatian Academic and Research Network (CARNet)

CARNet

CARNet is a public institution that facilitates the progress of individuals and society through the use of new information technologies. Primary and secondary institutions are able to take advantage of CARNet services, which include information and communication technologies and their application in education and infrastructure.

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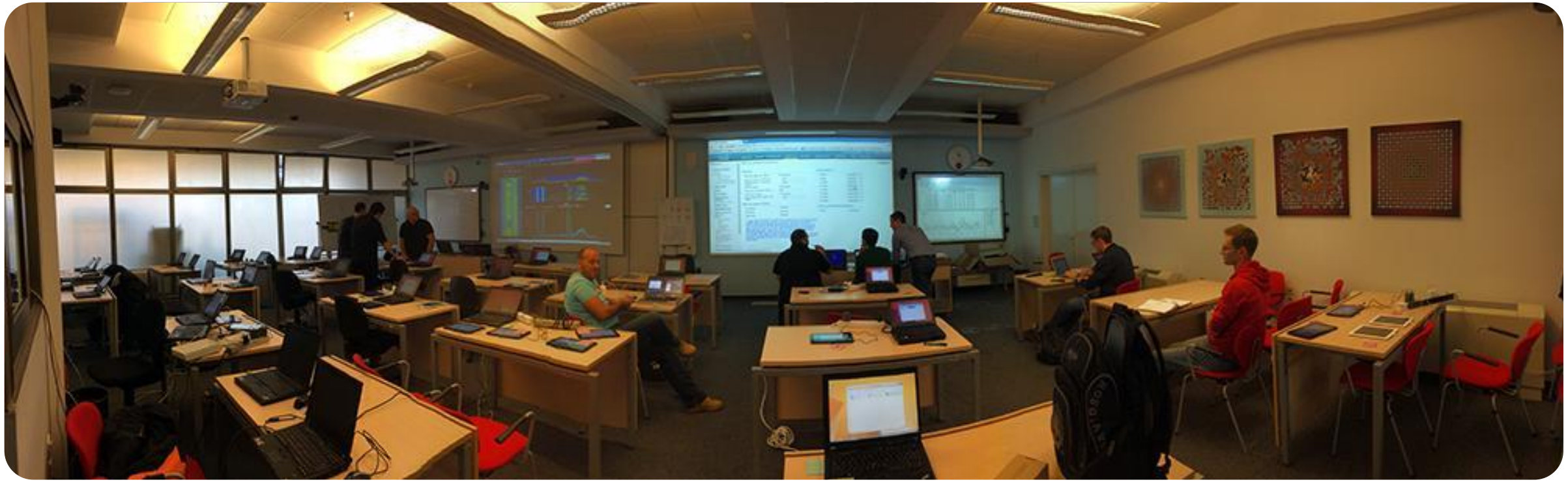
Test Methodology

Testing Environment



APs were placed outside a classroom separated from the client devices by a single drywall with a measured loss of 5dB. The classroom size was 12 meters (~39 feet) by 10 meters (~33 feet).

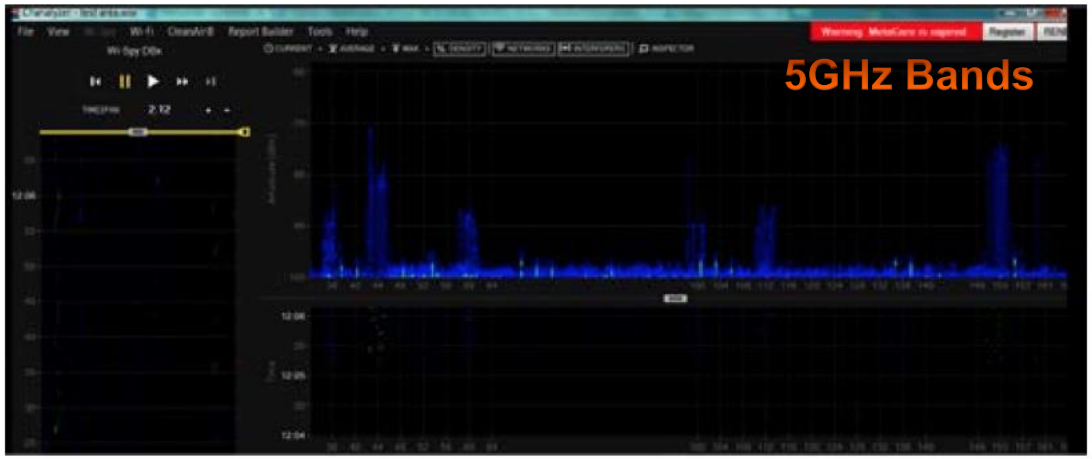
Test Methodology

RF Environment

There was no effort made to “clean up” the RF environment, as real-world deployments have to deal with random, and uncontrollable levels of modulated and unmodulated interference.

