

# Advanced RF Troubleshooting

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# Agenda



- **RF basics**
- **Tools of the trade**
- **Spectrum Analysis**
- **WiFi heatmap and site survey**
- **Client NIC**
- **Performance testing**
- **Packet captures**
- **advanced CLI examples**
- **Aruba Tools**

# Back to Basics



# Essential Elements of Healthy RF



Signal Strength

Low Interference

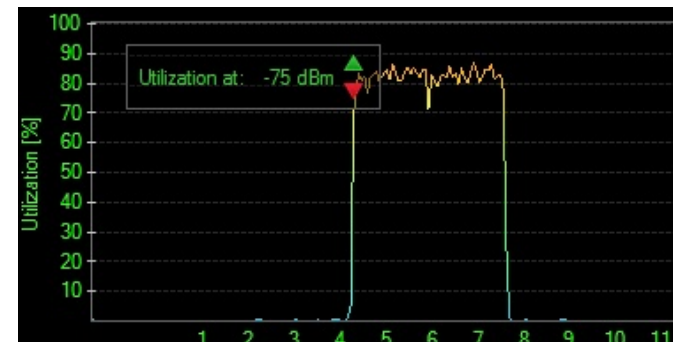


Client NIC



Good Noise Floor

Channel Utilization





# What Affects Signal Strength?



- **AP Characteristics**

- Number and type of Radios (a/b/g/n)
- Max Tx Power
- Receive Sensitivity
- Number of Spatial Streams
- Antenna – Internal/External
- Antenna Pattern
- Number of clients supported

**APs are not created equal**  
**Choose the right AP for the occasion**

# What Affects Signal Strength?

## AP Radiated Power (EIRP)

= Radio Transmit Power (dBm)

+ Transmit Antenna Gain (dBi)

Antenna is **PASSIVE** – Does Not **ADD** energy  
Higher Gain just means energy more focused  
**Not always** a good thing

- AP Regulatory Domain
- Country Code
- Radio Band (2.4GHz/5GHz)
- Channel (different channel has different allowed Max EIRP)

# What Affects Signal Strength?



- **Attenuation (Path Loss)**
  - Distance from AP/Line-of-sight
  - Building materials (walls, windows, partitions)
  - Furniture
  - People

**Client Received Power (dBm)**

= Radiated Power/EIRP (dBm)

- Path Loss (dB)

+ Receiver Antenna Gain (dBi)

# Attenuation of Common Building Material

	2.4GHz	5.0GHz
Fabric, blinds, ceiling tiles	~1dB	~1.5dB
Interior drywall	3-4 dB	3-5 dB
Cubicle wall	2-5 dB	4-9 dB
Wood door (Hollow – Solid)	3-4 dB	6-7 dB
Brick/Concrete wall	6-18 dB	10-30 dB
Glass/Window (not tinted)	2-3 dB	6-8 dB
Double-pane coated glass	13 dB	20 dB
Steel/Fire exit door	13-19 dB	25-32 dB

- **Noise**

- **Random** 'background' that has got mixed up with your signal. Fairly Static

- **Interference**

- **Additional** signals are added to the one you want. Can be intermittent or persistent.

## 802.11 Source

- Your APs (over-designed)
- Somebody else's APs (neighbor)
- Municipal Wi-Fi Network
- iPhone Personal Hotspots
- Neighboring clients
- APs
- Faulty Clients

## Non 802.11 Source

- Blue-tooth (headset, keyboards, mouse, speaker)
- Microwave Oven
- Cordless phones, mouse
- Very strong out-of-band source(GSM tower/DAS)
- Baby monitor
- WiMax (2.5GHz)
- ZigBee (802.15.4)
- Video or security cameras
- Faulty anything

# Signal to Noise Ratio (SNR)



**SNR is not actually a ratio**

**SNR = Signal (Received Power) – Noise floor**

**Assume:**

**Signal received is -65 dB; Noise floor is -85 dB**

**SNR = -65 – (-85) = 20**

**A minimum of 25-30 is essential to decode high 11n data rate**

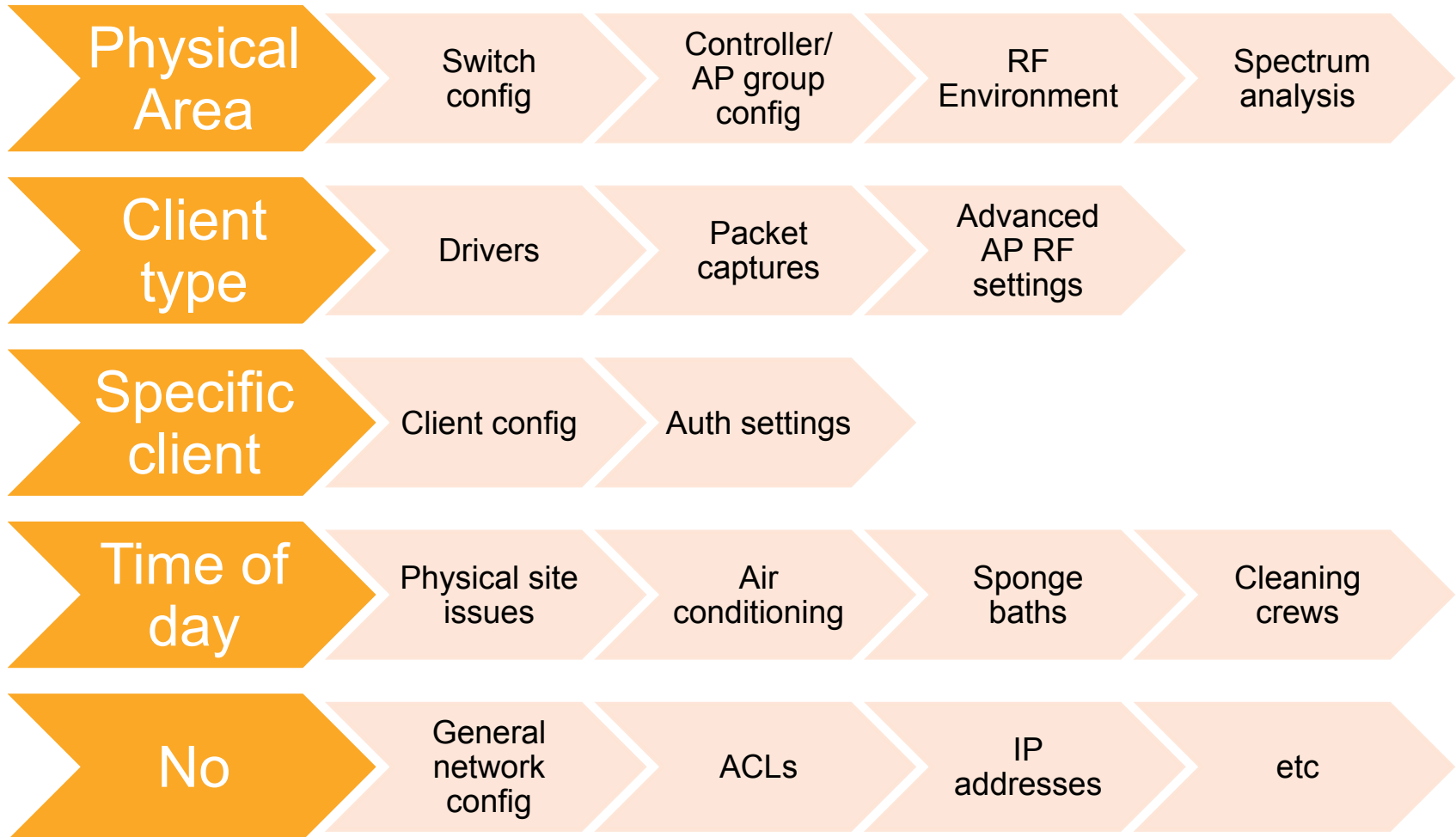


**802.11n data rates are dependent not only on SNR, but on error rates and the ability to support multiple spatial streams in the environment**

**A rough guideline is that a minimum SNR of 30 dB is necessary to demodulate higher 802.11n data rates and 35 dB required for higher 11ac rates**

## Questions to Ask

# Is the problem localized?



## Tools of the Trade

# ACE's first 7 questions



- **"show ap active" – Check power settings**
- **"show ap association client-mac xx:xx:xx" - SNR, retry rate, and noise floor in the client's area.**
- **"show ap arm history ap-name xxxx" - how many channel/power changes have been made over the last 24 hours. Any I or E flags?**
- **"show log all | include bootstrap" – APs rebooting?.**
- **"show user-table" – View mix of clients in the network. Any flags? WMM, 802.11K, band-steerable?**
- **"show user-table | include iPhone" – Large number? Turn off max-tx-fails.**
- **"tar crash" – Investigate any crashes**

- **Network Management/Monitoring Platform**
- **Spectrum Analysis**
- **Site-Survey**
- **Understanding Client NIC**
- **Performance Testing**
- **Packet Capture**
- **Command Line Interface (CLI)**
- **Aruba TAC**



# AirWave Overview (Show user-table | include iPhone)



Home Groups APs/Devices Clients Reports System Device Setup AMP Setup RAPIDS VisualRF  
Overview RF Performance Search Documentation License User Info

Welcome to AMP™ 7.6.3  
demo.airwave.com - Aruba Networks

Clients By Device Type



Windows 7	31.4%
iPhone	17.7%
Other	16.2%
OS X	12.4%
Android	6.2%
iPad	5.3%
Windows	4.6%
Aruba	2.4%
AppleTV	2.2%
Apple	1.5%

Clients By Device OS



Windows 7	31.9%
iOS	23.9%
Unknown	19.5%
Mac OS X	12.2%
Android	6.2%
Windows	4.4%
Windows XP	1.3%
Linux	0.4%
Windows Phone 7	0.2%

Monitoring Status



Up	69.3%
Down	30.7%

↓ 175 of 570 devices are Down

Configuration Compliance



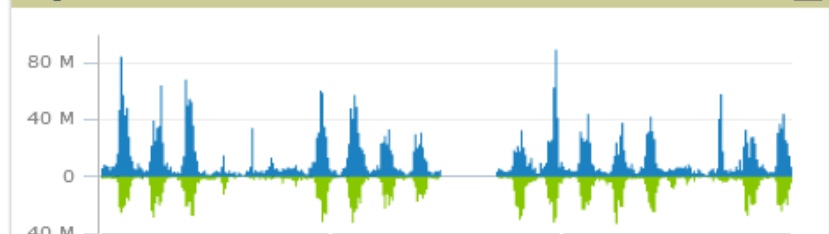
Mismatched	76.5%
Good	14.7%
Unknown	6.3%
Audit Disabled	2.5%

≠ 436 of 570 devices are Mismatched

Clients Last 3 weeks



Usage Last 3 weeks










# AP List (Show ap active)

Home	Groups	APs/Devices	Clients	Reports	System	Device Setup	AMP Setup	RAPIDS	VisualRF
List	New	Up	Down	Mismatched	Ignored				

 [Modify Devices](#)

1-55 ▼ of 55 APs/Devices Page 1 ▼ of 1 [Reset filters](#) [Choose columns](#) [Export CSV](#)

	Device	1st Radio ▼	1st Radio Ch. ▼	1st Radio TX Power ▼	2nd Radio ▲ ▼	2nd Radio TX Power
	dlogan-ap65	802.11bg	11	22 dBm	802.11a	149
	1344-2-72c (1344-1-al1.arubanetworks.com)	802.11bgn	11	12 dBm	802.11an	165
	1344-2-140C	802.11bgn	6	12 dBm	802.11an	36
	1344-2-130C	802.11bgn	1	12 dBm	802.11an	165
	1344-1-AL21 (1344-1-al21.arubanetworks.com)	802.11bgn	1	12 dBm	802.11an	149
	1344-1-AL33 (1344-1-al33.arubanetworks.com)	802.11bgn	1	12 dBm	802.11an	36
	1344-1-AL3 (1344-1-al3.arubanetworks.com)	802.11bgn	-	-	802.11an	-
	1344-2-205C	802.11bgn	6	12 dBm	802.11an	165
	1344-2-184C	802.11bgn	11	12 dBm	802.11an	165
	1344-1-AL10 (1344-1-al10.arubanetworks.com)	802.11bgn	11	12 dBm	802.11an	157

- TX Power settings
- Channels
- AP types
- Up/Down status
- Firmware

# AirWave RF Performance Dashboard



New Devices: 11 | Wired: 38 | Wireless: 361 | Down: 166 | Rogue: 300 | Clients: 413 | Alerts: 79

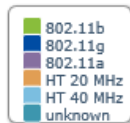
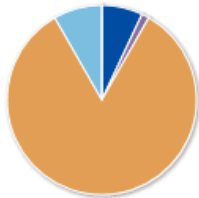
205c

Home | Groups | APs/Devices | Clients | Reports | System | Device Setup | AMP Setup | RAPIDS | VisualRF

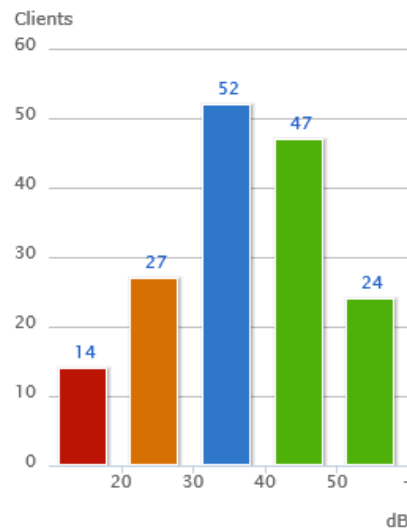
Overview | RF Performance | Search | Documentation | License | User Info

Clients | Folder ▾ Top

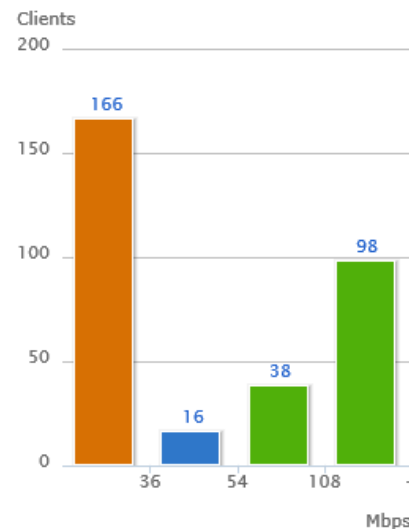
Summary



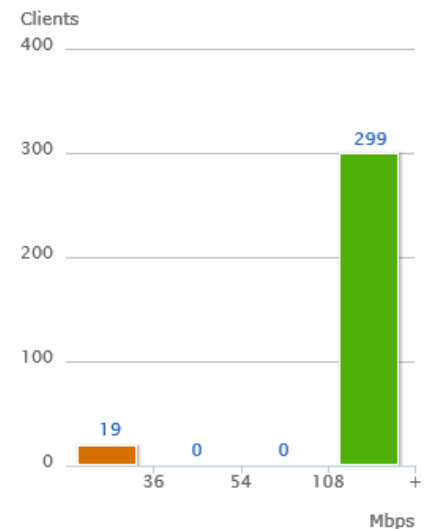
SNR



Speed



Goodput



Clients ▾	2.4 GHz	5 GHz
802.11a	-	5
802.11b	0	-
802.11g	27	-
HT 20 MHz	133	190
HT 40 MHz	0	32
Total	160	227

Lowest SNR Clients

Client ▾	SNR (dB)
64:20:0C:69:BE:79	15
70:56:81:EC:F8:6B	15
ARUBANETWORKS\ccourtney	12
rmarayanan	6
shirinaz@arubanetworks.com	13

More

Lowest Speed Clients

Client ▾	Speed (Mbps)
20:16:D8:33:E2:5A	0
ARUBANETWORKS\kmeredith	0
ARUBANETWORKS\sdamodaran	0
kenc	0
mmudaliar@arubanetworks.com	0

More

Lowest Goodput Clients

Client ▾	Goodput (Mbps)
78:CA:39:DE:3A:EE	0
ARUBANETWORKS\apingale	0
svitamanti@arubanetworks.com	0
vnambiar	0
wdai	0

More

# AP Monitoring (Show User Table)



Home Groups **APs/Devices** Clients Reports System Device Setup AMP Setup RAPIDS VisualRF

List Monitor Manage Audit Compliance New Up Down Mismatched Ignored

## Device Info

Status: Up (OK)  
Configuration: **Mismatched** (The settings on the device do not match the desired configuration policy.)  
Controller: [ethersphere-lms3](#) Aruba AP Group: [Corp1344-AM](#) Upstream Device: [1344-1-AP-alpha-sw1](#) Upstream Port: [gigabitethernet0/0/15](#)  
Type: Aruba AP 135 Remote Device: No Last Contacted: 2/28/2012 9:43 AM Uptime: 2 days 8 hrs 12 mins  
LAN MAC Address: D8:C7:C8:C0:C7:BC Serial: AX0025566  
IP Address: 10.6.66.71 Clients: 5 Usage: 19.06 Kbps  
Quick Links:    
Notes:

## Radios

Index ▲	Name	MAC Address	Clients	Usage (Kbps)	Channel	Tx Power	Antenna Type	Role	Active SSIDs
1	802.11bgn	D8:C7:C8:8C:7B:C0	0	0.00	1	0 dBm	Internal	AirMonitor and Access	-
2	802.11an	D8:C7:C8:8C:7B:D0	4	19.06	149	12 dBm	Internal	Access	ARUBA-VISITOR, et...

