Troubleshoot 11n Speeds

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Introduction

This document covers common issues to consider when troubleshooting wireless throughput issues. This document includes usage of tools to measure performance and throughput of the wireless network, which includes different vendor 802.11n access points (APs) in comparison with the Cisco 1252 AP under similar test conditions.

Prerequisites

Requirements

Cisco recommends that you have these requirements:

- Tools such as iPerf, and network analyzers such as OmniPeek and Cisco Spectrum Analysis
- 802.11n supported 1140, 1250, 3500, and 1260 Series APs

Components Used

The information in this document is based on these software and hardware versions:

- WS-SVC-WiSM Controller running software version 6.0.182
- AIR-LAP1142-A-K9 APs

Conventions

Refer to Cisco Technical Tips Conventions for more information on document conventions.

Background Information

802.11n is born due to a number of changes made on the APs Frame Aggregation: A–MPDU and A–MSDU.

- Block Ack Size
- MCS and Channel Bonding
- MIMO

• Using 5GHz over 2.4 GHz: also mention Wi-Fi certifies channel bonding on 5GHz

Troubleshoot the Controller for 11n Speeds

Complete these steps:

1. Verify that 802.11n support is enabled on the controller.

(WiSM-slot3-2) >show 802.11a
802.11a Network Enabled
11nSupport Enabled
802.11a Low Band Enabled
802.11a Mid Band Enabled
802.11a High Band Enabled
802.11a Operational Rates
802.11a 6M Rate Mandatory
802.11a 9M Rate Supported
802.11a 12M Rate Disabled
802.11a 18M Rate Supported
802.11a 24M Rate Mandatory
802.11a 36M Rate Supported
802.11a 48M Rate Supported
802.11a 54M Rate Supported
802.11n MCS Settings:
MCS 0 Supported
MCS 1 Supported
MCS 2 Supported
MCS 3 Supported
MCS 4 Supported
MCS 5 Supported

2. N rates are attained two ways. Speeds up to Modulation Coding scheme (MCS) 7 can be attained without using channel bonding. For MCS rates above 7 and up to 15, channel bonding needs to be enabled. You can verify if channel bonding is enabled using this **show** command on the controller:

AUTO
600 seconds [startup]
0
SNI.
00:1d:45:f0:d2:c0
371 seconds ago
STARTUP (5 dB)
40 MHz
known
known
known
known
known
known

3. You can also configure channel width per AP using these commands:

(WiSM-slot2-2) >config 802.11a disable AP0022.9090.8e97 (WiSM-slot2-2) >config 802.11a chan_width AP0022.9090.8e97 40 Set 802.11a channel width to 40 on AP AP0022.9090.8e97 The Guard interval and corresponding MCS rates help determine the data rates that are seen on the 802.11n clients. These are the commands to verify this configuration:

