Aruba Product Wireless Diagnostics

- Focus on Roaming and Throughput

Aruba Product Wireless Diagnostics

Focus on Roaming and Throughput

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#ArubaAirheads

Content

Critical Principles

Basic Diagnostics

Aruba Product Diagnostics

Roaming Symptoms

Throughput Symptoms

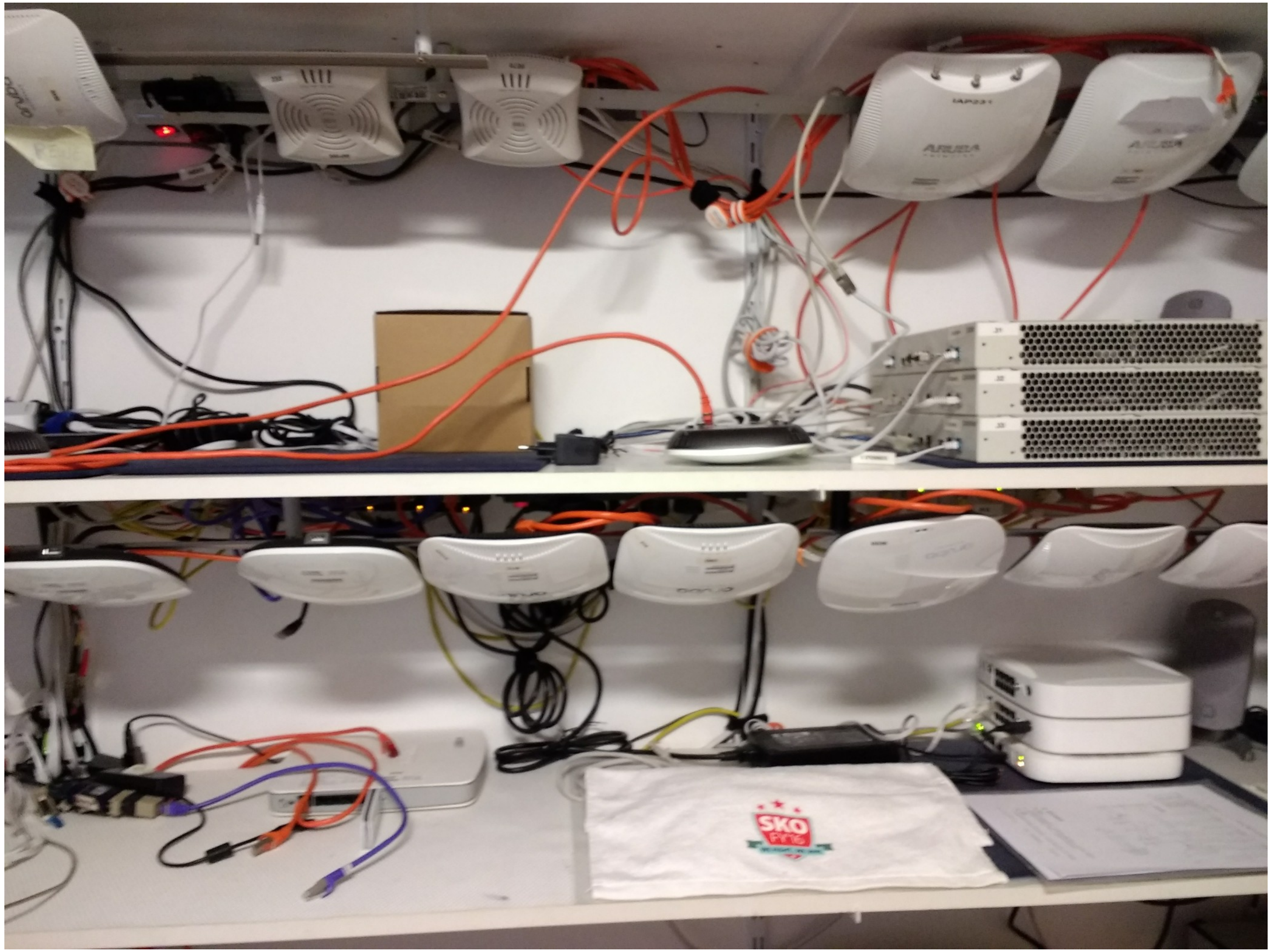
Critical Principles

Fact and Realities

Critical Principles

"it's just like Ethernet, without the wire"

Critical Principles – Perspective and Reality



- “If it’s wireless, how come there are so many cables?”
- Wireless is replacing a low-variable cable
- with a high-variable medium:
  - People
  - Obstacles
  - Air (free space)
- 802.11 is not simple…

Critical Principles

Because the casual user cannot see, touch or otherwise perceive 802.11, mythology contradicts reality:

Mythology: (definition)

"a popular belief or assumption that has grown up around someone or something"

"Her Internet is faster than mine!"

"If it's wireless, how hard can it be not to install the wires?"

"The network is making the clients roam badly !"

"My old, outdated client should work better with a new 802.11ac network !"

"Modern 802.11 clients are built to roam perfectly in all possible environments"

"But it worked with the old network !"

Prepare to defeat mythology with facts

Critical Principles

"To be prepared is half the victory"
Miguel De Cervantes

"In preparing for battle I have always found that plans are useless, but planning is indispensable. "
Dwight D. Eisenhower

"If you fail to plan, you are planning to fail!"
Benjamin Franklin & Others

Are we properly prepared to retrieve files from a controller ?
Guide the customer toward meaningful acceptance testing ?

Critical Principles - Summary

802.11 brings mobility, but at the cost of complexity

802.11 is not Ethernet (but we can apply the same visualization in some cases)

STA are responsible for at least 50% of the equation

Prepare well to visualize the Facts efficiently

Basic Diagnostics

Review of Diagnostic Methodology

Basic Diagnostics

Visualizing the Failure Path

Basic Diagnostics

– "Identification of a condition, disease, disorder, or problem by systematic analysis of the background or history, examination of the signs or symptoms, evaluation of the research or test results, and investigation of the assumed or probable causes"

– Principles of Diagnostics (review)

- What changed ?
- Key isolating/critical questions
- Types of Data
- Establish shortest failure path (cut the circuit in half)
- Isolate horizontally and vertically

Recall school courses on troubleshooting and problem solving theory – what have you applied and found useful in practice ?

Basic Diagnostics

– Critical/Isolating Questioning

- What breaks ? How can we visualize the symptom ? (ICMP echo ?)
- When did the problem start ? What changed at or near that time ?
- WIFI and wired ?
- 5Ghz and 2.4Ghz ?
- Specific client device type ? (upgrade drivers !!!)
- Specific AP or Physical Area ?
- Stationary or Roaming ?
- Is the AP stable ? (ARM channel changes, noise floor ?)
- Are the symptoms reproducible at will ?
- Duration and frequency of occurrence ?

Basic Diagnostics

– Types of Data

Live Data – Obtained during the event/symptom – only depicts current situation

– Historical Data – Obtained after the event – depicts data before,during and after event (?)

– Static Data – Facts that do not change irrespective of symptoms (controller HW, SW version)

– Dynamic Data – Facts that change dependent on symptoms (ICMP fails, voice call breaks)

– Multi-Dimensional Data – Facts that are most meaningful when correlated with other facts

- 802.11 client with **high drop rates**, even better is to know if **SNR** is low at the **time**
- Client disconnections **correlated with authentication failures**
- WIFI client frame loss **when there is no frame loss on the wired path**

Basic Diagnostics – One possible Visualization Model

– Visualizing the failure path

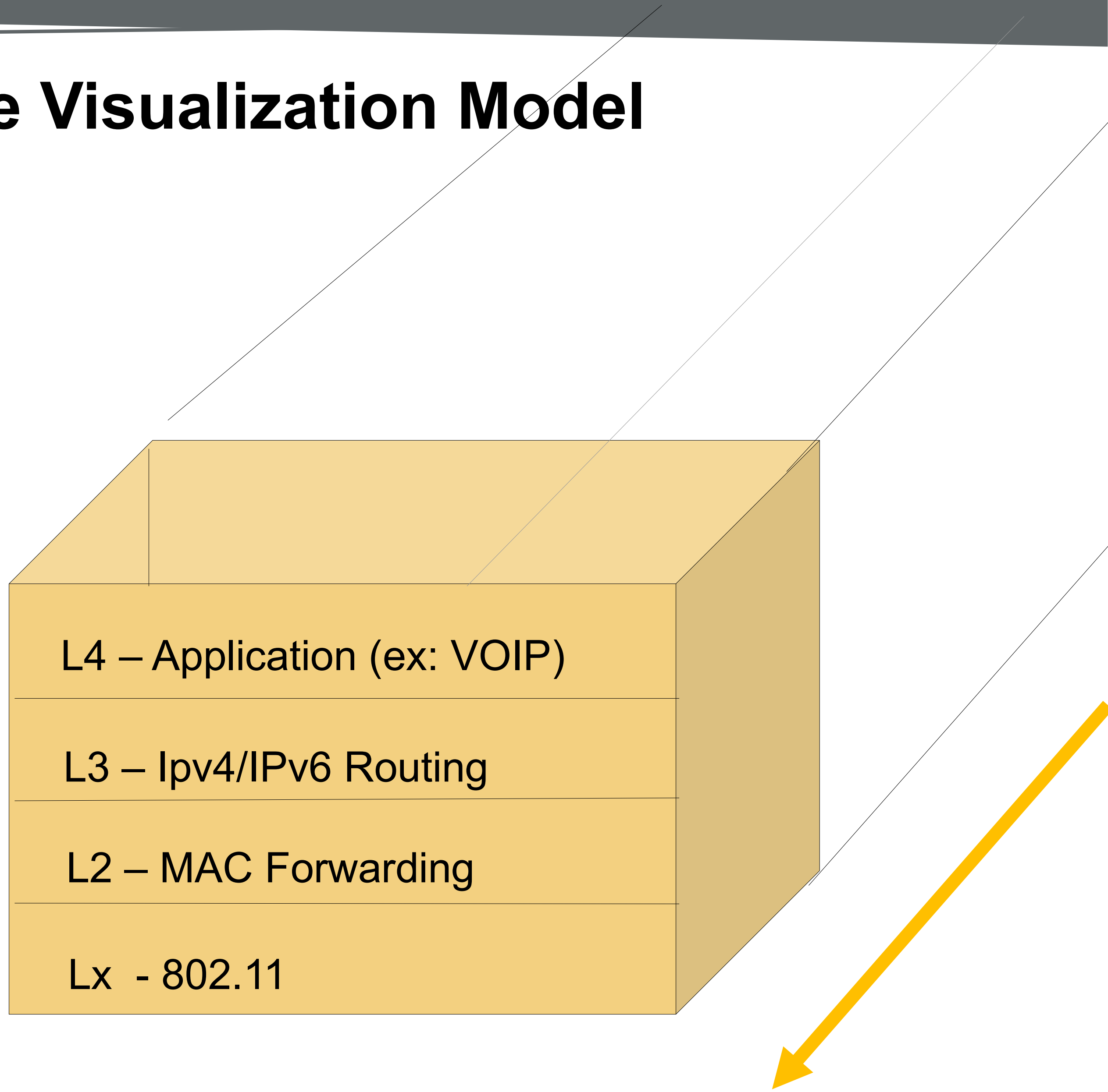
- Horizontal – the logical/Physical path
- Vertical – OSI 7 Layer stack (until further notice)

ICMP echo ?