## Wired Interfaces

Name ▲	MAC Address	Clients	Admin Status	Operational Status	Type	Duplex	Aruba Port Mode	Input Capacity	Output Capacity
Enet0	D8:C7:C8:C0:C7:BC	0	Up	Up	gigabitEthernet	Full	N/A	1000 Mbps	1000 Mbps
Enet1	D8:C7:C8:C0:C7:BD	0	Up	Down	gigabitEthernet	Half	Active Standby	10 Mbps	10 Mbps

## View Device Events



# Radio Details



New Devices: 11 Wired: 38 Wireless: 361 Down: 166 Rogue: 300 Clients: 417 Alerts: 79

205c

Home Groups APs/Devices Clients Reports System Device Setup AMP Setup RAPIDS VisualRF

List Monitor Manage Audit Compliance New Up Down Mismatched Ignored

## AP Monitoring | Radio Statistics

Monitoring 802.11bgn radio for AP 1344-2-205C

Run a command...

### Issues Summary

**Issue:** Interfering Devices Detected:  
**Description:** Cordless Base Freq Hopper, Video Device Fixed Freq

### 802.11 Radio Counters Summary (frames/sec)

	Current	Last Hour	Last Day	Last Week
Unacked	0	1	59	32
Retries	0	0	4	3
Failures	0	1	5	4
Dup Frames	0	0	0	0
FCS Errors	7	14	58	172

Clients Usage Cha... Noise Power MAC... 802.... Utili... Goo...  
Utilization on 1344-2-205C 3 days ago to 1 hour ago



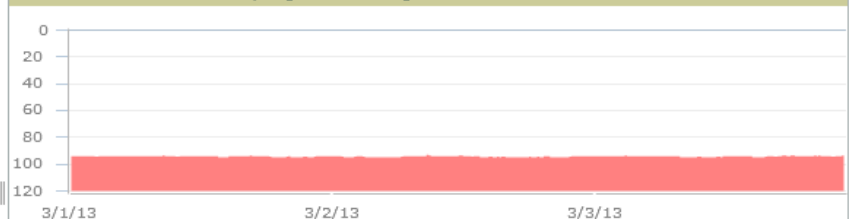
Show All

- ☒ Busy
- ☒ Interference
- ☒ Receiving
- ☒ Transmitting

Maximum Average

50.4 % 36.6 %  
6.3 % 0 %  
48.8 % 35 %  
2.4 % 1.2 %

Clients Usage Cha... Noise Power MAC... 802.... Utili... Goo...  
Noise on 1344-2-205C 3 days ago to 1 hour ago



Show All

- ☒ Noise

Maximum Average

-93 dBm -94.5 dBm



1 year ago

now



# Radio Details Continued (Show AP ARM history)



## ARM Events

1-5 ▼ of 13 ARM Events Page 1 ▼ of 3 > > | [Reset filters](#) [Choose columns](#) [Export CSV](#)

Time ▼	Trap Type ▼	Previous Tx Power ▼	Current Tx Power ▼	Previous Channel ▼	Current Channel ▼	Previous Secondary Channel ▼	Current Secondary Channel ▼	Change Reason ▼
3/4/2013 7:31 PM	Channel Change	-	-	1	6	None	None	Noise Threshold
3/4/2013 7:26 PM	Channel Change	-	-	6	1	None	None	Interference
3/4/2013 12:32 PM	Channel Change	-	-	1	6	None	None	Interference
3/4/2013 9:53 AM	Channel Change	-	-	6	1	None	None	Interference
3/4/2013 7:15 AM	Channel Change	-	-	11	6	None	None	Interference

1-5 ▼ of 13 ARM Events Page 1 ▼ of 3 > > | [Reset filters](#)

## Detected Interfering Devices

1-5 ▼ of 5 Interfering Devices Page 1 ▼ of 1 [Choose columns](#) [Export CSV](#)

Device Type	Last Seen ▼	Start Channel	End Channel	Signal	Duty Cycle (%)
Video Device Fixed Freq	3/4/2013 7:33 PM	1	4	-46	99
Cordless Base Freq Hopper	3/4/2013 7:33 PM	1	14	-75	5
XBox Freq Hopper	3/4/2013 6:29 PM	1	14	-82	5
Microwave	3/4/2013 3:19 PM	4	9	-61	50
Bluetooth	3/4/2013 12:53 PM	1	14	-69	5

1-5 ▼ of 5 Interfering Devices Page 1 ▼ of 1

## Active BSSIDs

BSSID ▲	SSID	Controller Web UI
D8:C7:C8:88:D0:C0	ethersphere-wpa2	<a href="#">Dashboard &gt; Access Point</a>
D8:C7:C8:88:D0:C2	ARUBA-VISITOR	<a href="#">Dashboard &gt; Access Point</a>



# Client Diagnostics




New Devices: 35 Up: 560 Wired: 34 Down: 194 Wired: 5 Rogue: 1 Clients: 210 Alerts: 23


Log out peter


205c


[Home](#) [Groups](#) [APs/Devices](#) **Clients** [Reports](#) [System](#) [Device Setup](#) [AMP Setup](#) [RAPIDS](#) [VisualRF](#)

[Connected](#) [All](#) [Rogue Clients](#) [Guest Users](#) [Client Detail](#) [Diagnostics](#) [VPN Sessions](#) [VPN Users](#) [Tags](#)

Client  
ARUBANETWORKS\jturner  
  
good

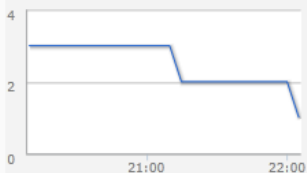
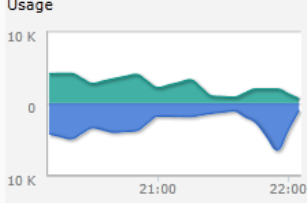
Network  
ethersphere-wpa2  
  
good  
1 possible issue

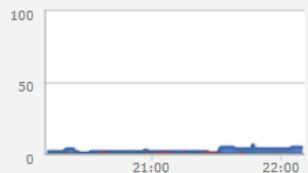
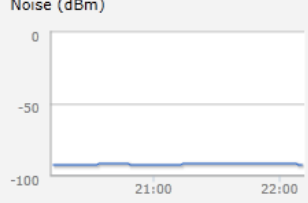
AP  
1344-2-92C  
  
good

Controller  
ethersphere-lms3  
  
good

**Radio Info**  
AP: 1344-2-92C  
AP Type: Aruba AP 135  
Last Contacted: 2/27/12 10:09 PM  
Radio: 802.11an  
Band: 5 GHz  
Channel: 165  
TX Power: 16 dBm  
Antenna:  
MAC Address: D8:C7:C8:83:A3:70  
Notes:  
Floor Plan: [Sunnyvale -> 1344 Crossman -> HQ Floor2](#)

**Performance**  
Clients: 1  
Noise: -93 dBm  
Total Usage: 1.59 Kbps  
Usage To Clients: 616 bps  
Usage From Clients: 976 bps  
Uptime: 100%

**Trends**  
**Clients**  
  
**Usage**  


**Channel Utilization**  
  
**Noise (dBm)**  


**Quality**  
Overall rating: good

**Possible Issues (Network)**  

Indicator	Value	Ideal
<a href="#">Too Many Down Neighbor APs</a>	21	0

**Additional Indicators (Network)**  

Indicator	Value	Ideal
<a href="#">Channel Utilization</a>	5.51%	≤ 60%
<a href="#">Noise floor</a>	-93 dBm	≤ -90 dBm
<a href="#">Avg. SNR</a>	40.02 dB	≥ 35 dB
<a href="#">Avg Frame errors/sec</a>	7 frames/s	≤ 250 frames/s

# ArubaOS Dashboard - Performance



All Radios 5 GHz 2.4 GHz

## Clients

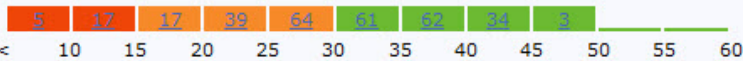
Total: [396](#)

Client PHY

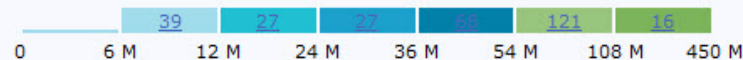
a [10](#) a HT [386](#) a HT 40MHz 0  
g 0 g HT 0 g HT 40MHz 0  
b 0

## SNR

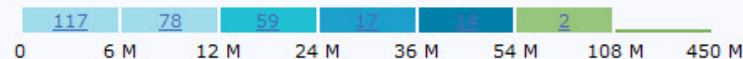
SNR (dB)



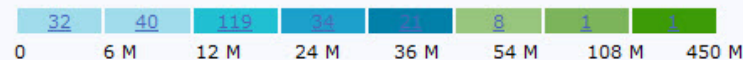
Speed (bps)



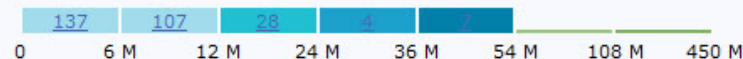
Goodput (bps)



To Client (bps)



From Client (bps)



## APs

Overall Goodput (bps): [32.2 M](#)

Goodput (bps):

37.5 M

Frames dropped:

< 1% (610/128 K)

Frames types:

Frame rates:

To Client

From Client

22.6 M

N/A

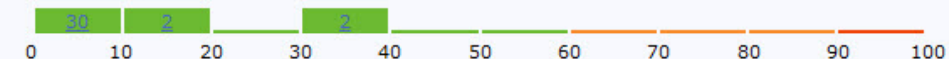
## Noise Floor

Noise Floor (dBm)

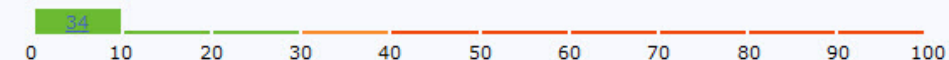


## Channel Utilization

Channel Busy (%)



Interference (%)



## Interference

# AOS RF Dashboard – Security



MOBILITY CONTROLLER | [Monitoring > Security Summary](#)

[Dashboard](#) | [Monitoring](#) | [Configuration](#) | [Diagnostics](#) | [Maintenance](#) | [Plan](#)

Last updated: 08:05:23 pm | ? | [Logout admin](#)

[Performance](#)  
[Usage](#)  
[Security](#)  
[Potential Issues](#)  
[WLANs](#)  
[Access Points](#)  
[Clients](#)

### Discovered APs & Clients

SummaryDetails

AP Classification	Active APs	Associated Clients
Rogue	0	0
Suspected Rogue	<a href="#">9</a>	<a href="#">4</a>
Interfering	<a href="#">35</a>	<a href="#">67</a>
Neighbor	0	0
Valid	<a href="#">192</a>	<a href="#">57</a>
Manually Contained	0	0
Total	<a href="#">236</a>	<a href="#">128</a>

### Events

		Last 4 hrs	Last 24 hrs	All
Containment	Infrastructure	0	0	0
	Client	0	0	0
	Total	0	0	0
Detection	Low	0	0	0
	Med	<a href="#">28</a>	<a href="#">72</a>	<a href="#">669</a>
	High	<a href="#">34</a>	<a href="#">64</a>	<a href="#">334</a>
	Total	<a href="#">62</a>	<a href="#">136</a>	<a href="#">1,003</a>

Discovered Access Points: Active = Yes, AP Classification = Rogue

[Locate](#) [Contain Manually](#) [Reclassify](#) [Delete](#) [Export](#)

BSSID	Band	PHY Type	SSID	Channel	Clients	AP Classification	Encryption	Marked to		
						Rogue		Contain		

- No matches found -

# AOS RF Dashboard – Potential Issues



ARUBA networks

MOBILITY CONTROLLER | [Monitoring > Potential Issues](#)

Dashboard

Monitoring

Configuration

Diagnostics

Maintenance

Plan

Last updated: 08:05:56 pm

Performance

Usage

Security

> **Potential Issues**

WLANs

Access Points

Clients

**Potential Issues**

Clients with potential issues: [11 out of 21](#)

	2.4 GHz	5 GHz
Low SNR	0	<a href="#">1</a>
Low speed	0	<a href="#">1</a>
Low goodput	<a href="#">5</a>	<a href="#">6</a>

Radios with potential issues: [25 out of 198](#)

	2.4 GHz	5 GHz
High noise floor	0	0
Busy channel	0	0
High interference	<a href="#">12</a>	0
Low goodput	<a href="#">8</a>	<a href="#">6</a>
High client association	0	0

# AOS RF Dashboard – WLAN



MOBILITY CONTROLLER | [Monitoring > WLANs](#)

[Dashboard](#)

[Monitoring](#)

[Configuration](#)

[Diagnostics](#)

[Maintenance](#)

[Plan](#)

Last updated: 08:08:15 pm | [?](#) | [Logout admin](#)

Performance

Usage

Security

Potential Issues

[WLANs](#)

Access Points

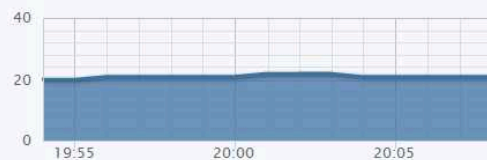
Clients

## WLANs (3)

WLAN	Clients	APs	Radios	Usage (bps)	Frames	Bytes	Frames Retried (to client)	Frames Dropped (to client)	Goodput (bps)
AMX	0	13	13	0	0	0	0%	0%	--
GLC	14	99	157	277.1 K	8.6 K	2.1 M	17% (625/3.6 K)	< 1% (18/3.6 K)	16.7 M
SANDS HOTSPOTS	7	14	22	78.4 K	896	588.2 K	67% (285/425)	5% (23/448)	3.2 M

## All WLANs (22)

Clients



■ Clients

Usage



AP Name	Band	Clients	Usage (bps)
MIC05-AP20	2.4 GHz	0	--
MIC05-AP20	5 GHz	0	0
MIC04-AP26	2.4 GHz	0	0
MIC04-AP26	5 GHz	0	0
MIC05-AP21	2.4 GHz	0	0
MIC05-AP21	5 GHz	0	0
MIC04-AP28	2.4 GHz	0	--
MIC04-AP28	5 GHz	0	0
MIC04-AP01	2.4 GHz	0	--

Client	Device Type	Client PHY
10.0.0.187	Win 7	a HT
10.0.0.64	Win 7	a HT
10.0.1.30	--	a HT
10.0.1.21	iPhone	g HT
10.0.0.84	iPhone	g HT
30:38:55:4e:4c:3b	--	g
10.165.163.44	iPad	a HT
44:d8:84:66:af:24	--	g HT

# AOS RF Dashboard – Access Points



MOBILITY CONTROLLER | [Monitoring > Radios](#)

[Dashboard](#) | [Monitoring](#) | [Configuration](#) | [Diagnostics](#) | [Maintenance](#) | [Plan](#)

Last updated: 08:08:55 pm | ? | [Logout admin](#)

Performance

Usage

Security

Potential Issues

WLANs

> [Access Points](#)

Clients

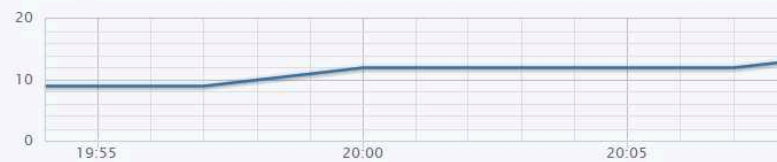
**Radios (157 of 198):** Radio Mode = Access

Prev 100 Next 100 APs Radios All Radios 5 GHz 2.4 GHz Show: Default Columns

AP Name	Band	Radio Mode	Clients	Channel	Noise Floor (dBm)	EIRP (dBm)	Channel Utilization	Frames	Bytes	Frames (to client)	Frames Retried (to client)	Frames Dropped (to client)	Frames (from client)	Frame Rates (to client)
MIC04-AP01	5 GHz	Access	0	165	-96	20		0	0	0	0%	0%	0	--
MIC04-AP02	2.4 GHz	Access	2	1	-96	15		63	4.8 K	59	0%	0%	4	
MIC04-AP02	5 GHz	Access	1	153	-94	20		452	71.4 K	223	5% (11/223)	0%	229	
MIC04-AP03	2.4 GHz	Access	0	6	-94	15		0	0	0	0%	0%	0	--
MIC04-AP03	5 GHz	Access	0	48	-92	20		0	0	0	0%	0%	0	--
MIC04-AP04	2.4 GHz	Access	0	11	-93	15		0	0	0	0%	0%	0	--
MIC04-AP04	5 GHz	Access	0	44	-94	20		0	0	0	0%	0%	0	--
MIC04-AP05	2.4 GHz	Access	0	11	-95	15		0	0	0	0%	0%	0	--
MIC04-AP05	5 GHz	Access	0	52	-95	20		0	0	0	0%	0%	0	--
MIC04-AP06	2.4 GHz	Access	0	1	-96	15		0	0	0	0%	0%	0	--

