

# 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:

```
(WiSM-slot3-2) >show advanced 802.11a channel
Automatic Channel Assignment
Channel Assignment Mode..... AUTO
Channel Update Interval..... 600 seconds [startup]
Anchor time (Hour of the day)..... 0
Channel Update Contribution..... SNI.
Channel Assignment Leader..... 00:1d:45:f0:d2:c0
Last Run..... 371 seconds ago
DCA Sensitivity Level..... STARTUP (5 dB)
DCA 802.11n Channel Width..... 40 MHz
Channel Energy Levels
Minimum..... unknown
Average..... unknown
Maximum..... unknown
Channel Dwell Times
Minimum..... unknown
Average..... unknown
Maximum..... unknown
802.11a 5 GHz Auto-RF Channel List
Allowed Channel List.....
36,40,44,48,52,56,60,64,149,
153,157,161
Unused Channel List.....
100,104,108,112,116,132,136,
```

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:
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
CF Poll Request mandatory..... Disabled
--More-- or (q)uit
CFP Period..... 4
CFP Maximum Duration..... 60
Default Channel..... 36
Default Tx Power Level..... 1
DTPC Status..... Enabled
Fragmentation Threshold..... 2346
Pico-Cell Status..... Disabled
Pico-Cell-V2 Status..... Disabled
TI Threshold..... -50
Traffic Stream Metrics Status..... Disabled
Expedited BW Request Status..... Disabled
World Mode..... Enabled
EDCA profile type..... default-wmm
Voice MAC optimization status..... Disabled
Call Admission Control (CAC) configuration
Voice AC - Admission control (ACM)..... Enabled
Voice max RF bandwidth..... 75
```

4.
  - 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

