Roaming Behavior and Client Troubleshooting

Presented by
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About me

- Herman Robers
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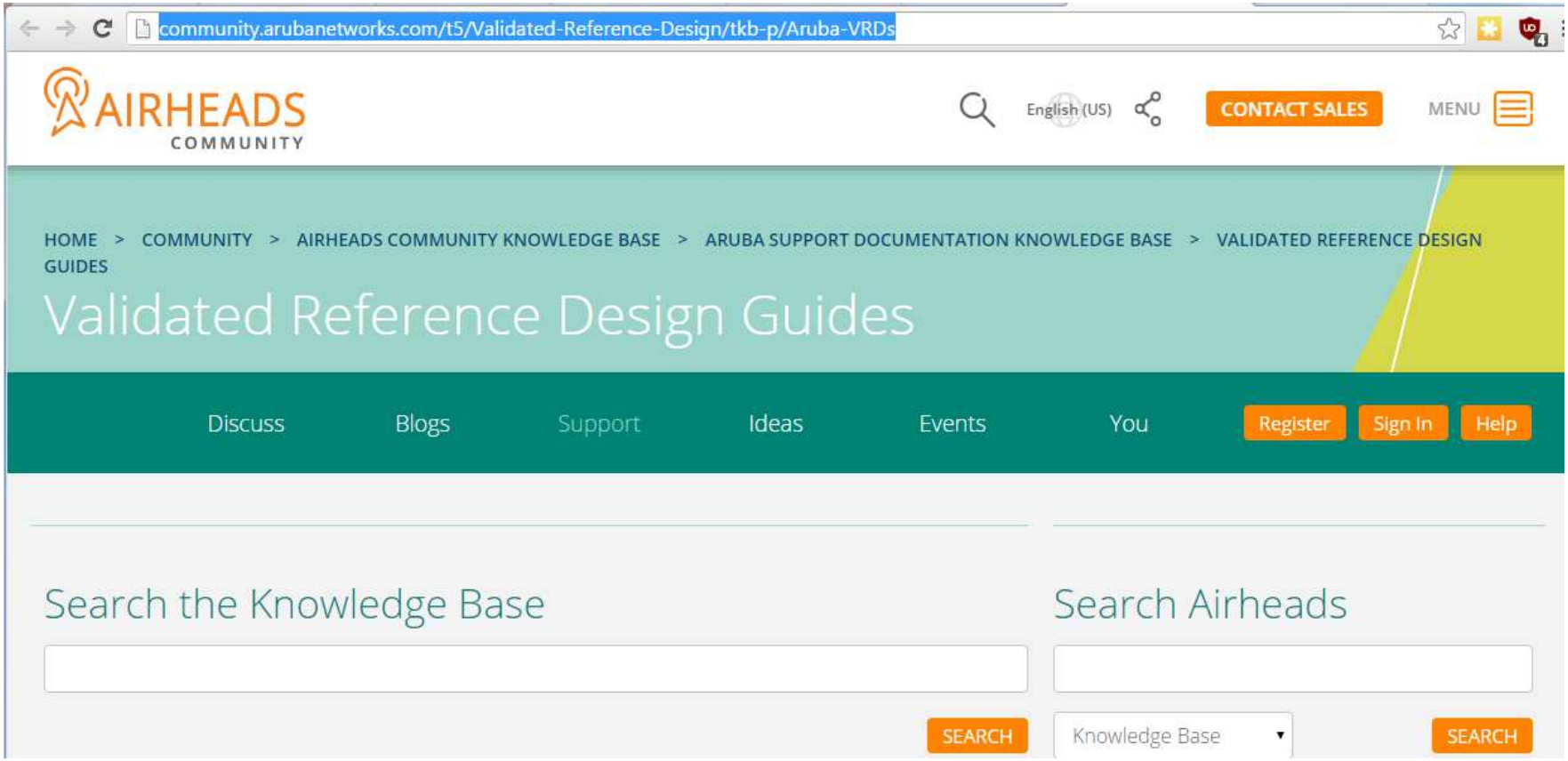
Agenda

This session will be focused on what you need to do your jobs on a daily basis as a wireless network designer, engineer and/or administrator

- **Design for roaming:**
  - Channel planning for roaming
  - Access Point Planning and Placement
  - Adaptive Radio Management (ARM)
- **Client Roaming**
- **Client Troubleshooting**