ARP/Routing Tables?

FDB/Bridge Table ?

Association/Station Tables

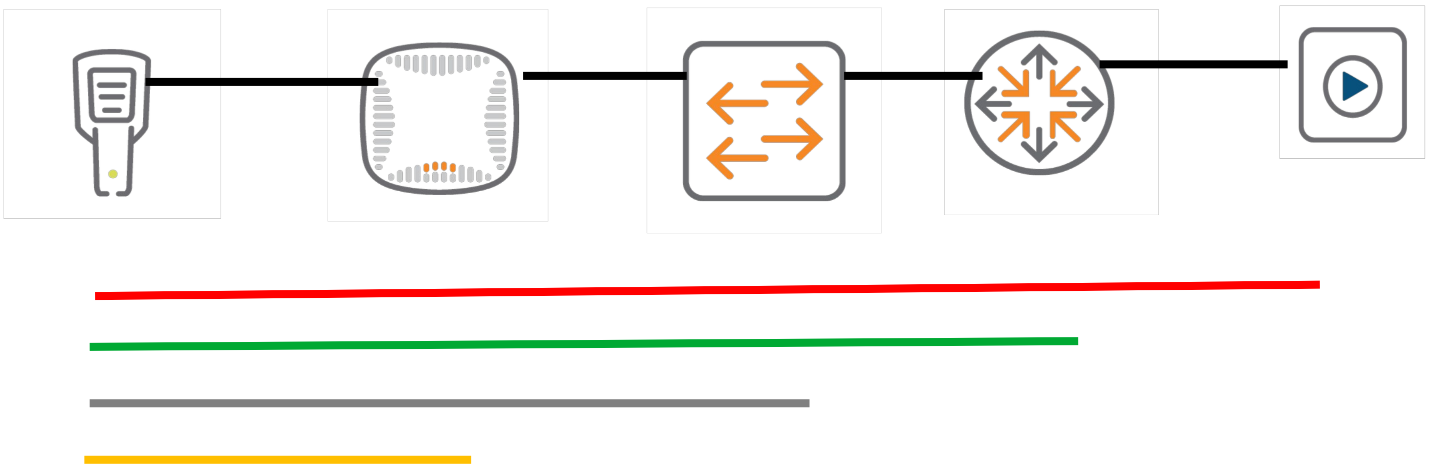


Are there other visualization approaches proven useful ?

Basic Diagnostics

– Visualizing the failure path

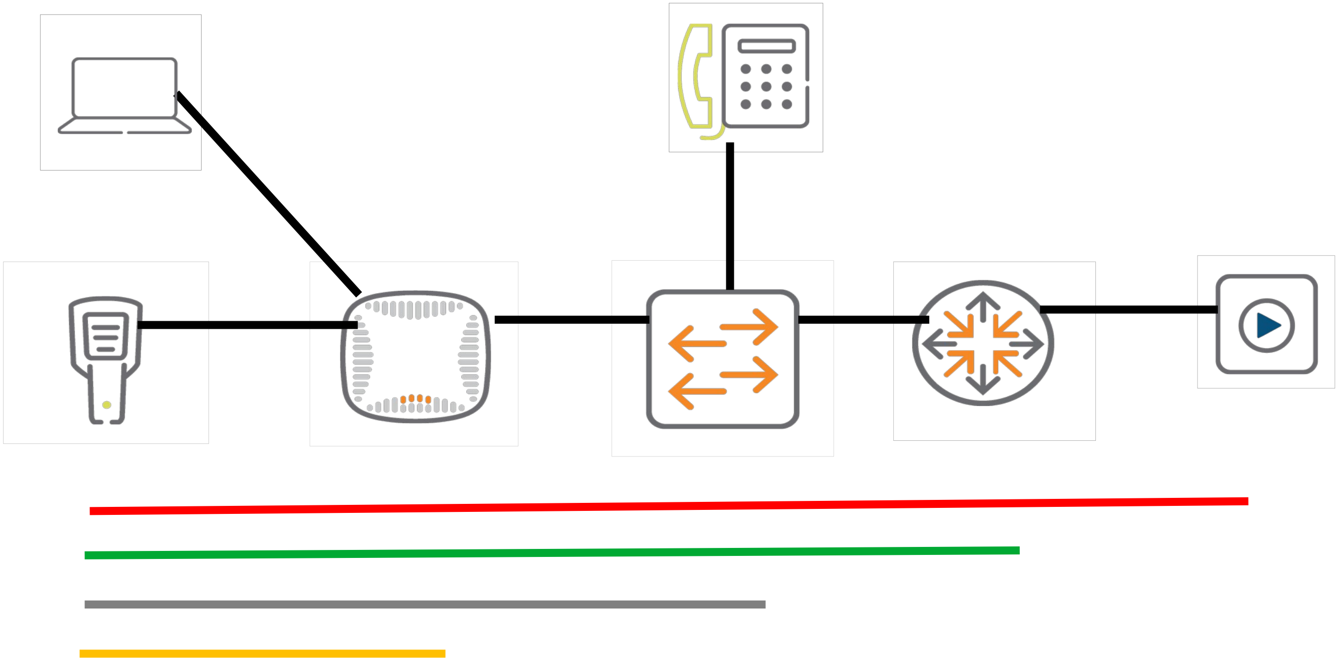
- 802.11 from AP to Controller
- Tunnel mode - Encryption from client to controller
- L2 to Router
- L3 beyond Router
- L4 on top



Basic Diagnostics

– Visualizing/simplifying the failure path - „cut the circuit in half“

- Replacement Methods
- Injection Methods
- Reproduction Methods



Basic Diagnostics - Summary

Visualize
Reality
Prepare
Types of Data

Visualize the network/symptoms vertically and horizontally

Isolating Questions

Reduce to shortest Failure Path

Utilize replacement/injection/reproduction methods

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What can the equipment tell us ?

Aruba Product Diagnostics

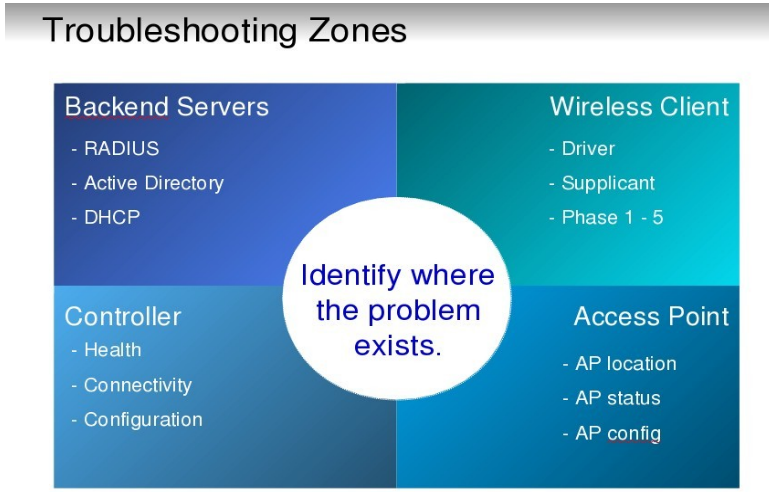
How We Visualize

Aruba Product Diagnostics

– Sources of Data – Monitoring Systems – Airwave – Central – IMC – start at the top, wider view

– Controller/Virtual Controller

- Dashboard Data – short term history
- MM/MD/Controller tech-support Bundle (tar logs tech-support)
- datapath/controlpane packet-capture
- AP Tech-support
- AP Spectrum data/replays
- AP Packet capture



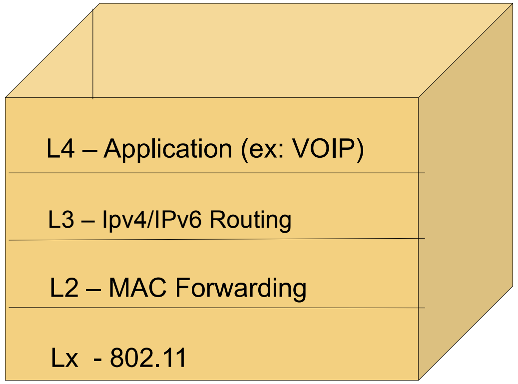
– Apply thinking to data gathered:

- Does the data visualize the symptom ?
- Actual or historical Data ?
- Multi-dimensional/dependent Data ?

Aruba Advanced Troubleshooting Course – Recommended !

Aruba Product Diagnostics

Layer 4	Application	show airgroup	show ucc client	show ucc call cdr
		show datapath sess	show datapath dpi	
Layer 3	IPv4,IPv6,	show ip int	show ip route	show arp*
	Routing	show datapath route		
Layer 2	L2, FDB, STP	show datapath bwm	show datapath debug dma	show spann
	VLANS	show datapath bridge	show trunk	
Layer 1	Physical	show port	show switches	show cpu details
		show mem	show interface	



airheads TECH TALK LIVE

Aruba Product Diagnostics – Command Lists

Prepare CLI „script“ command lists for a given symptom

An example used for client disconnect/roaming symptoms:

show tech-support user <mac> <filename>

show ap association | inc <client mac>
show ap association client <client mac>

show ap remote debug mgmt- client <client mac>
show ap debug client-table ap-name <apname. | inc <client mac>
show ap debug client-stats <client mac>

show ap client trail client <client mac>
Show auth mac <client mac>

show user-table verbose | inc <client mac>

Aruba Product Diagnostics – Command Lists

An example used for controller overload conditions:

show datapath frame 10

show datapath bwm

show firewall | inc Rate

show datapath cp-bwm

show cpuload current

show datapath message-queue

show datapath utilization

AirRecorder experience ?