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-slot2-2) >show wlan 1
WLAN Identifier..... 1
Profile Name..... wlab5WISMip22
Network Name (SSID)..... wlab5WISMip22
Status..... Enabled
MAC Filtering..... Disabled
Broadcast SSID..... Enabled
AAA Policy Override..... Disabled
Network Admission Control
NAC-State..... Disabled
Quarantine VLAN..... 0
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..... Global Servers
Accounting..... Disabled
Local EAP Authentication..... Disabled
Security
802.11 Authentication:..... Open System
Static WEP Keys..... Disabled
802.1X..... Disabled
Wi-Fi Protected Access (WPA/WPA2)..... Enabled
WPA (SSN IE)..... Disabled
WPA2 (RSN IE)..... Enabled
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](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.maclester.edu/crash/software/pc/iperf/kperf\\_setup.exe](http://www.maclester.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 listening on TCP port 5001
TCP window size: 256 KByte
-----
Client connecting to 10.10.10.10, TCP port 5001
TCP window size: 256 KByte
-----
[1788] local 10.10.10.20 port 1155 connected with 10.10.10.10 port 5001
[1820] local 10.10.10.20 port 1153 connected with 10.10.10.10 port 5001
[1868] local 10.10.10.20 port 1150 connected with 10.10.10.10 port 5001
[1836] local 10.10.10.20 port 1152 connected with 10.10.10.10 port 5001
[1804] local 10.10.10.20 port 1154 connected with 10.10.10.10 port 5001
[1852] local 10.10.10.20 port 1151 connected with 10.10.10.10 port 5001
[ ID] Interval      Transfer      Bandwidth
[1788] 0.0-60.1 sec  124 MBytes   17.3 Mbits/sec