Shameless plug: Airheads community

http://community.arubanetworks.com/t5/Validated-Reference-Design/tkb-p/Aruba-VRDs



802.11 Wireless Communications Refresher

Basic 802.11 Wireless Communications
Fundamentals

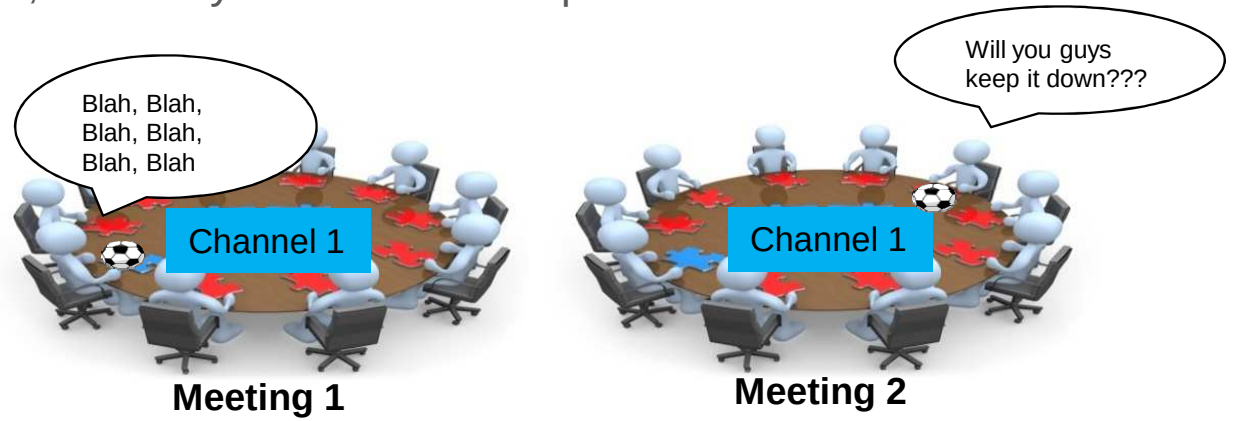
Wireless Networks allow one device to communicate at a time per channel

Each Wi-Fi channel is in effect a hub that is in the air

- In the analogy below, only the person with the ball can talk.
- All the others within earshot can hear him speak, **including potentially others outside of the meeting area** depending on how loud the person is speaking
- The volume that the speaker speaks with is equivalent to the wireless transmit power
- Access points can transmit at a much higher power than clients can
- A significant imbalance between the power that the access point communicates at and a client transmits at is the equivalent to having a conversation where one person shouts while the other person whispers

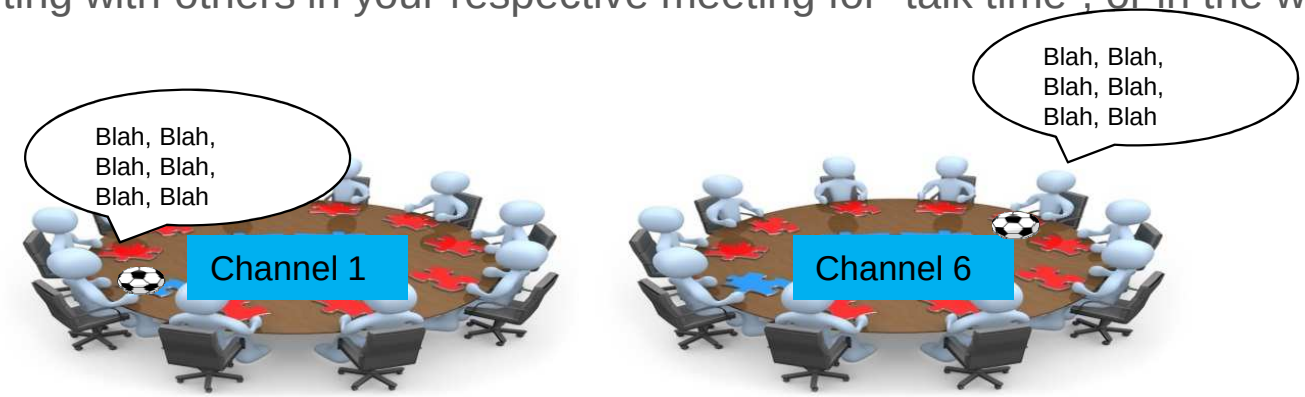
Basic 802.11 Wireless Communications
Fundamentals