Aruba Product Diagnostics

– Remote Sessions - Add Aruba support to your „Virtual support team“

– Majority of sessions show improvement potential

– Better success noted when Local resources take ownership and leadership of remote session

– Require a plan in advance, be prepared - some actions require preparation/permissions

- Port mirror
- Packet Capture & related Sniffer PCs
- Client reproduction - Client logging enabled
- SSH/HTTPS controller connection – temporary passwords ?
- File Download from network devices, upload to Aruba/HPE

Narrate/Summarize steps – define further actions

Coffee Breaks

Experiences and thoughts on remote access ?

Gather helpful data when engaging Aruba/HPE Support

– Minimal data that should be gathered to help report a problem for quick resolution
  – Answers to the critical/isolating questions
  – Controller tech-support (tar logs tech-support)
  – AP tech-support (Example AP - before/After diffs are helpful)
  – user tech-support (basic client info)

– Augmenting or focused data
  – Airwave RF and Client health report for the specified problem report
  – Relative syslog messages
  – AP remote packet capture if it is a reproducible connectivity problem
  – Network Diagrams or Drawings depicting failure path

Examples of multi-dimensional data ?

Aruba Product Diagnostics - Summary

Visualize Reality
Prepare
Types of Data

Vertical and Horizontal
Isolating questions
Reduce path

Utilize central Monitoring information sources – Airwave, IMC, syslog/trap servers

Gather basic operational information, augment with focused data

Use Remote access efficiently

Establish realistic and usable problem reporting process

Make Aruba Support part of the solution team

Roaming Symptoms

"The AP tells my smartphone to be stupid"

Roaming Symptoms

Multiple Moving Parts/Multi-dimensional

Roaming Defined

802.11 STA moves from one BSSID within the ESSID to another BSSID

Time between last ACKd data frame over BSSID_1 and the 1st ACKd data frame over BSSID_2

Could be considered when data is sent and recieved from upstream network

– Authentication adds delay - 10-600ms (worst-case - full RADIUS exchange)

– DHCP may play a role

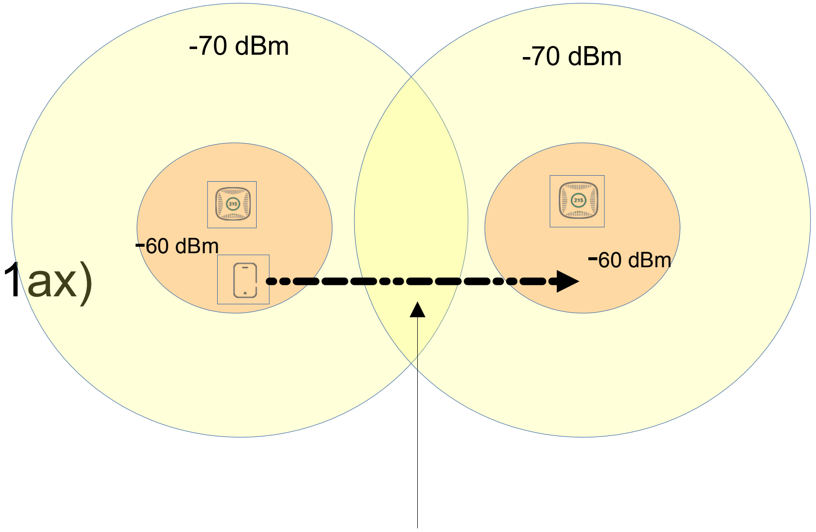
– Network Learning L2 and L3 may play a role

– VOIP will suffer if any roam produces frame loss or delay > 150ms

– Difficult to guarantee that at least one frame will not be seriously delayed/lost between

– BSSID_1 and BSSID_2 - if using ICMP to measure, the simple test is maximum 1 frame lost

When to Roam?



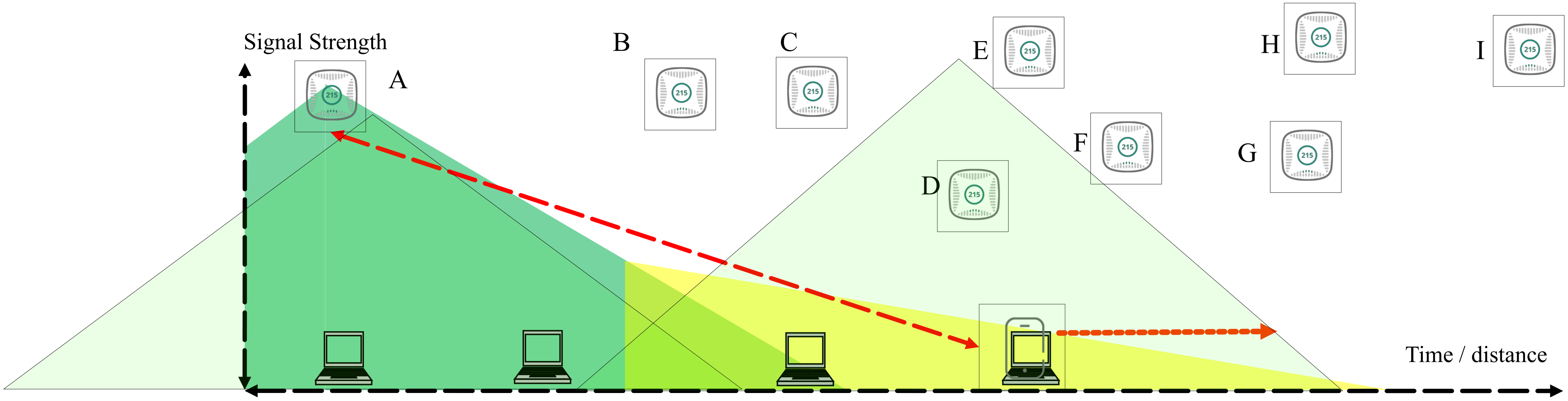
– What is the desired mobile device roaming behavior?
– The STA is solely responsible for the ultimate roaming decision (11ac/11ax)
– No standard clearly identifies or mandates roaming behavior
– Clients choose to roam based on all, some, or none of the following:
  – Current AP signal strength
  – Passive Probe listening methods
  – Active Probe Request methods
  – Channel noise, interference, utilization levels, Retries, Data Rates, Bit Error Rate
  – Signal strength of neighboring AP
  – Other unknown conditions decided upon by the client driver

Do these notes match your experience ?

Roaming Factors

– Probing Threshold - the earlier this happens, the better the roaming results
– Roaming Threshold - the earlier this happens, the better the roaming results
– Delta (hysteresis) - Received signal difference between better APs
– Scan time - Client needs sufficient time to find best APs
– Scan Interval - regular passive scans ? on demand ?
– Potential AP table space/sorting
– Hidden SSID
– DFS Channels - Must hear before active probing on DFS channel
– Number of Channels - takes longer to probe all possible Aps
– Scan patterns, static channel plans

When to Roam?



SNR=15, RSSI= -75dBm, Retry Rate <15%,Drop Rate < 10%

But what if the client doesn’t send probe requests or authentication requests until -75dBm ?
Applications are already likely suffering degradation

Client chooses to roam too late – degradation already present

Causes of poor Roaming Behavior

Old wireless NIC drivers (outdated regulatory DB, poor roaming algorithm)

Non-default wireless NIC configuration (i.e. roaming aggressiveness / power-save)

Non-default OS configuration (i.e. power save mode)

Incorrect Controller/AP configuration

– AP transmit power is too high

– All 802.11 data rates enabled

– Protocols or features enabled that many devices don't support

– Too Many strong signals – client never hits roaming threshold

– Sub-optimal AP mounting

  - vertical stacking in multi-floor building
  - Antenna orientation
  - Poor placement choice - obstacles

Roaming Goals & Objectives

- Provide Best Possible Roaming experience – consider weakest client/sensitive applications
- Latency One-way Delay <50ms
- Round Trip Delay < 100 ms between STA and STA
- Jitter < 50ms (some documents state < 10ms)
- Packet Loss < 1% (5% can be tolerable in some networks)
- Consecutive lost packets < 3

- Provide clean RF field for STA to roam before service degredation occurs
- Primary and secondary coverage
- Add improvements through 802.11k, 802.11r

VOIP frames are more frequent than one per second

Visualizing Roaming

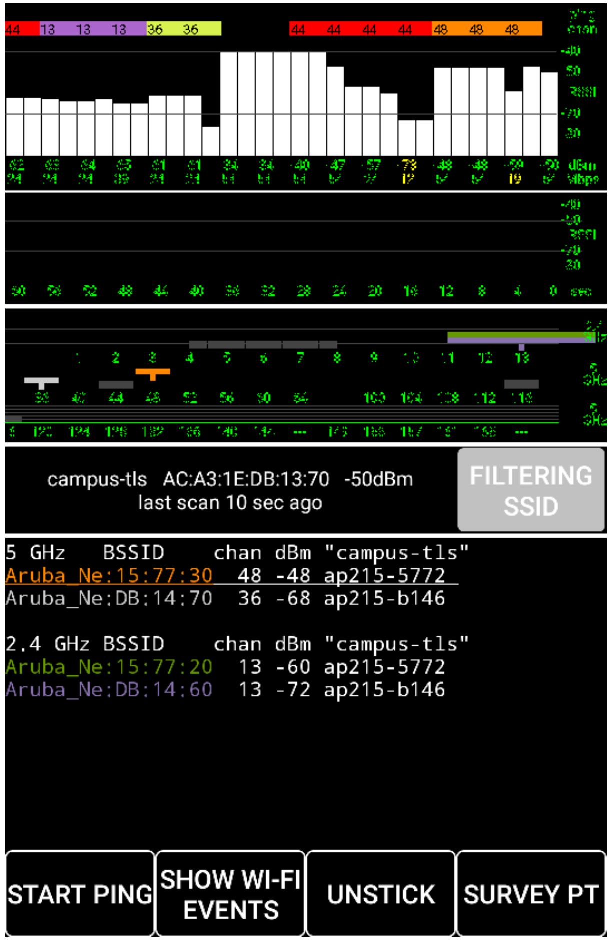
– Visualize Horizontal – simplify the path – avoid wandering around the coverage zone
  - Visualize from client and DS perspective
  - Most roaming issues can be demonstrated with 2 APs and 20m