[1868] 0.0-60.1 sec  123 MBytes   17.1 Mbits/sec
[1820] 0.0-60.2 sec  110 MBytes   15.4 Mbits/sec
[1804] 0.0-60.1 sec  84.6 MBytes  11.8 Mbits/sec
[1852] 0.0-60.1 sec  89.2 MBytes  12.4 Mbits/sec
[1836] 0.0-60.2 sec  86.3 MBytes  12.0 Mbits/sec
[SUM] 0.0-60.2 sec  617 MBytes   86.0 Mbits/sec
[1952] local 10.10.10.20 port 5001 connected with 10.10.10.10 port 2663
[1832] local 10.10.10.20 port 5001 connected with 10.10.10.10 port 2664
[1748] local 10.10.10.20 port 5001 connected with 10.10.10.10 port 2665
[1732] local 10.10.10.20 port 5001 connected with 10.10.10.10 port 2666
[1800] local 10.10.10.20 port 5001 connected with 10.10.10.10 port 2667
[1812] local 10.10.10.20 port 5001 connected with 10.10.10.10 port 2668
[ ID] Interval      Transfer      Bandwidth
[1800] 0.0-60.0 sec  114 MBytes   15.9 Mbits/sec
[1812] 0.0-60.0 sec  117 MBytes   16.3 Mbits/sec
[1952] 0.0-60.1 sec  89.6 MBytes  12.5 Mbits/sec
[1748] 0.0-60.1 sec  129 MBytes   18.1 Mbits/sec
[1732] 0.0-60.1 sec  111 MBytes   15.5 Mbits/sec
[1832] 0.0-60.1 sec  112 MBytes   15.6 Mbits/sec
[SUM] 0.0-60.1 sec  672 MBytes   93.8 Mbits/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:

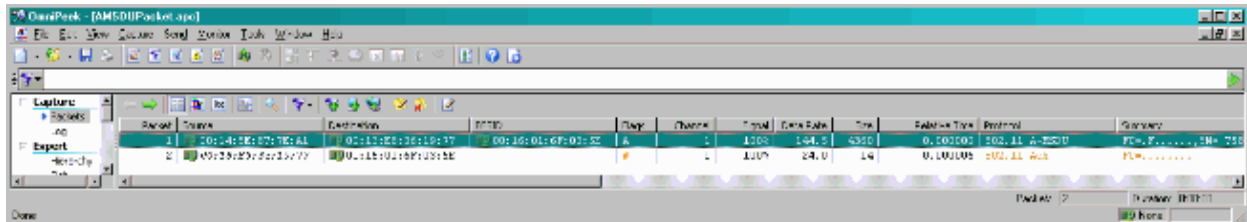
```
Iperf s -u l 56k
```

Run this command on the client side:

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

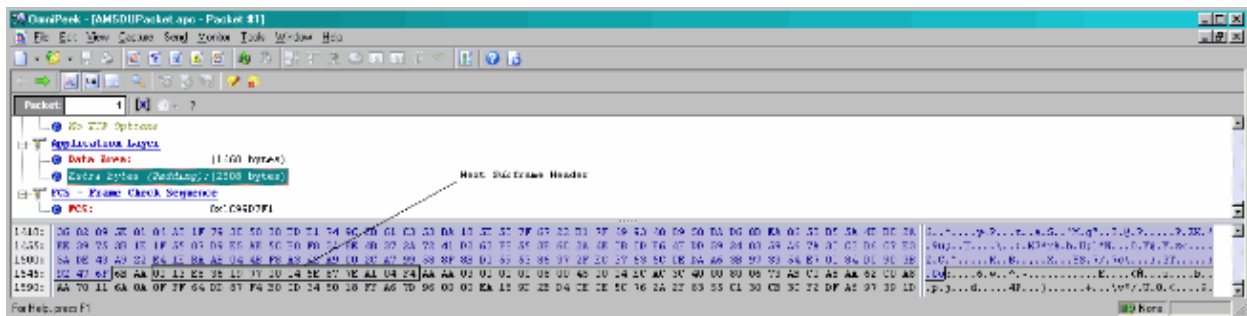
This is an example of Omnipeek captures to analyze **Aggregate MAC service data unit**:

### A-MSDU trace shows one packet

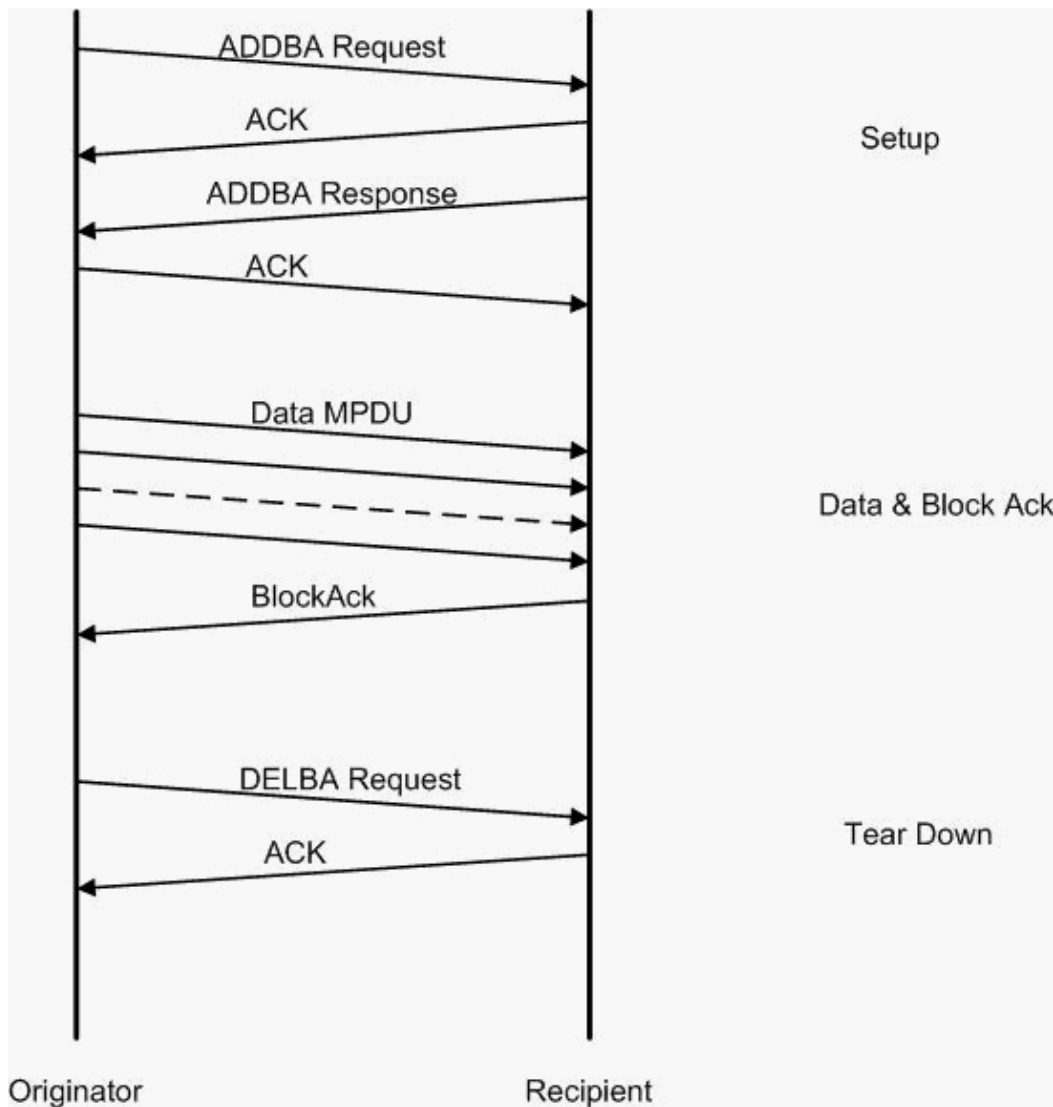


- Only the first sub frame is shown.
- Need to inspect hex dump to see additional sub frames.