**All Radios**

2.4 GHz Clients



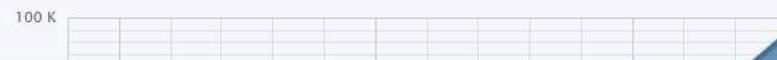
■ Clients

5 GHz Clients

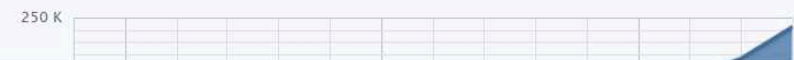


■ Clients

2.4 GHz Usage



5 GHz Usage





# AOS RF Dashboard – Clients



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Performance

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Security

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WLANs

Access Points

[Clients](#)

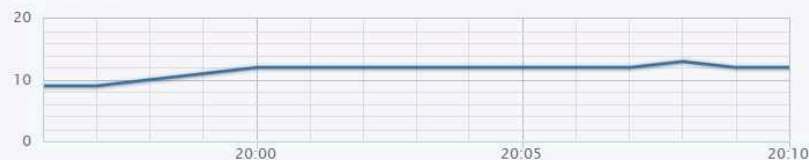
## Clients (21)

Show: Default Columns

Client	Client PHY	Device Type	Role	SNR (dB)	Speed (bps)	Goodput (bps)	Usage (bps)	Frames	Bytes	Frames Retried (to client)	Frames Dropped (to client)	WLAN
<a href="#">10.0.0.187</a>	a HT	Win 7	authenticated	41	98 M	10.2 M	6.4 K	400	48.0 K	24% (38/158)	0%	<a href="#">GLC</a>
<a href="#">10.0.0.64</a>	a HT	Win 7	authenticated	39	68 M	17.9 M	37.8 K	1.1 K	283.3 K	24% (106/439)	0%	<a href="#">GLC</a>
<a href="#">10.0.1.30</a>	a HT	--	authenticated	37	134 M	20.4 M	26.0 K	857	194.8 K	13% (51/381)	0%	<a href="#">GLC</a>
<a href="#">10.0.1.21</a>	g HT	iPhone	authenticated	42	65 M	3.8 M	34	6	256	0%	0%	<a href="#">GLC</a>
<a href="#">30:38:55:4e:4c:3b</a>	g	--	--	--	--	--	--	--	--	0%	0%	<a href="#">SANDS HOTSPOT:</a>
<a href="#">10.165.163.44</a>	a HT	iPad	MBS_GUEST	--	--	--	0	0	0	0%	0%	<a href="#">SANDS HOTSPOT:</a>
<a href="#">44:d8:84:66:af:24</a>	g HT	--	--	--	--	--	0	0	0	0%	0%	<a href="#">SANDS HOTSPOT:</a>
<a href="#">48:60:bc:bf:58:76</a>	g HT	--	--	42	--	--	0	0	0	0%	0%	<a href="#">GLC</a>
<a href="#">58:94:6b:a9:02:50</a>	a HT	--	--	34	129 M	14.3 M	20.6 K	778	154.6 K	37% (119/325)	< 1% (2/327)	<a href="#">GLC</a>
<a href="#">78:a3:e4:89:f5:1a</a>	a HT	--	--	25	65 M	--	0	0	0	0%	0%	<a href="#">GLC</a>

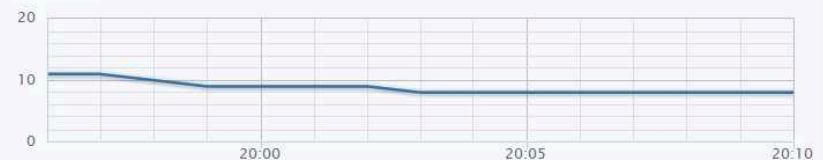
## All Clients

### 2.4 GHz Clients



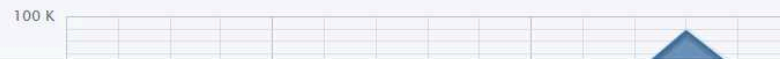
■ Clients

### 5 GHz Clients

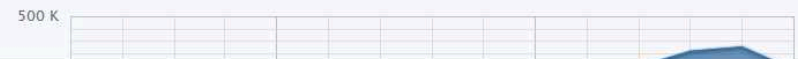


■ Clients

### 2.4 GHz Usage



### 5 GHz Usage



# Spectrum Analysis

- **Aruba AP in Spectrum Mode**
- **Aruba AP in Hybrid Spectrum Mode**
  - AP-9x/10x/13x
  - Software configurable
- **Dedicated Spectrum Analysers**
  - Fluke Networks – AirMagnet Spectrum XT
  - Metageek – Wi-Spy
  - Others
- **Airwave VisualRF**

# Wireless Tools – Spectrum Analysis



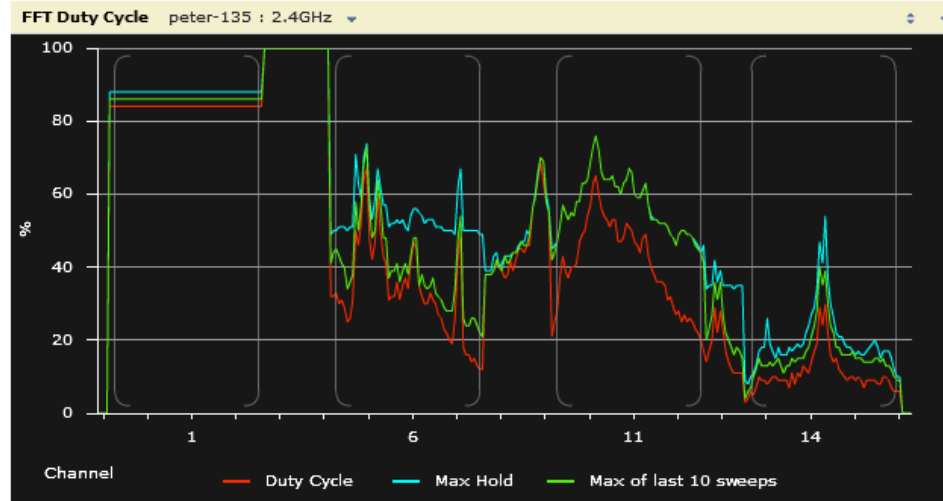
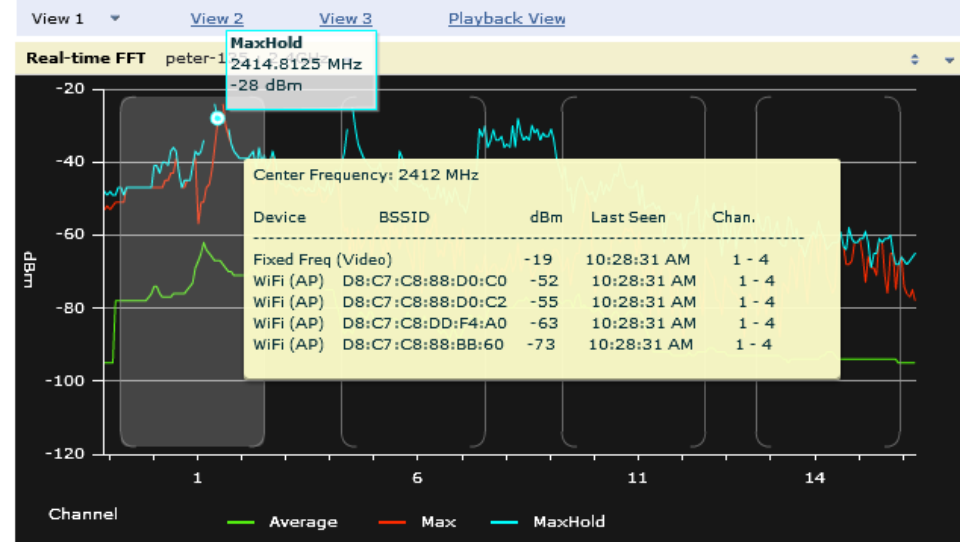
MOBILITY CONTROLLER | Aruba3200 > Spectrum Analysis

Spectrum Dashboards

Spectrum Monitors

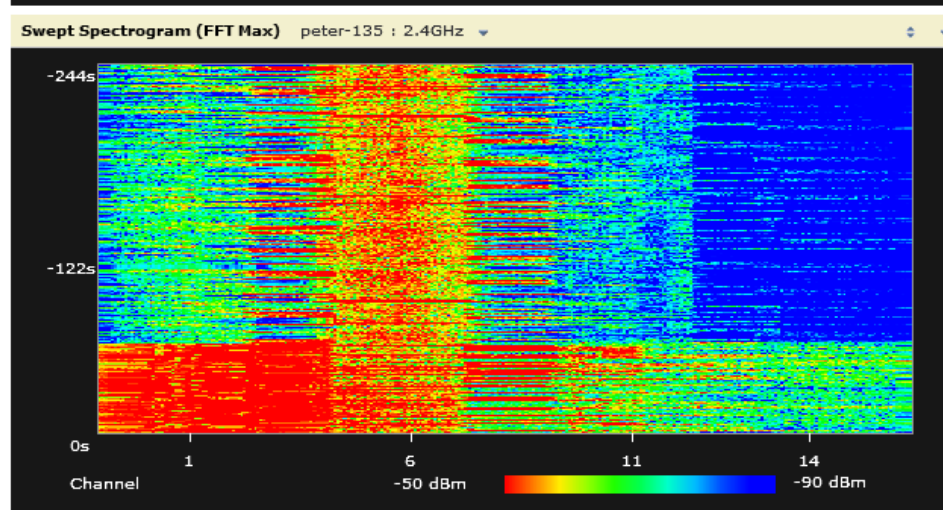
Session Log

[Log out admin](#)



Active Devices Table (139) peter-135 : 2.4GHz

Device Type	BSSID	SSID	Signal (dBm)	Duty Cycle	Discovered	Activit Durat
WiFi (AP)	00:24:6C:81:A6:B0	peter-plm-3200	-37	1%	3-5 11:21:41 AM	5m 2
WiFi (AP)	D8:C7:C8:88:D0:C2	ARUBA-VISITOR	-55	0%	3-5 11:21:41 AM	5m 2
WiFi (AP)	D8:C7:C8:87:EE:00	appletest	-42	0%	3-5 11:21:41 AM	5m 2
WiFi (AP)	D8:C7:C8:87:EE:01	test-wep	-44	1%	3-5 11:21:41 AM	5m 2
WiFi (AP)	00:1A:1E:50:17:D0	aruba-ap	-56	0%	3-5 11:21:41 AM	5m 2
WiFi (AP)	6C:F3:7F:B7:29:A3	employee200-7	-61	1%	3-5 11:21:41 AM	5m 2
WiFi (AP)	6C:F3:7F:A6:0E:82	instant	-64	1%	3-5 11:21:41 AM	5m 2
WiFi (AP)	D8:C7:C8:AC:3D:81	CPPM-test	-65	1%	3-5 11:21:42 AM	5m 2
WiFi (AP)	6C:F3:7F:A6:0C:C2	instant	-64	0%	3-5 11:21:42 AM	5m 2
WiFi (AP)	D8:C7:C8:8C:71:62	ARUBA-VISITOR	-61	0%	3-5 11:21:42 AM	5m 2
WiFi (AP)	00:18:4D:DB:E4:50	Net-AP	-59	0%	3-5 11:21:42 AM	5m 2
WiFi (AP)	D8:C7:C8:5B:7C:23	Q_Amigo_IAP	-65	0%	3-5 11:21:43 AM	5m 2



# Wireless Tools – Spectrum Analysis



MOBILITY CONTROLLER | Aruba3200 > Spectrum Analysis

Spectrum Dashboards

Spectrum Monitors

Session Log

[Log out admin](#)

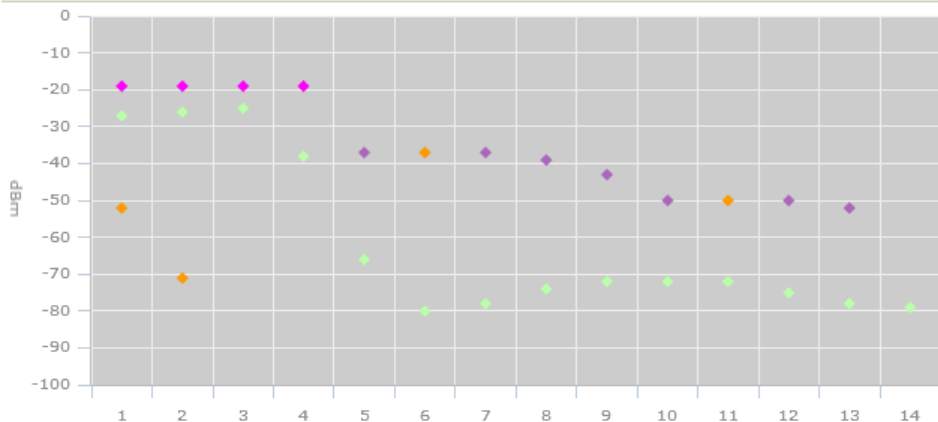
[View 1](#) [View 2](#) [View 3](#) [Playback View](#)

Record

Save Spectrum Views

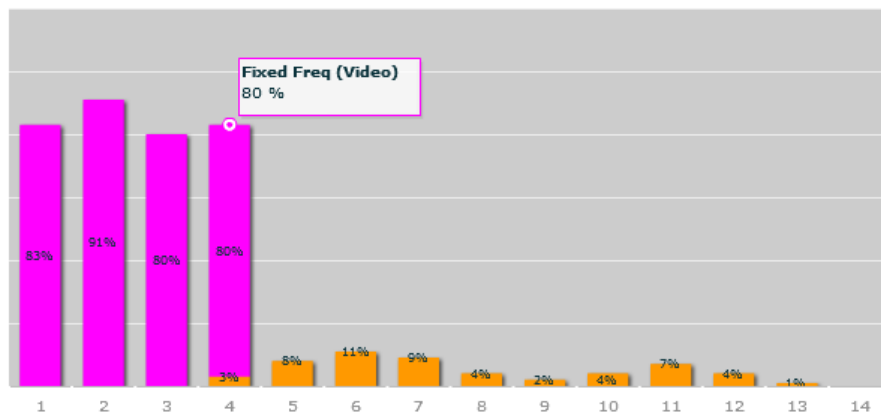
?