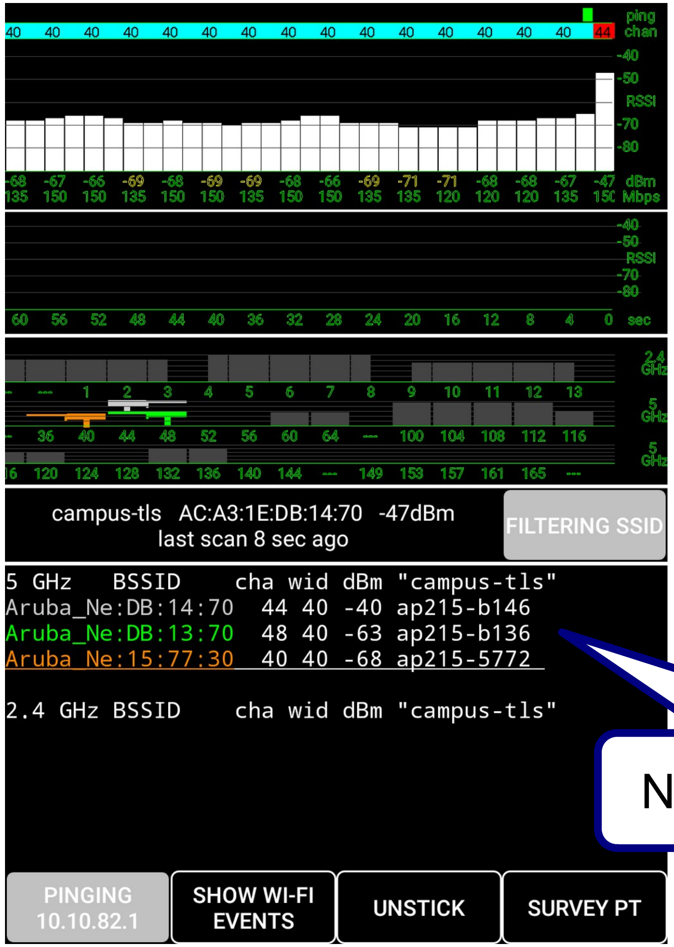
– Visualize Vertical – 802.11, Auth, L2, L3 – Multi-dimensional Data

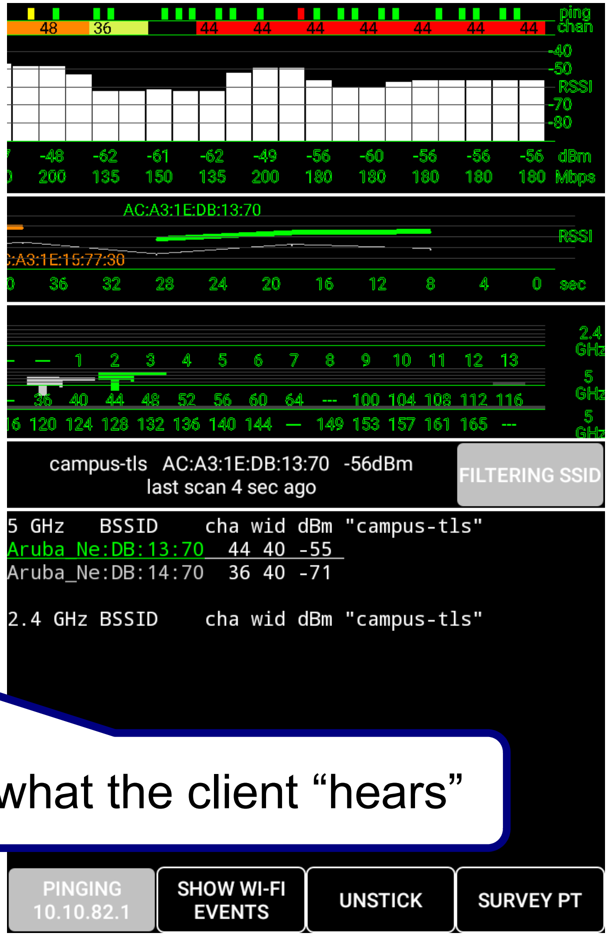
– Visualize effect of symptoms – ICMP echo ?

– Logs and user-debug show the events, but not what happens between events
  - Start with the events
  - Proceed to what happens between

Visualizing Roaming – on the ground







Note what the client "hears"

Departure SNR and better choice APs

Visualizing Roaming

– Always examine the connection from the perspective of the client and the AP/controller
– Begin categorization with the client in a stationary position
– Controlled roaming tests examining both sides of the connection
– Remain aware of data types – live and historical, static and multi-dimensional

Controller Commands

Show ap association client-mac <client mac>
Show ap debug client-table ap-name <apname> | inc <client mac>
Show ap debug client-stats <client mac>
Show ap remote debug mgmt
Show auth
Show ap client trail <client mac>
Show ap virtual-beacon-report client-mac <client mac>
Show user-table verbose

IAP Commands (note : some commands function only on the IAP where the client is actually connected)

Show ap association
Show ap debug client-table
Show ap debug client-stats
Show ap debug radio-stats radio X
Show ap debug mgmt
Show client table
Show ap client trail

Detailed View of Wireless Device's 802.11 Connection Status-CLI

(MC-LOCAL-1) #**show ap debug client-table ap-name** f0:5c:19:c0:bf:ba

```
Client Table
------------
MAC              ESSID   BSSID            Assoc_State  HT_State  AID  PS_State    UAPSD          Tx_Pkts  Rx_Pkts  PS_Qlen  Tx_Retries  Tx_Rate  Rx_Rate  Last_ACK_SNR  Last_Rx_SNR  TX_Chains
Tx_Timestamp             Rx_Timestamp             MFP Status (C,R)  Idle time  Client health (C/R)
---              -----   -----            -----------  --------  ---  --------    -----          -------  -------  -------  ----------  -------  -------  ------------  -----------  ---------  ------------  ----------------  ---------  -------------------
a4:84:31:fb:e3:66  k-tele  f0:5c:19:8b:fb:b1  Associated  WQSs  0x1  Power-save  (0,0,0,0,N/A,0)  2152  14478  0  290  72  72  33  34  3[0x7]  Wed Mar  1 11:14:35 2017  Wed Mar  1
11:14:36 2017  (0,0)  1  86/85


Client Table
------------
MAC              ESSID   BSSID            Assoc_State  HT_State  AID  PS_State    UAPSD          Tx_Pkts  Rx_Pkts  PS_Qlen  Tx_Retries  Tx_Rate  Rx_Rate  Last_ACK_SNR  Last_Rx_SNR  TX_Chains
Tx_Timestamp             Rx_Timestamp             MFP Status (C,R)  Idle time  Client health (C/R)
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a4:84:31:fb:e3:66  k-tele  f0:5c:19:8b:fb:b1  Associated  WQSs  0x1  Power-save  (0,0,0,0,N/A,0)  2152  14478  0  290  72  72  33  34  3[0x7]  Wed Mar  1 11:14:35 2017  Wed Mar  1
11:14:36 2017  (0,0)  1  86/85


a4:84:31:fb:e3:66  k-tele  f0:5c:19:8b:fb:b1  Associated  WQSs  0x1  Awake  (0,0,0,0,N/A,0)  2154  14490  0  290  72  43  19  22  3[0x7]  Wed Mar  1 11:14:37 2017  Wed Mar  1
11:14:37 2017  (0,0)  0  86/85


a4:84:31:fb:e3:66  k-tele  f0:5c:19:8b:fb:b1  Associated  WQSs  0x1  Power-save  (0,0,0,0,N/A,0)  2155  14498  0  290  72  72  17  19  3[0x7]  Wed Mar  1 11:14:38 2017  Wed Mar  1
11:14:39 2017  (0,0)  1  86/85


a4:84:31:fb:e3:66  k-tele  f0:5c:19:8b:fb:b1  Associated  WQSs  0x1  Power-save  (0,0,0,0,N/A,0)  2156  14513  0  291  72  6  7  6  3[0x7]  Wed Mar  1 11:14:40 2017  Wed Mar  1
11:14:40 2017  (0,0)  0  86/85
```

If you memorize one Aruba CLI command – this is it !

Roaming Symptoms - Summary

Many roaming problems occur when the client decides to roam too late or simply make poor choices

Establish client behavior stationary, then move to roaming tests

Reduce to shortest failure path possible

Visualize client’s view on the ground – departing SNR, alternative AP s in the area

Critical to differentiate vertically between 802.11, auth, and higher layer symptoms

Throughput Symptoms

“But the advertisement said 1.3Giga-somethings ?”

Throughput Symptoms

Validating Expectations

MCS	Modulation	Bits per Symbol	Coding Ratio	1 Spatial Stream		2 Spatial Streams		3 Spatial Streams		4 Spatial Streams	
				SGI	No SGI	SGI	No SGI	SGI	No SGI	SGI	No SGI
MCS 0	BPSK	1	1/2	6.5	7.2	13.0	14.4	19.5	21.7	26.0	28.9
MCS 1	QPSK	2	1/2	13.0	14.4	26.0	28.9	39.0	43.3	52.0	57.8
MCS 2	QPSK	2	3/4	19.5	21.7	39.0	43.3	58.5	65.0	78.0	86.7
MCS 3	16-QAM	4	1/2	26.0	28.9	52.0	57.8	78.0	86.7	104.0	115.6
MCS 4	16-QAM	4	3/4	39.0	43.3	78.0	86.7	117.0	130.0	156.0	173.3
MCS 5	64-QAM	6	2/3	52.0	57.8	104.0	115.6	156.0	173.3	208.0	231.1
MCS 6	64-QAM	6	3/4	58.5	65.0	117.0	130.0	175.5	195.0	234.0	260.0
MCS 7	64-QAM	6	5/6	65.0	72.2	130.0	144.4	195.0	216.7	260.0	288.9
MCS 8	256-QAM	8	3/4	78.0	86.7	156.0	173.3	234.0	260.0	312.0	346.7
MCS 9	256-QAM	8	5/6	N/A	N/A	N/A	N/A	260.0	288.9	N/A	N/A

Throughput Symptoms

Hey man, where‘s my bandwidth ?

AP and Client Maximum theoretical TX and RX Rate – at the moment, and start subtracting:

- actual data TX rate – varies by frame – AP and STA rates are asynchronous
- 802.11 Contention time
- 802.11 overhead – control frames
- retries/drops (and uncalculable effect on TCP or UDP)
- Channel Width adjustments
- jumbo frames or not ?

= 802.11 bits

- TCP/IP overhead (or UDP)
- TCP ACKs
- TCP retransmissions
- client/server system variances

= Application throughput (often ~ 60% of the theoretical maxumum)

VALIDATED REFERENCE DESIGN

VERY HIGH-DENSITY 802.11ac NETWORKS

Theory Guide

Version 1.0

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Throughput Symptoms

Why is Wired Bandwidth Fixed but Wireless Bandwidth Varies?
- 802.11 is cool, but costs...

Wired networks have a fixed relationship between bandwidth and time. Wired interfaces send at well-known, fixed PHY rates: 10 Gbps, 1 Gbps, DS-3, T-1, and so on. Furthermore, most wired network topologies are:

* Effectively point-to-point (for example, switched Ethernet and fiber links)

* Ethernet is usually Full duplex

* Collision-free due to lack of contention and direct medium sensing

* Free from external interference

* Served by aggregating equipment at all layers (access, distribution, or core) with considerably higher backplane bandwidth than any individual interface.