### A-MSDU next Sub frame shown appended

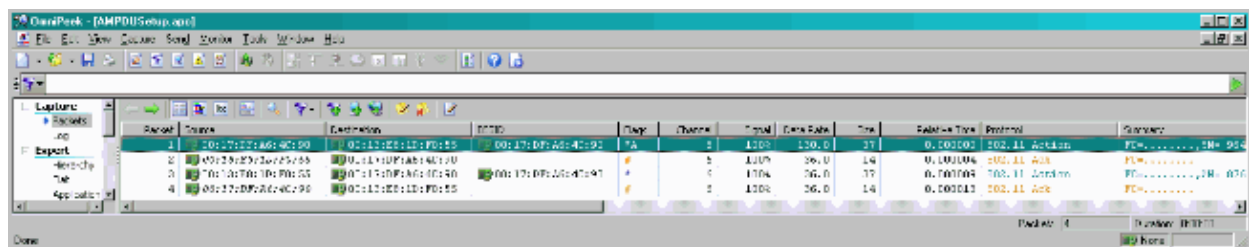


- An A-MPDU is a structure that contains multiple MPDUs, transported as a single PSDU by the PHY.
- Indication that packet is Data A-MPDU in Physical layer convergence procedure (PLCP).



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

### A-MPDU Setup

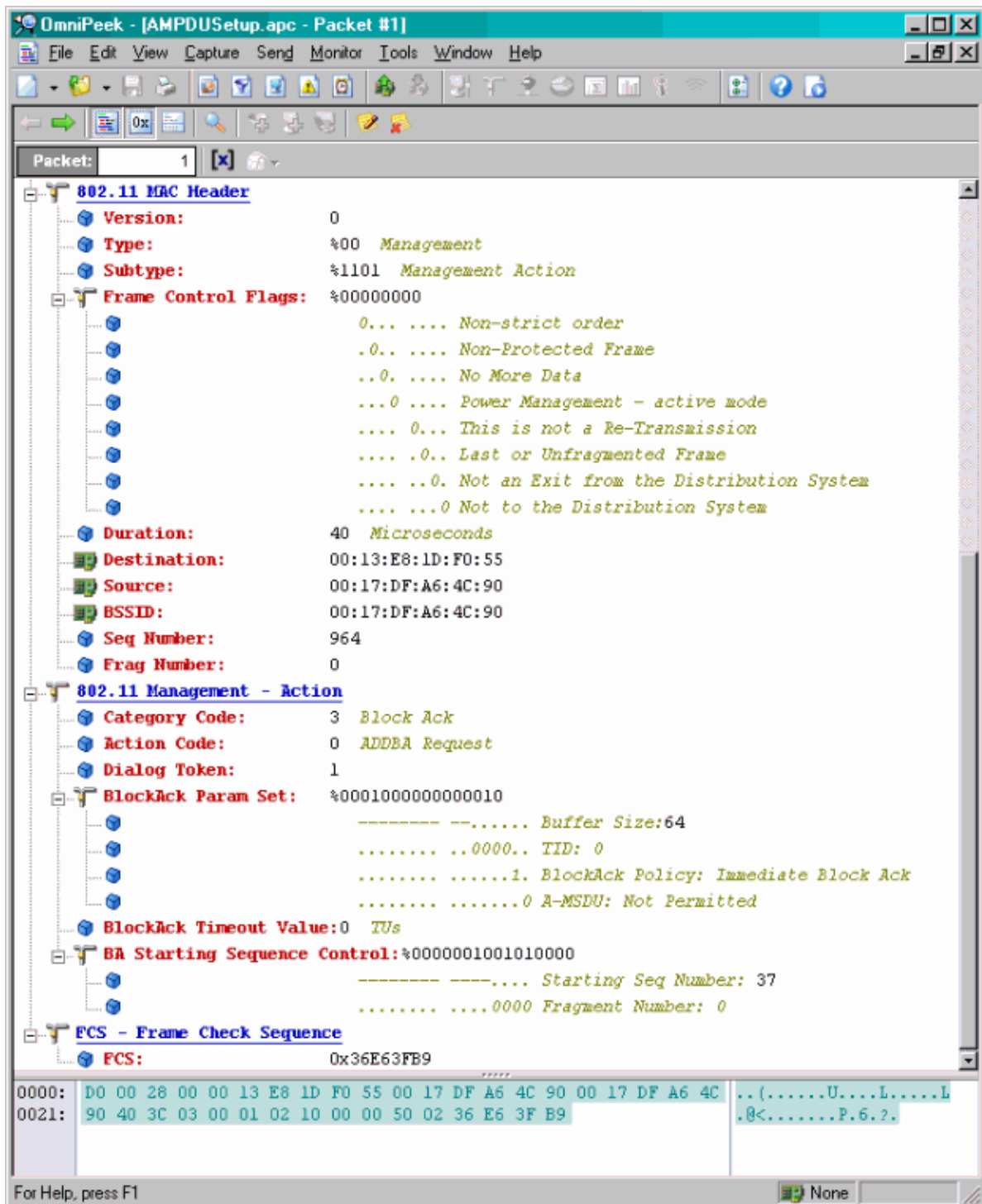


- ADDBA Add Block Acknowledgement
- ADDBA Request Contains identifier, Block Ack Policy, Buffer Size, etc.