(WiSM-slot3-2) >show 802.11a	
802.11a Network Enabled	
11nSupport Enabled	
802.11a Low Band Enabled	
802.11a Mid Band Enabled	
802.11a High Band Enabled	
802.11a Operational Rates	
802.11a 6M Rate Mandatory	
802.11a 9M Rate Supported	
802.11a 12M Rate Disabled	
802.11a 18M Rate Supported	
802.11a 24M Rate Mandatory	
802.11a 36M Rate Supported	
802.11a 48M Rate Supported	
802.11a 54M Rate Supported	
802.11n MCS Settings:	
MCS 0 Supported	
MCS 1 Supported	
MCS 2 Supported	
MCS 3 Supported	
MCS 4 Supported	
MCS 5 Supported	
MCS 6 Supported	
MCS 7 Supported	
MCS 8 Supported	
MCS 9 Supported	
MCS 10 Supported	
MCS 11 Supported	
MCS 12 Supported	
MCS 13 Supported	
MCS 14 Supported	
MCS 15 Supported	
802.11n Status:	
802.11n Status: A-MPDU Tx:	
802.11n Status: A-MPDU Tx: Priority 0 Enabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled Priority 5 Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled Priority 5 Disabled Priority 6 Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled Priority 5 Disabled Priority 6 Disabled Priority 7 Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled Priority 5 Disabled Priority 6 Disabled Priority 7 Disabled Beacon Interval 100	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled Priority 5 Disabled Priority 6 Disabled Priority 7 Disabled Beacon Interval 100 CF Pollable mandatory Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled Priority 5 Disabled Priority 6 Disabled Priority 7 Disabled Beacon Interval 100 CF Pollable mandatory Disabled	
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled Priority 5 Disabled Priority 6 Disabled Priority 7 Disabled Beacon Interval 100 CF Pollable mandatory Disabled More or (q)uit	
802.11n Status:A-MPDU Tx:Priority 0Priority 1DisabledPriority 2DisabledPriority 3DisabledPriority 4DisabledPriority 5DisabledPriority 6DisabledPriority 7DisabledBeacon Interval100CF Pollable mandatoryDisabledMore or (q)uitCFP Period	
802.11n Status:A-MPDU Tx:Priority 0EnabledPriority 1DisabledPriority 2DisabledPriority 3DisabledPriority 4DisabledPriority 5DisabledPriority 6DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledCF Pollable mandatoryDisabledMore or (q)uitCFP Period	
802.11n Status:A-MPDU Tx:Priority 0EnabledPriority 1DisabledPriority 2DisabledPriority 3DisabledPriority 4DisabledPriority 5DisabledPriority 6DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledPriority 7DisabledCF Pollable mandatoryDisabledMore or (q)uitCFP Period	
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802.11n Status:A-MPDU Tx:Priority 0EnabledPriority 1DisabledPriority 2DisabledPriority 3DisabledPriority 4DisabledPriority 5DisabledPriority 6DisabledPriority 7DisabledPriority 7DisabledBeacon Interval100CF Pollable mandatoryDisabledMore or (q)uitCFP Period	
802.11n Status:A-MPDU Tx:Priority 0EnabledPriority 1DisabledPriority 2DisabledPriority 3DisabledPriority 4DisabledPriority 5DisabledPriority 6DisabledPriority 7DisabledBeacon Interval.100CF Pollable mandatory.DisabledCFP Period.4CFP Maximum Duration.60Default Channel.36Default Tx Power Level.1DTPC Status.EnabledPrico-Cell Status.DisabledPico-Cell-V2 Status.Disabled	
B02.11n Status:A-MPDU Tx:Priority 0.EnabledPriority 1.DisabledPriority 2.DisabledPriority 3.DisabledPriority 4.DisabledPriority 5.DisabledPriority 6.DisabledPriority 7.DisabledPriority 7.Disabled-More or (q)uitCFP Period.CFP Maximum Duration.60Default Channel.36Default Tx Power Level.1DTPC Status.EnabledFragmentation Threshold.2346Pico-Cell Status.DisabledPico-Cell-V2 Status.DisabledTI Threshold50	
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802.11n Status:A-MPDU Tx:Priority 0EnabledPriority 1DisabledPriority 2DisabledPriority 3DisabledPriority 4DisabledPriority 5DisabledPriority 6DisabledPriority 7DisabledBeacon Interval100CF Pollable mandatoryDisabledCFP Poll Request mandatoryDisabledMore or (q)uitCFP Period	
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802.11n Status: A-MPDU Tx: Priority 0 Priority 1 Disabled Priority 2 Disabled Priority 3 Priority 4 Disabled Priority 5 Disabled Priority 6 Disabled Priority 7	mm
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802.11n Status:A-MPDU Tx:Priority 0EnabledPriority 1DisabledPriority 2DisabledPriority 3DisabledPriority 4DisabledPriority 5DisabledPriority 6DisabledPriority 7DisabledPriority 7DisabledBeacon Interval.100CF Pollable mandatory.DisabledCFP Pollable mandatory.DisabledMore or (q)uitCFPCFP Maximum Duration.60Default Channel.36Default Tx Power Level.1DTPC Status.DisabledFragmentation Threshold.2346Pico-Cell Status.DisabledTi Threshold50Traffic Stream Metrics Status.DisabledExpedited BW Request Status.DisabledWorld Mode.EnabledEDCA profile type.default-wmVoice MAC optimization status.DisabledCall Admission Control (CAC) configurationCallade	mm
802.11n Status: A-MPDU Tx: Priority 0 Enabled Priority 1 Disabled Priority 2 Disabled Priority 3 Disabled Priority 4 Disabled Priority 5 Disabled Priority 6 Disabled Priority 7 Disabled Priority 7 Disabled Beacon Interval 100 CF Pollable mandatory Disabled More or (q)uit CFP Period	mm
802.11n Status: A-MPDU Tx: Priority 1	mm

Voice	reserved roaming bandwidth	6
Voice	load-based CAC mode	Enabled
Voice	tspec inactivity timeout	Disabled
Video	AC - Admission control (ACM)	Disabled
Voice	Stream-Size	84000
Voice	Max-Streams	2
Video	max RF bandwidth	Infinite
Video	reserved roaming bandwidth	0

4.

Ensure A-MPDU packet aggregation. For best effort, QoS levels are enabled via these commands:

♦ config 802.11a 11nSupport a-mpdu tx priority 0 enable

♦ config 802.11b 11nSupport a-mpdu tx priority 0 enable

5. All three antennas on the A radio must be used. Make sure the antennas are the same model.

6. On the WLAN configured for client connectivity, WMM should be allowed or required, and AES or open encryption only must be used. This can be verified using this command output:

(WiSM-glot 2-2) schow wlap 1	
(WISH-SIGUZ-Z) /SHOW WIGH I	1
Drafile Nome	
Notrievic Name (CCLD)	wiabSWISMIPZZ
Status	wiadswismipzz
MAG Hiltoning	
MAC Filtering	
Broadcast SSID	
AAA Policy Override	Disabled
Network Admission Control	
NAC-StateD	Isabled
Quarantine VLAN0	_
Number of Active Clients	0
Exclusionlist Timeout	60 seconds
Session Timeout	1800 seconds
CHD per WLAN	Enabled
Webauth DHCP exclusion	Disabled
Interface	management
WLAN ACL	unconfigured
DHCP Server	Default
DHCP Address Assignment Required	Disabled
Quality of Service	Silver (best effort)
WMM	Allowed
CCX - AironetIe Support	Enabled
CCX - Gratuitous ProbeResponse (GPR)	Disabled
CCX - Diagnostics Channel Capability	Disabled
Dot11-Phone Mode (7920)	Disabled
Wired Protocol	None
IPv6 Support	Disabled
Peer-to-Peer Blocking Action	Disabled
Radio Policy	All
DTIM period for 802.11a radio	1
DTIM period for 802.11b radio	1
Radius Servers	
Authentication Glo	obal Servers
Accounting Dis	sabled
Local EAP Authentication	Disabled
Security	
802.11 Authentication: Ope	en System
Static WEP Keys Dis	sabled
802.1X Dis	sabled
Wi-Fi Protected Access (WPA/WPA2) Ena	abled
WPA (SSN IE) Disabl	Led
WPA2 (RSN IE) Enable	ed
TKIP Cipher Disabled	
AES Cipher Enabled	
Auth Key Management	
802.1x Enabled	