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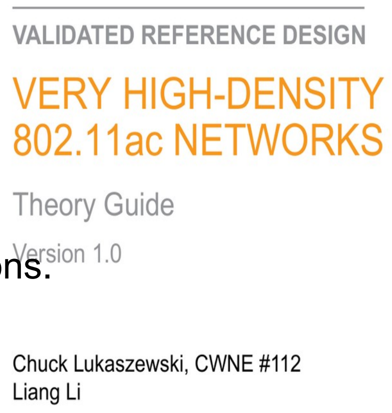
Throughput Symptoms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WIFI (802.11) ?

A radio channel is hub, not a switch. It is shared between all users who can hear one another's transmissions.

* Only one transmission is allowed at any one time in the same RF collision domain.

* Collisions cannot be directly sensed, so a listen-before-talk method must be used, which consumes time (reduces capacity).

* Protocol overhead to take control of the channel reduces the usable capacity. This overhead can vary with load and external interference.

* The data rate for any single data frame payload can vary by over 2 orders of magnitude based on a **dizzying array of criteria** (for example, from 6 Mbps to 1.3 Gbps).

* The maximum data rate of a given client varies widely based on the capabilities of its hardware (principally its Wi-Fi generation and number of spatial streams).

* All transmissions must be acknowledged or they are assumed to have failed. ACK,RTS,CTS, sounding frames are sent at a very low data rate, which reduces overall channel efficiency.

* The result is that it is utterly impossible to know from a simple speed test result what the actual conditions of the test might have been.

Throughput Symptoms

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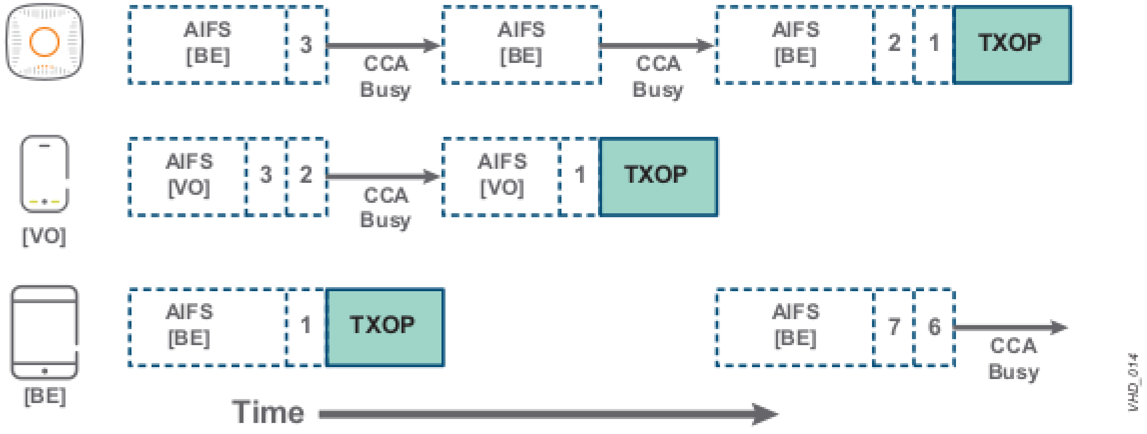
CSMA/CA - carrier sense multiple access with **collision avoidance**
- Full duplex Ethernet does not need to avoid collisions…

Collision Domain
- Aps and Clients – clients move !

Preamble Rate vs. Payload Rate
- Each frame that is transmitted by a Wi-Fi radio is sent at two different data rates.
  Legacy and VHT preambles – Required to be sent at 6 Mbps BPSK rate
  PHY Service Data Unit (PSDU) payload – Sent at chosen data payload rate

How much airtime does it cost to transmit X Data payload ?
- Idle + Idle-Arbitration + Busy(transmitting)

90-byte TCP ack @ 1SS VHT20 @ MCS8 (86.7Mbps)
Requires 8.3µs
The preamble requires 44µs
Most of the airtime is not data – it's preamble



Throughput Symptoms

MAC Unit	Payload Bytes	Payload Bits	Data Rate	µsec	% Airtime with CSMA	% Airtime TXOP Only
AIFS[BE]				43.0	14.5%	
Contention Window [BE]				72.0	23.9%	
Legacy Preamble			6 Mbps	20.0	6.7%	10.9%
RTS	20	160	24 Mbps	6.7	2.2%	3.6%
SIFS				16.0	5.4%	8.8%
Legacy Preamble			6 Mbps	20.0	6.7%	10.9%
CTS	14	112	24 Mbps	4.7	1.6%	2.6%
SIFS				16.0	5.4%	8.8%
Legacy Preamble			6 Mbps	20.0	6.7%	10.9%
VHT Preamble			6 Mbps	24.0	8.1%	13.1%
A-MPDU	94	752	86.7 Mbps	8.7	2.9%	4.7%
SIFS				16.0	5.4%	8.8%
Legacy Preamble			6 Mbps	20.0	6.7%	10.9%
Block Ack	32	256	24 Mbps	10.7	3.6%	5.8%
Total Airtime including CSMA		**1,280**		**297.7**	**100.0%**	**100.0%**
Effective TXOP rate including CSMA				**4.3**		

Total Airtime for TXOP only	**182.7**
Effective TXOP data rate for TXOP only	**7.0**

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Liang Li

Throughput Symptoms

Factors affecting throughput:

Collision Domain – AP and clients avoid collision – one TX at a time
- unless the AP and client are in an RF chamber – we are not testing one AP

Preamble Rate vs. Payload Rate
– not all frames/not the entire frame at max rate

Payload overhead
- most of the „bits“ in the air are not payload
- Rocket example
- 802.11 bits are not TCP bits

Control Frame overhead - Control/basic rates take airtime“

VALIDATED REFERENCE DESIGN

VERY HIGH-DENSITY 802.11ac NETWORKS

Theory Guide

Version 1.0

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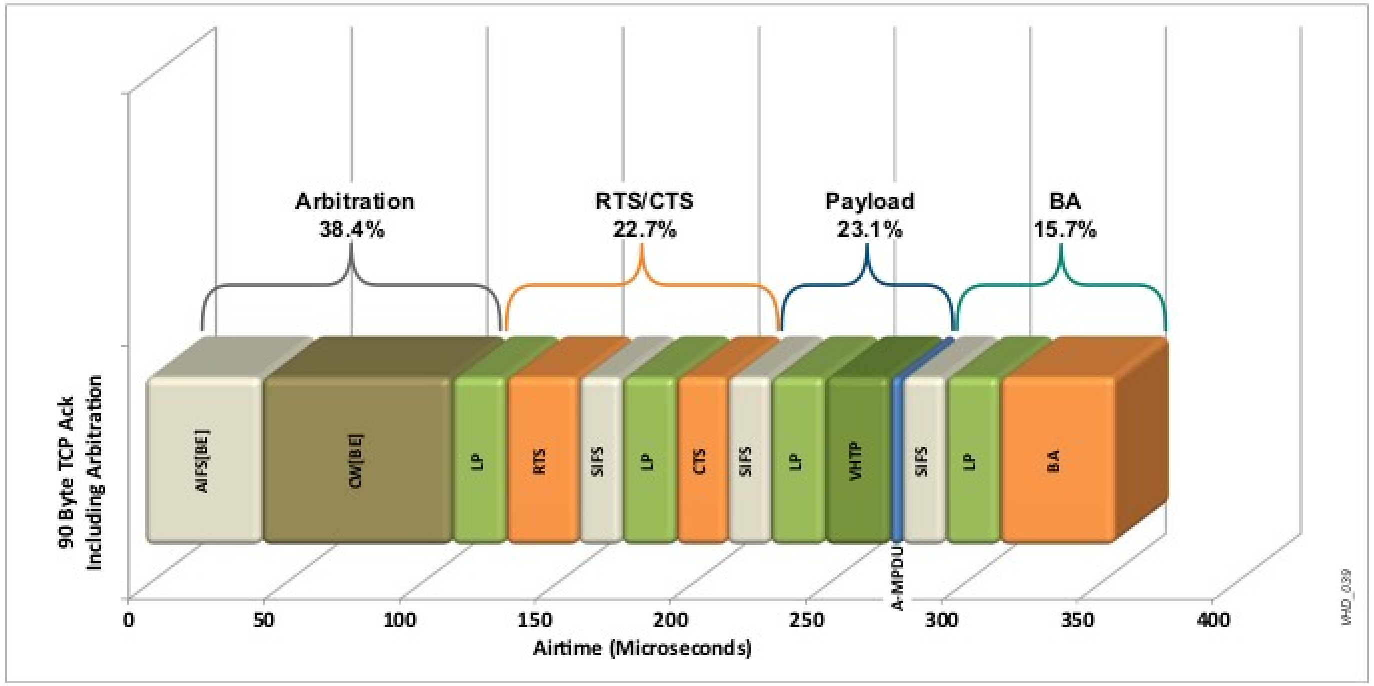