- ADDBA Response Can change policy and buffer size.

### A-MPDU Setup

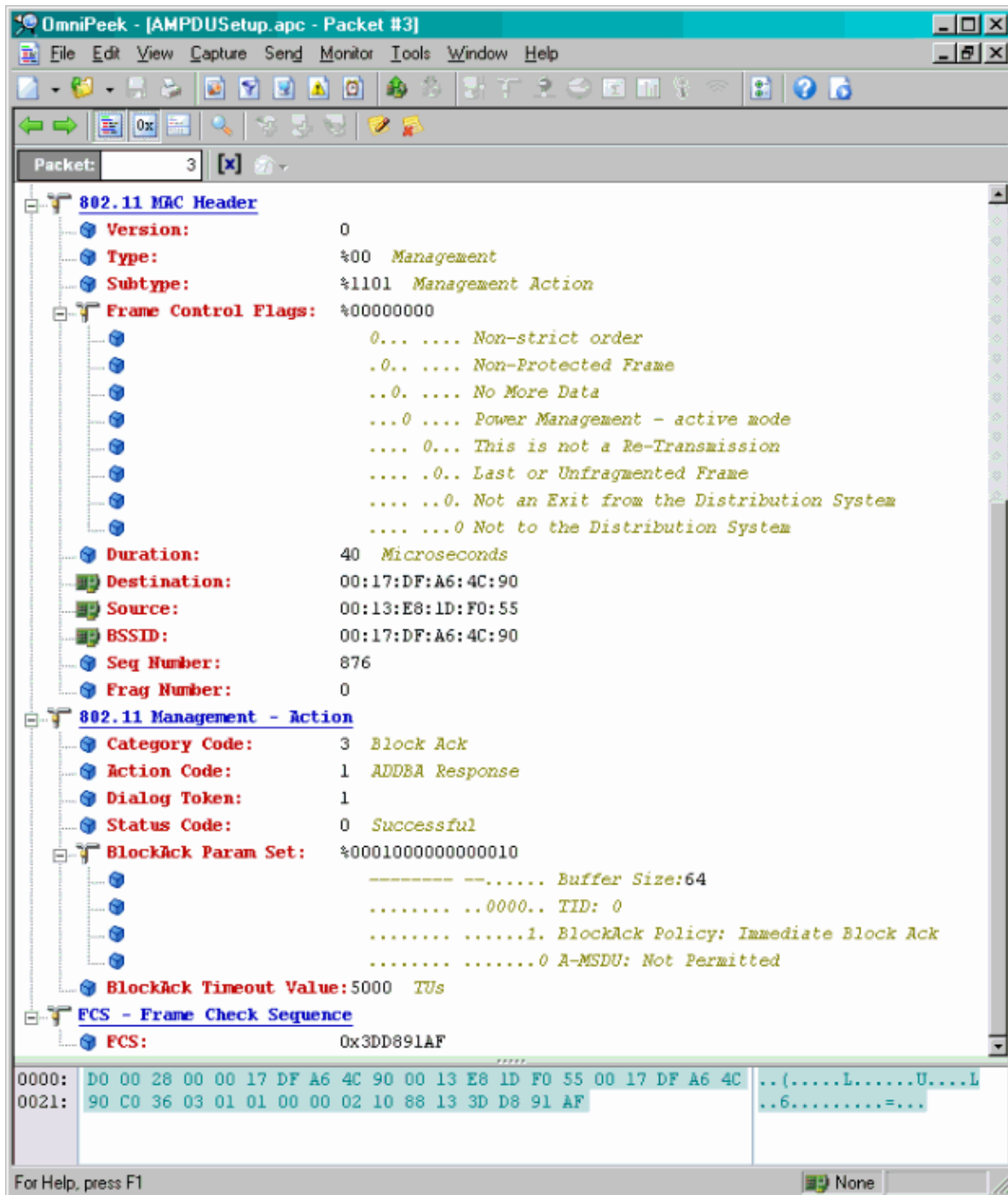
- ADDBA Request
- AP1250 uses a timeout of zero to indicate no timeout.