PSK Disabled
CCKM Disabled
FT(802.11r) Disabled
FT-PSK(802.11r) Disabled
FT Reassociation Timeout 20
FT Over-The-Air mode Enabled
FT Over-The-Ds mode Enabled
CKIP Disabled
IP Security Disabled
IP Security Passthru Disabled
Web Based Authentication Disabled
Web-Passthrough Disabled
Conditional Web Redirect Disabled
Splash-Page Web Redirect Disabled
Auto Anchor Disabled
H-REAP Local Switching Enabled
H-REAP Learn IP Address Enabled
Infrastructure MFP protection Enabled (Global
Infrastructure
MFP Disabled)
Client MFP Optional
Tkip MIC Countermeasure Hold-down Timer 60
Call Snooping Disabled
Band Select Enabled
Load Balancing Enabled

7. Antenna Diversity: if using only two antennas for any reason, you need to use antenna A and B for transmitter/receiver ports.

On the Client side:

- 1. Supplicant used to control the wireless card, preferred to match the vendor of the supplicant to the wireless card.
- 2. Client drivers: you need to make sure the latest client drivers are running on the wireless cards.
- 3. Contact your wireless adapter vendor.
- 4. Make sure you are using 11n certified adapter to achieve 11n data rates.

Wi-Fi certified products:

http://www.wi-fi.org/certified_products.php

How to Improve Performance:

- 1. Channel utilization Network analyzers report channel utilization in percentage of time spent transmitting and receiving frames. This helps to measure the potential variance in speed due to distance from an access point. This will help monitor and see for example, if a channel is fully occupied transmitting at 1Mbps under ideal conditions would perform at 0.94Mbps under 100% utilization.
- 2. The physical medium used in wireless as well dictates the performances. Using 802.11g or 802.11a over 802.11b offers much higher throughputs, often up to 30 mbps over 802.11b where a 6mpbs radio capacity is divided between all the associated stations.
- 3. Cell Sizes It is recommended to shrink the cell sizes to have the clients as closer to the APs as possible. This will benefit the data rates at which the client can connect to the AP. This can be done by reducing the power levels on the AP to the lowest.
- 4. Shrinking cell size also decreases co-channel interference. If using RRM, the APs should pick channels dynamically per the deployment. However, if implementing dynamic channel assignment, ensure that you do not have two APs at high power levels on the same channel right next to each other.
- 5. Protection also causes throughput hit.

How to Calculate Throughput via iPerf

Iperf Setup Tips

For those customers or testers that do not own Chariot, Iperf can be used instead. This is available at http://www.macalester.edu/crash/software/pc/iperf/kperf_setup.exe.

Measuring TCP Throughput

Run this command on the server side:

Iperf s -w 256k

Run this command on the client side:

Iperf c <server IP address> -P 6 w 256k -r t 60

Server TCP wir	listening o ndow size:	n TCP por 256 KByte	t 5001					
Client TCP wir	connecting ndow size:	to 10.10. 256 KByte	10.10,	ICP port 50	001 			
[1788] [1820] [1868] [1836] [1804]	local 10.10 local 10.10 local 10.10 local 10.10 local 10.10	1.10.20 po 1.10.20 po 1.10.20 po 1.10.20 po 1.10.20 po 1.10.20 po	rt 1155 rt 1153 rt 1150 rt 1152 rt 1154	connected connected connected connected	with with with with with	10.10.10.10 10.10.10.10 10.10.10.10 10.10.10.10 10.10.10.10	port port port port port	5001 5001 5001 5001 5001
[ID]] [1788] [1868] [1820] [1804] [1852]	Interval 0.0-60.1 s 0.0-60.1 s 0.0-60.2 s 0.0-60.1 s 0.0-60.1 s	Transf ec 124 ec 123 ec 123 ec 110 ec 84.6	er MBytes MBytes MBytes MBytes MBytes	Bandwidth 17.3 Mbits 17.1 Mbits 15.4 Mbits 11.8 Mbits 12.4 Mbits	s/sec s/sec s/sec s/sec s/sec	10.10.10.10	pore	2001
[1836] [SUM] [1952] [1832] [1748] [1732]	0.0-60.2 se local 10.10 local 10.10 local 10.10 local 10.10	ec 86.3 c 617 M 10.20 po 10.20 po 10.20 po 10.20 po 10.20 po	MBytes Bytes rt 5001 rt 5001 rt 5001 rt 5001	12.0 Mhits 86.0 Mbits connected connected connected connected	s/sec /sec with with with with	10.10.10.10 10.10.10.10 10.10.10.10 10.10.10.10	port port port port	2663 2664 2665 2666
[1800] [1812] [1D]] [1800] [1812] [1952] [1748]	local 10.10 local 10.10 Interval 0.0-60.0 s 0.0-60.0 s 0.0-60.1 s 0.0-60.1 s	1.10.20 po 1.10.20 po Transf sec 114 sec 117 sec 89.6 sec 129	rt 5001 rt 5001 MBytes MBytes MBytes MBytes MBytes	connected connected Bandwidth 15.9 Mbits 16.3 Mbits 12.5 Mbits 18.1 Mbits	with with s/sec s/sec s/sec s/sec	10.10.10.10 10.10.10.10	port port	2667 2668
[1732] [1832] [SUM]	0.0-60.1 s 0.0-60.1 s 0.0-60.1 se	ec 111 ec 112 c 672 M	MBytes MBytes Bytes	15.5 Mbits 15.6 Mbits 93.8 Mbits	s/sec s/sec /sec			

The first circled number in this image represents the upstream throughput, the second circled number represents downstream (AP to client) throughput.