Throughput Symptoms

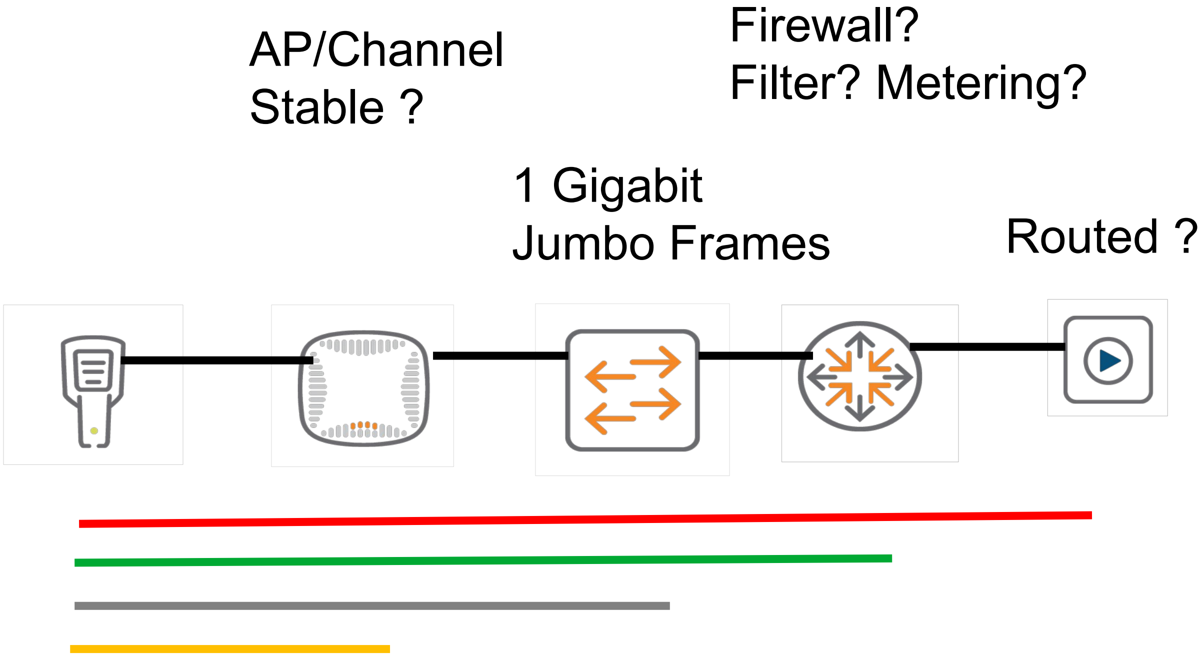
Determine the true path

Reduce path to L2 - Reduce path to shortest possible

Eliminate all external influences

Estimate STA current capabilities

Contrast Radio utilization v.s. STA interface frames v.s. application throughput

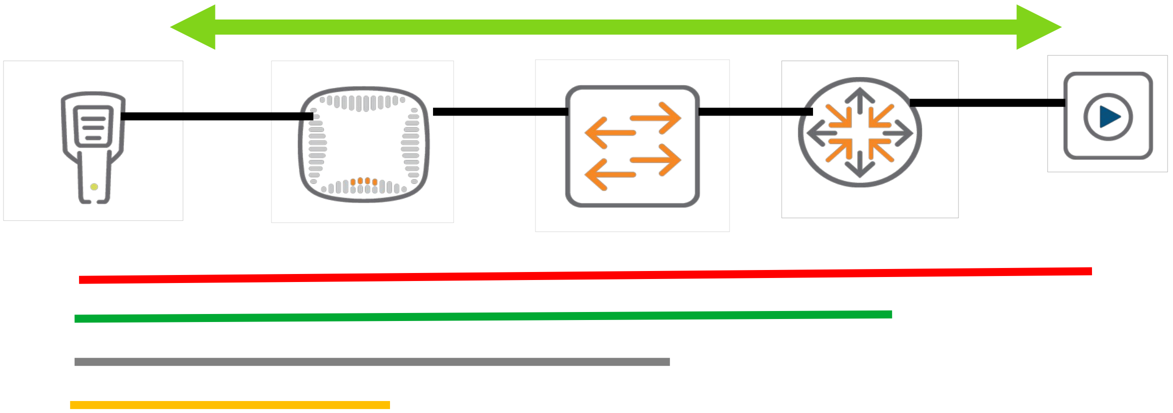


Throughput Symptoms

UDP is uni-directional at L3/4, but 802.11 still requires ACK at L2 back to sender

UDP – watch for „offered load“ - like pouring water into a bottle – too much in, greater loss

TCP requires ACK at L4
- can we calculate the number of TCP ACKS required ?
- Really appropriate for throughput measurement ?



airheads TECH TALK LIVE

Throughput Symptoms

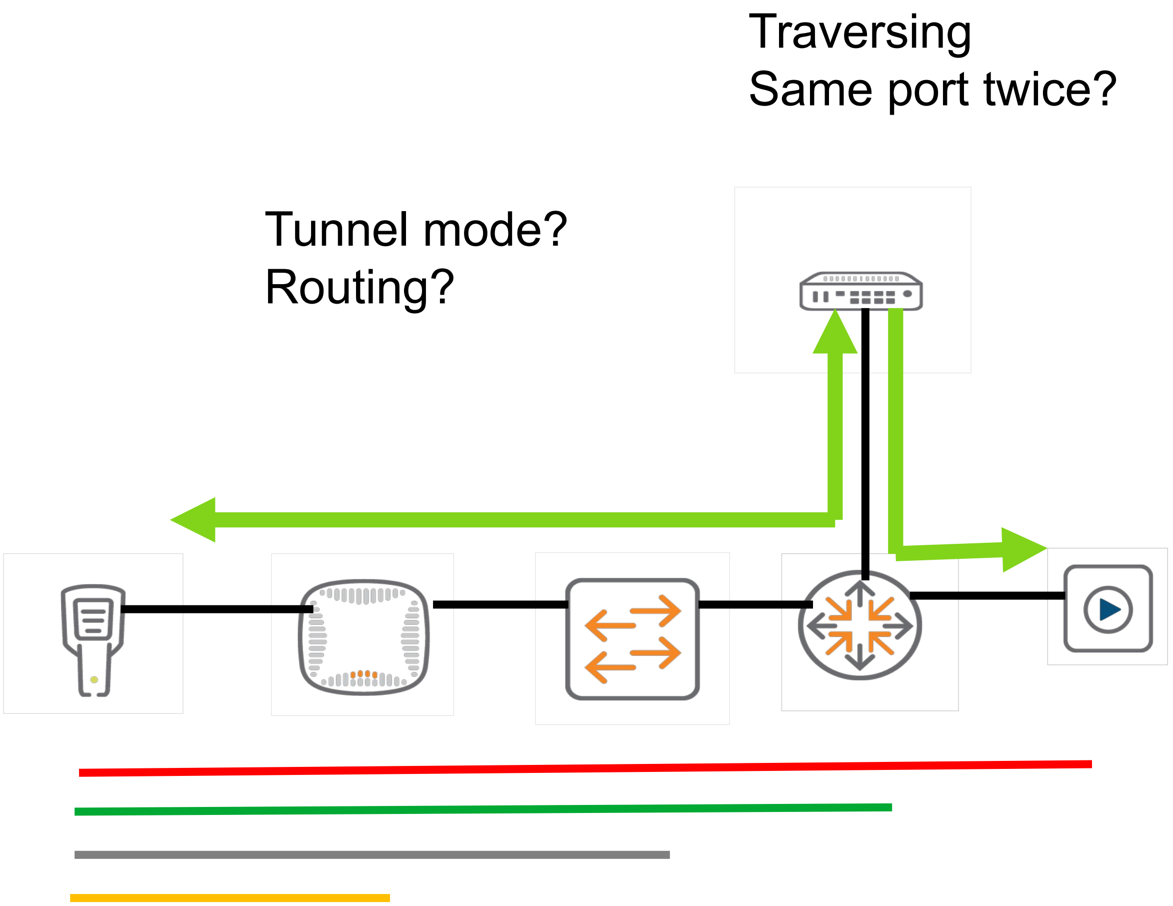
Verify Ethernet port flow-control

Verify Ethernet path MTU

Account for Tunnel-mode

Account for Routing hops

Verify Controller datapath load



Throughput Symptoms

– Validate each step in the path AP to controller, controller to server, STA to controller, STA to server

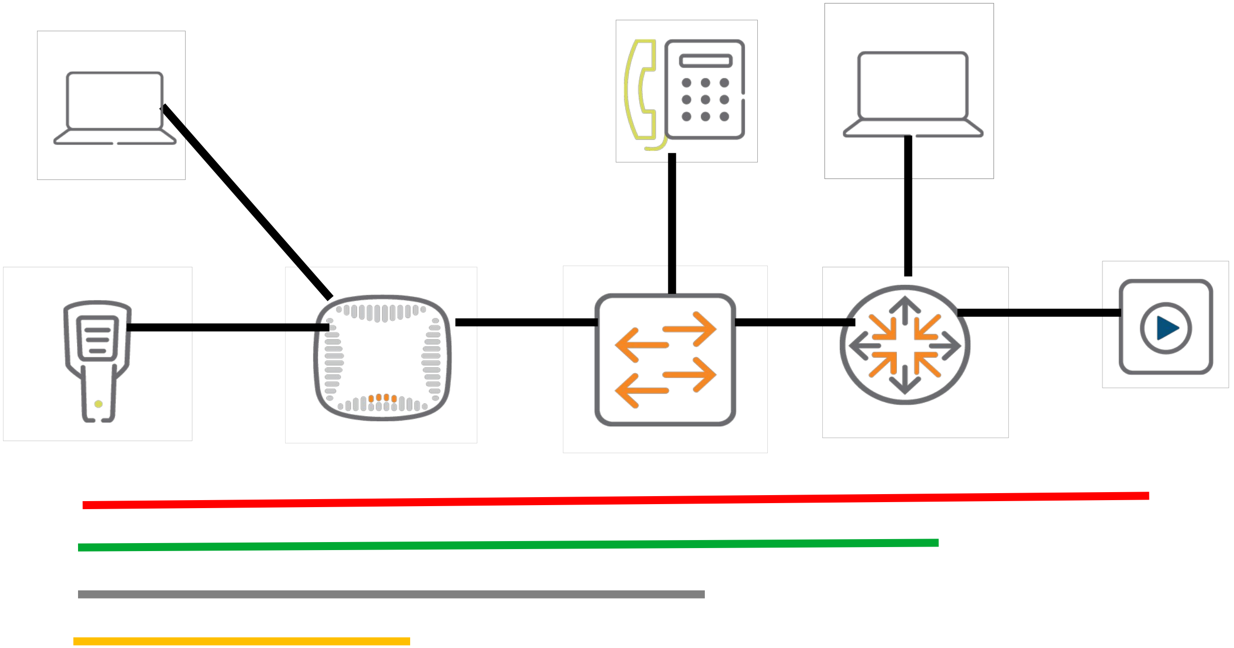
– Differentiate between 802.11 and wired path

– Controller/AP perf-test are usable as a quick “sanity check”.

– better results from purpose-built tools

– smaller controllers: ~300Mbps max.

– default CP firewall metering watch out !