- CARNet’s existing WLAN and motion sensors were present in 2.4GHz, and were enabled throughout the testing.

- MetaGeek’s Wi-Spy DBx spectrum analysis was used to view the 2.4 Hz ISM band and 5 GHz UNII bands.



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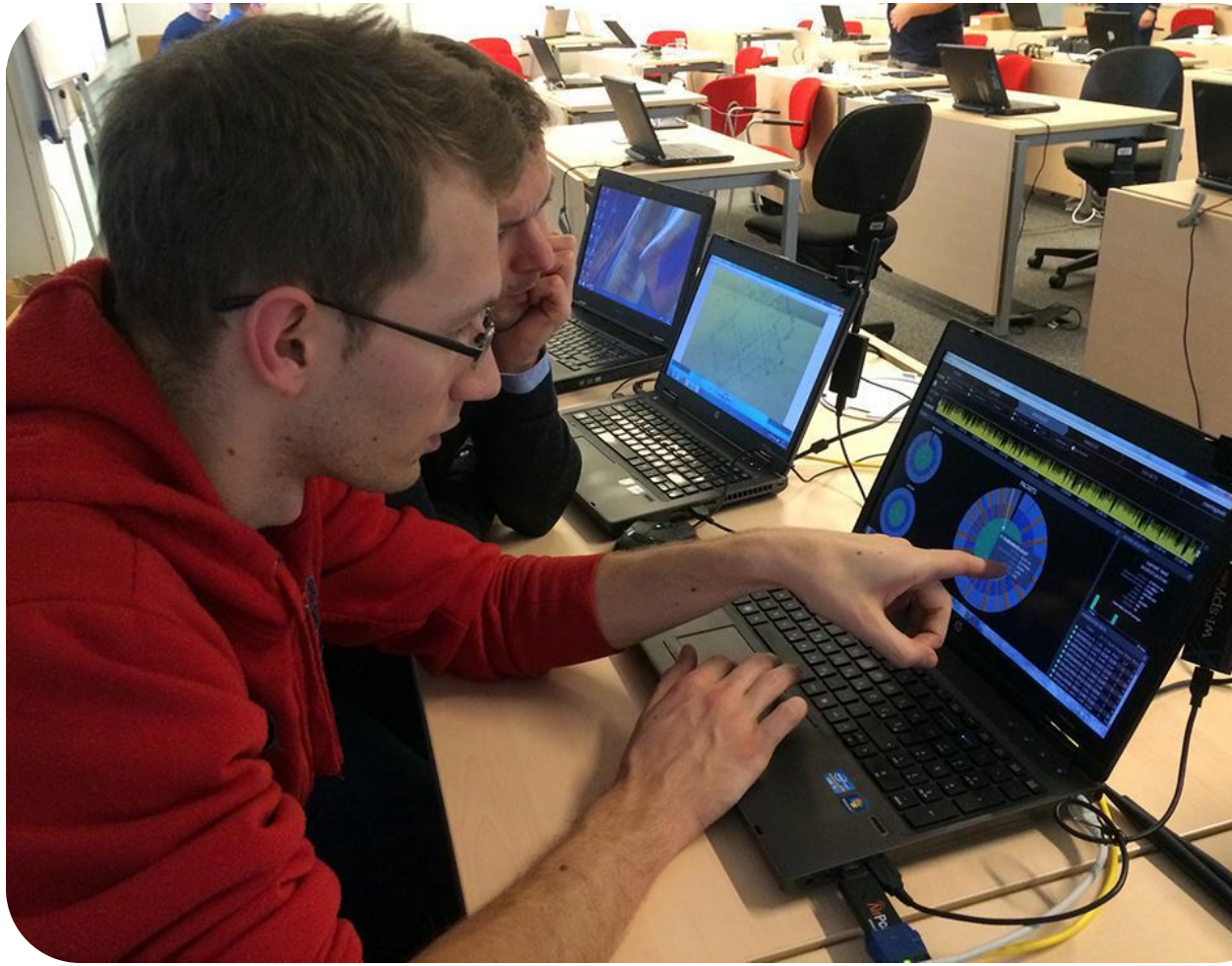
The Rules

1. Clients must be tested in order: 13, 23, 36, 60, 36-Distributed.
2. Each vendor is allowed a trial run, if requested.
3. If a TCP session to a client fails in any test, that test is considered to have failed, and vendor does not progress to the next round of testing.
4. Each test may be run three times, and the highest number is recorded.
5. Only publicly available code allowed. Latest version recommended, but not required.
6. Each vendor can choose their own channel(s) & channel width for testing, and Open System Authentication without encryption is required.