- **The same channel being re-used in close proximity negates the benefit of the additional access point (same contention domain/co-channel interference)**
  - In the analogy below, the two tables/meetings are clients associated to two different access points on the same channel and can hear each other
  - This causes things to be repeated, or in the wireless world re-transmitted
  - Another bad thing is that meeting 2 can't hear what exactly is being said in meeting 1 so it can't pick a good time to interrupt
  - The louder the speaker's voice (transmit power) the worse this problem can be
  - In other words, too many wireless access points can be as bad as too few access points



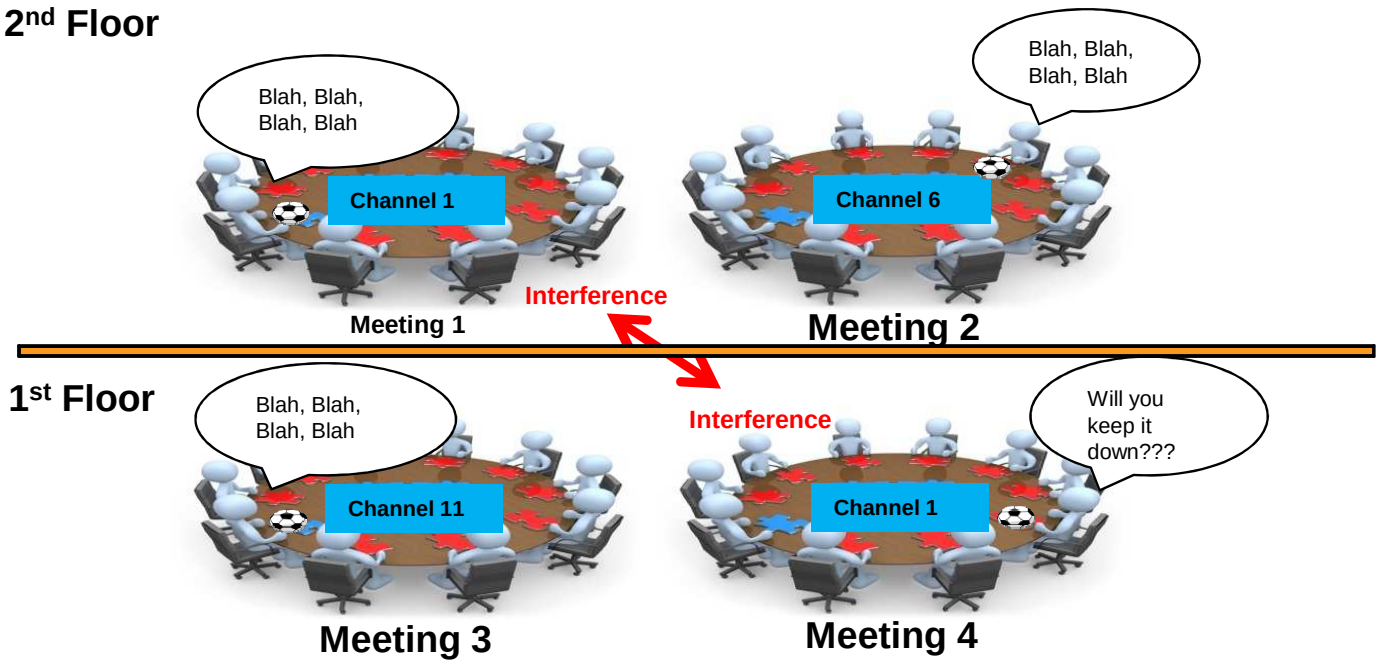
Basic 802.11 Wireless Communications
Fundamentals

- **The solution is to use another channel so that the communications don't overlap each other**
  - In the analogy below, the two tables/meetings are clients associated to two different access points but now are on different channels
  - Now each can communicate within each meeting without having to worry about hearing things from the other meeting and being interrupted with noise
  - Once again, only one speaker can speak at a time in each meeting but you only have to worry about competing with others in your respective meeting for "talk time", or in the wireless world, "Airtime"