Measuring UDP Throughput

Close the previous Iperf applications on both the server and client side. Both need to be set up again, but this time for UDP performance testing.

Run this command on the server side:

Iperf s -u l 56k

Run this command on the client side:

Iperf c <server IP address> -u b 50M l 56k P

This is an example of Omnipeek captures to analyze Aggregate MAC service data unit:

A–MSDU trace shows one packet

DaniPeek - (AH50)UPasket.apc]										
🔮 Ele Est New C	apture Send Monitor Tools Window -	Help									_ 문 프
🗋 - 😂 - 🖬 🌫	🖻 🖻 🖻 📓 🎒 🖏 🖏 🖓	20000000	106								
*											<u>۵</u>
Equip A		16 3 16 18 A A A A A A A A A A A A A A A A A A									
* -acsets	Ranset Source	Destination	017210	Elege	Chancel	E goal	Deta Rahe	376	Relative Time	Profesol	Simony
E boset	1 10 00:14:5E:57:7E:AL	P01:12:28:36:19:37	100:16:01:6F:01:5Z	ă.	:	1005	144.5	4350	0.001001	502.11 A-RSUU	FT-, F, 5H- 755
-ierorche	2 📑 00:28:20:82:15:77	100101800106P00305E			L .	100%	2 4 . U	16	0.000005	502.11 Ach	PU=
	4			20.42	81.49	100	191.45	0.00		CONTRACTOR OF	AND AND ADD ADD
										Packet/ 2	Durwiner (hith 11
Done											By None //

- Only the first sub frame is shown.
- Need to inspect hex dump to see additional sub frames.

A-MSDU next Sub frame shown appended

🔅 OuriPerk - (MH500Packet.app - Packet #1)	
The fire Wew Secure Send Lonke Head Head	비즈
■ · 60 · 月本 回答回答 例の 出てえる可可でく 图 回答	
· · · · · · · · · · · · · · · · · · ·	
Packet 4 [0] dir 7	
_ 0 No TTP Options	-
in W Application Layer	
e Data Anea: (160 hytes)	
Gotte System (NextSupple) (2000 bytem) Heat Subframe Header	
-T PCs - Prane Check Sequence	
	1
1400 16 16 17 18 16 18 18 18 18 18 18 18 18 18 18 18 18 18	-
1.35 FR 39 75 30 15 1F 35 05 05 85 48 50 50 F0 22 48 40 07 23 32 41 01 61 77 35 37 60 16 17 10 16 17 10 10 30 24 24 10 16 17 17 35 37 40 10 16 17 17 35 37 10 10 10 10 10 10 10 10 10 10 10 10 10	
	- 1
Porthep.prestP1	- 16

• An A–MPDU is a structure that contains multiple MPDUs, transported as a single PSDU by the PHY.

• Indication that packet is Data A-MPDU in Physical layer convergence procedure (PLCP).



This is an example of Omnipeek captures to analyze **Aggregate MAC protocol data unit**:

A-MPDU Setup

59 Our	iPeek - [AMP	DUSetup.a	ao]										
🚊 Els	을 Ele Ele Yew Colore Send Zonion Tudy Webox Hele 📰 📰 📰 📰												
🗋 - 🕯													
- 7 -													۵
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	-acsets	Rendet	Source	Destination	00010	Пар	Charrel	E gruei	Data Rate	276	Relative Titre	Protocol	Success
EPa	ert E	1	10:17:17:A6:4C:90	FP 00:12:28:10:FD:55	10 00:17:07:A6:40:91	7à	:	1005	130.0	37	0.001001	202.11 Action	PT=
	-lere-che	2	💵 (0:28:29:20:20:65)	DOUGTABLADE 40:00			5	100%	36.0	14	0.000004	502.11 A08	PU=constants
	Tet 1	а	📑 10: 10: 70: 10: F0: 55	1001113:0F:A6:40:30	📑 00: 17: DF: A6: 40: 91	*	ę	1004	26.0	.17	0.101003	302, 11 Action	FG,2H026
	Application will	4	📑 05:17:DF:26:40:99	B01:12:20:10:F0:55		1.	2	1005	36. D	14	0.000013	502.11 Ack	FC
4	ا آن است	4				19	120.4		1 B 1	1			
												Parketr 4	Duradiony [H11H11
Done													Nora /

- ADDBA Add Block Acknowledgement
- ADDBA Request Contains identifier, Block Ack Policy, Buffer Size, etc.
- ADDBA Response Can change policy and buffer size.

A-MPDU Setup

- ADDBA Request
- AP1250 uses a timeout of zero to indicate no timeout.



A-MPDU Setup

- ADDBA Response
- Receiver needs to indicate Block Ack Agreement was successfully established.



A-MPDU Data Transfer

- Block Ack contains compressed bitmap to indicate MPDUs received.
- Refer to the IEEE 802.11n section 9.10.7 HT-immediate Block Ack extensions for information on sending the Block Ack.