Test Methodology

Evaluation Criteria

- Downlink throughput tests using 1 MB file transferred using the latest version of IxChariot from a single AP to 13, 23, 36, 60, and 36 (distributed)
- Mix of 11ac and 11n clients: 1SS, 2SS, 3SS
- Increasing number of clients added for each new throughput test
- Must perform in the presence of known interference



Access Points Under Test

Access Points

Vendor	AP Model(s) Being Tested
Aerohive	121, 230, 330
Aruba	IAP-225
Cisco	1700, 2700, 3700
HP	430, 525, 560
Meraki	MR34
Ruckus	R300, R500, R700, 7982, 7372
Ubiquiti	Uni-Fi Pro
Xirrus	XR520, XR4430

Client Devices

PHY Support	Real-World Client Mix	Total: 60
802.11ac	2x2:2	5
802.11ac	1x1:1	2
802.11n	3x3:3	25
802.11n	2x2:2	16
802.11n	1x1:1	12

Access Point Details

Manufacturer	Model	PHY	Dual-Band	TxR:SS
Aerohive	121	802.11n	Y	2x2:2
Aerohive	230	802.11ac	Y	3x3:3
Aerohive	330	802.11n	Y	3x3:3
Aruba	225	802.11ac	Y	3x3:3
Cisco	1700	802.11ac	Y	3x3:2
Cisco	2700	802.11ac	Y	3x4:3
Cisco	3700	802.11ac	Y	4x4:3
HP	430	802.11n	Y	3x3:2
HP	525	802.11ac	Y	2x2:2
HP	560	802.11ac	Y	3x3:3
Meraki	MR34	802.11ac	Y	3x3:3
Ruckus	7372	802.11n	Y	2x2:2
Ruckus	7982	802.11n	Y	3x3:3
Ruckus	R300	802.11n	Y	2x2:2
Ruckus	R500	802.11ac	Y	2x2:2
Ruckus	R700	802.11ac	Y	3x3:3
Ubiquiti	Uni-Fi Pro	802.11n	Y	2x2:2
Xirrus	XR520	802.11n	Y	2x2:2
Xirrus	XR4430	802.11n	Y	3x3:3

Client Device Details

Qty	Manufacturer & Model	802.11n	802.11ac	20MHz	40MHz	80MHz	1SS	2SS	3SS	802.11h
1	Samsung S-SM-T230	Y		Y			Y			Y
1	Samsung S-SM-T235	Y		Y	Y		Y	Y		Y
2	Samsung S-SM-T700	Y	Y	Y	Y	Y	Y	Y		Y
1	Samsung S-SM-T705	Y	Y	Y	Y	Y	Y	Y		Y
1	Samsung S-SM-T800	Y	Y	Y	Y	Y	Y			Y
1	Samsung S-SM-T805	Y	Y	Y	Y	Y	Y			Y
1	Samsung S-SM-N910C	Y	Y	Y	Y	Y	Y	Y		Y
1	Samsung S-SM-P600	Y	Y	Y	Y		Y	Y		Y
6	Samsung N8000	Y		Y	Y		Y			Y
4	iPad 3	Y		Y	Y		Y			Y
1	iPad 4	Y		Y	Y		Y			Y
1	MacBook Pro 15” (2011)	Y		Y	Y		Y	Y	Y	Y
10	Lenovo X200 laptops	Y		Y	Y		Y	Y	Y	
14	Lenovo T400 laptops	Y		Y	Y		Y	Y	Y	
15	HP Pro Tablet 610 G1	Y		Y	Y		Y	Y		Y