## 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.

Packet	Source	Destination	SSID	Flags	Channel	Signal	Data Rate	Size	Rate vs. Time	Protocol
1	00:13:8E:06:19:77	00:14:5E:07:7E:A1	00:16:01:5F:02:5E	A	1	100%	135.0	78	0.000000	TCP
2	00:13:8E:06:19:77	00:14:5E:07:7E:A1	00:16:01:5F:02:5E	A	1	100%	135.0	78	0.000005	TCP
3	00:13:8E:06:19:77	00:14:5E:07:7E:A1	00:16:01:5F:02:5E	A	1	100%	135.0	78	0.000008	TCP
4	00:13:8E:06:19:77	00:14:5E:07:7E:A1	00:16:01:5F:02:5E	A	1	100%	135.0	78	0.000011	TCP
5	00:13:8E:06:19:77	00:14:5E:07:7E:A1	00:16:01:5F:02:5E	A	1	100%	135.0	78	0.000014	TCP
6	00:13:8E:06:19:77	00:14:5E:07:7E:A1	00:16:01:5F:02:5E	A	1	100%	135.0	78	0.000017	TCP
7	00:13:8E:06:19:77	00:14:5E:07:7E:A1	00:16:01:5F:02:5E	A	1	100%	135.0	78	0.000020	TCP
8	00:16:01:5F:02:5E	00:13:8E:06:19:77		A	1	100%	35.0	33	0.000023	003.11 BA

## Capabilities Advertised in Beacons

```

HT Capability Info
  Element ID: 45 HT Capability Info
  Length: 26
  HT Capability Info: %0001100001101110
    0..... L-SIG TXOP Protection Support: Not Supported
    .0..... AP allows use of 40MHz Transmissions In Neighboring BSSs
    ..0..... Device/BSS does Not Support use of PSMP
    ...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..... Short GI for 40 MHz: Supported
    ..... ..1..... Short GI for 20 MHz: Supported
    ..... ...0.... Device is Not Able to Receive PPDUs with GF Preamble
    ..... ....11.. Spatial Multiplexing Enabled
    ..... .....1. Both 20MHz and 40MHz Operation is Supported
    ..... .....0 LDPC coding capability: Not Supported

  A-MPDU Parameters: %00011011
    xxx.... Reserved
    ...110.. Minimum MPDU Start Spacing: 8 usec
    .....11 Maximum Rx A-MPDU Size: 64K

  Supported MCS Set
    One Spatial Stream: %11111111
    MCS Index 0 Supported - BPSK. Coding Rate: 1/2
    MCS Index 1 Supported - QPSK. Coding Rate: 1/2
    MCS Index 2 Supported - QPSK. Coding Rate: 3/4
    MCS Index 3 Supported - 16 QAM. Coding Rate: 1/2
    MCS Index 4 Supported - 16 QAM. Coding Rate: 3/4
    MCS Index 5 Supported - 64 QAM. Coding Rate: 2/3
    MCS Index 6 Supported - 64 QAM. Coding Rate: 3/4
    MCS Index 7 Supported - 64 QAM. Coding Rate: 5/6

    Two Spatial Streams: %01111111
    MCS Index 8 Supported - BPSK. Coding Rate: 1/2
    MCS Index 9 Supported - QPSK. Coding Rate: 1/2
    MCS Index 10 Supported - QPSK. Coding Rate: 3/4
    MCS Index 11 Supported - 16 QAM. Coding Rate: 1/2
    MCS Index 12 Supported - 16 QAM. Coding Rate: 3/4
    MCS Index 13 Supported - 64 QAM. Coding Rate: 2/3
    MCS Index 14 Supported - 64 QAM. Coding Rate: 3/4
    MCS Index 15 Not Supported - 64 QAM. Coding Rate: 5/6

  Rx Bitmask b16-b23: %00000000
  Rx Bitmask b24-b31: %00000000
  Rx Bitmask b32-b39: %00000000
  Rx Bitmask b40-b47: %00000000