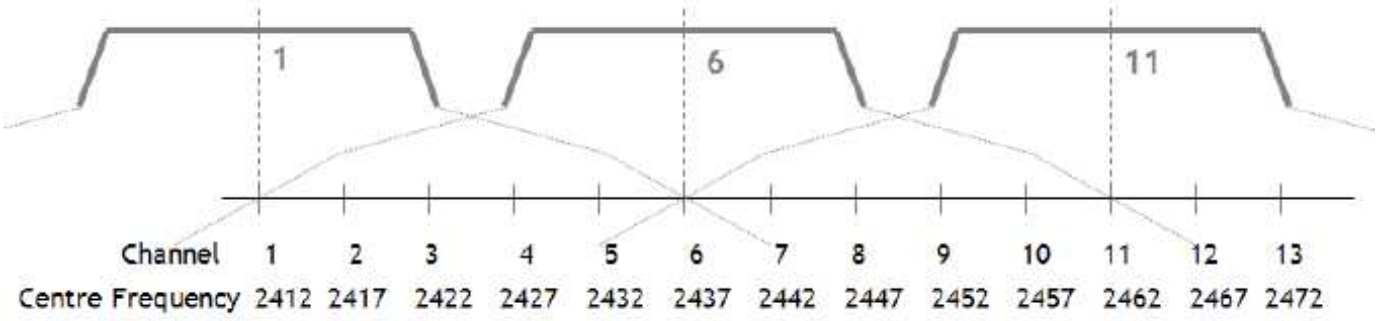
Basic 802.11 Wireless Communications
Fundamentals

- **Wireless is 3 Dimensional – goes through floors**
  - Common sense but easy to forget
  - The louder the meetings are (transmit power), the worse this gets



Basic 802.11 Wireless Communications
Fundamentals

- **There are a finite amount of available channels to communicate on (US regulatory Domain)**
  - **2.4 GHz – "B/G Band" – 3 Channels**
    - Only 3 non-overlapping channels (1,6,11) that can be used
    - Discussion if 4 channel plan (1,5,9,13) in EU/ETSI is useful in high-density seems a religious one
    - Older technology
    - Limited number of channels means more channel overlap and potential same channel interference when in close proximity. This is known as Co-Channel Interference and is another reason that too much access point power is a bad idea
    - Travels further than 5 GHz – A because of longer frequency
    - Adjacent channel Interference