Test 1: 13 Clients

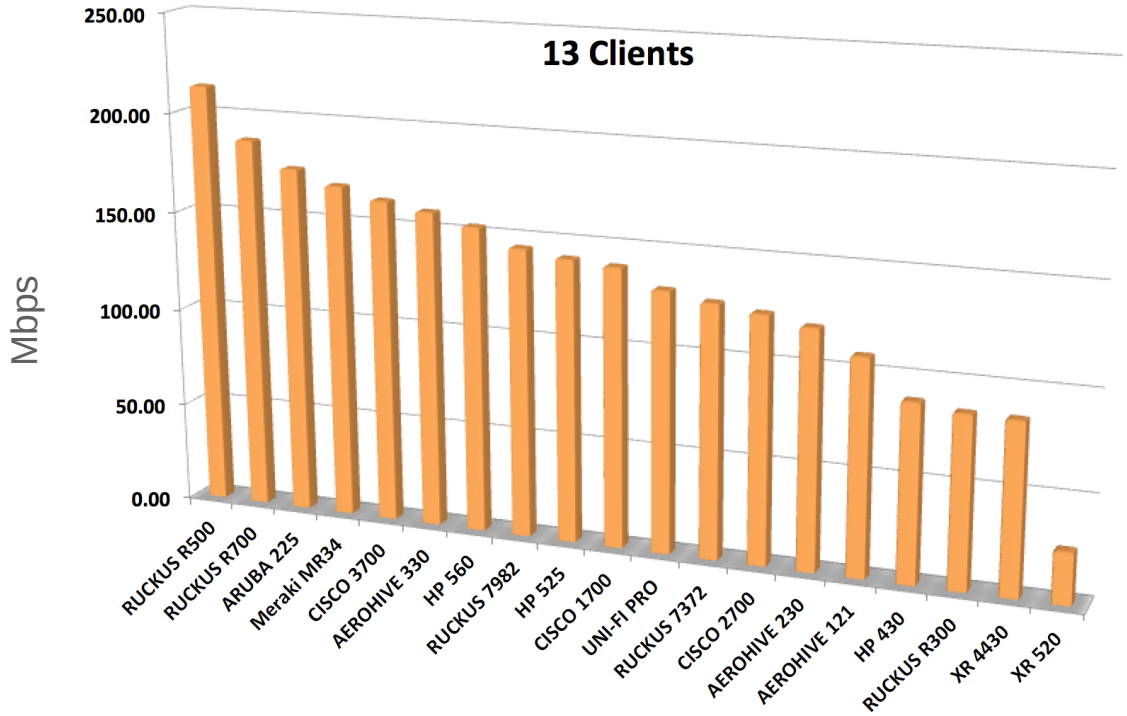
- 13 Clients of various type
- 802.11ac & 802.11n enabled
- All Dual-Band capable
- Mix of 1SS and 2SS

Client #	Type	PHY	Dual-Band?
Client 1	Samsung S-SM-T230	802.11n 1x1:1	Yes
Client 2	Samsung S-SM-T235	802.11n 2x2:2	Yes
Clients 3-4	Samsung S-SM-T700	802.11ac 2x2:2	Yes
Client 5	Samsung S-SM-T705	802.11ac 2x2:2	Yes
Client 6	Samsung S-SM-T800	802.11ac 1x1:1	Yes
Client 7	Samsung S-SM-T805	802.11ac 1x1:1	Yes
Client 8	Samsung S-SM-N910C	802.11ac 2x2:2	Yes
Client 9	Samsung S-SM-P600	802.11ac 2x2:2	Yes
Clients 10-13	Samsung N8000	802.11n 1x1:1	Yes

Test 1: 13 Clients

Results

*Ruckus R500 outperformed Aruba 225 by **22%***



Ranking	Manufacturer	AP Model	Result (Mbps)
1	Ruckus	R500	213.26
2	Ruckus	R700	187.69
3	Aruba	225	175.00
4	Meraki	MR34	168.19
5	Cisco	3700	162.66
6	Aerohive	330	158.92
7	HP	560	153.48
8	Ruckus	7982	144.87
9	HP	525	141.74
10	Cisco	1700	139.89
11	Ubiquiti	Uni-Fi Pro	130.78
12	Ruckus	7372	126.80
13	Cisco	2700	123.82
14	Aerohive	230	119.52
15	Aerohive	121	108.10
16	HP	430	89.06
17	Ruckus	R300	86.00
18	Xirrus	XR4300	85.58
19	Xirrus	XR520	25.90