Interference Power peter-135 : 2.4GHz



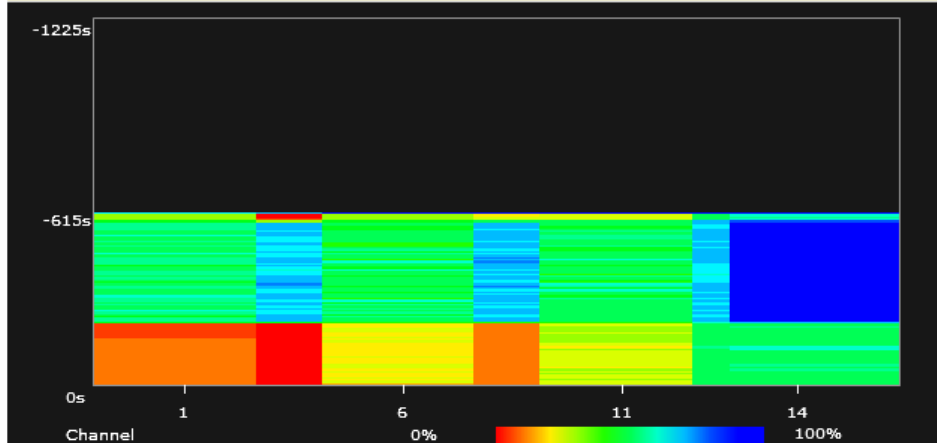
◆ Noise Floor ◆ WiFi ACI ◆ Max AP ◆ Fixed Freq (Others) ◆ Fixed Freq (Video) ◆ Freq Hopper (Cordless Base)

Device Duty Cycle peter-135 : 2.4GHz

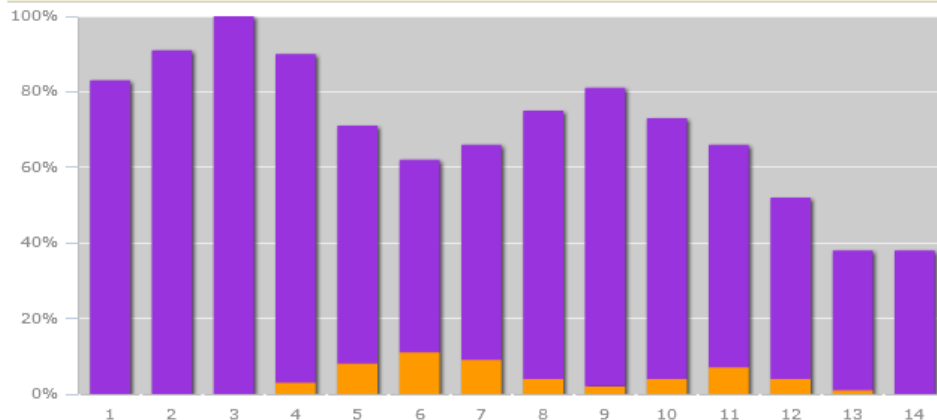


■ WiFi (AP) ■ Fixed Freq (Others) ■ Fixed Freq (Video) ■ Freq Hopper (Cordless Base)