50 Onnif	Poek - [AM	PDUDataAnd	BlockAck.epc]										_ I X
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Capt	ure 🗠	00	i 🖬 🖬 🔟 🔍 💎 -	8998 88 B									
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C Lope	www.etu	2	😰 00: 13: Kö: 36: 19: 77	14: 5K: 57: 70: A1	100:16:01:5F:03:5E	*	1	100%	130.0	75	0.000003	TEP	
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E Stati	ation	0	😰 00:16:01:07:03:5E	B00:10:50:36:19:77		1 C	1	100%	30.0	32	0.000023	002.11 88	
- Josef	where T												
1		*											1. O. I. O. M.
											Packets 8	Duration	0.00.00
Done												📑 None	11

Capabilities Advertised in Beacons

ė	T	HT	Capability Info	
		8	Element ID:	45 HT Capability Info
	-	۲	Length:	26
	÷	T	HT Capability Info:	\$0001100001101110
		1	()	0 L-SIG TXOP Protection Support: Not Supported
		-	. 🕤	.0 AP allows use of 40MHz Transmissions In Neighboring BSSs
		1	. 🕎	0 Device/BSS does Not Support use of PSMP
		4	. 🕲	1 BSS does Allow use of DSSS/CCK Rates @40MHz
		-	. 🞯	1 Maximal A-MSDU size: 7935 bytes
		-	. 🐨	0 Does Not Support HT-Delayed BlockAck Operation
		-	. 🚱	00 No Rx STBC Support
		-	- 🞯	0 Transmitter does Not Support Tx STBC
		÷	. 🚱	
		-	. 🞯	
		1	- 🐨	
		÷	. 🕥	11 Spatial Multiplexing Enabled
		÷		1. Both 20MHz and 40MHz Operation is Supported
		- i	. 🗊	
	÷	T	A-MPDU Parameters:	\$00011011
		÷	. 🞯	xxx Reserved
		÷	. (9	110 Minimum MPDU Start Spacing: 8 usec
		 	. 🞯	11 Maximum Rx A-MPDU Size: 64K
	P	1	Supported MCS Set	
		÷	• One Spatial Stream	: \$1111111
			MCS Index 0 Sup	ported - BPSK. Coding Rate: 1/2
			MCS Index I Sup	ported - QPSK. Coding Rate: 1/2
			MCS Index 2 Sup	portea - grsk. Coaing Rate: 3/4
			MUS Index 3 Sup	portea - 16 gum. Coaing Mate: 1/2
			MUS Index 4 Sup	portea - 16 QAM. Coding Rate: 3/4
			MUS Index 5 Sup	ported = 64 QAM. Coding Rate: 2/3
			MCS Index 8 Sup	contest - 64 QMM. Coding Rate: 5/4
		1	The Sectial Stream	e. 50111111
		T	MCS Index 8 Sum	worted - BPSK. Coding Rate: 1/2
			MCS Index 9 Sup	ported = OPSK. Coding Rate: 1/2
			MCS Index 10 Su	ported - OPSK. Coding Rate: 3/4
			MCS Index 11 Su	ported = 16 020, Coding Rate: 1/2
			MCS Index 12 Su	oported - 16 OAM. Coding Rate: 3/4
			MCS Index 13 Su	oported - 64 QAM. Coding Rate: 2/3
				oported - 64 QAM. Coding Rate: 3/4
				t Supported - 64 QAM. Coding Rate: 5/6
		1.	🕥 Rx Bitmask b16-b23	\$0000000
			🍘 Rx Bitmask b24-b31	: \$0000000
		1	🎯 Rx Bitmask b32-b39	: \00000000
			🍘 Rx Bitmask b40-b47	\$0000000
			🎯 Rx Bitmask b48-b55	\$0000000

Capabilities advertised in Beacons:

🞯 Rx Bitnask b64-b76:	400000000000
- 🞯 Reserved:	\$000
- 🎯 Highest Supported Ra	ate:0 Maps
🜒 Reserved:	\$00000
📵 Tx Supported MCS Set	t: NO Not Defined
- 🕲 Tx and Rx HCS Set:	\$0 Σqual
🎯 Tx Naximun Humber Sp	patial Streams Supported:400 1 Spatial Stream
	m: +0 Not Supported
🛛 🎯 Reserved:	\$0000000000000000000000000000000000000
🏋 HT Extended Capabiliti	es Info:%000000000000000
🕲	XXXX Reserved
(9)	0
(9)	
🕲	
🕲	xxxx x Reserved
🕲	
	0 Transmitter Supports PCO: Supported
🚏 Tx Beam Forming Capabi	lity (TXBE): \$000000000000000000000000000000000000
🕲	xxx Reserved
🞯	0 0
🞯	
🕲	0 0
🞯	
🞯	0 0 CSI Number of BF Antennas: 1 TX Antenna Sounding
🞯	0000 Kining (No Grouping: STA Supports Groups of 1 (No Grouping)
🞯	
🞯	
🕲	0 0
🕲	
🕲	Uncompressed BF Peedback Matrix: Not Supported
🞯	Explicit CSI TRBF Capable: Not Supported
	Calibration: Not Supported
19	
	TX NUP Capable: Not Supported
	0 2x NDP Capable: Not Supported
Series Coloradore Const	0 implicit imp Ecciving Capable: Not Supported
Antenna Selection Capa	
	A Kesetrea
	A De SSEL (anable: Not Supported D De SSEL (anable: Not Supported
	0 Interna Indices Readhack Camble: Not Supported
	0 Evaluate Indices requests asymptotics for Supported
	0. Interna Indices Readback Resed Ty ICEL Canable: Not Supported
	A Reference of the control of the co