Throughput Symptoms – Controller Information

```
(DE-cx7008-1) *#show interface gigabitethernet 0/0/0

GE 0/0/0 is up, line protocol is up
Hardware is Gigabit Ethernet, address is 20:4C:03:0A:A1:E1 (bia 20:4C:03:0A:A1:E1)
Description: GE0/0/0 (RJ45 Connector)
Encapsulation ARPA, loopback not set
Configured: Duplex ( AUTO ), speed ( AUTO )
Negotiated: Duplex (Full), speed (1000 Mbps)
Jumbo Support is enabled on this interface MTU 9216
Last clearing of "show interface" counters 22 day 1 hr 5 min 43 sec
link status last changed 22 day 1 hr 0 min 42 sec
    64353698 packets input, 17227387340 bytes
    Received 13170783 broadcasts, 0 runts, 2982 giants, 0 throttles
    0 input error bytes, 0 CRC, 0 frame
    8123360 multicast, 51182915 unicast
    50663142 packets output, 11226901479 bytes
    0 output errors bytes, 0 deferred
    0 collisions, 0 late collisions, 0 throttles
This port is TRUSTED
POE Status of the port is OFF
```

Throughput Symptoms – Controller Information

(DE-cx7008-1) *#show firewall-cp

CP firewall policies

IP Version	Source IP	Source Mask	Protocol	Start Port	End Port	Action	hits	contract
ipv4	any		6	2126	2126	Permit	0	
ipv4	any		6	5001	5001	Permit	1	
ipv4	**any**		**17**	**5001**	**5001**	**Permit**	**155647**	
ipv6	any		0	0	65535	Deny	0	
ipv6	any		6	2126	2126	Permit	0	
ipv6	any		17	49170	49200	Permit	0	
ipv4	any		17	1900	1900	Permit	6	
ipv4	any		17	5999	5999	Permit	0	

Throughput Symptoms – Controller Information

```
(DE-cx7008-1) *#show datapath bwm

Datapath Bandwidth Management Table Entries
-------------------------------------------
Contract Types :
   0 - CP Dos 1 - Configured contracts 2 - Internal contracts
------------------------------------------------
Flags: Q - No drop, P - No shape(Only Policed),
       T - Auto tuned
--------------------------------------------------------------------
Rate: pps - Packets-per-second (256 byte packets), bps - Bits-per-second
--------------------------------------------------------------------
      Cont                          Avail     Queued/Pkts
Type   Id    Rate       Policed      Credits    Bytes      Flags   CPU      Status
----  ----  ---------  ----------  -------  -----------   ------- -------  ------
0     1     9792 pps        399008      306       0/0            4       ALLOCATED
0     2     3936 pps             0      123       0/0            4       ALLOCATED
…


| 1            |      Rate limit Control-Plane bound untrusted unicast packets        |  untrusted-ucast  |
|              |      - Used to limit Web CC traffic to CP
```

Throughput Symptoms – Controller Information

```
(DE-cx7008-2) *#show datapath utilization

Datapath Network Processor Utilization
+------+-----+---------+---------+----------+
|     Cpu    | Cpu utilization during past  |
| Type |  Id |  1 Sec     4 Secs    64 Secs |
+------+-----+---------+---------+----------+
  SPGW |   3 |      1% |      1% |       1% |
    SP |   4 |     33% |     34% |      27% |
   DPI |   5 |      0% |      0% |       0% |
    FP |   6 |      0% |      0% |       0% |
    FP |   7 |     71% |     71% |      46% |

Datapath CPU Allocation Summary
  Slow Path (SP) : 1,  Slow Path Gateway (SPGW) : 1
  Fast Path (FP) : 2,  Fast Path Gateway (FPGW) : 0
  DPI : 1, Crypto (CRYP) : 0
```

```
(DE-cx7008-2) *#  show log all 50 | include Resource
Sep 18 15:15:36  nanny[3162]: <399838> <3162> <WARN> |nanny|  Resource 'Controlpath CPU' has exceeded  45%  threshold (actual:52%).
Sep 18 15:16:37  nanny[3162]: <399838> <3162> <WARN> |nanny|  Resource 'Controlpath CPU' has dropped below  45%  threshold (actual:17%).
```

Throughput Symptoms – AP Information

```
(DE-cx7008-1) *#show ap port status ap-name  Lab3-ap345-58b4

AP "Lab3-ap345-58b4" Port Status (updated every 60 seconds)
-----------------------------------------------------------
Port  MAC                Type  Forward Mode  Admin    Oper  Speed  Duplex  802.3az  802.3bz  PoE  STP  Portfast  TX-Packets  TX-Bytes
 RX-Packets  RX-Bytes
----  ---                ----  ------------  -----    ----  -----  ------  -------  -------  ---  ---  --------  ----------  --------
 ----------  --------
0     38:17:c3:c1:58:b4  2.5G  N/A           enabled  down  N/A    N/A     N/A      N/A      N/A  N/A  N/A       0           0
 0           0
1     38:17:c3:c1:58:b5  GE    none          enabled  down  N/A    N/A     N/A      N/A      N/A  N/A  N/A       0           0
 0           0
```

```
(DE-cx7008-1) *#show ap debug port status ap-name  Lab3-ap345-58b4

AP "Lab3-ap345-58b4" Port Status
--------------------------------
Port  MAC                Type  Forward Mode  Admin    Oper  Speed   Duplex  802.3az  802.3bz  PoE  STP  Portfast  Loop-Protect
Storm-Control  TX-Packets  TX-Bytes  RX-Packets  RX-Bytes    Loop-Detection-TX  Loop-Detection-RX
----  ---                ----  ------------  -----    ----  -----   ------  -------  -------  ---  ---  --------  ------------
-------------  ----------  --------  ----------  --------    -----------------  -----------------
0     38:17:c3:c1:58:b4  2.5G  N/A           enabled  up    1 Gb/s  full    disabled N/A      N/A  N/A  N/A       OFF           OFF
          8792        2374776   1978165     1659902199  0                  0
1     38:17:c3:c1:58:b4  GE    N/A           enabled  down  N/A     N/A     N/A      N/A      N/A  N/A  N/A       OFF           OFF
          0           0         0           0           0                  0
```

Throughput Symptoms – AP Information

(DE-cx7008-1) *#show ap consolidated-provision info ap-name Lab3-ap345-58b4

ap name: Lab3-ap345-58b4
ipv4 address type: dynamic
ipv4 address: 10.0.103.114
ipv4 netmask: 255.255.255.0
ipv4 gateway: 10.0.103.34
ipv4 lease: 172800
ipv4 dhcp server: 192.168.17.31
ipv4 dns server: 192.168.17.52, 0.0.0.0
ipv6 address: none
master: 10.0.30.51
master discover type: Provisioned manually
previous lms: 10.0.30.51
lms addrs [0]: 10.0.30.51
lms addrs [1]: 10.0.30.52
lms addrs [2]: 10.10.10.51

Throughput Symptoms – Controller perf-test

Configure controller firewall-cp to allow desired frames

Conf t
firewall cp
ipv4 permit any proto 6 ports 5001 5001 position 1
end
write memory

Start iperf 2.x server on the Aruba Controller:

#perf_test server start controller tcp window 2M

On the wired PC or WIFI STA, start the iperf client:

iperf –c <Controller IP address> -P 4 –i 1 –w 2M

Display results on the Aruba Controller:

show perf-test reports controller

Throughput Symptoms – 802.11 STA Test

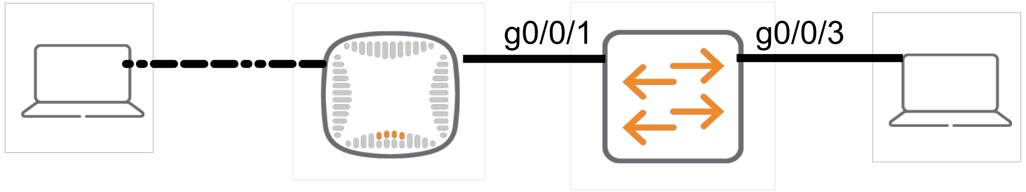
```
(DE-cx7008-2) *#show ap vht-rates bssid  70:3a:0e:88:53:70 | include SGI,8
AP "Lab3-ap315-8536" Radio 0 BSSID 70:3a:0e:88:53:70 Very-high-throughput Rates (Mbps)
MCS  Streams  20 MHz  20 MHz SGI  40 MHz  40 MHz SGI  80 MHz   80 MHz SGI  [160 MHz]  [160 MHz SGI]
0    1         6.5     7.2         13.5    15.0        29.3     32.5        [ 58.5]    [ 65.0]
7    2       130.0   144.4        270.0   300.0       585.0    650.0       [1170.0]   [1300.0]
8    2       156.0   173.3        324.0   360.0       702.0    780.0       [1404.0]   [1560.0]

(DE-cx7008-2) *#show ap association client-mac  ac:fd:ce:5e:af:a6

Association Table
-----------------
Name             bssid              mac                auth  assoc  aid  l-int  essid     vlan-id  tunnel-id    phy              assoc. time  num assoc  Flags  Band steer moves (T/S)  phy_cap
----             -----              ---                ----  -----  ---  -----  -----     -------  ---------    ---              -----------  ---------  -----  ---------------------    -------
Lab3-ap315-8536  70:3a:0e:88:53:70  ac:fd:ce:5e:af:a6  y     y      1    10     lab3-psk  130      0x10020      a-VHT-80sgi-2ss  9m:1s        1          WVAB   0/0                      a-VHT-80sgi-2ss-V


(DE-cx7008-2) *#show ap debug client-table ap-name  Lab3-ap315-8536 | include a6,SNR
MAC                ESSID     BSSID              Assoc_State  HT_State  AID  PS_State    UAPSD                 Tx_Pkts  Rx_Pkts  PS_Qlen  Tx_Retries  Tx_Rate  Rx_Rate  Last_ACK_SNR
Last_Rx_SNR  TX_Chains  Tx_Timestamp              Rx_Timestamp              MFP Status (C,R)  Idle time  Client health (C/R)
ac:fd:ce:5e:af:a6  lab3-psk  70:3a:0e:88:53:70  Associated   cWvSsEBbR  0x1  Power-save  (0,0,0,0,N/A,0)  1125     3314     0        511         526      866      45
41           4[0xf]     Fri Sep 20 12:51:59 2019  Fri Sep 20 12:51:59 2019  (0,0)             2          97/97
```

```
sadams@Tuxedo1:~$ iw wlp5s0 link
Connected to 70:3a:0e:88:53:70 (on wlp5s0)
        SSID: lab3-psk
        freq: 5785
        RX: 141072 bytes (511 packets)
        TX: 132902 bytes (641 packets)
        signal: -62 dBm
        tx bitrate: 780.0 MBit/s VHT-MCS 8 80MHz short GI VHT-NSS 2
        bss flags:      short-slot-time
        dtim period:    1
        beacon int:     100
```



iperf -c 10.0.130.103 -w 2M -P 10

iperf -s -w 2M -1

Path verified – STA operational TX/RX identified

Throughput Symptoms – 802.11 STA Test

```
sadams@Tuxedo1:~$ iperf -c 10.0.130.103 -w 2M -P 10
------------------------------------------------------------
Client connecting to 10.0.130.103, TCP port 5001
TCP window size:  416 KByte (WARNING: requested 2.00 MByte)
------------------------------------------------------------
[ 12] local 10.0.130.101 port 57642 connected with 10.0.130.103 port 5001
[  4] local 10.0.130.101 port 57624 connected with 10.0.130.103 port 5001
[  6]  0.0-10.0 sec  53.1 MBytes  44.4 Mbits/sec
[  5]  0.0-10.1 sec  51.5 MBytes  43.0 Mbits/sec
[ 11]  0.0-10.1 sec  5.25 MBytes  4.36 Mbits/sec
[SUM]  0.0-10.1 sec   525 MBytes   436 Mbits/sec
```

```
herz:~ # iperf -s -w 2M -1
------------------------------------------------------------
Server listening on TCP port 5001
TCP window size:  416 KByte (WARNING: requested 2.00 MByte)
------------------------------------------------------------
[  5] local 10.0.130.103 port 5001 connected with 10.0.130.101 port 57606
[ 12]  0.0-10.1 sec  54.0 MBytes  44.9 Mbits/sec
[  4]  0.0-10.1 sec  51.5 MBytes  42.8 Mbits/sec
[ 11]  0.0-10.1 sec  53.9 MBytes  44.8 Mbits/sec
[ 10]  0.0-10.3 sec  5.25 MBytes  4.28 Mbits/sec
[SUM]  0.0-10.3 sec   525 MBytes   428 Mbits/sec
```