Test 2: 23 Clients

Summary

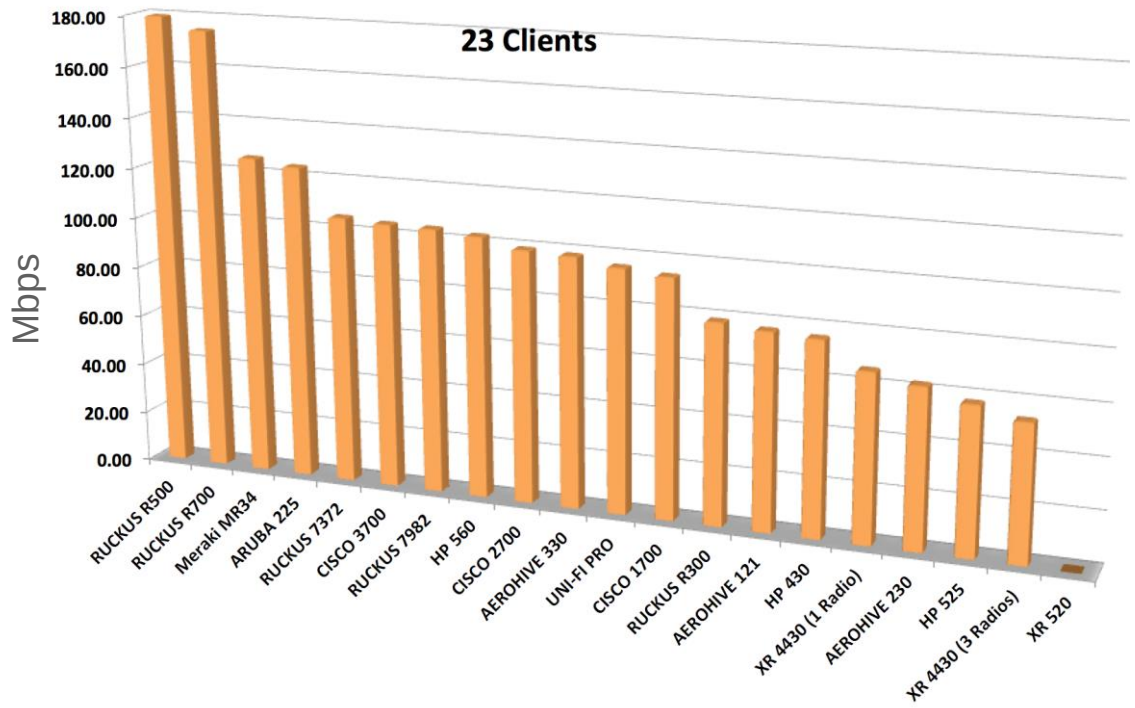
- Added 10 additional client devices into the test
- All 802.11n enabled
- All Dual-Band capable
- Mix of 1SS and 2SS

Client #	Type	PHY	Dual-Band?
Client 14	Samsung N8000	802.11n 1x1:1	Yes
Client 15-16	iPad 3	802.11n 1x1:1	Yes
Client 17-23	HP Pro Tablet 610	802.11n 2x2:2	Yes

