

Troubleshoot 11n Speeds

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Contents

Introduction

Prerequisites

- Requirements

- Components Used

- Conventions

Background Information

Troubleshoot the Controller for 11n Speeds

- How to Calculate Throughput via iPerf

- Capabilities Advertised in Beacons

Related Information

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

Test Bed for 11n throughput:

http://www.cisco.com/en/US/prod/wireless/ideas_in_motion.html

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.mcalester.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:

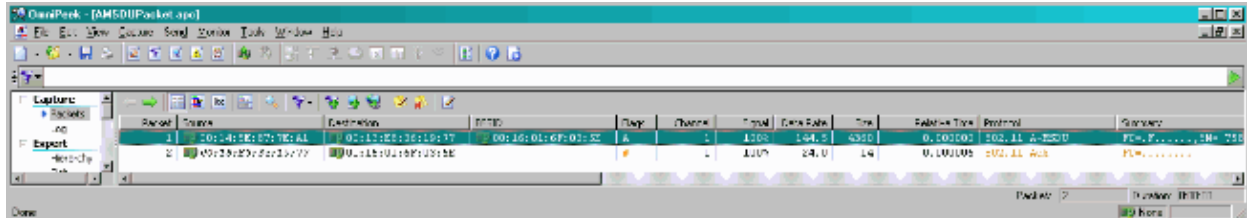
```
Iperf s -u l 56k
```

Run this command on the client side:

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

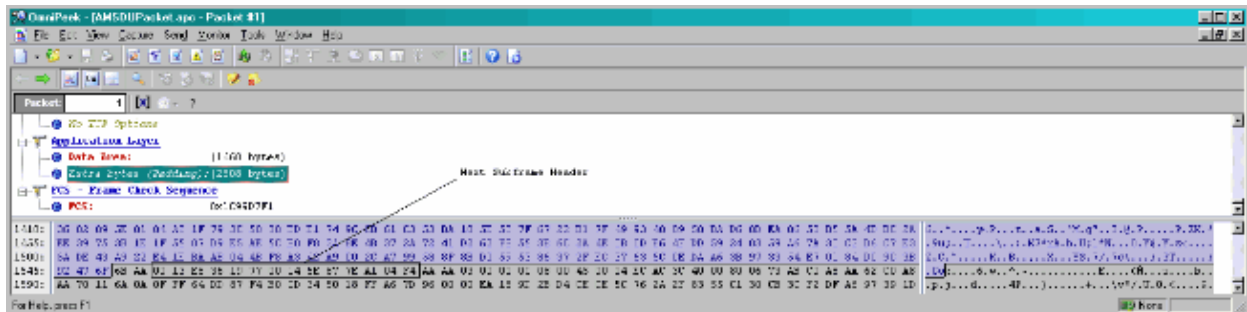
This is an example of Omnipcap captures to analyze **Aggregate MAC service data unit**:

A-MSDU trace shows one packet

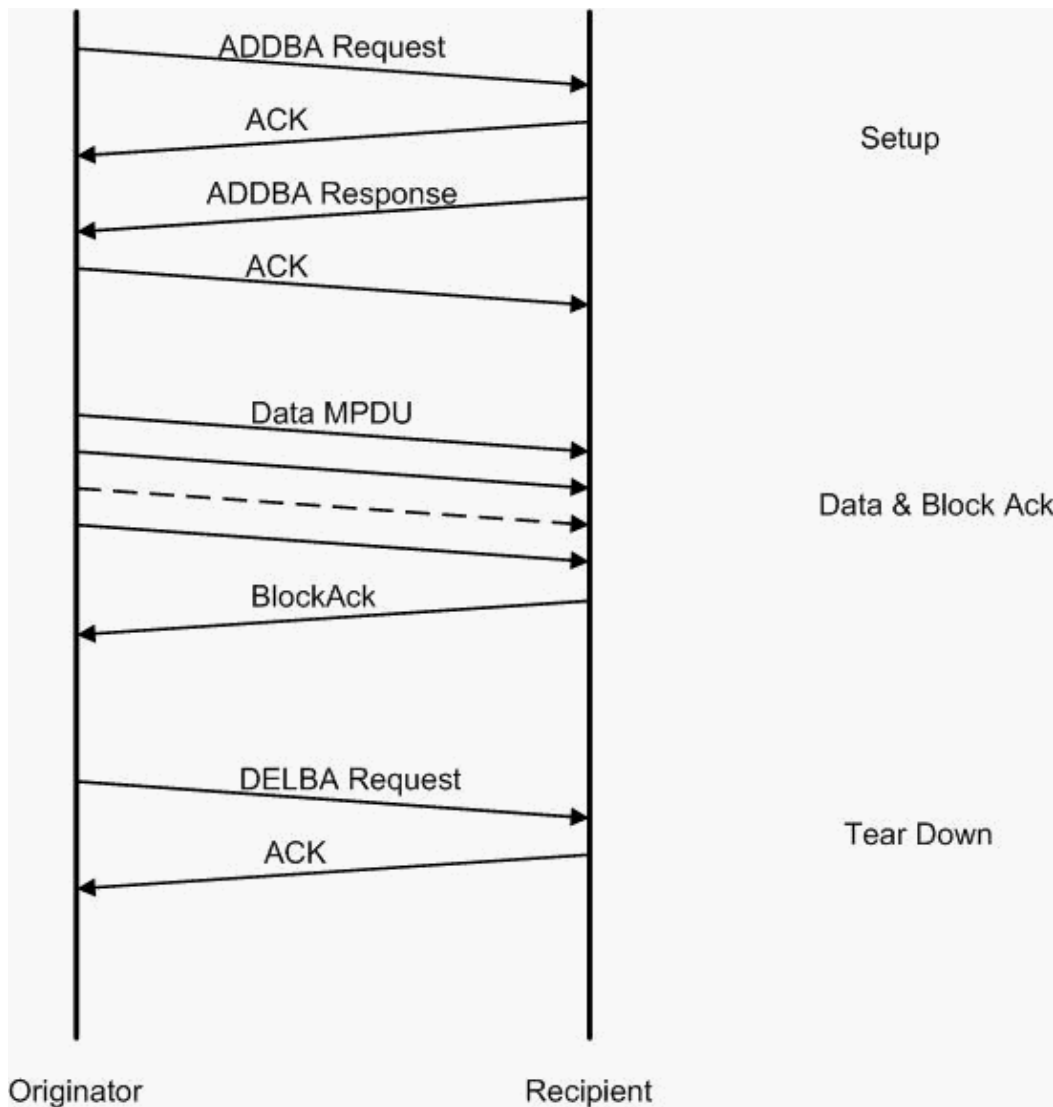


- Only the first sub frame is shown.
- Need to inspect hex dump to see additional sub frames.

A-MSDU next Sub frame shown appended

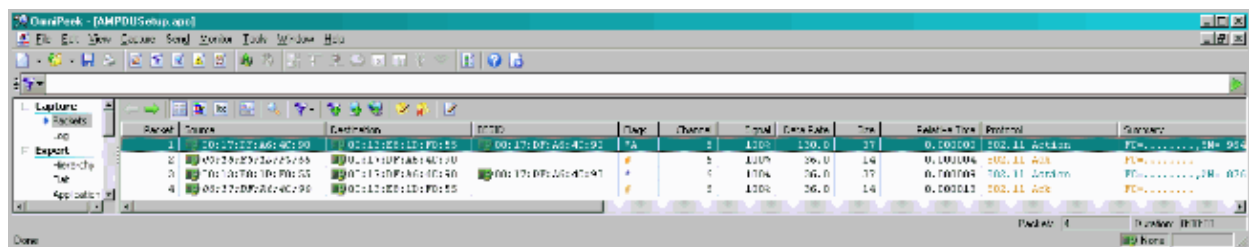


- An A-MPDU is a structure that contains multiple MPDUs, transported as a single PSDU by the PHY.
- Indication that packet is Data A-MPDU in Physical layer convergence procedure (PLCP).