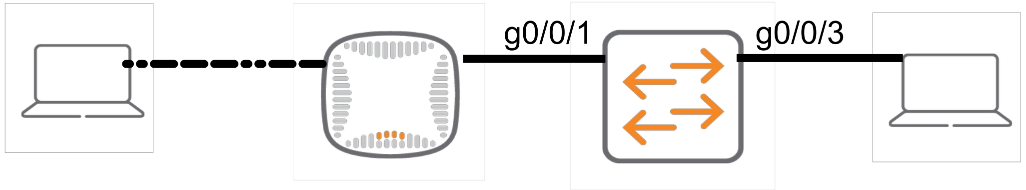
```
(DE-cx7008-2) *#show ap debug client-stats client-mac ac:fd:ce:5e:af:a6 advanced | include
Transmitted,Dropped,Retried,Received,VHT
Tx Frames Dropped              843
Tx Frames Transmitted          27967
Tx Bytes Transmitted           5141614
Tx Time Frames Dropped         2472
Tx Time Frames Transmitted     270788
Tx Data Transmitted Retried    6367                22% Retried
Tx Data Transmitted            27967
Tx Data Bytes Transmitted      5141614
Tx Time Data Transmitted       270788
Tx Dropped After Retry         0
Tx Dropped No Buffer           0
Tx VHT 468 Mbps                18442               65% transmitted at 468Mbps
Tx VHT 526.5 Mbps              9449
Tx VHT 585 Mbps                76
Tx WMM [BE] Dropped            103
Tx EAPOL Frames Dropped        0
Rx Frames Received             393210
Rx Data Frames Retried         13
Rx VHT 520 Mbps                130
Rx VHT 585 Mbps                9624
Rx VHT 650 Mbps                95002
Rx VHT 702 Mbps                7296
Rx VHT 780 Mbps                249771              63% received at 780Mbps
Rx VHT 866.7 Mbps              18479
SLB: Probe Requests Received   0
SLB: Probe Response Received   0
```

```
(DE-cx7008-2) *#show ap radio-summary ap-name  Lab3-ap315-8536

APs Radios information
----------------------
Name             Group  AP Type  IP Address    Band  Mode         EIRP/MaxEIRP  NF/U/I    TD            TM                     TC
----             -----  -------  ----------    ----  ----         ------------  ------    --            --                     --
Lab3-ap315-8536  Lab3   315      10.0.130.119  2.4   AP:HT:11     7.0/19.5      -94/15/2  0/0/0/33/0/0  100/100/100/66/100/100 0/0/0/0/0/0
Lab3-ap315-8536  Lab3   315      10.0.130.119  5     AP:VHT:157E  10.0/14.0     -92/16/1  0/0/0/70/67/0 0/0/0/29/31/0          0/0/0/0/0/0
```

AP radio 67-70% utilized with Data

AP radio 29-31% utilized with MGMT frames

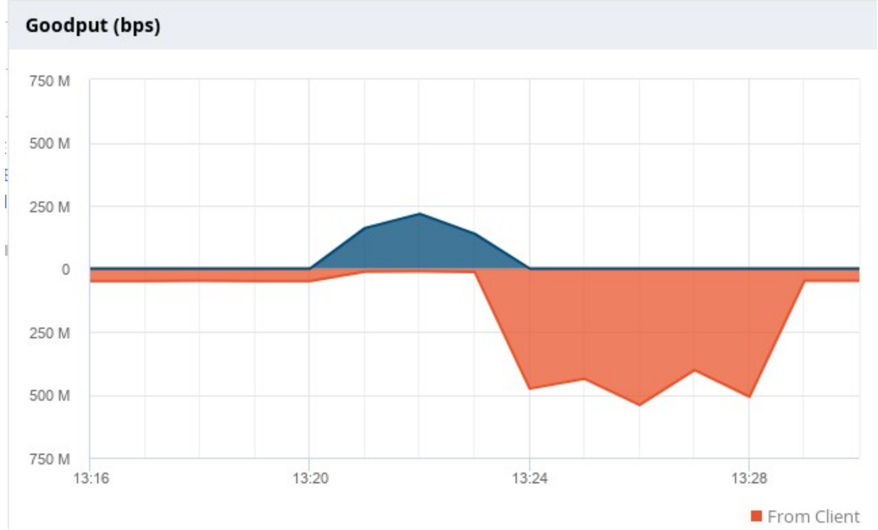


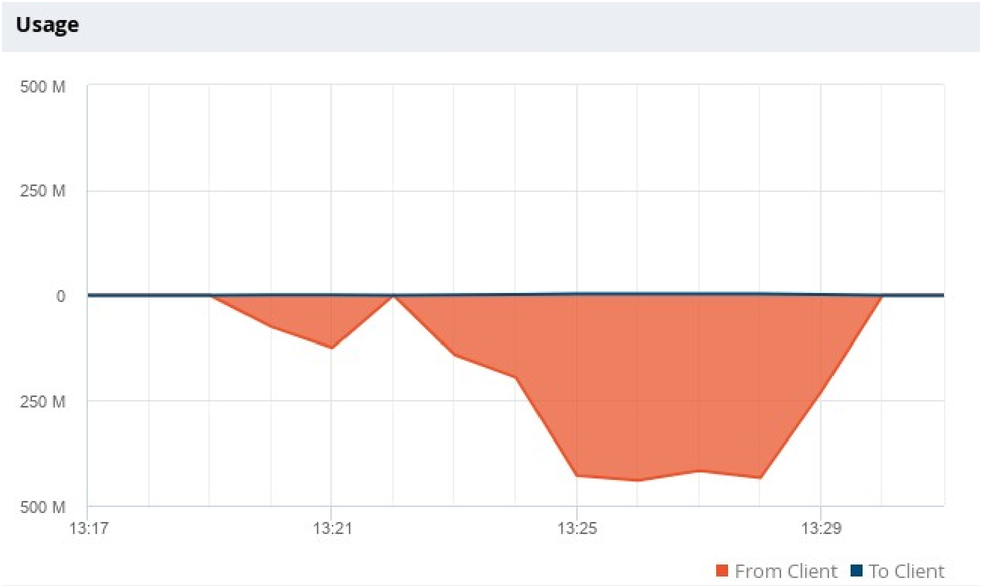
iperf -c 10.0.130.103 -w 2M -P 10

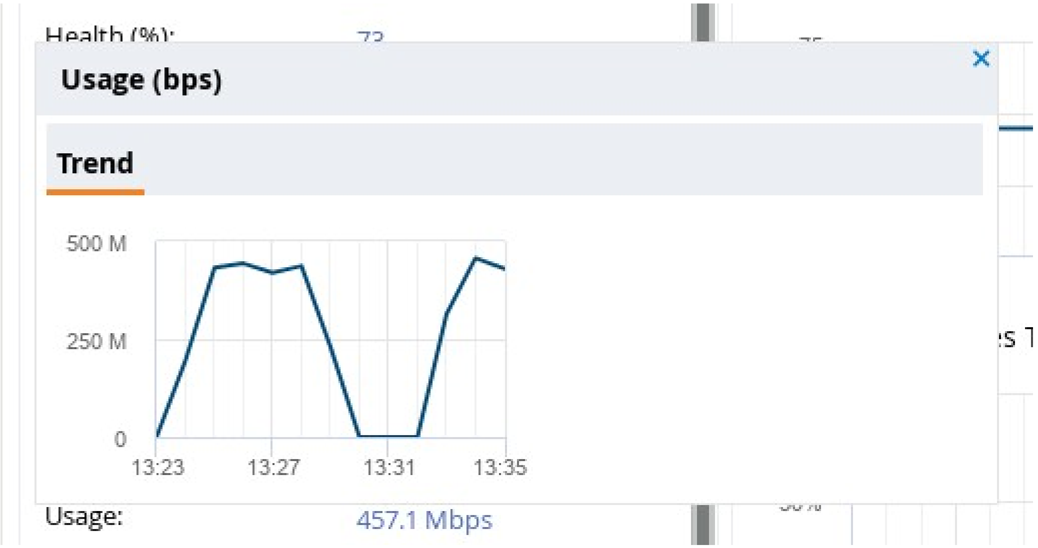
iperf -s -w 2M -1

Effects of MGMT frames, retries on the final result

Throughput Symptoms – 802.11 STA Test







Throughput Symptoms - Discussion

802.11 is shared media – the sender cannot always transmit at will – it must wait the contention time

802.11 bits are not the same as TCP (or UDP) bits – rocket payload principle

Speed tests often use buffering techniques, frame aggregation, client and server variances

Real-life networks generally use small frames < 500 bytes, performance test tools usually set this artificially

TCP requires bi-directional data frames/retry interaction

Expect approximately 60-70% of theoretical Maximum – divided by the number of clients

Which is more important ?
- Single STA, near perfect conditions attaining 700Mbps TCP throughput
- 4 STA In real-life daily conditions attaining 100Mbps TCP throughput each

Do I really want any given STA streaming 700Mbps upstream to my switches ? What about Multicast ?

Are such maximum throughput tests accurately Reflecting the reliability and service level of the Network ?

How valuable are such single-client max. throughput tests ?

Throughput Symptoms - Summary

Verify the test path carefully – Ethernet, flow control, routing

Establish realistic and meaningful acceptance tests

Experiment to remove client/server variances (threads, TCP window size, UDP offered load, UDP throttling)

Use Aruba 802.11 throughput calculator to estimate expected single STA throughput

Measure application throughput, and radio utilization

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airheads TECH TALK LIVE

Thank You