Capabilities advertised in Beacons:

```
B Element ID:
                   61 Additional HT Information
 🗑 Length:
                  - 22
 🗑 Primary Channel:
                  6
 🜍 Srvc Int Granularity: $000 5ms
 🔮 PSRP STRs Only: 👘 40 Association Requests are Accepted Regardless of PSMP Capability
 🗑 RIFS Hode:
                   41 Use of RIFS Permitted
                   %1 Use Any Channel Width Enabled Under Supported Channel Width Set
 🌚 STA Channel Width:
 2nd Channel Offset: 401 Above the Frimary Channel
 XXXXXXXX XXX..... Reserved
                     -- 😡
                     -- 🗑
   ......
                      . 📾
                     xxxx.... Reserved
                     ....0.... PCO Phase: Switch To/Continue Use 200Hz Phase
   . 📦
                     .....0.. ....... PCO Active: Not Active in the BSS
   - 🐨
   . 📦
                     .....0. ..... L-SIG TNOP Protection: Not Full Support
   .
                     .....0 ...... Secondary Beacon: Primary Beacon
                     ..... 0..... Dual CTS Protection: Not Required
   . 📦
   . 🙃
                     .
                     Basic MCS Set
 in T One Spatial Stream: $00000000
    -- 🌒 MCS Index 0 Not Supported - BPSK. Coding Rate: 1/2
    ... MCS Index 1 Not Supported - QPSK. Coding Rate: 1/2
    ... 📵 MCS Index 2 Not Supported - QPSK. Coding Rate: 3/4
    --💮 MCS Index 3 Not Supported - 16 QAM. Coding Rate: 1/2
     . MCS Index 4 Not Supported - 16 QAM. Coding Rate: 3/4
    -- 😏 MCS Index 5 Not Supported - 64 QAM. Coding Rate: 2/3
    ... 🗑 MCS Index 6 Not Supported - 64 QAM. Coding Rate: 3/4
     😋 MCS Index 7 Not Supported - 64 QAM. Coding Rate: 5/6
 Two Spatial Streams: $00000000
    ... MCS Index 8 Not Supported - BPSK. Coding Rate: 1/2
     😙 MCS Index 9 Not Supported - QPSK. Coding Rate: 1/2
    ... MCS Index 10 Not Supported - QPSK. Coding Rate: 3/4
     😋 MCS Index 11 Not Supported - 16 QAM. Coding Rate: 1/2
    -- 🕲 MCS Index 13 Not Supported - 64 QAM. Coding Rate: 2/3
    ... 🗑 MCS Index 14 Not Supported - 64 QAM. Coding Rate: 3/4
    - 😋 MCS Index 15 Not Supported - 64 QAM. Coding Rate: 5/6
   😙 Rx Bitnask b16-b23: 300000000
   🜍 Rx Bitnask b24-b31: 🛛 \00000000
   🞯 Rx Bitnask b32-b39: 🛛 300000000
   🗑 Rx Bitnask b40-b47:
                     $00000000
```

Association similar with addition of Block Ack setup for A-MPDU:

194	📰 00:13:E8:1D:F0:55	B00:17:DF:A6:4C:90	802.11 Ack		¥	100%	6.0	14
195	EE 00:17:DF:A6:4C:90	🕎 Ethernet Broadcast	802.11 Beacon	E 00:17:DF:A6:4C:90	*	100%	6.0	204
196	EE 00:13:E8:1D:F0:55	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	*	100%	1.0	81
197	E 00:17:DF:A6:4C:90	100:13:E8:1D:F0:55	802.11 Probe Rsp	100:17:DF:A6:4C:90	*+	100%	6.0	204
198	00:13:E8:1D:F0:55	B00:17:DF:A6:4C:90	802.11 Åck		¥	100%	6.0	14
199	D0:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast		100%	1.0	87
200	D0:13:E8:36:19:77	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	*	100%	1.0	81
201	B00:17:DF:A6:4C:90	B00:13:E8:36:19:77	802.11 Probe Rsp	00:17:DF:A6:4C:90	*+	100%	6.0	204
202	00:13:E8:36:19:77	B00:17:DF:A6:4C:90	802.11 Ack	-		100%	6.0	14
203	00:13:E8:36:19:77	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	*	100%	1.0	74
204	B00:13:E8:36:19:77	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	*	100%	1.0	81
205	00:17:DF:A6:4C:90	00:13:E8:36:19:77	802.11 Probe Rsp	100:17:DF:A6:4C:90	*+	100%	6.0	204
206	00:13:E8:36:19:77	00:17:DF:A6:4C:90	802.11 Ack	-	#	100%	6.0	14
207	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	8	52%	1.0	55
208	D0:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	*	97\$	1.0	55
209	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	*	100%	1.0	87
210	B00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast		100%	1.0	55
211	00:17:DF:A6:4C:90	Ethernet Broadcast	802.11 Beacon	00:17:DF:A6:4C:90	*	100%	6.0	204
212	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	*	95%	1.0	55
213	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast		100%	1.0	87
214	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Reg	Ethernet Broadcast	*	100%	1.0	55
215	EP 00:13:E8:1D:F0:55	FE 00:17:DF:A6:4C:90	802.11 Auth	1 00:17:DF:A6:4C:90	*	100%	36.0	34
216	EP 00:17:DF:A6:4C:90	R. 00:13:E8:1D:F0:55	802.11 Ack		¥	100%	36.0	14
217	EE 00:17:DF:A6:4C:90	E 00:13:E8:1D:F0:55	802.11 Auth	E 00:17:DF:A6:4C:90	*	100%	36.0	34
218	FP 00:13:E8:1D:F0:55	🕎 00:17:DF:A6:4C:90	802.11 Ack		ÿ	100%	36.0	14
219	FP 00:13:E8:1D:F0:55	FE 00:17:DF:A6:4C:90	802.11 Assoc Reg	EE 00:17:DF:A6:4C:90	*	100%	36.0	134
220	E 00:17:DF:A6:4C:90	ER 00:13:E8:1D:F0:55	802.11 Ack		¥	100%	36.0	14
221	FP 00:17:DF:A6:4C:90	F2 00:13:E8:1D:F0:55	802.11 Assoc Rsp	PP 00:17:DF:A6:4C:90		100%	130.0	180
222	📳 00:13:E8:1D:F0:65	00:17:DF:A6:4C:90	802.11 Ack		#	100%	36.0	14
223	3 192.168.170.89	3 224.0.0.1	IGMP	00:17:DF:A6:4C:90		100%	130.0	84
224	💵 00:13:E8:1D:F0:55	BO0:17:DF:A6:4C:90	802.11 Ack		#	100%	36.0	14
225	3 192.168.170.89	3 224.0.0.1	IGMP	B) 00:17:DF:A6:4C:90	+	100%	130.0	84
226	III 00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack			100%	36.0	14
227	BO:17:DF:A6:4C:90	BO:13:E8:1D:F0:55	WLCCP	00:17:DF:A6:4C:90		100%	130.0	92
228	#9 00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Åck		¥ .	100%	36.0	14
229	<pre>Provide Contemp = Provide Contemp = Provide</pre>	F2 00:13:E8:1D:F0:55	802.11 Action	FP 00:17:DF:A6:4C:90		100%	130.0	37
230	#9 00:13:E8:1D:F0:55	B00:17:DF:A6:4C:90	802.11 Åck		#	100%	36.0	14
231	00:13:28:1D:F0:55	00:17:DF:A6:4C:90	802.11 Action	00:17:DF:A6:4C:90	*	100%	36.0	37
232	B 00:17:DF:A6:4C:90	00:13:E8:1D:F0:55	802.11 Ack		#	100%	36.0	14