Quality Spectrogram (Channel Availability) peter-135 : 2.4GHz



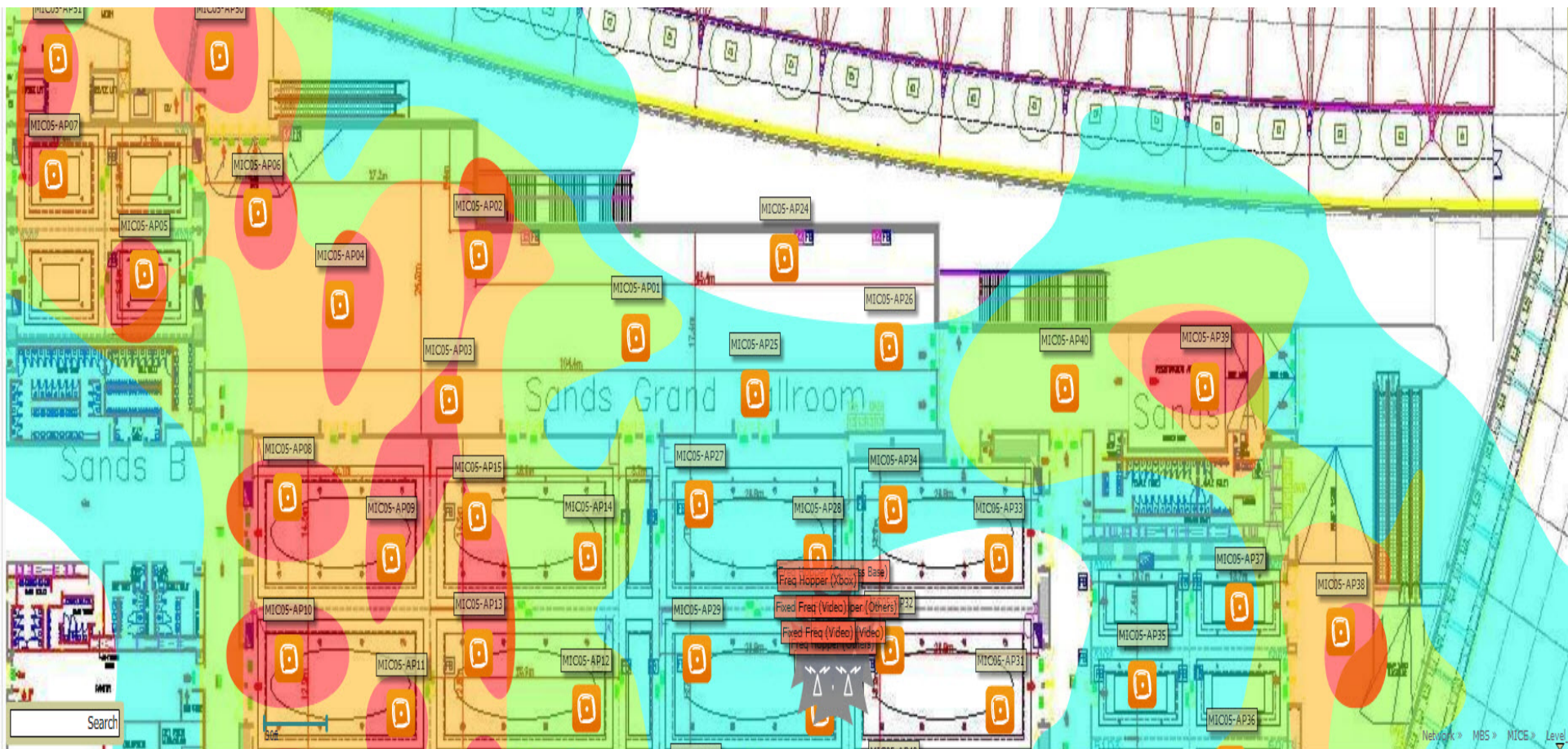
Channel Metrics peter-135 : 2.4GHz



■ WiFi Utilization ■ Non-WiFi + WiFi ACI Utilization

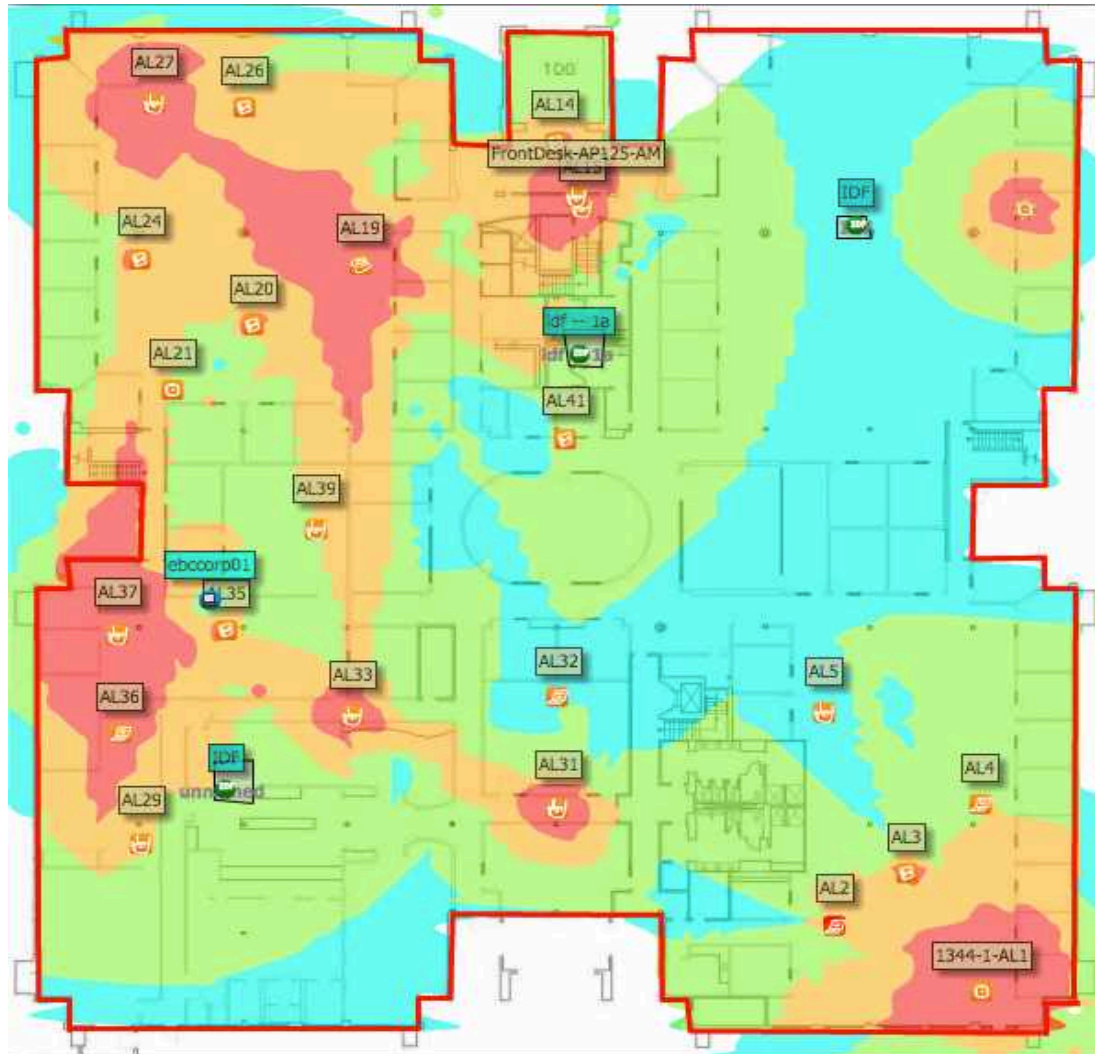


# Wireless Tools – Visual RF



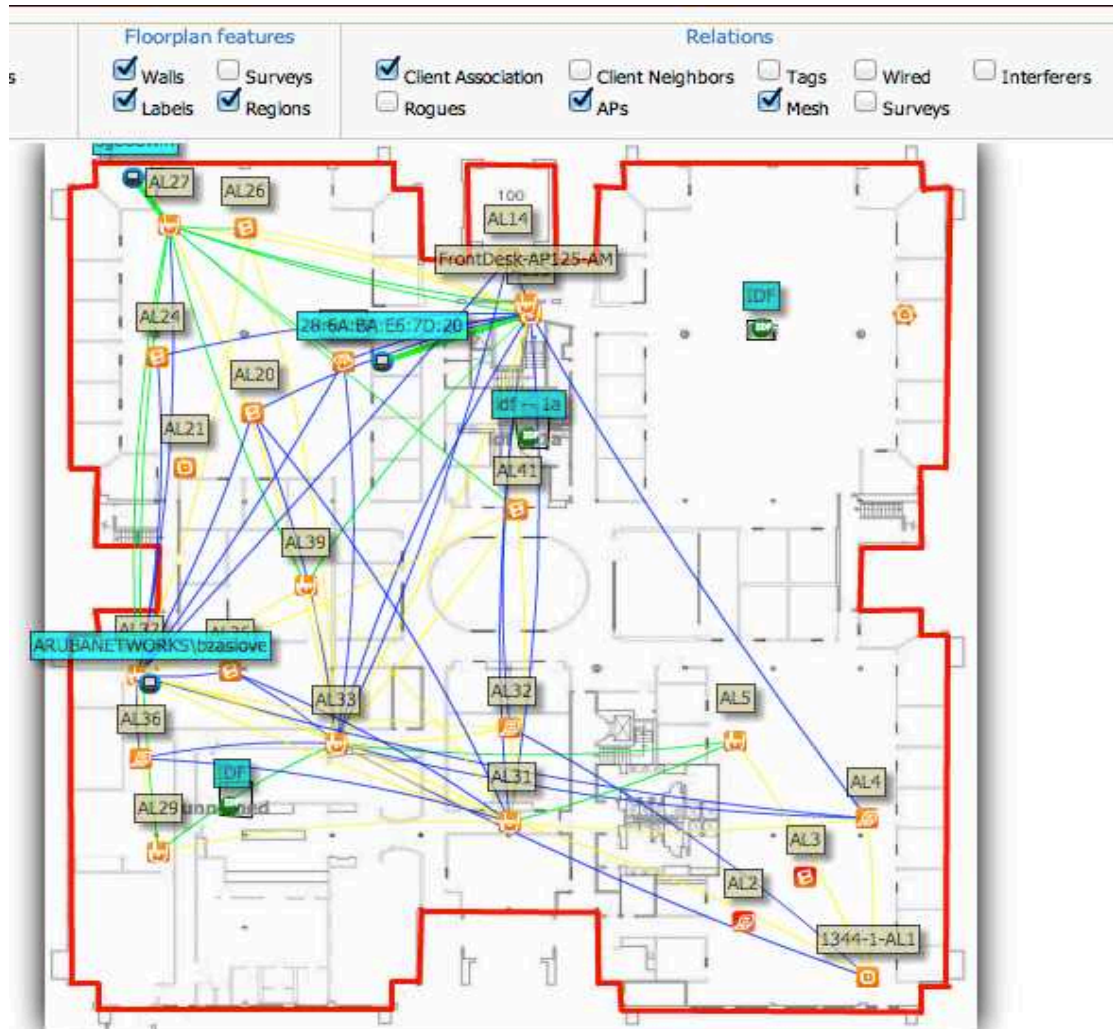
# Wi-Fi Heatmap & Site-Survey

# Heatmap (AirWave VisualRF)

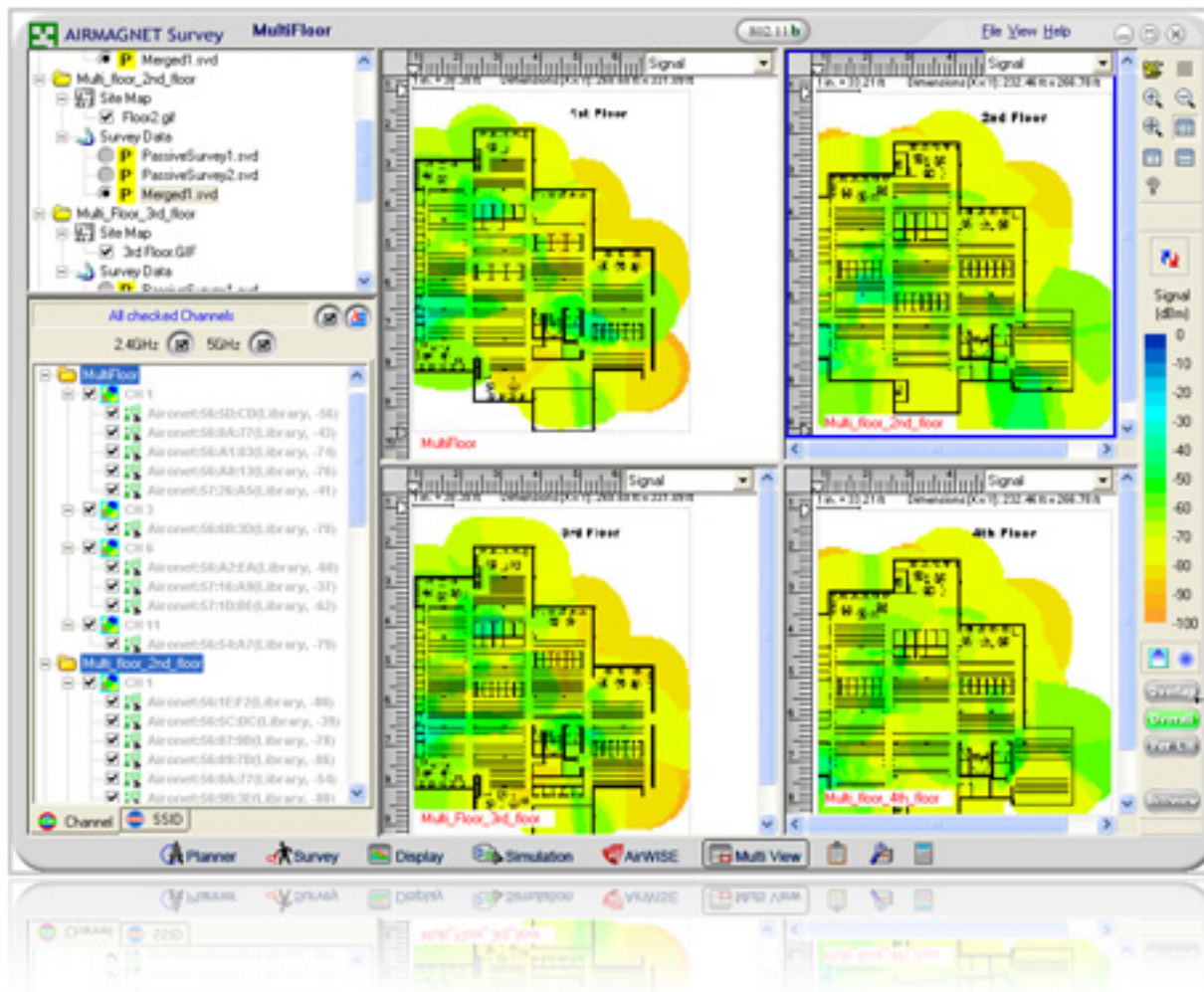




# AirWave (Client Association)



# Site-Survey (AirMagnet Survey Pro)

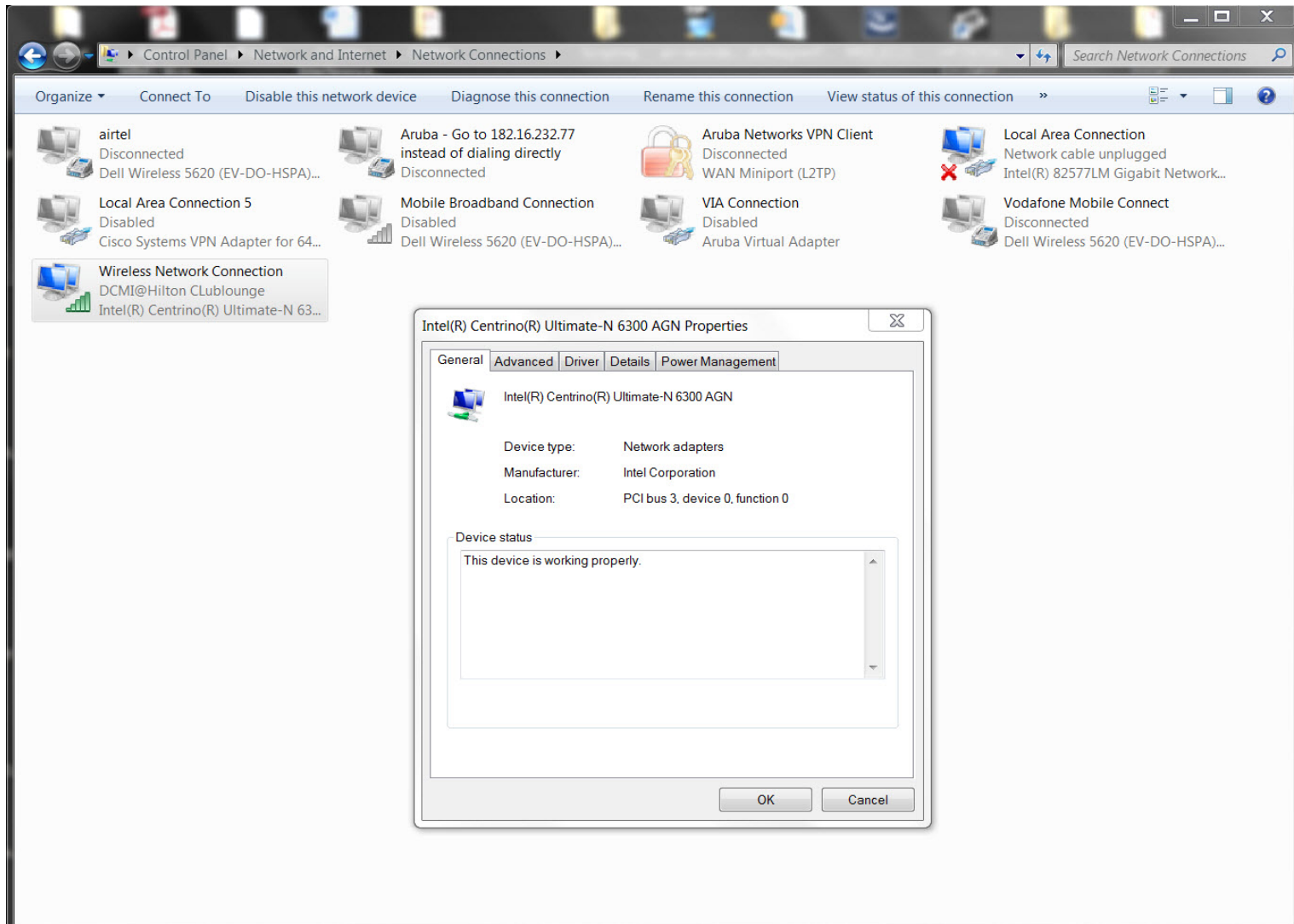


Takes two to Tango

Understanding the client NIC

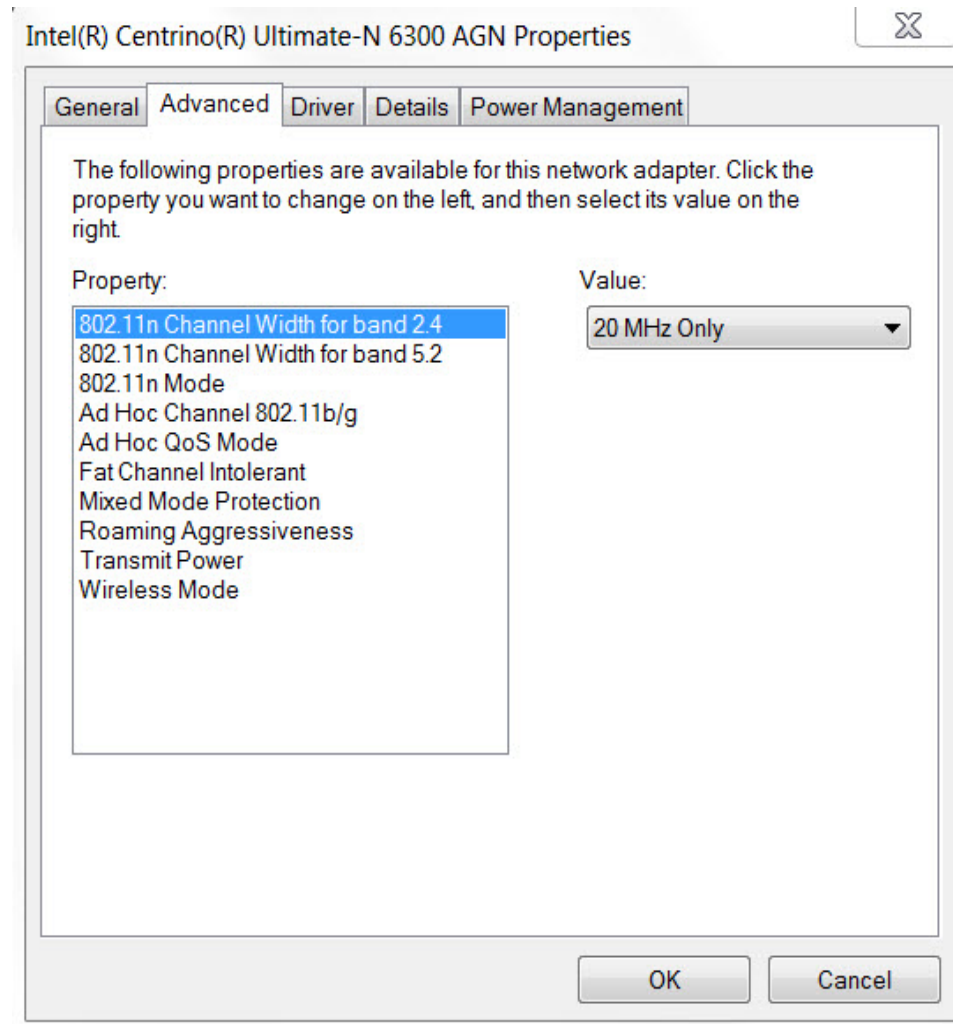
- **Client devices have different characteristics and capabilities**
  - Is it 802.11a, 802.11g, b/g/n, a/b/g/n?
  - If the client supports 11n, is it 1, 2 or 3 spatial streams?
  - Is the wireless NIC using the latest driver?
  - Smartphones often use lower transmit power to save battery
  - SNR works in **both directions**—the client needs sufficient SNR to demodulate 802.11 data rates—noise close to the client can hurt performance
  - Sometimes, the client can hear the AP, but the AP cannot hear the client

# Wireless NIC Details

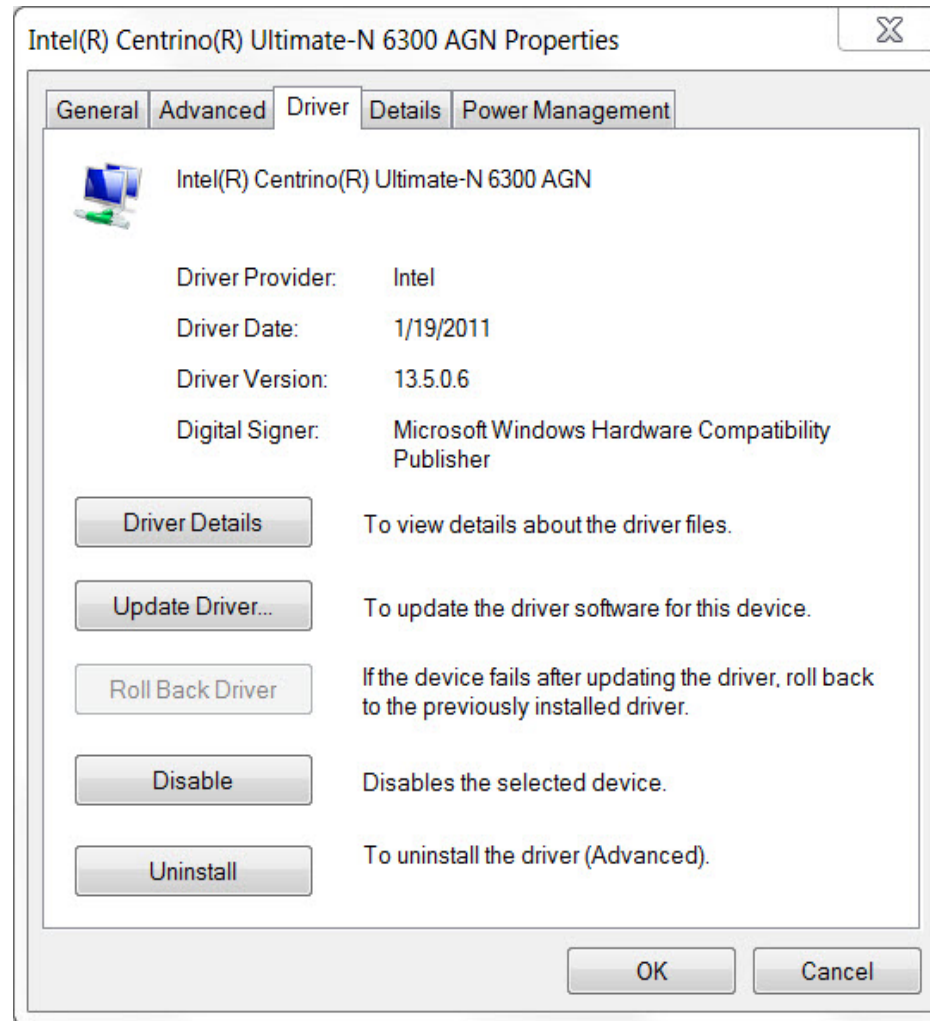




# Wireless NIC Details Cont.



# Wireless NIC Details Cont.



# Wireless NIC Connectivity (Windows 7)

```
C:\Users\ckrispin>netsh wlan show interface
```

```
There is 1 interface on the system:
```

```
Name                : Wireless Network Connection
Description          : Intel(R) Centrino(R) Ultimate-N 6300 AGN
GUID                 : f079b84f-1fdf-47a9-8baa-6e8ab9b10b8c
Physical address     : 00:24:d7:7c:44:28
State                : connected
SSID                 : DCMI@Hilton CLublounge
BSSID                : 00:04:e2:ff:d8:78
Network type         : Infrastructure
Radio type           : 802.11g
Authentication       : Open
Cipher               : None
Connection mode      : Auto Connect
Channel              : 11
Receive rate (Mbps)  : 54
Transmit rate (Mbps) : 54
Signal               : 99%
Profile              : DCMI@Hilton CLublounge
```

```
Hosted network status : Not available
```



# Performance Testing

When testing, it is best to do **wired** to **wireless** client testing.

This allows testing the performance of the wireless LAN, and not depending on Internet access and limited bandwidth.

Pure performance can be measured.

- **iperf/jperf**
- **ixChariot**
- **Veriwave – WaveDeploy**
  
- **iperf (Traffic flow is from client to server)**
  - Server (receiver)
    - `iperf -s -w 512k -i 1`
  - Client (sender)
    - `iperf -c <Server IP> -w 512k -i 1 -t 60 -P 4`

# Packet Capture

- **Local Packet Capture**
  - Tools running on laptop (Omnipeek/Wireshark)
  - You have to be where the problem is
- **Remote Packet Capture**
  - Use Aruba AP as remote agent
  - Anywhere with network access to AP
- **Session and port Mirroring**

# Advanced RF Troubleshooting with CLI

# Running Controller CMD from AWMS



## Device Info

Status: Up (OK)  
Configuration: **Mismatched** (The settings on the device do not match the desired configuration policy.)  
Controller: [ethersphere-lms3](#) Aruba AP Group: corp1344 Upstream Device: [1344-1-AP-alpha-sw1](#) Upstream Port: [gigabitethernet0/0/35](#)  
Type: Aruba AP 135 Remote Device: No Last Contacted: 2/23/2012 2:22 AM Uptime: 4 days 16 hrs 9 mins  
LAN MAC Address: D8:C7:C8:C0:B4:C6 Serial: AX0023139  
IP Address: 10.6.66.32 Clients: 2 Usage: -  
Quick Links: [Open controller web UI...](#) [Run a command...](#)  
Notes:

## Radios

Index	Name	MAC Address	Clients	Usage (Kbps)	Channel	Tx Power	Antenna Type	Role	Active SSIDs
1	<a href="#">802.11bgn</a>	D8:C7:C8:8B:4C:60	0	0.00	1	20 dBm	Internal	Access	ARUBA-VISITOR, et...
2	<a href="#">802.11an</a>	D8:C7:C8:8B:4C:70	2	0.00	149	20.5 dBm	Internal	Access	ARUBA-VISITOR, et...

## Wired Interfaces

Name	MAC Address	Clients	Admin Status	Operational Status	Type	Duplex	Aruba Port Mode	Input Capacity	Output Capacity
Enet0	D8:C7:C8:C0:B4:C6	0	Up	Up	gigabitEthernet	Full	N/A	1000 Mbps	1000 Mbps
Enet1	D8:C7:C8:C0:B4:C7	0	Up	Down	gigabitEthernet	Half	Active Standby	10 Mbps	10 Mbps



# Useful AOS CLI (run from AirWave)

Monitoring **AL21 (1344-1-al21.arubanetworks.com)** in group **Ethersphere-lms3** in folder **Top > Sunnyvale HQ** Poll Control  
This Device is in monitor-only-with-firmware-upgrades mode.

## Device Info

Status: Up (OK)

Configuration: **Mismatched** (The settings on the device do not match the desired configuration policy.)

Controller: **ethersphere-lms3**

Type: **Aruba AP 135**

LAN MAC Address: **D8:C7:C8:C0:B4:C6**

IP Address: **10.6.66.32**

Quick Links:

[Open controller web UI...](#)

Notes:

✓ Run a command...

show ap association ap-name "1344-1-AL21"

show ap debug counters ap-name "1344-1-AL21"

show ap debug client-table ap-name "1344-1-AL21"

show datapath session ap-name "1344-1-AL21" table

show datapath session ap-name "1344-1-AL21" counters

show ap debug bandwidth-management ap-name "1344-1-AL21"

show ap tech-support ap-name "1344-1-AL21"

show ap arm bandwidth-management ap-name "1344-1-AL21"

show ap arm state ap-name "1344-1-AL21"

show ap arm scan-times ap-name "1344-1-AL21"

show ap arm rf-summary ap-name "1344-1-AL21"

## Radios

Index ▲	Name	MAC Address	Clients
1	<a href="#">802.11bgn</a>	D8:C7:C8:8B:4C:60	0
2	<a href="#">802.11an</a>	D8:C7:C8:8B:4C:70	2

## Wired Interfaces

Name ▲	MAC Address	Clients	Admin Sta
Enet0	D8:C7:C8:C0:B4:C6	0	Up
Enet1	D8:C7:C8:C0:B4:C7	0	Up



# Advanced CLI Examples

# Verify All Known APs are UP

- show ap active

```
(Aruba-Demo-Master3200) #  
(Aruba-Demo-Master3200) #show ap active
```

Active AP Table

Name	Group	IP Address	11g Clients	11g Ch/EIRP/MaxEIRP	11a Clients	11a Ch/EIRP/MaxEIRP	AP Type	Flags	Uptime	Outer IP
AP-28	demo	172.30.0.242	0	AP:HT:6/9/20.5	2	AP:HT:44+/20/21	125	E	29m:7s	N/A
AP-B6	demo	172.30.0.244	1	AP:HT:1/9/20.5	0	AP:HT:36+/18/21	125abg	E	23m:11s	N/A
AP-2A	demo	172.30.0.246	0	AP:HT:1/9/20.5	1	AP:HT:157+/21/21	125	E	30m:34s	N/A
Ap105A-MPP-00:24:6c:c0:01:00	AP-Group1	172.30.0.247	8	AP:HT:6/6/20.5	4	MPP:149+/6/20.5	105	M	1h:42m:4s	N/A
AP65C-MPT-00:1a:1e:c7:68:e0	AP-Group1	172.30.0.249	1	AP:11/22/22	0	MP:149/15/23	65	EM	1h:40m:15s	N/A
AP65A-MPT-00:1a:1e:c7:67:c8	AP-Group1	172.30.0.251	12	AP:6/9/22	2	MP:149/15/23	65	EM	1h:43m:42s	N/A
AP65B-MPT-00:1a:1e:c7:67:d6	AP-Group1	172.30.0.253	16	AP:1/9/22	9	MP:149/15/23	65	EM	1h:43m:42s	N/A

Flags: R = Remote AP; P = PPPOE; E = Wired AP enabled; A = Enet1 in active/standby mode;  
L = Client Balancing Enabled; D = Disconn. Extra Calls On; B = Battery Boost On;  
X = Maintenance Mode; d = Drop Mcast/Bcast On; N = 802.11b protection disabled;  
a = Reduce ARP packets in the air; S = RFprotect Sensor; d = Disconnected Sensor  
M = Mesh; U = USB modem; K = 802.11K Enabled;

Channel followed by "\*" indicates channel selected due to unsupported configured channel.