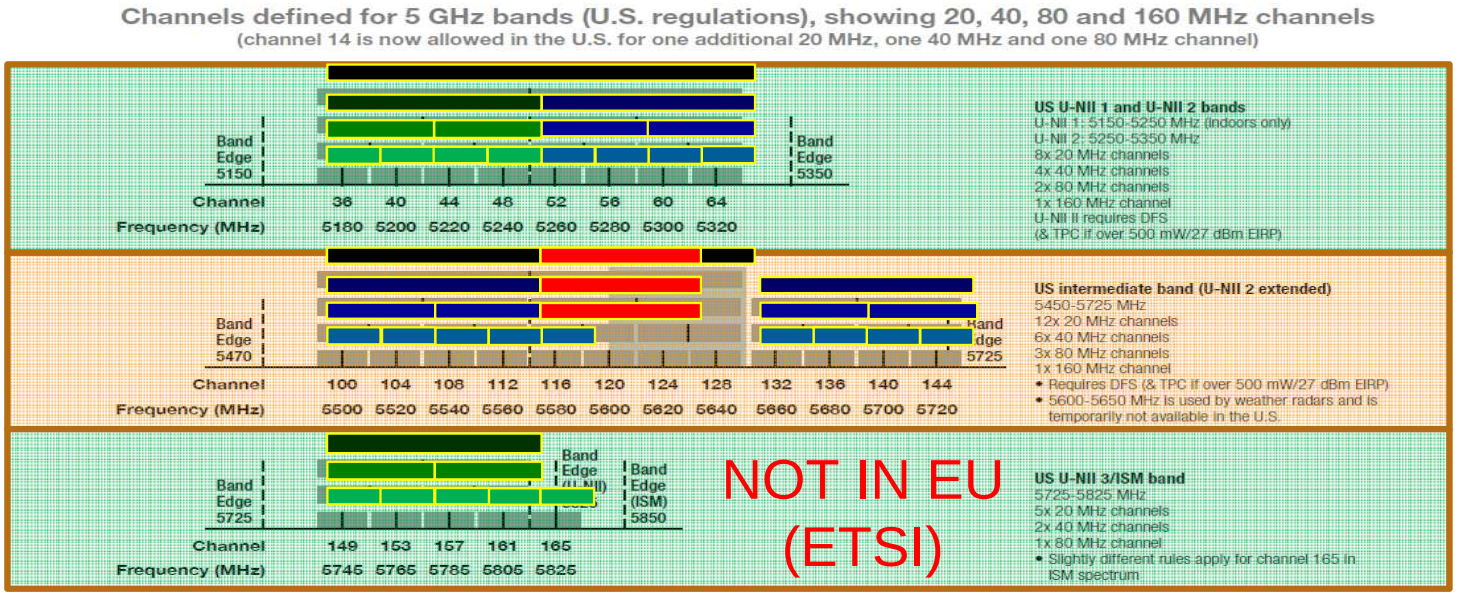


Basic 802.11 Wireless Communications
Fundamentals

- **There are a finite number of available channels to communicate on (US regulatory Domain)**
- **5 GHz Channel Bonding**

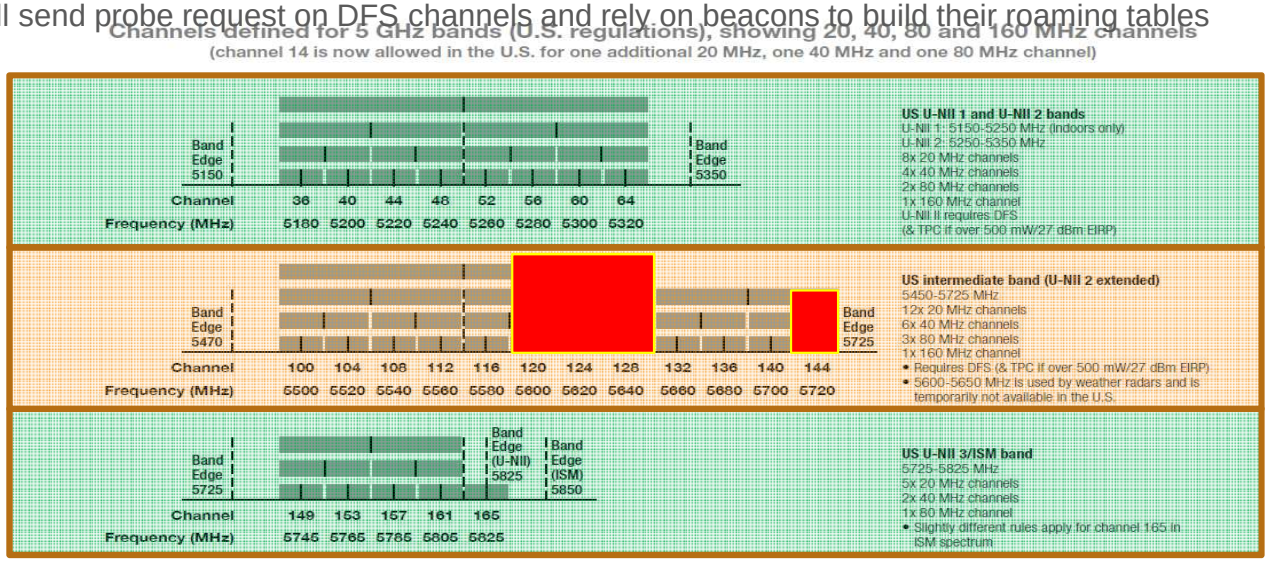
  Bonding channels means higher throughput but less available channels and thus more co-channel Interference because of channel overlap
  - 20 MHz Channels
    - 9 - Non-DFS FCC / 4 Non-DFS ETSI
    - 13 - DFS FCC / 15 DFS ETSI
  - 40 MHz Channels (802.11n)
    - 4 - Non-DFS / 2 Non-DFS
    - 6 – DFS / 7 DFS in ETSI
  - 80 MHz Channels (802.11ac)
    - 2 - Non-DFS / 1 Non-DFS in ETSI
    - 3 – DFS / 3 Non-DFS in ETSI
  - 160 MHz Channels (802.11ac)
    - 1 - Non-DFS
    - 1 – DFS

  Remember that the 80/160MHz Channel usage is dynamic as opposed to 40MHz channels which are static