Test 2: 23 Clients

Results

*Ruckus R500 outperformed Meraki MR34 by **42%***

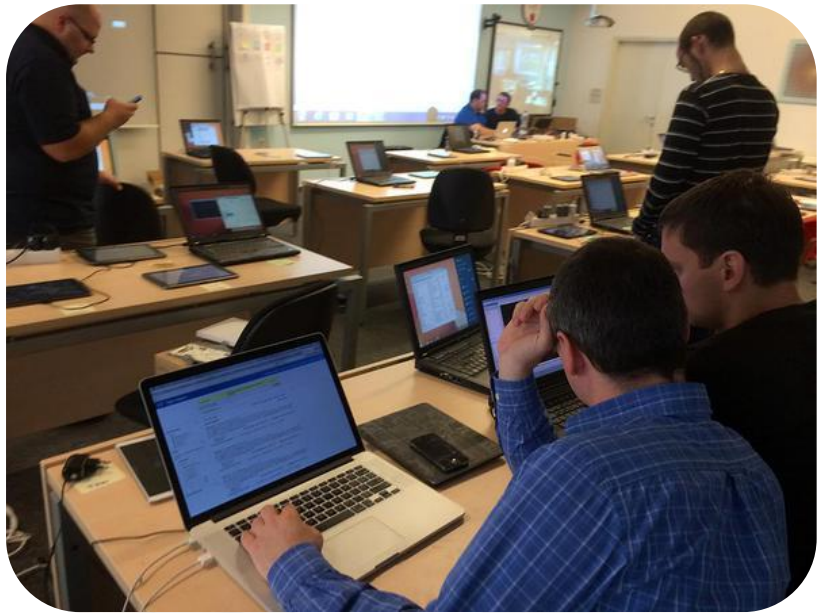


Ranking	Manufacturer	AP Model	Result (Mbps)
1	Ruckus	R500	179.59
2	Ruckus	R700	174.92
3	Meraki	MR34	126.30
4	Aruba	225	124.09
5	Ruckus	7372	105.73
6	Cisco	3700	104.67
7	Ruckus	7982	104.36
8	HP	560	103.03
9	Cisco	2700	99.41
10	Aerohive	330	98.66
11	Ubiquiti	Uni-Fi Pro	95.94
12	Cisco	1700	94.17
13	Ruckus	R300	78.90
14	Aerohive	121	77.29
15	HP	430	76.27
16	Xirrus	XR4430 (1 radio)	66.15
17	Aerohive	230	62.74
18	HP	525	58.00
19	Xirrus	XR4430 (3 radios)	53.63
20	Xirrus	XR520	0.00*

Test 3: 36 Clients

Summary

- Added 13 additional client devices into the test
- All 802.11n enabled
- All dual-band capable
- Mix of 1SS, 2SS, & 3SS

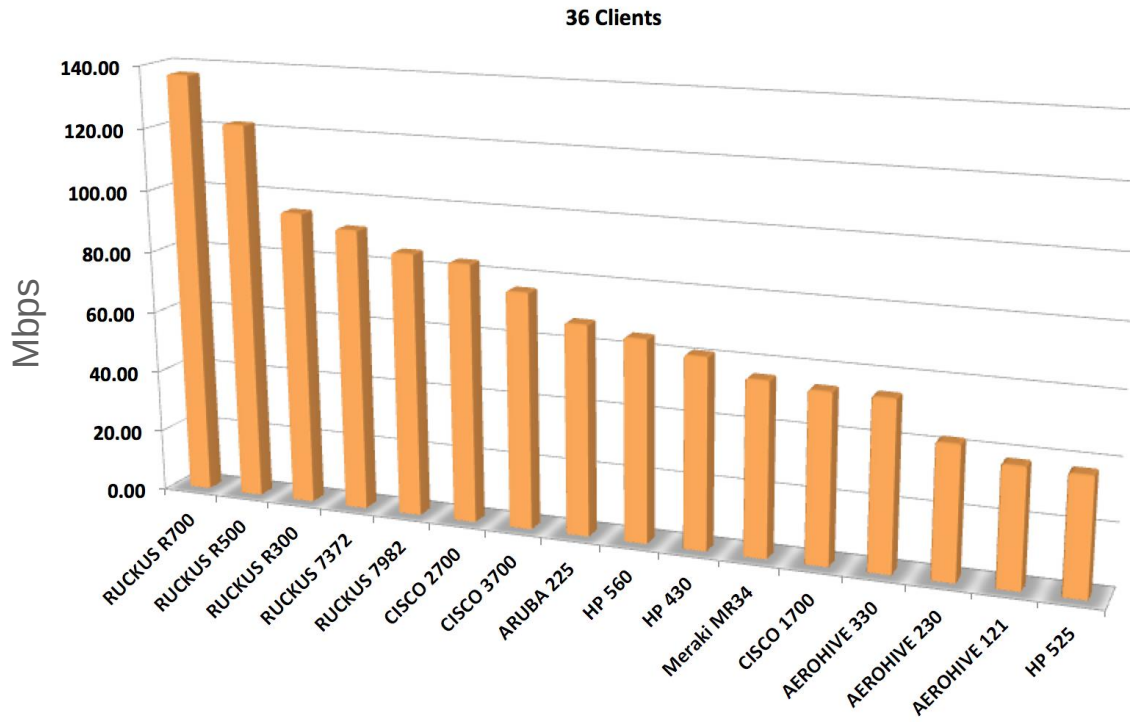


Client #	Type	PHY	Dual-Band?
Client 24-25	iPad 3	802.11n 1x1:1	Yes
Client 26	iPad 4	802.11n 1x1:1	Yes
Client 27	Samsung N8000	802.11n 1x1:1	Yes
Client 28	MacBook Pro 15” (2011)	802.11n 3x3:3	Yes
Client 29-36	HP Pro Tablet 610	802.11n 2x2:2	Yes

Test 3: 36 Clients

Results

Ruckus AP's were the top 5 performing AP's.
The Ruckus R700 outperformed Cisco 2700 by ***64%***