Verifying A-MPDU is enabled on the controller

S W HT Capability Info		
Bienent ID:	45 HT Capability Info (83)	
- Cragth:	26 (04)	
· T HT Capability Info:	40001100001101110 (05-06)	
- •	0 L-SIG IND? Brotection Support: Not Supported	
	.0 30 allows use of 4000x Transmissions In Delphoring 201s	
-9		
- •	E	
	0 Transmitter does Not Support Tx STBC	
		A MPDLL coopling and soon in the
ST A-RPDU Pacameters	N00011011 [07]	-
	zzz Reserved [07 Hask 0x20]	beacon
	220 Miniana MNDO Start Specing: # same [87 Bask Ox1C]	
	11 Maximum Rx A-MODU Sizes 64E [07 Back 0x00]	
T Supported BCS Set		

Above is a beacon frame from an SSID enabled for n rates

.

- interface Dot11Radio1
- Radio AIR-RM1252A, Base Address 0011.9ea6.8520, BBlock version 0.00, Software version 2.10.20

- Nadio AIR-MIT252A, Base Address U0114eas.8520, BBook Version 0.00, S Serial number: FOC121205A Number of supported simultaneous BSSID on Dot11Radio1: 16 Carrier Set: Americas (OFDM) (US) (.4) Uniform Spreading Required: Yes Configured Frequency: 5180 MHz, Channel 36, 40MHz, extended above
- Allowed Frequencies: 5180(36) 5200(40) 5220(44) 5240(48) *5260(52) *5280(56) *5300(60) *5320(64) *5500(100) *5520(104) *5540(108) *5560(112) *5680(136) *5660(132) *5680(136) *5700(140) 5745(149) 5765(153) 5785(157) 5805(161) 5825(165)
- " Solog(112) "Solog(110) "Solog(132) "Solog(136) "Solog(146) Solog(146) Solog(146) Solog(157) Solo Listen Frequencies: 5180(36) 5200(40) 5220(44) 5240(45) 5200(52) 5280(56) 5300(40) 5320(64) 5500(100) 5520(104) 5540(108) 5560 (112) 5580(115) 5580(115) 5580(136) 5780(146) 5745(149) 5745(157) 5805(161) 5825(165) Beaton Flags 20105: Beatons are enabled Configured Power: 14 dBm (level 1) Active power levels by rate 6.0-bf to 56.0-b, 8.0 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 10 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m15.-4, 11 dBm, changed due to regulatory maximum m0. to m11. m12, m13, m14, m15. Default Rates: basic-6,0 9,0 basic-12,0 18,0 basic-24,0 36,0 48,0 54,0 m1. m12, m13, m14, m15. Best Range Rates: basic-6,0 9,0 12,0 18,0 24,0 36,0 48,0 54,0 m0, m1, m2, m3, m4, m5, m6, m7, m8, m9, m10, m11, m12, m13, m14, m15. Best Throughput Rates: basic-6,0 basic-12,0 basic-12,0 basic-12,0 basic-24,0 basic-36,0 basic-48,0 basic-54,0 m0, m1, m2, m3, m4, m5, m7, m8, m10, m11, m12, m13, m14, m15. Best Throughput Rates: basic-6,0 basic-9, .

- .
- Miles miles. Best Throughput Rates: basic-6.0 basic-9.0 basic-12.0 basic-18.0 basic-24.0 basic-36.0 basic-48.0 basic-54.0 m0. m1. m2. m3. m4. m5. m6. m7. m8. m9. m10. m11. m12. m13. m14. m15.