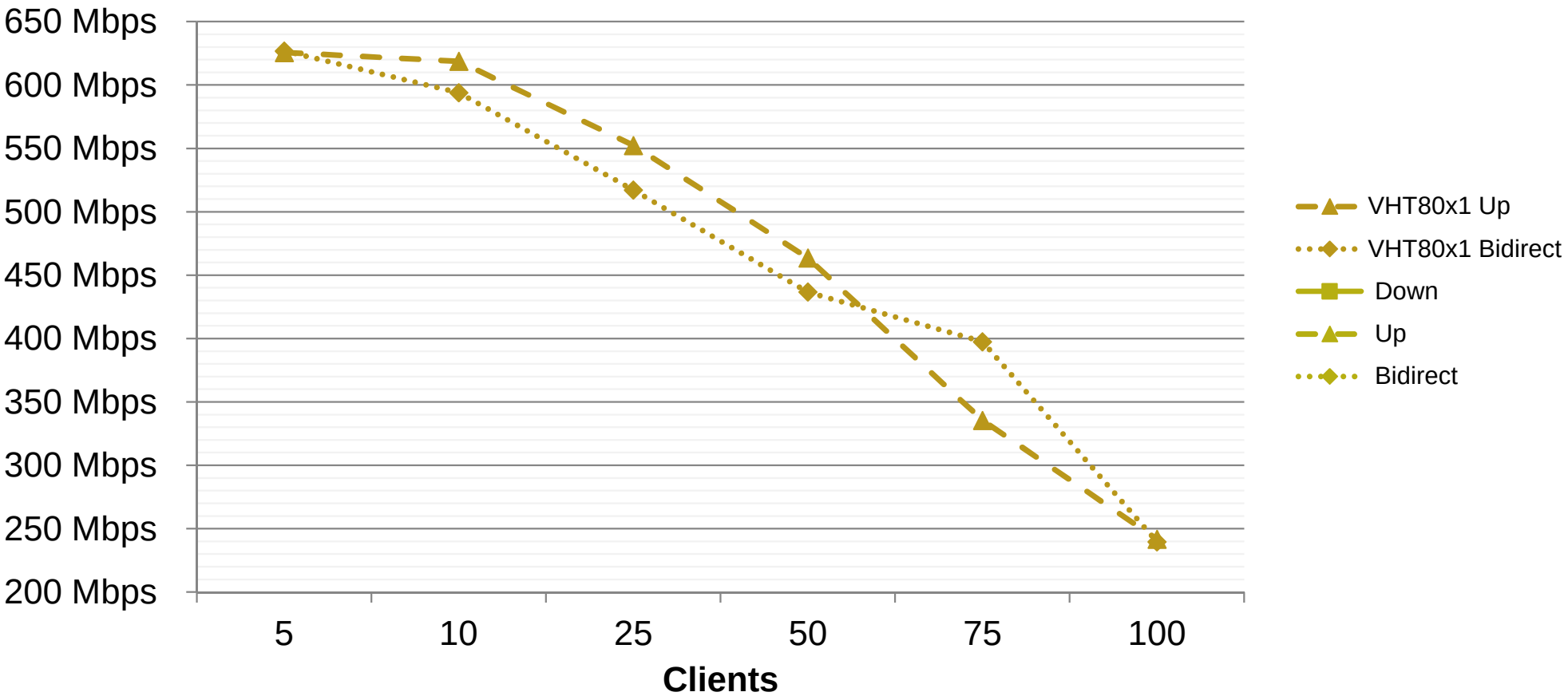


Basic 802.11 Wireless Communications
Fundamentals

- **There are a finite amount of available channels to communicate on (US regulatory Domain)**
- **5 GHz Channels – Things you should know**
  - Higher frequency so it only travels about 60% of the distance that 2.4 GHz does equating to approximately a 6dB power difference
  - Channel 144 was added as part of the 802.11ac amendment and is not supported by some clients and should not be used yet
  - US FCC: Channels 120-128 were used by weather radar. We have these channels back from the FCC but they are not currently supported yet.
  - Not all devices will send probe request on DFS channels and rely on beacons to build their roaming tables