  Rx Bitmask b48-b55: %00000000
  
```

## Capabilities advertised in Beacons:



```

Element ID:      61  Additional HT Information
Length:         22
Primary Channel: 6
Srvc Int Granularity: %000 5ms
PSRP STAs Only: %0 Association Requests are Accepted Regardless of PSMP Capability
RIFS Mode:      %1 Use of RIFS Permitted
STA Channel Width: %1 Use Any Channel Width Enabled Under Supported Channel Width Set
2nd Channel Offset: %01 Above the Primary Channel
HT Info Element 2: %0000000000000100
    xxxxxxxx xxx..... Reserved
    ..... 0..... OBSS Non-HT STAs: Use of Protection for Non-HT STAs Not Needed
    ..... 0..... Transmit Burst Limit: No Limit
    ..... 1..... Non-Greenfield STAs: One or more HT STAs are Not Greenfield Capable
    ..... 00 Operating Mode: Pure HT (No Protection) - All STAs in the BSS are 20/40 MHz HT
HT Info Element 3: %0000000000000000
    xxxx..... Reserved
    .... 0... .. PCO Phase: Switch To/Continue Use 20MHz Phase
    ..... 0..... PCO Active: Not Active in the BSS
    ..... 0..... L-SIG TXOP Protection: Not Full Support
    ..... 0..... Secondary Beacon: Primary Beacon
    ..... 0..... Dual CTS Protection: Not Required
    ..... 0..... Dual Beacon: No Secondary Beacon Transmitted
    ..... ..xxxxx Reserved
Basic MCS Set
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 12 Not Supported - 16 QAM, Coding Rate: 3/4
    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 Bitmask b16-b23: %00000000
Rx Bitmask b24-b31: %00000000
Rx Bitmask b32-b39: %00000000
Rx Bitmask b40-b47: %00000000

```

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

194	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack		#	100%	6.0	14
195	00:17:DF:A6:4C:90	Ethernet Broadcast	802.11 Beacon	00:17:DF:A6:4C:90	*	100%	6.0	204
196	00:13:E8:1D:F0:55	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	100%	1.0	81
197	00:17:DF:A6:4C:90	00:13:E8:1D:F0:55	802.11 Probe Rsp	00:17:DF:A6:4C:90	*+	100%	6.0	204
198	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack		#	100%	6.0	14
199	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	100%	1.0	87
200	00:13:E8:36:19:77	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	100%	1.0	81
201	00:17:DF:A6:4C:90	00:13:E8:36:19:77	802.11 Probe Rsp	00:17:DF:A6:4C:90	*+	100%	6.0	204
202	00:17:DF:A6:4C:90	00:17:DF:A6:4C:90	802.11 Ack		#	100%	6.0	14
203	00:13:E8:36:19:77	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	100%	1.0	74
204	00:13:E8:36:19:77	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	100%	1.0	81
205	00:17:DF:A6:4C:90	00:13:E8:36:19:77	802.11 Probe Rsp	00:17: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 Req	Ethernet Broadcast	*	52%	1.0	55
208	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	97%	1.0	55
209	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	100%	1.0	87