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

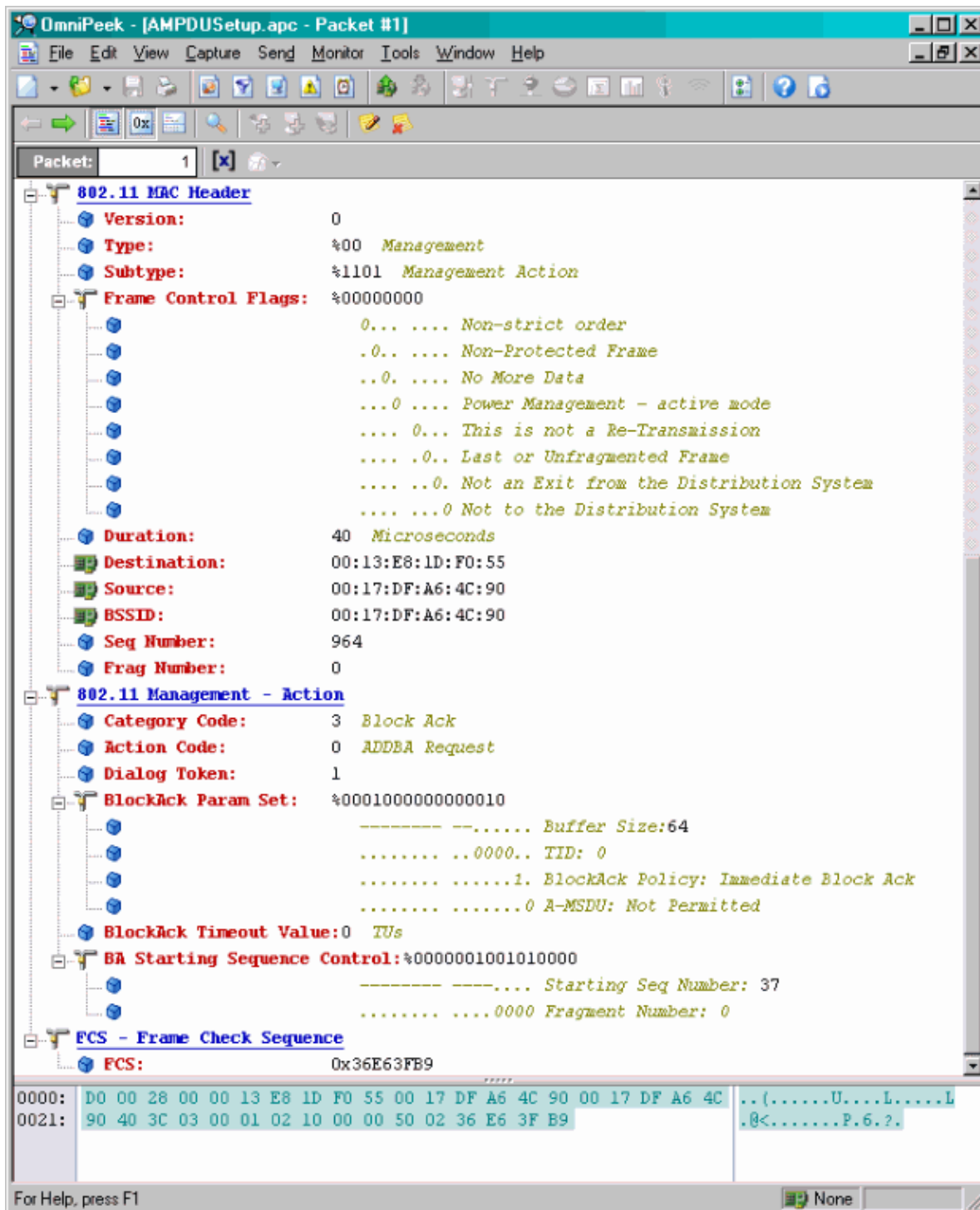
A-MPDU Setup



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

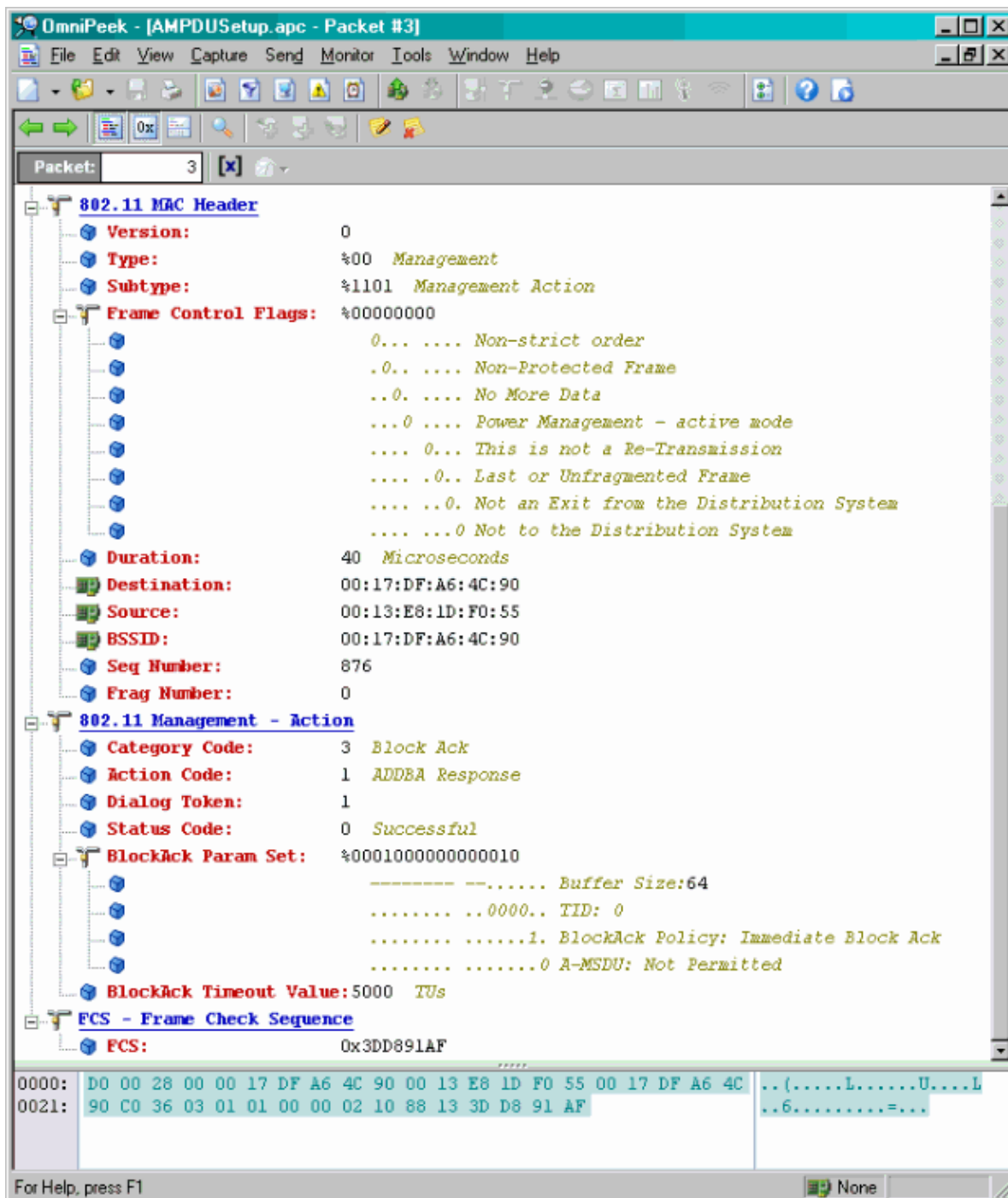
A-MPDU Setup

- 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	IP	MAC	Frame	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%	130.0	75	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%	130.0	75	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%	130.0	75	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%	130.0	75	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%	130.0	75	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%	130.0	75	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%	130.0	75	0.000020	TCP	
8	00:16:01:5F:02:5E	00:13:8E:06:19:77		A	1	100%	30.0	35	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 PPDU 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: 4000 5ms
PSRP STAs Only: 40 Association Requests are Accepted Regardless of PSMP Capability
RIFS Mode: 41 Use of RIFS Permitted
STA Channel Width: 41 Use Any Channel Width Enabled Under Supported Channel Width Set
2nd Channel Offset: 401 Above the Primary Channel
HT Info Element 2: 400000000000000100
    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: 400000000000000000
    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
    ..... ..xxxxxx Reserved
Basic MCS Set
One Spatial Stream: 400000000
    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: 400000000
    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: 400000000
Rx Bitmask b24-b31: 400000000
Rx Bitmask b32-b39: 400000000
Rx Bitmask b40-b47: 400000000

```

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