In HD: VHT20 Beats VHT40 & VHT80 – 2SS Clients



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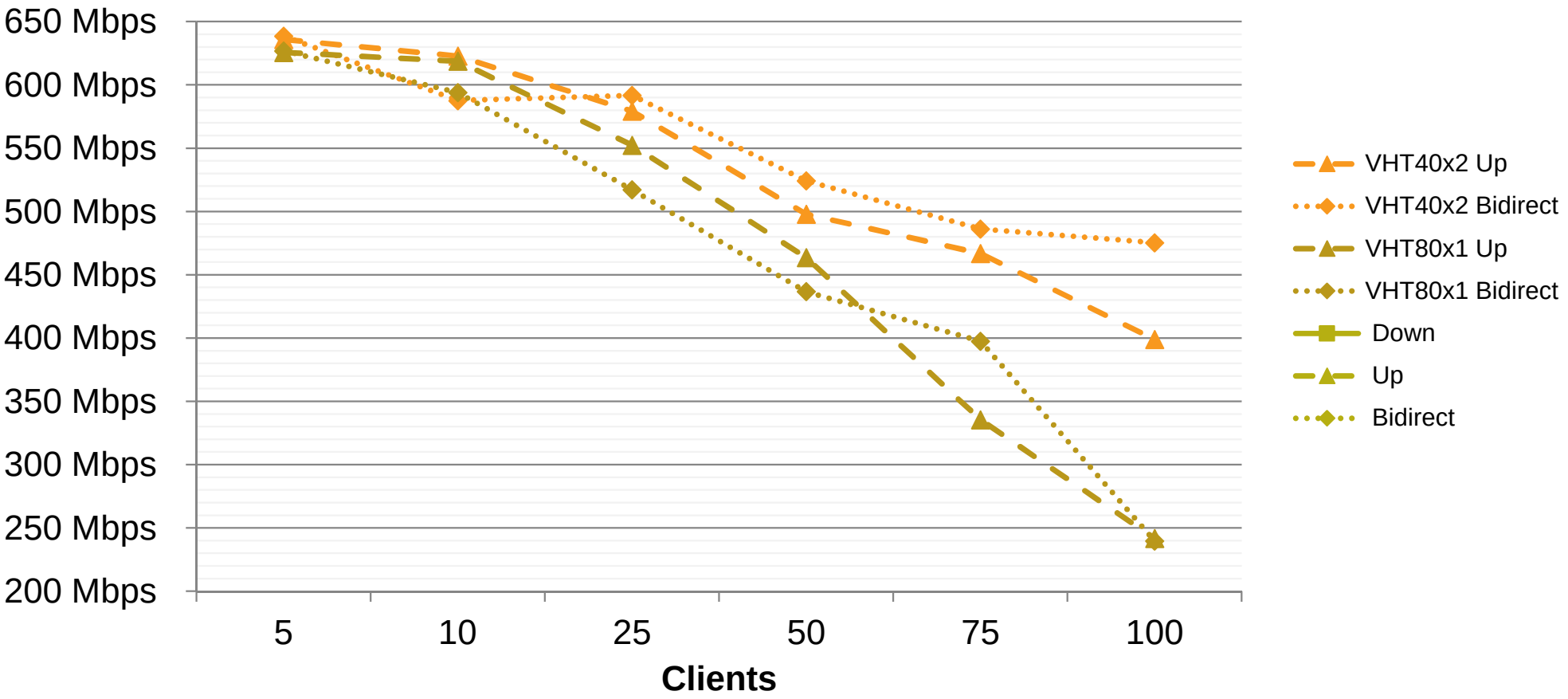