Ranking	Manufacturer	AP Model	Result (Mbps)
1	Ruckus	R700	137.00
2	Ruckus	R500	122.16
3	Ruckus	R300	95.24
4	Ruckus	7372	91.27
5	Ruckus	7982	85.23
6	Cisco	2700	83.56
7	Cisco	3700	76.21
8	Aruba	225	67.84
9	HP	560	65.09
10	HP	430	61.43
11	Meraki	MR34	56.00
12	Cisco	1700	54.50
13	Aerohive	330	54.45
14	Aerohive	230	42.68
15	Aerohive	121	38.16
16	HP	525	37.67

Test 4: 60 Clients

Summary

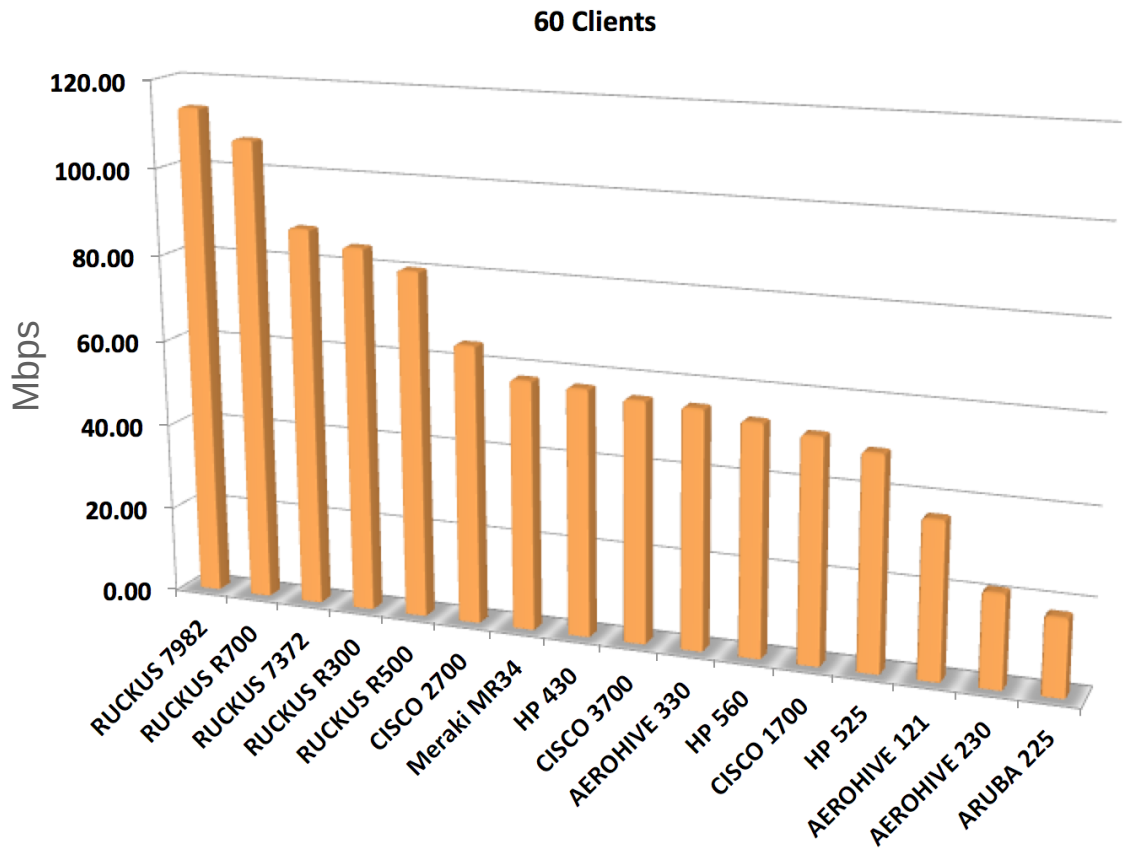
- Added 24 additional client devices into the test
- All 802.11n enabled, 3x3:3
- All Dual-Band capable

Client #	Type	PHY	Dual-Band?
Clients 37-46	Lenovo X200 laptop	802.11n 3x3:3	Yes
Clients 47-60	Lenovo T400 laptop	802.11n 3x3:3	Yes

Test 4: 60 Clients

Summary

Ruckus AP's were the top 5 performing AP's.
The Ruckus R7982 outperformed Cisco 2700 by ***76%***



Ranking	Manufacturer	AP Model	Result (Mbps)
1	Ruckus	7982	113.65
2	Ruckus	R700	107.06
3	Ruckus	7372	87.85
4	Ruckus	R300	84.50
5	Ruckus	R500	80.25
6	Cisco	2700	64.48
7	Meraki	MR34	57.70
8	HP	430	57.06
9	Cisco	3700	55.68
10	Aerohive	330	55.17
11	HP	560	53.35
12	Cisco	1700	51.66
13	HP	525	49.28
14	Aerohive	121	36.14
15	Aerohive	230	21.52
16	Aruba	225	17.78