Num APs:7

```
(Aruba-Demo-Master3200) #
```

# Verify All Known SSIDs are Broadcasting



- **show ap bss-table ap-name <ap name>**

```
(ArubaThailand) #show ap bss-table
```

```
Aruba AP BSS Table
```

bss	ess	s/p	ip	phy	type	ch/EIRP/max-EIRP	cur-cl	ap name	in-t(s)	tot-t	mtu	acl-state
---	---	---	---	---	---	-----	-----	-----	-----	-----	---	-----
00:1a:1e:80:02:f0	Bangkok_Corp	1/1	192.168.101.253	a-HT	ap	153-/19/36	2	Bangkok_ICH_AP1	0	2h:41m:15s	1578	-
00:1a:1e:80:02:f1	Bangkok_Voice	1/1	192.168.101.253	a-HT	ap	153-/19/36	0	Bangkok_ICH_AP1	0	2h:41m:15s	1578	-
00:1a:1e:80:02:e0	Bangkok_Corp	1/1	192.168.101.253	g-HT	ap	1/19/33	0	Bangkok_ICH_AP1	0	2h:41m:15s	1578	-
00:1a:1e:80:02:e1	Bangkok_Voice	1/1	192.168.101.253	g-HT	ap	1/19/33	0	Bangkok_ICH_AP1	0	2h:41m:15s	1578	-
00:1a:1e:c0:00:2f	N/A	1/1	192.168.101.253	e	N/A	N/A	N/A	Bangkok_ICH_AP1	0	2h:41m:15s	1578	N/A

```
Channel followed by "*" indicates channel selected due to unsupported configured channel.
```

```
Num APs:5
```

```
Num Associations:2
```

```
(ArubaThailand) #
```

# Check Device's 802.11 status



```
(Aruba-Demo-Master3200) #show ap association client-mac 00:21:6a:51:71:ea
```

Flags: W: WMM client, A: Active, K: 802.11K client, B: Band Steerable

PHY Details: HT: High throughput; 20: 20MHz; 40: 40MHz  
<n>ss: <n> spatial streams

## Association Table

Name	bssid	mac	auth	assoc	aid	l-int	essid	vlan-id	tunnel-id	phy	assoc. time	num assoc	Flags
AP-B6	00:1a:1e:89:4b:70	00:21:6a:51:71:ea	y	y	2	10	demo	1	0x1090	a-HT-40sgi-2ss	18m:48s	1	WAB

00:21:6a:51:71:ea-00:1a:1e:89:4b:70 Stats

Parameter	Value
Channel	36
Channel Frame Retry Rate(%)	0
Channel Frame Low Speed Rate(%)	0
Channel Frame Non Unicast Rate(%)	0
Channel Frame Fragmentation Rate(%)	0
Channel Frame Error Rate(%)	0
Channel Bandwidth Rate(Kbps)	1
Channel Noise	96
Client Frame Retry Rate(%)	0
Client Frame Low Speed Rate(%)	0
Client Frame Non Unicast Rate(%)	0
Client Frame Fragmentation Rate(%)	0
Client Frame Receive Error Rate(%)	0
Client Bandwidth Rate(kbps)	1
Client Tx Packets	12030
Client Rx Packets	3884
Client Tx Bytes	996873
Client Rx Bytes	4318530
Client SNR	56
Client Tx Rate	18 mbps
Client Rx Rate	6 mbps

```
(Aruba-Demo-Master3200) #
```

# View Device's 802.11 Performance



- **show ap debug client-table ap-name <ap name>**

```
(ArubaThailand) #show ap debug client-table ap-name Bangkok_ICH_API
```

```
Client Table
```

MAC	ESSID	BSSID	Assoc_State	HT_State	AID	PS_State	UAPSD	Tx_Pkts	Rx_Pkts	PS_Pkts	Tx_Retries	Tx_Rate	Rx_Rate
Last_ACK_SNR	Last_RX_SNR	TX_Chains	Tx_Timestamp	Rx_Timestamp									
00:1e:c2:b4:86:90	Bangkok_Corp	00:1a:1e:80:02:f0	Associated	WM	0x1	Power-save	(0,0,0,0)	6415	19684	4	1422	13	13
-128	11	3[0x7]	Sun Aug 17 08:13:27 2008	Sun Aug 17 08:13:33 2008									
00:18:de:66:09:5c	Bangkok_Corp	00:1a:1e:80:02:f0	Associated	None	0x3	Power-save	(0,0,0,0)	59	5103	0	0	54	6
54	54	2[0x3]	Sun Aug 17 08:12:05 2008	Sun Aug 17 08:13:33 2008									
00:16:ea:5f:c6:d4	Bangkok_CorpLegacy	00:1a:1e:80:02:f2	Associated	None	0x1	Awake	(0,0,0,0)	52	1600	0	0	54	12
61	57	2[0x3]	Sun Aug 17 08:12:33 2008	Sun Aug 17 08:13:33 2008									
00:1e:4c:c9:db:72	Bangkok_Corp	00:1a:1e:80:02:e0	Associated	M	0x1	Awake	(0,0,0,0)	1292	3011	0	0	130	130
65	66	2[0x5]	Sun Aug 17 08:13:33 2008	Sun Aug 17 08:13:33 2008									
00:11:24:92:64:70	Bangkok_CorpLegacy	00:1a:1e:80:02:e2	Associated	None	0x1	Awake	(0,0,0,0)	256991	82863	0	390	54	36
52	53	2[0x5]	Sun Aug 17 08:12:27 2008	Sun Aug 17 08:12:27 2008									

```
UAPSD:(VO,VI,BK,BE)
```

```
HT Flags: A - LDPC Coding; W - 40Mhz; S - Short GI; M - Max A-MSDU  
D - Delayed BA; G - Greenfield; R - Dynamic SM PS  
Q - Static SM PS; N - A-MPDU disabled
```

```
(ArubaThailand) #
```

# Check 802.11 and non-802.11 Interference

```
(ArubaThailand) #show ap arm rf-summary ap-name Bangkok_ICH_API
```

## Channel Summary

channel	retry	low-speed	non-unicast	frag	bwidth	phy-err	mac-err	noise	cov-idx	intf_idx
161	0	0	0	0	0	0	4	106	8/0	9/106//0/0
1	57	53	3	0	7	0	7	91	10/0	853/126//0/0
48	0	0	0	0	0	0	0	0	0/0	173/123//0/0
165	0	0	0	0	0	0	0	0	0/0	198/11//0/0
5	0	0	0	0	0	0	0	0	0/0	40/849//0/0
6	0	0	0	0	0	0	0	0	0/0	537/496//0/0
7	0	0	0	0	0	0	0	0	0/0	62/929//0/0
11	0	0	0	0	0	0	0	0	0/0	736/341//0/0
149	0	0	0	0	0	0	0	0	0/0	118/70//0/0
36	0	0	0	0	0	0	0	0	0/0	286/20//0/0
153	0	0	0	0	0	0	0	0	0/0	189/83//0/0
40	0	0	0	0	0	0	0	0	0/0	57/144//0/0
157	0	0	0	0	0	0	0	0	0/0	121/63//0/0
44	0	0	0	0	0	0	0	0	0/0	343/80//0/0

## HT Channel Summary

1-5	1868
7-11	2068
149-153	460
36-40	507
157-161	299
44-48	719

```
Interface Name           :wifi0
Current ARM Assignment    :161-/21
Target Coverage Index     :10
Covered channels a/g     :0/0
Free channels a/g        :9/0
ARM Edge State            :disable
Last check channel/pwr   :21s/3m:16s
Last change channel/pwr  :1h:5m:52s/54m:57s
Next Check channel/pwr   :3m:49s/3m:3s
```

```
Interface Name           :wifil
Current ARM Assignment    :1/30
Target Coverage Index     :10
Covered channels a/g     :0/0
Free channels a/g        :0/3
ARM Edge State            :disable
Last check channel/pwr   :2m:21s/1m:1s
Last change channel/pwr  :2m:21s/15m:14s
Next Check channel/pwr   :1m:43s/4m:15s
```

```
(ArubaThailand) #
```

- **General AP/Client**

- show ap active [ap-name] <AP name>
- show ap bss-table [ap-name] <AP name>
- show ap association [ap-name] <AP name>
- show ap association client-mac <client MAC>
- show ap debug client-table ap-name <AP name>
- show ap debug client-table ap-name <AP name> | include <client MAC>
- show ap debug client-stats <client MAC> advanced
- show ap remote debug mgmt-frames ap-name <AP name>

- **ARM**

- show ap monitor ap-list ap-name <AP name>
- show ap arm rf-summary ap-name <AP name>
- show ap arm history ap-name <AP name>
- show ap arm scan-times ap-name <AP name>
- show ap arm state ap-name <AP name>

- **RF**

- show ap debug radio-stats ap-name <AP name> radio [0 or 1] advanced



- **User**

- show user [IP address or client MAC]
- show user-table verbose
- show auth-tracebuf [client MAC or count]
- show datapath session table <user IP address>

- **System**

- show ap debug system-status ap-name <AP name>
- show ap tech-support ap-name <AP name>
- show ap spectrum tech-support ap-name <AP name>
- show tech-support
- tar logs tech-support

## 6.2 troubleshooting updates



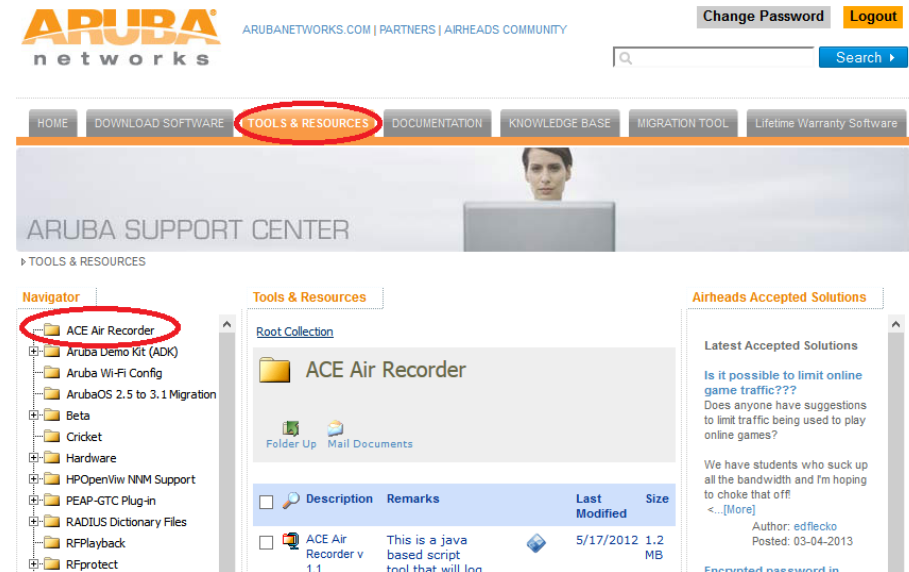
- **Show AP debug counters**
- **Show ap radio-summary**
- **Show ap debug system-status**
- **PCAP enhancements**



# Aruba Tools



- Routinely Gather CLI output
- Java based, can run in Windows or Mac OS X
- Available from the support site in the tools section



The screenshot shows the Aruba Networks Support Center website. The top navigation bar includes links for HOME, DOWNLOAD SOFTWARE, TOOLS & RESOURCES (highlighted with a red circle), DOCUMENTATION, KNOWLEDGE BASE, MIGRATION TOOL, and Lifetime Warranty Software. Below the navigation bar, the page title is "ARUBA SUPPORT CENTER". The main content area is divided into three sections: Navigator, Tools & Resources, and Airheads Accepted Solutions. In the Navigator section, "ACE Air Recorder" is highlighted with a red circle. In the Tools & Resources section, there is a "Root Collection" for "ACE Air Recorder" with a table listing the tool. The table has columns for Description, Remarks, Last Modified, and Size. The entry for "ACE Air Recorder v 1.1" is listed with a description: "This is a java based script tool that will log".

Description	Remarks	Last Modified	Size
ACE Air Recorder v 1.1	This is a java based script tool that will log	5/17/2012	1.2 MB

- **\$ java -jar AirRecorder-1.1-release.jar -u admin -p admin -e enable 192.168.1.1**

300,show ap arm bandwidth-management ap-name %  
{ap:name}

3600,show ap arm neighbors ap-name %{ap:name}

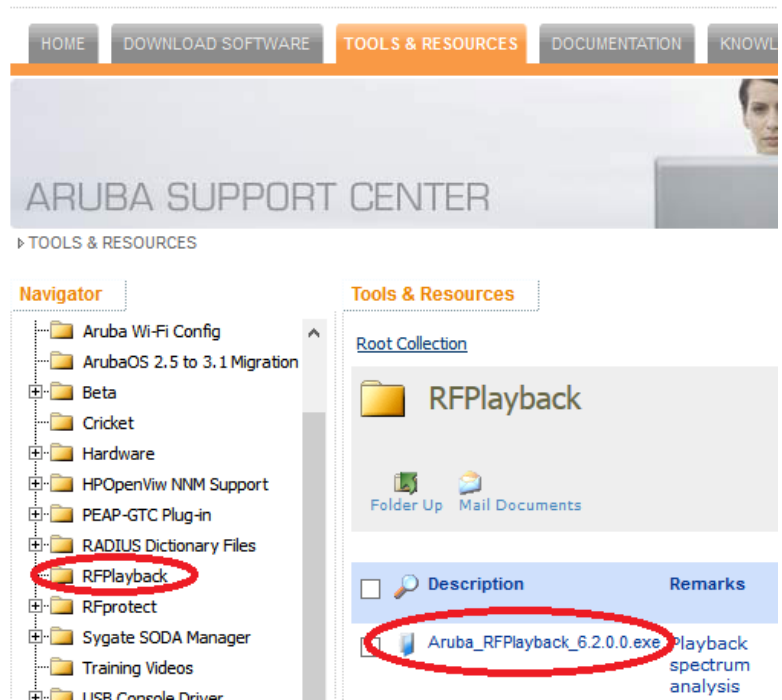
300,show ap arm rf-summary ap-name %{ap:name}

3600,show ap arm scan-times ap-name %{ap:name}

- View Spectrum recordings without connecting to the controller
- Installs Adobe Air as part of the installation
- Available from the Tools section of the support site



ARUBANETWORKS.COM | PARTNERS | AIRHEADS COMM



The screenshot shows the Aruba Support Center website. The top navigation bar includes links for HOME, DOWNLOAD SOFTWARE, TOOLS & RESOURCES (highlighted), DOCUMENTATION, and KNOWLEDGE. Below the navigation bar, the page title is "ARUBA SUPPORT CENTER". Under the "TOOLS & RESOURCES" section, there is a "Navigator" on the left and a "Tools & Resources" panel on the right. The "Navigator" lists various folders, with "RFPlayback" highlighted by a red circle. The "Tools & Resources" panel shows a "Root Collection" with a folder named "RFPlayback". Below this, there is a table with two columns: "Description" and "Remarks". The table contains one entry: "Aruba\_RFPlayback\_6.2.0.0.exe" with the remark "Playback spectrum analysis". This entry is also highlighted by a red circle.

Description	Remarks
Aruba_RFPlayback_6.2.0.0.exe	Playback spectrum analysis



Questions?





# AIRHEADS

## LAS VEGAS 2012

- ▶ **JOIN:** [community.arubanetworks.com](http://community.arubanetworks.com)
- ▶ **FOLLOW:** [@arubanetworks](https://twitter.com/arubanetworks)
- ▶ **DISCUSS:** [#airheadsconf](https://twitter.com/airheadsconf)

# Backup Slides



# What To Do Before You Call TAC?

(to help resolve problems faster)



# What to do before you call TAC?



- **Provide the Aruba WLAN Controller logs and output of show tech-support**
  - CLI Example:
    - tar logs tech-support
    - copy flash: logs.tar tftp:<tftp server IP address> <file name>
- **If this information is not available, then at a minimum, please provide:**
  - ArubaOS Version (including build number)
  - Controller Model
  - Client Type
  - Radio band and Channel width
  - ESSID Opmode
- **Provide the Syslog Server file of the Aruba WLAN Controller at the time of the problem.**
  - If no Syslog Server is available to capture log output from the Aruba WLAN Controller then please set one up as soon as possible since it is a highly suggested troubleshooting and monitoring best practice.
  - A free Syslog server can be found at Kiwi Enterprises (<http://www.kiwisyslog.com/>)

# What to do before you call TAC? (cont'd)



- **State if this is a new or existing installation.**
  - This will help the support team to take different troubleshooting approaches depending on whether the customer has:
    - An outage in the network that worked in the past
    - A network configuration that has never worked
    - A brand new install
- **State if anything has recently changed in the network (external to Aruba) or if anything has recently changed in the Aruba WLAN Controller or AP configuration.**
- **If there was a configuration change then please list the exact configuration steps and commands used.**
- **State the date and time (if possible) when the problem first occurred**
- **Is the problem reproducible?**
  - If the problem is reproducible then please list the exact steps taken to recreate the problem.