210	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Req	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 Req	Ethernet Broadcast	*	95%	1.0	55
213	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	100%	1.0	87
214	00:13:CE:89:DC:A2	Ethernet Broadcast	802.11 Probe Req	Ethernet Broadcast	*	100%	1.0	55
215	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Auth	00:17:DF:A6:4C:90	*	100%	36.0	34
216	00:17:DF:A6:4C:90	00:13:E8:1D:F0:55	802.11 Ack		#	100%	36.0	14
217	00:17:DF:A6:4C:90	00:13:E8:1D:F0:55	802.11 Auth	00:17:DF:A6:4C:90	*	100%	36.0	34
218	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack		#	100%	36.0	14
219	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Assoc Req	00:17:DF:A6:4C:90	*	100%	36.0	134
220	00:17:DF:A6:4C:90	00:13:E8:1D:F0:55	802.11 Ack		#	100%	36.0	14
221	00:17:DF:A6:4C:90	00:13:E8:1D:F0:55	802.11 Assoc Rsp	00:17:DF:A6:4C:90	*	100%	130.0	180
222	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack		#	100%	36.0	14
223	192.168.170.89	224.0.0.1	IGMP	00:17:DF:A6:4C:90		100%	130.0	84
224	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack		#	100%	36.0	14
225	192.168.170.89	224.0.0.1	IGMP	00:17:DF:A6:4C:90	+	100%	130.0	84
226	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack		#	100%	36.0	14
227	00:17:DF:A6:4C:90	00:13:E8:1D:F0:55	WLCPP	00:17:DF:A6:4C:90		100%	130.0	92
228	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack		#	100%	36.0	14
229	00:17:DF:A6:4C:90	00:13:E8:1D:F0:55	802.11 Action	00:17:DF:A6:4C:90	*	100%	130.0	37
230	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Ack		#	100%	36.0	14
231	00:13:E8:1D:F0:55	00:17:DF:A6:4C:90	802.11 Action	00:17:DF:A6:4C:90	*	100%	36.0	37
232	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

The image shows a Wireshark capture of an 802.11 Beacon frame. The 'HT Capability Info' field is expanded, showing various HT capabilities. The 'A-MPDU Parameters' sub-field is highlighted with a red arrow pointing to the text 'A-MPDU enabled and seen in the beacon'. Other sub-fields include 'HT Capabilities Info' and 'Supported MCS Set'.

Element ID	Length	Value
45	26 (04)	HT Capability Info (03)
00000000100110	(03-04)	HT Capabilities Info
0		Short GI for 40 MHz: Supported
1		Short GI for 20 MHz: Supported
2		Device is Not Able to Receive STBC with OFDM
3		Spatial Multiplexing Enabled
4		Both 40MHz and 20MHz Operation is Supported
5		LDPC coding capability: Not Supported
6		A-MPDU Parameters
0		Reserved (07 Sub field)
1		Minimum MPDU Start Spacing (7 use) (07 Sub field)
2		Maximum Tx A-MPDU Size (07 Sub field)

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

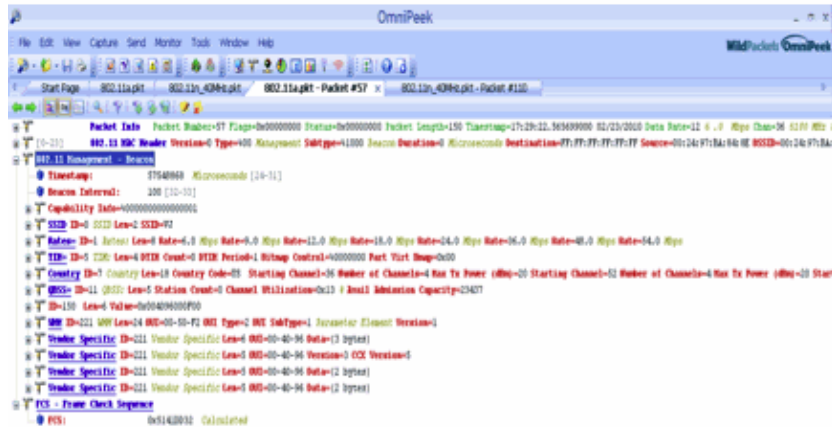








# 802.11A Beacon frame



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