Test 5: 36 Client Test (distributed)

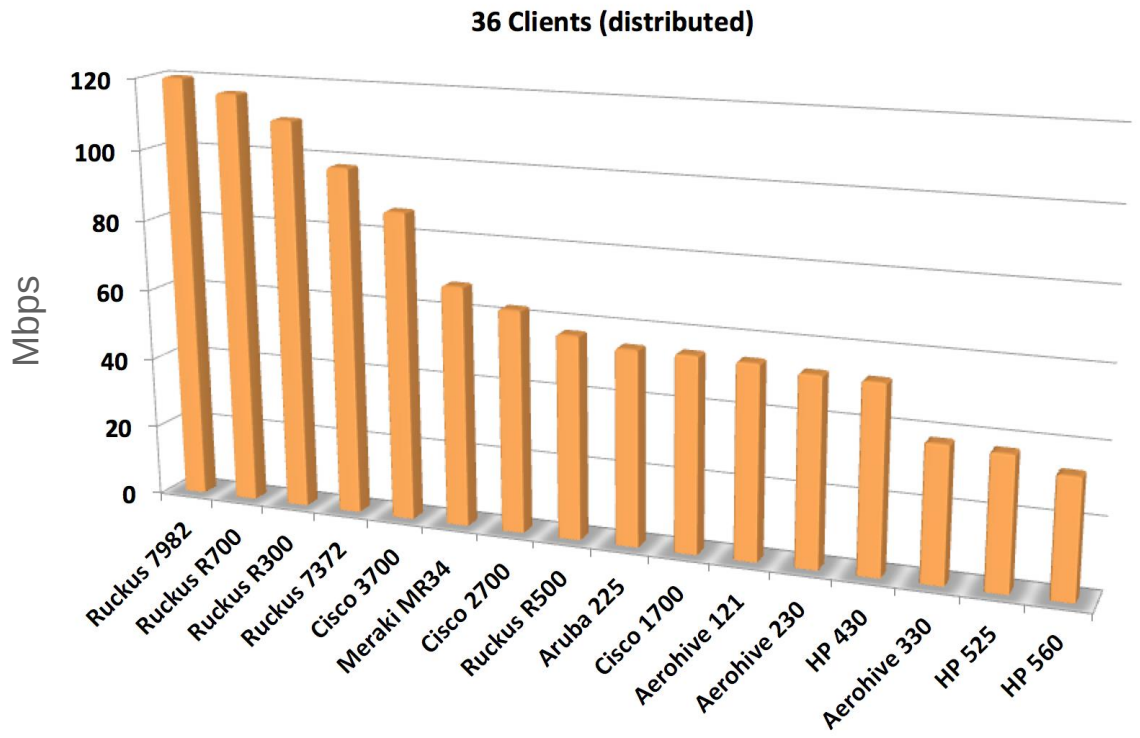
Summary

- Same 36 clients
- Client devices distributed in 270° arc rather than a standard classroom pattern

Test 5: 36 Client Test (distributed):

Results

Ruckus AP's were the top 4 performing AP's.
The Ruckus R7982 outperformed Cisco 3700 by ***38%***



Ranking	Manufacturer	AP Model	Result (Mbps)
1	Ruckus	R7982	120.00
2	Ruckus	R700	116.42
3	Ruckus	R300	110.00
4	Ruckus	7372	98.00
5	Cisco	3700	86.95
6	Meraki	MR34	67.76
7	Cisco	2700	62.67
8	Ruckus	R500	57.19
9	Aruba	225	54.91
10	Cisco	1700	54.84
11	Aerohive	121	54.36
12	Aerohive	230	52.85
13	HP	430	52.53
14	Aerohive	330	38.00
15	HP	525	37.30
16	HP	560	33.36
17	Ubiquiti	Uni-Fi Pro	n/a
18	Xirrus	XR520	n/a
19	Xirrus	XR430	n/a

n/a: access points that were unable to complete tests

Summary

- WLAN infrastructure needs to support the increase in data transfer due to device and application proliferation
- Ruckus APs surpassed the competition in a high-density environment by 22%-76% in Aggregate TCP Throughput.
- Ruckus mid-range APs outperformed competitors high-end 802.11ac Aps

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