# What to do before you call TAC? (cont'd)



- **Provide the wireless device's make, model number, and its OS version including any service packs or patches,**
- **Provide the Wireless LAN Card's make, model number, driver date, driver version, and configuration on the wireless device.**
- **Highly Useful Information:**
  - (Information below should be provided as an addition to the previous slides that contain critical Information needed)
  - Provide a detailed network topology (including all the devices in the network between the user and the Aruba WLAN Controller with IP addresses and Interface numbers if possible)
    - The diagram can be in format of Visio, PowerPoint, JPEG, TIF, etc. or it can even be hand written and then faxed to support "1-408-227-4550"
  - Provide any wired or wireless sniffer traces taken during the time of the problem.

# What to do before you call TAC? (cont'd)



- **Get the following log output during the problem IF Syslog server output can't be provided**
  - show log errorlog all
  - show log network all | include '<wireless device's mac address>'
  - show log security all | include '<wireless device's mac address>'
  - show log system all
  - show log user-debug all | include '<wireless device's mac address>'
  - show log user all | include '<wireless device's mac address>'
  - show log wireless all



# What to do before you call TAC? (cont'd)



- **Provide customer site access information to the Aruba WLAN Controller if possible.**
  - This is another highly suggested troubleshooting best practice that should be implemented.
  - The customer site access should only be enabled when a problem occurs (or if Aruba support is monitoring the device).
  - The most common access given by customers is through Adobe Acrobat Connect or WebEx.
  - Otherwise customers will provide a VPN (PPTP, L2TP, SSL) connection that limits the support person to only have IP access to the Aruba WLAN Controller, AP, and AWMS.
  - Analog dialup or SSH access to the Aruba Controller are other access methods that the support person can use to reach the Aruba WLAN Controller too.

# Remote Packet Capture with Aruba AP

# Remote Packet Capture with Aruba AP



- Using any Aruba AP (AP or AM, CAP or RAP) to perform remote packet capture
- Wireshark 1.6 (or above) running on any computer
- **IP connectivity** between AP/AM and capturing computer

# Setting Up Remote Packet Capture

Controller > Air Monitors

Local Air Monitors							Search
	AM Name ▲	AP Group ▲	AM IP ▲	AP Type ▲	IPSEC ▲	Uptime ▲	
	ap105-35	am	172.18.163.144	105	Enable	3d:0h:3m:44s	
1   1-1 of 1							10 ▾
Overview							Packet Capture
							Launch AirMagnet

Monitoring > Air Monitor: 172.18.163.144 > Packet Capture

◀ Back

## Search Result

<input type="checkbox"/>	ID	Type	Radio	Channel	Packets	Status	Target	Filter
--------------------------	----	------	-------	---------	---------	--------	--------	--------

None found.

Refresh Stop Delete Pause Resume New

New Raw Packet Capture [Launch WildPackets](#)

## Raw Packet Capture

WildPackets Ethereal | Target IP: 172.18.164.171 | Port: 5000 | Channel: 6 | 802.11g

Start Cancel


To send packets to WildPackets, you need to use Air Monitor IP Address 172.18.163.144.



# Setting Up Remote Packet Capture

Monitoring > Air Monitor: 172.18.163.144 > Packet Capture

## Search Result

<input type="checkbox"/>	ID	Type	Radio	Channel	Packets	Status	Target	Filter
<input type="checkbox"/>	1 	RAW	80211b/g-HT-40 6			in-progress	172.18.164.171/5000	

Refresh

Stop

Delete

Pause

Resume

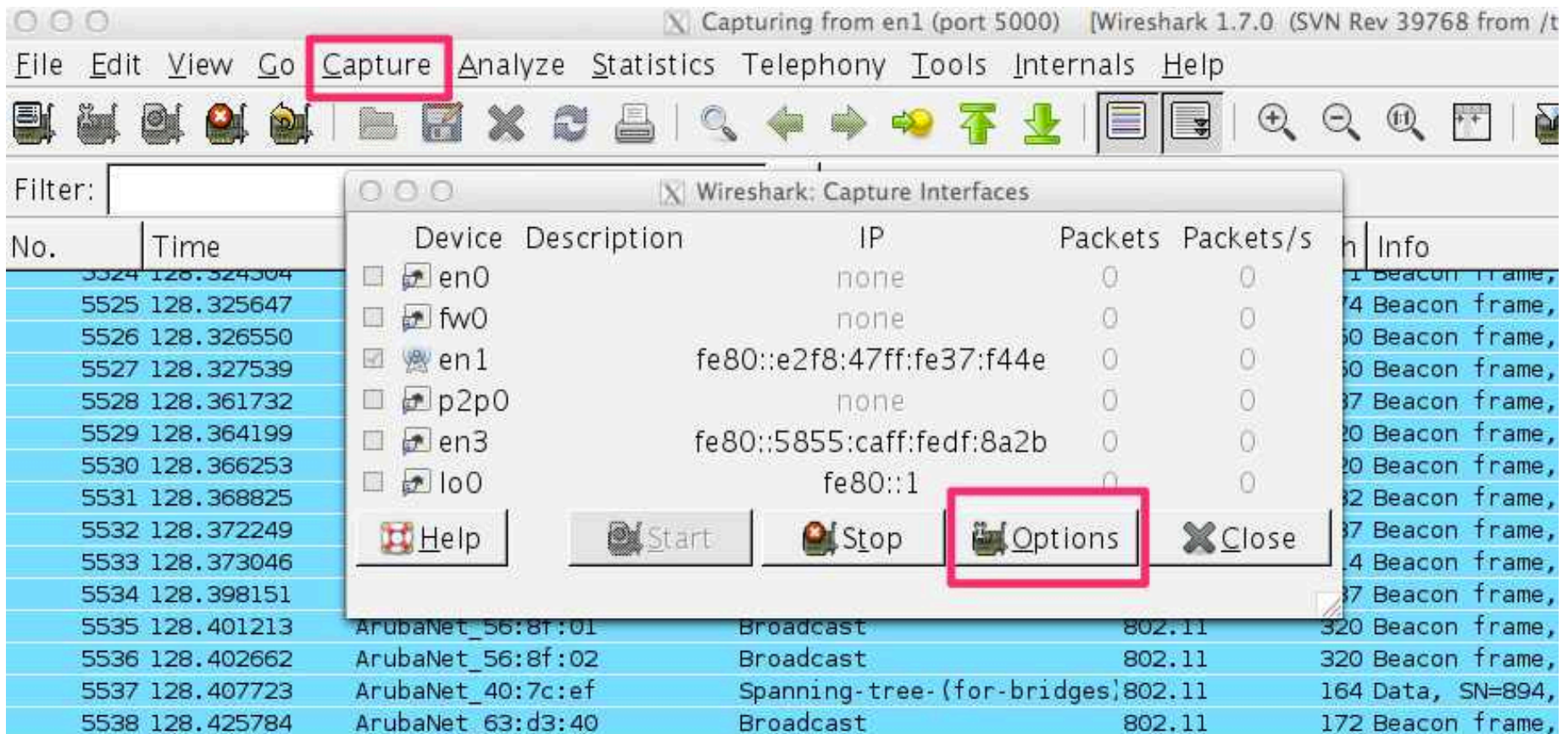
New

New Raw Packet Capture



[Launch WildPackets](#)

# Set-up computer as receiver





# Set-up computer as receiver

Wireshark: Capture Options

Capture

Capture	Interface	Link-layer header	Prom. Mode	Snaplen [B]	Buffer [MB]	Mon. Mode	Capture Filter
<input type="checkbox"/>	<b>en0</b>	Ethernet	enabled	default	1	n/a	
<input type="checkbox"/>	<b>fw0</b>	Apple IP-over-IEEE 1394	enabled	default	1	n/a	
<input checked="" type="checkbox"/>	<b>en1</b> fe80::e2f8:47ff:fe37:f44e 172.18.164.171 2001:470:fb07:2:e2f8:47ff:f... 2001:470:fb07:2:d827:1cae:...	Ethernet	enabled	default	1	disabled	port 5000

☐ Capture on all interfaces

Capture File(s)

File:

☐ Use multiple files

☒ Next file every

☒ Use pcap-ng format

Display Options

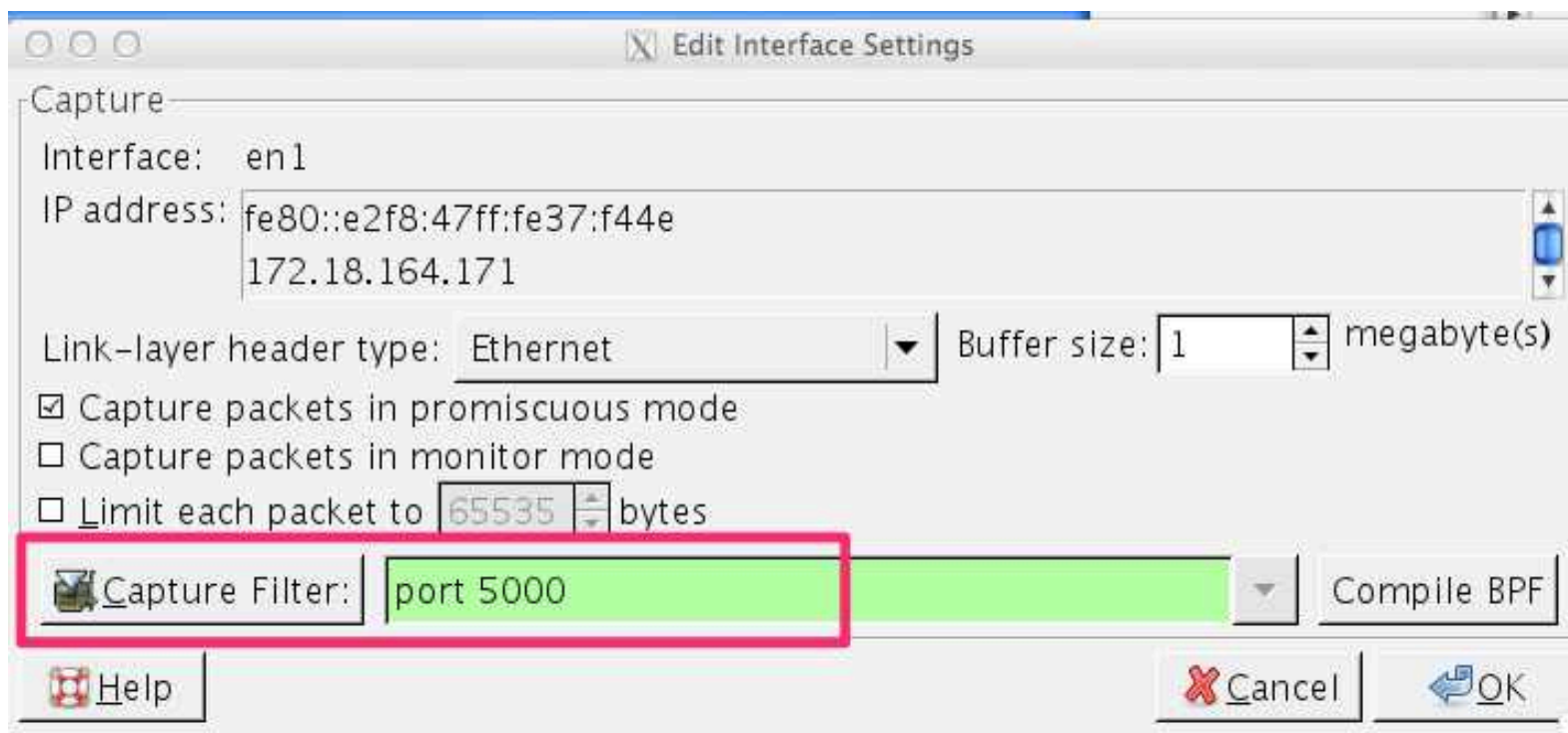
☒ Update list of packets in real time

☒ Automatic scrolling in live capture



# Set-up computer as receiver

- **Filter on traffic on port 5000**



Edit Interface Settings

Capture

Interface: en1


IP address: fe80::e2f8:47ff:fe37:f44e  
172.18.164.171


Link-layer header type: Ethernet Buffer size: 1 megabyte(s)