MCS Rates on 802.11n beacon



Supported MCS rates

25		(OmniPeek
1 14		dit View Capiture Sand Monthly Trude Window Hells	March Color
			0.01
-		such a reason for the reason of the reason o	V 0 1
100		And Page B02 114 pet B02 120_40946 pet B02 114 pet - Packet #12	BULTIN_RPREAK - Packet #100 ×
-		NUMBER OF STREET, STRE	
	15	STR B-0 STO LON-2 SSR-W	
	14	The Red Till Land Hill County will be and the state of th	A West Republication
	14	Country 19-7 Country Learnin Country Cole-01. Starting Changel-16 Summer of	Channels-4 Kan To Power (dBo)-20 Utarting Channel-12 Summer of Channels-4 Kan To Power (dBo)-20 U
- 14	14	Gent- ID-11 (101) Lou-I Matter Count-O Changel Williamine-Oul3 4 South Mr.	Intention Copacity-20427
	êΥ.	AT Capability Date	
		Clowest Div 46 AT Capability data (10)	
		• Longt &: 25 (14)	
		T IT Conditity Info-weekington	
	1.2	T Supported W.S. Set	
	1.7	o T day Restal Downey Militian (197)	
		RE Index 0 Supported - SHE. Coding Sales 1/2	
		RCE Index 1 Supported - QUE, Coding Sates 1/2	
		- I Mid Index 2 Supported - \$250. Colleg Seter 3/4	
		• MCS Index 3 Supported - 14 GMM. Coding Bates 1/2	
		- WES Index 4 Supported - 14 GMR, Coding Aster 1/4	
		With Index 5 Supported - of ONL Coding Anter 1/4	
		REI Index 7 Supervised - 48 GBR, Coding Spins 1/6	
		o T Two Spatial Harmony Mililian (07)	
		- RCI Index 8 Supported - 1992, Colleg Sate: 1/2	
		#CE Index 9 Supported - GNE. Colleg Rates 1/2	
		- Ref Index 10 Supported - ONE. Collar Rete: 3/4	
		- Wit Index 11 Supported - 14 GML Colley Arte: 1/2	
		 Will Index 13 Dependent - 14 GML Control Later 2/2 	
		RE Index 14 Deported - 64 GML Coding Sales 3/8	
		• Will Index 18 Deported - of GAR. Coding Jates 5/8	
		- * By Bilowerk bl8-b73: +00000000 (11)	
		• Bx Bilimanh b74-b15: 400000000 (91)	
		TX Bitmanh B10-619: V00000000 [11]	
		By Bitmank kis att.	
		Be Bilmanh bit bill bille bille	
		. Bx Bilmash bdd b76: 4000000000000 [94-91 Back def7975]	
		. Bigheat Supported Baterd . Htps: [98-10 Hank doffCl]	
		- • Reserved: +000000 [19 Rule (107)	
		IN AMBORING BCI DATI AN AND DELITER [100 BPH 0000]	

802.11a with N rates Enabled

<u>م</u>	OmniPeek	. * *
He Edit View Capture Send Monitor Tools I	nindow rela	WMPschulz CompPeek
2-0-03-03-03-03-04-04	1 9 Y 2 6 10 9 1 - 1 10 0 0 11	
Stat Page 1022 314 obt 1022 334 4284	and BULLIANS - Dated #17 BULLIA 40440 att - Parket #110	
to an Indiana a log to a state of	the i washington and the second s	
a T Parist Into Judici Radovici	18 Figure-Bellondonon Traine-Bellondonon Parket Laborh-202 Titerriake-16-	Charles disconnects do reaction in the Reserved A. M. Mars Charles do 1010 Mile
a T (1-22) ANT. 11 Kint Readed Version-0 To	me-400 Assagement Subtype-11000 heater Sanatian-0 Storescouts Beats	1001100-FF1FF1FF1FF1FF1FF1FF1FF1FF1F01F110110110
in T 107.11 Honogeneral - Bearing		
Timestamp: 248054850357 Kin	crossource (24-21)	
- Beacon Enternal : 302 (32-31)		
* Y Capability Info-Accorosconconcel		
8-Y MID 19-0 1110 Lan-2 Millions		
# T Bales- Bell Setter Leard Baland.0 20pp	Rate-9.0 Kips Bale-53.0 Kips Bale-58.0 Kips Bale-36.0 Kips Bale-36.0	Nyo Bale-60.0 Nyo Bale-16.0 Nyo
a T THE B-S THE LEA-S STIR COMI-S STIR	Person-1 Noting Control-V0000000 Part Yort Meng-Cold	Marking Characteril States of Characteric Soc In Surger (State 1) Hard
and the main while the Allert the first of	Changed With and an order of the state of the state of the	Starting changers, subject of changes in the set of some set
of The Conductory Lafe	Contract of Contract of State of States of Contract of States	 Bearson frame including
Closed Iby 41 AT Capabil	Late Date (197)	 Deacon manie mouoling
- Campbin 26 (114)		A-MPDU and MCS rates
· T HE Capabellity Info-+0001100000101110	à	supported
*** A 4990 Parameters-100013838		
· T Supported HCS Set He Bilmark hid-hill		I Be Bilmark hill hill-hill-volucions he Bilmark hill-hill-volucions he Bilmar
* T If Extended Capabilities Info-100000	Monegoriome	
· T To Bean Forming Capability (Table)-10	000000000000000000000000000000000000000	
a T Astenas Selection Capability (BUE)-		
and the later while had an encoded	Friday Changelow	
a T BE BOILD AN LOUIS BUILDED AN PO DET	Typest MT Sattypest Jacantar Flouret Septemb	
The Trader Speciality ID-221 Vender Dents for	Loand 402-00-40-bit Balan(2 Sector)	
a T reader Specific Bodil Vender Specific	Los-5 000-00-40-06 Version-0 CCX Version-5	
in T Tender Specific ID-221 Vender Specific	Leard 600-00-60-96 Balar(2 leyter)	
is T reader Specific ID-011 Ventor Specific	Los-5 (00-00-00 Belo-(2 Bytes)	
A T PIN I Frame Charle Sciences		

802.11A Beacon frame



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