☒ Capture packets in promiscuous mode

☐ Capture packets in monitor mode

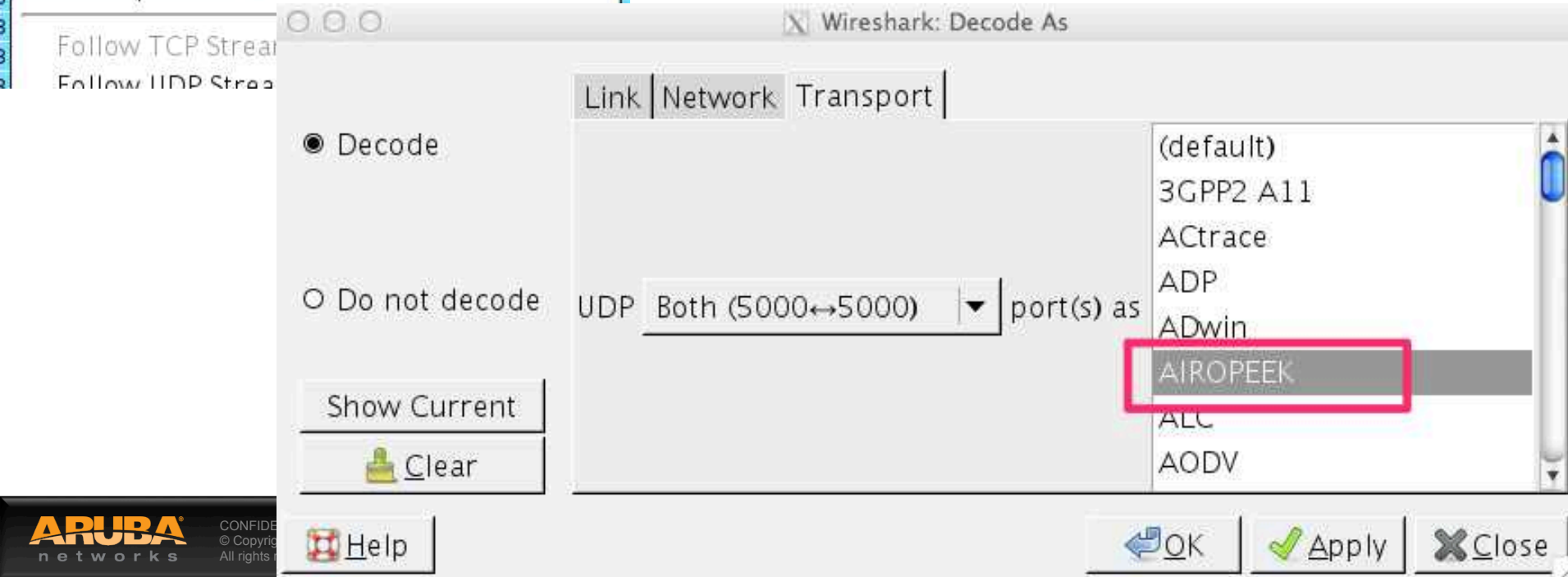
☐ Limit each packet to 65535 bytes

 Capture Filter: port 5000 Compile BPF

 Help Cancel OK

# Set-up computer as receiver

- **Decode as AIROPEEK**



# Packet Capture



en1 (port 5000) [Wireshark 1.7.0 (SVN Rev 39768 from /trunk)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
5519	128.313209	ArubaNet_63:d3:43	IntelCor_98:6a:b0	802.11	144	Probe Response, SN=886, FN=0, Flags=.....C, BI=100, SSID=K-
5520	128.313966	ArubaNet_63:d3:44	IntelCor_98:6a:b0	802.11	144	Probe Response, SN=887, FN=0, Flags=.....C, BI=100, SSID=K-
5521	128.319645	ArubaNet_56:8f:01	IntelCor_98:6a:b0	802.11	314	Probe Response, SN=3624, FN=0, Flags=.....C, BI=100, SSID=e
5522	128.322260	ArubaNet_56:8f:02	IntelCor_98:6a:b0	802.11	314	Probe Response, SN=3597, FN=0, Flags=.....C, BI=100, SSID=bric
5523	128.323715	ArubaNet_63:d3:40	Broadcast	802.11	172	Beacon frame, SN=888, FN=0, Flags=.....C, BI=100, SSID=brid
5524	128.324504	ArubaNet_63:d3:41	Broadcast	802.11	171	Beacon frame, SN=889, FN=0, Flags=.....C, BI=100, SSID=spli
5525	128.325647	ArubaNet_63:d3:42	Broadcast	802.11	174	Beacon frame, SN=890, FN=0, Flags=.....C, BI=100, SSID=MTK-
5526	128.326550	ArubaNet_63:d3:43	Broadcast	802.11	150	Beacon frame, SN=891, FN=0, Flags=.....C, BI=100, SSID=K-12
5527	128.327539	ArubaNet_63:d3:44	Broadcast	802.11	150	Beacon frame, SN=892, FN=0, Flags=.....C, BI=100, SSID=K-12
5528	128.361732	ArubaNet_80:3b:a0	Broadcast	802.11	287	Beacon frame, SN=2782, FN=0, Flags=.....C, BI=100, SSID=gue
5529	128.364199	ArubaNet_80:3b:a1	Broadcast	802.11	320	Beacon frame, SN=2781, FN=0, Flags=.....C, BI=100, SSID=eth
5530	128.366253	ArubaNet_80:3b:a2	Broadcast	802.11	320	Beacon frame, SN=2781, FN=0, Flags=.....C, BI=100, SSID=eth
5531	128.368825	ArubaNet_36:2b:e2	Broadcast	802.11	332	Beacon frame, SN=3842, FN=0, Flags=.....C, BI=100, SSID=ins
5532	128.372249	ArubaNet_36:2b:e3	Broadcast	802.11	337	Beacon frame, SN=3837, FN=0, Flags=.....C, BI=100, SSID=ins
5533	128.373046	ArubaNet_36:2b:e4	Broadcast	802.11	314	Beacon frame, SN=3834, FN=0, Flags=.....C, BI=100, SSID=ins
5534	128.398151	ArubaNet_56:8f:00	Broadcast	802.11	287	Beacon frame, SN=925, FN=0, Flags=.....C, BI=100, SSID=gues
5535	128.401213	ArubaNet_56:8f:01	Broadcast	802.11	320	Beacon frame, SN=924, FN=0, Flags=.....C, BI=100, SSID=ethe
5536	128.402662	ArubaNet_56:8f:02	Broadcast	802.11	320	Beacon frame, SN=924, FN=0, Flags=.....C, BI=100, SSID=ethe
5537	128.407723	ArubaNet_40:7c:ef	Spanning-tree-(for-bridges)	802.11	164	Data, SN=894, FN=0, Flags=p....F.C
5538	128.425784	ArubaNet_63:d3:40	Broadcast	802.11	172	Beacon frame, SN=895, FN=0, Flags=.....C, BI=100, SSID=brid
5539	128.426580	ArubaNet_63:d3:41	Broadcast	802.11	171	Beacon frame, SN=896, FN=0, Flags=.....C, BI=100, SSID=spli

Frame 1: 76 bytes on wire (608 bits), 76 bytes captured (608 bits)

Ethernet II, Src: ArubaNet\_c0:6d:b6 (d8:c7:c8:c0:6d:b6), Dst: Apple\_37:f4:4e (e0:f8:47:37:f4:4e)

Internet Protocol Version 4, Src: 172.18.164.103 (172.18.164.103), Dst: 172.18.164.171 (172.18.164.171)

User Datagram Protocol, Src Port: complex-main (5000), Dst Port: complex-main (5000)

Airopeek encapsulated IEEE 802.11

IEEE 802.11 Clear-to-send, Flags: .....C



# Packet (beacon)

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
5524	128.324504	ArubaNet_63:d3:41	Broadcast	802.11	171	Beacon frame, SN=889, FN=0, Flags=.....C, BI=100, SSID=spli
5525	128.325647	ArubaNet_63:d3:42	Broadcast	802.11	174	Beacon frame, SN=890, FN=0, Flags=.....C, BI=100, SSID=MTK-
5526	128.326550	ArubaNet_63:d3:43	Broadcast	802.11	150	Beacon frame, SN=891, FN=0, Flags=.....C, BI=100, SSID=K-12
5527	128.327539	ArubaNet_63:d3:44	Broadcast	802.11	150	Beacon frame, SN=892, FN=0, Flags=.....C, BI=100, SSID=K-12
5528	128.361722	ArubaNet_80:2b:20	Broadcast	802.11	287	Beacon frame, SN=2782, FN=0, Flags=.....C, BI=100, SSID=Aruba

Subtype: 0  
Flags: 0x0  
Duration: 0  
Destination address: Broadcast (ff:ff:ff:ff:ff:ff)  
Source address: ArubaNet\_63:d3:42 (00:0b:86:63:d3:42)  
BSS Id: ArubaNet\_63:d3:42 (00:0b:86:63:d3:42)  
Fragment number: 0  
Sequence number: 890  
Frame check sequence: 0x7fdb3303 [correct]

IEEE 802.11 wireless LAN management frame

Fixed parameters (12 bytes)

- Timestamp: 0x0000003c15338aa5
- Beacon Interval: 0.102400 [Seconds]
- Capabilities Information: 0x0431

Tagged parameters (72 bytes)

- Tag: SSID parameter set: MTK-test
- Tag: Supported Rates 1(B), 2(B), 5.5, 11, 6, 9, 12, 18, [Mbit/sec]
- Tag: DS Parameter set : Current Channel: 11
- Tag: Traffic Indication Map (TIM): DTIM 0 of 0 bitmap
- Tag: ERP Information
- Tag: Extended Supported Rates 24, 36, 48, 54, [Mbit/sec]
- Tag: RSN Information
- Tag: Vendor Specific: AtherosC: Unknown

- **Example**

1. The AP-105 has an IP address of 172.18.163.144
2. There is a laptop with IP address 172.18.164.171 and has Wireshark 1.7.0 and listening on port 5000
3. The syntax specifies 1 for the last value because it is telling the AP to send the frames in AIROPEEK pcap format.

```
(Aruba3600) #pcap raw-start 172.18.164.144 172.18.164.171 5000 1  
pcap-id:1
```

# Useful Wireshark Display Filters



- **Show only 802.11 traffic**
  - wlan
- **Show 802.11 traffic to/from a client**
  - wlan.addr==<mac address>
- **Hide (or show) beacon frames**
  - wlan.fc.type\_subtype != 0x08 / wlan.fc.type\_subtype == 0x08
- **Show management frames for a specific SSID**
  - wlan\_mgt.ssid == "SSID\_NAME"
- **Show everything except beacon and ACK frames**
  - (!wlan.fc.type\_subtype == 0x08) && (!wlan.fc.type\_subtype == 0x1d)

# Back to Basics



# Essential Elements of Healthy RF



Signal Strength

Low Interference



Client NIC



Good Noise Floor

Channel Utilization



# What Affects Signal Strength?



- **AP Characteristics**

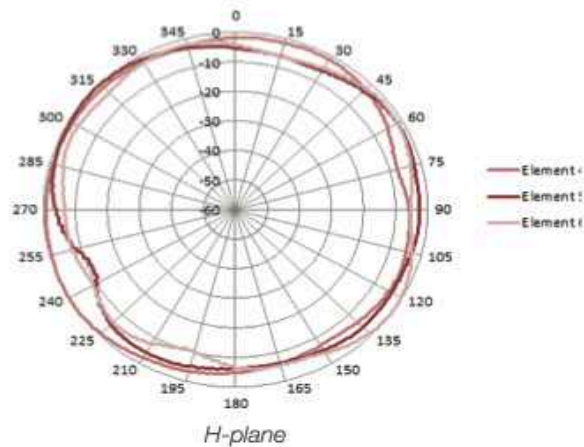
- Number and type of Radios (a/b/g/n)
- Max Tx Power
- Receive Sensitivity
- Number of Spatial Streams
- Antenna – Internal/External
- Antenna Pattern
- Number of clients supported

**APs are not created equal**  
**Choose the right AP for the occasion**

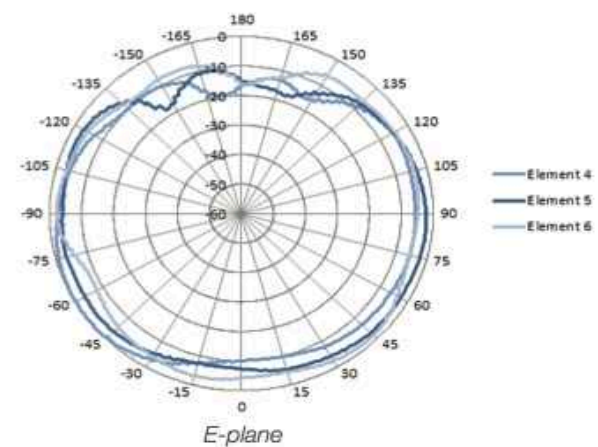
# AP-135 Antenna Pattern

## AP-135 ANTENNA PATTERN PLOTS

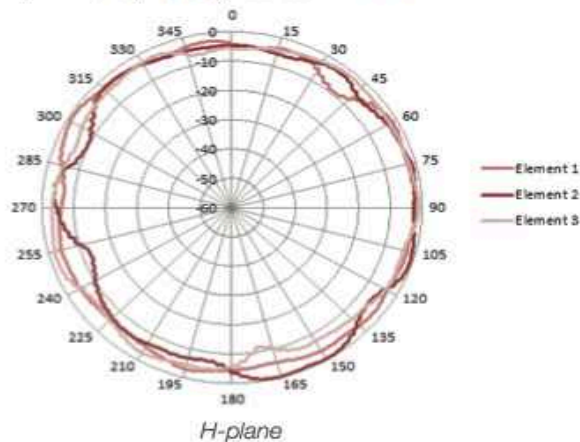
2.450 GHz, H-Plane, 20 degrees down-tilt



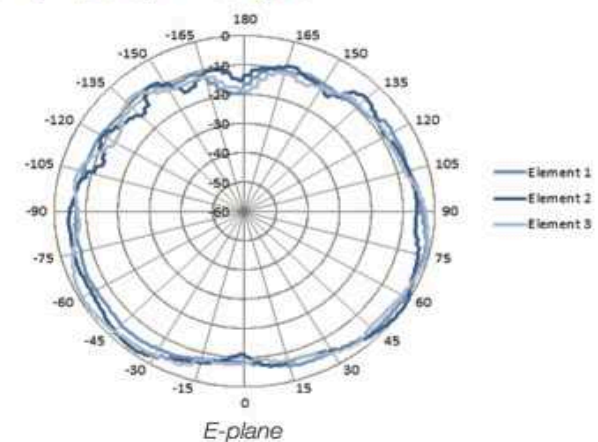
2.450 GHz, E-plane, AP facing down



5.500 GHz, H-Plane, 20 degrees down-tilt

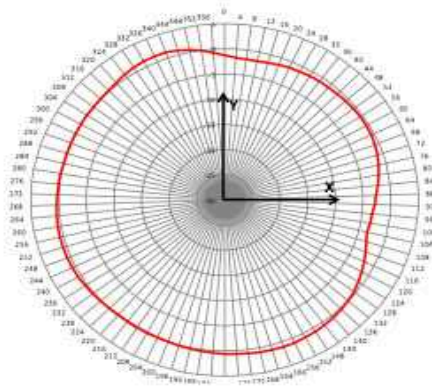
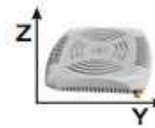
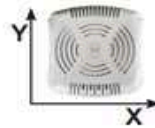


5.500 GHz, E-plane, AP facing down

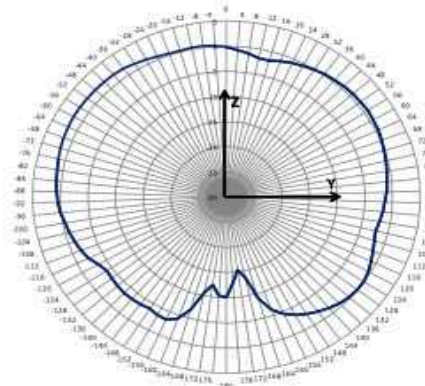


# AP-93 Antenna Pattern

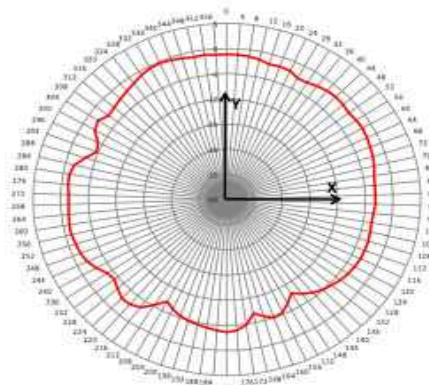
## ANTENNA PLOTS



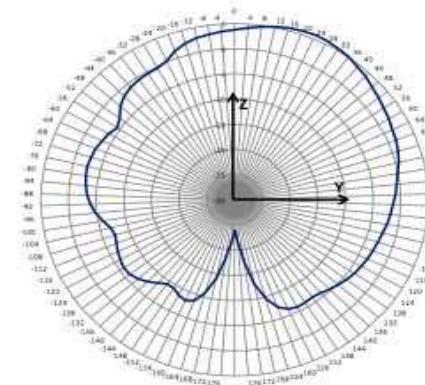
H-plane - 2.45 GHz



E-plane - 2.45 GHz



H-plane - 5.5 GHz



E-plane - 5.5 GHz

# What Affects Signal Strength?

## AP Radiated Power (EIRP)

= Radio Transmit Power (dBm)

+ Transmit Antenna Gain (dBi)

Antenna is **PASSIVE** – Does Not **ADD** energy  
Higher Gain just means energy more focused  
**Not always** a good thing

- AP Regulatory Domain
- Country Code
- Radio Band (2.4GHz/5GHz)
- Channel (different channel has different allowed Max EIRP)



# What Affects Signal Strength?



- **Attenuation (Path Loss)**
  - Distance from AP/Line-of-sight
  - Building materials (walls, windows, partitions)
  - Furniture
  - People

**Client Received Power (dBm)**

= Radiated Power/EIRP (dBm)

- Path Loss (dB)

+ Receiver Antenna Gain (dBi)

# Attenuation of Common Building Material

	2.4GHz	5.0GHz
Fabric, blinds, ceiling tiles	~1dB	~1.5dB
Interior drywall	3-4 dB	3-5 dB
Cubicle wall	2-5 dB	4-9 dB
Wood door (Hollow – Solid)	3-4 dB	6-7 dB
Brick/Concrete wall	6-18 dB	10-30 dB
Glass/Window (not tinted)	2-3 dB	6-8 dB
Double-pane coated glass	13 dB	20 dB
Steel/Fire exit door	13-19 dB	25-32 dB



# Noise, Interference, and SNR

.... Signals are **corrupted** so they don't make sense to the receiver ...

- **Noise**
  - **Random** 'background' that has got mixed up with your signal. Usually doesn't vary too much over time.
- **Interference**
  - **Additional** signals are added to the one you want. Can be intermittent or persistent.

# Source of Interference

## 802.11 Source

- Your own APs (over-designed)
- Somebody else's APs (neighbor)
- Municipal Wi-Fi Network
- iPhone Personal Hotspots
- Clients connected to other's APs
- Faulty Clients

## Non 802.11 Source

- Blue-tooth (headset, keyboards, mouse, modem)
- Microwave Oven
- Cordless phones, mouse
- Very strong out-of-band source (GSM tower)
- Baby monitor
- WiMax (2.5GHz)
- ZigBee (802.15.4)
- Video or security cameras
- Faulty anything

# Signal to Noise Ratio (SNR)



**SNR is not actually a ratio**

**SNR = Signal (Received Power) – Noise floor**

**Assume:**

**Signal received is -65 dB; Noise floor is -85 dB**

**SNR = -65 – (-85) = 20**

**A minimum of 25-30 is essential to decode high 11n data rate**

**SNR determines the ability of wireless devices to demodulate data rates**

## Legacy SNR Table

Rate (Mbit/s)	1	2	5.5	11	6	9	12	18	24	36	48	54
Noise (dBm)	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85	-85
SNR (RSSI) (dB)	4	6	8	10	4	5	7	9	12	16	20	21
Signal Level (dBm)	-81	-79	-77	-75	-81	-80	-78	-76	-73	-69	-65	-64

**802.11n data rates are dependent not only on SNR, but on error rates and the ability to support multiple spatial streams in the environment**

**There isn't one table to display 11n data rates like there is for legacy data rates**

**A rough guideline is that a minimum SNR of 30 dB is necessary to demodulate higher 802.11n data rates**

**35 dB will be required for higher 11ac data rates**