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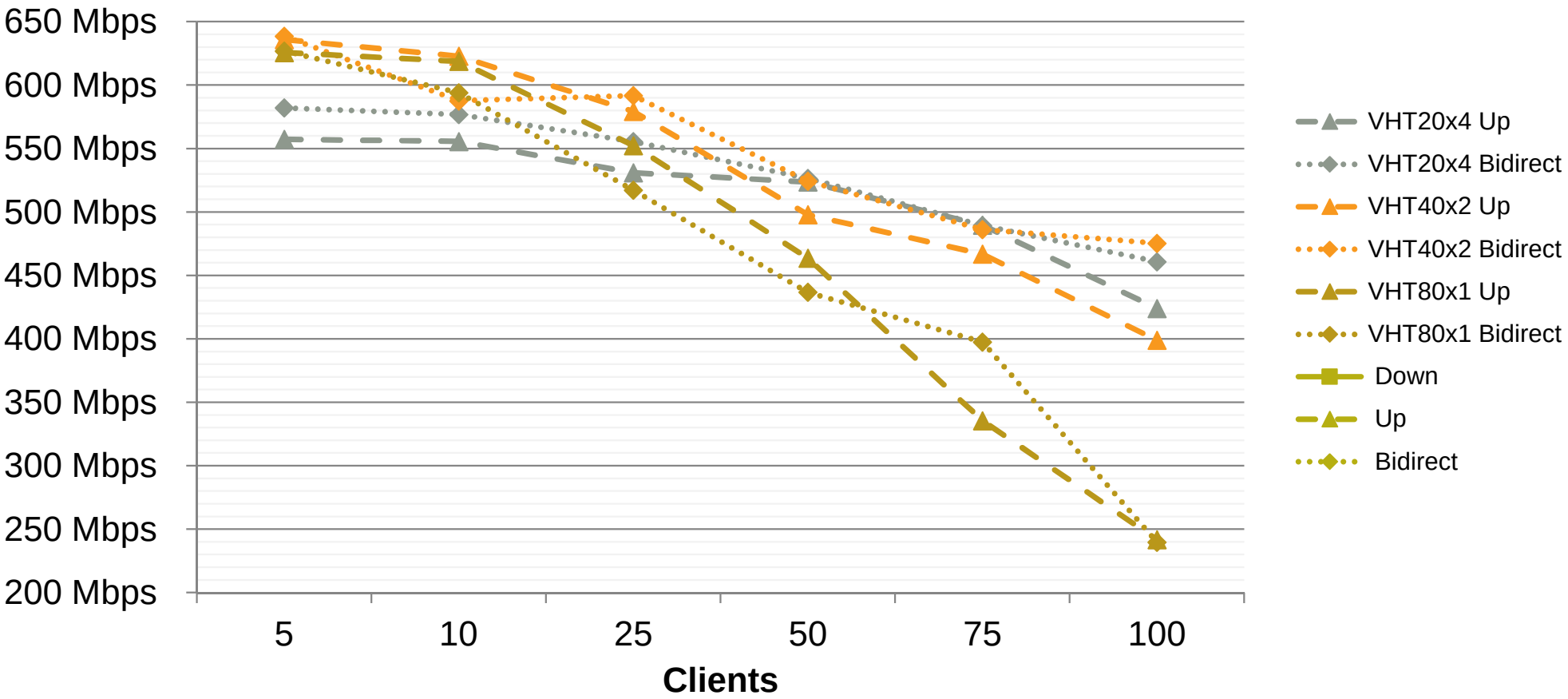


Basic 802.11 Wireless Communications
Fundamentals

- **Should I use DFS Channels?**
  - Are they really needed?
    - What are the expectations of throughput?
    - **Are you planning on using 80MHz channels? Do you really need to?**
    - If the environment is very dense access point wise, can you just use 20 or 40MHz channels?
    - How much attenuation do you have between your APs?
  - Do all your devices scan the DFS channels?
  - Do they support all channels http://www.mikealbano.com/2015/01/wifi-client-capabilities.html (https://docs.google.com/spreadsheets/d/1qwsQgTKH1lSD3AVRVpifWDKLmWvVsCDo1F-VmINX9f8/pubhtml)
  - Is the 2.4 GHz spectrum clean enough to support 2.4 GHz fallback for clients that don't?
  - Or do we have enough non-DFS 5GHz coverage for fallback?
  - Are you using VoIP and is seamless voice handover as clients roam important?
  - What is your tolerance for user complaints and troubleshooting?
  - Are you close to an airport, seaport, weather station?
    - Depending on the age of the radar you may get radar detections
      - AP must change channel on radar detect!
      - If no channel is available then go completely silent on 802.11a in APM mode (monitor)
      - B/G will continue to operate normally

Basic 802.11 Wireless Communications
Fundamentals

- **What channel width should I be using?**
  - If you are **NOT using DFS channels**
    - 80 MHz
      - 2 channels (FCC) / 1 channel (ETSI)
      - In a 2 AP deployment which really means never
      - Too much CCI if there are more than 2 APs (FCC) or 1 AP (ETSI)
    - 40 MHz
      - 4 channels / 2 (ETSI)
      - Close office space or cubicles with outer offices ringing
      - No more than 4 (2 in ETSI) AP's with line of sight between each other
    - 20 MHz
      - 9 channels (some older devices don't see channel 165) / 4 in ETSI
      - Wide open office space with dense AP deployment
      - More than 4 AP's that have line of sight to each other
      - Dense cubicles
      - Device density with each user having at least 2 devices (laptop, smartphone, tablet, VoIP phone)

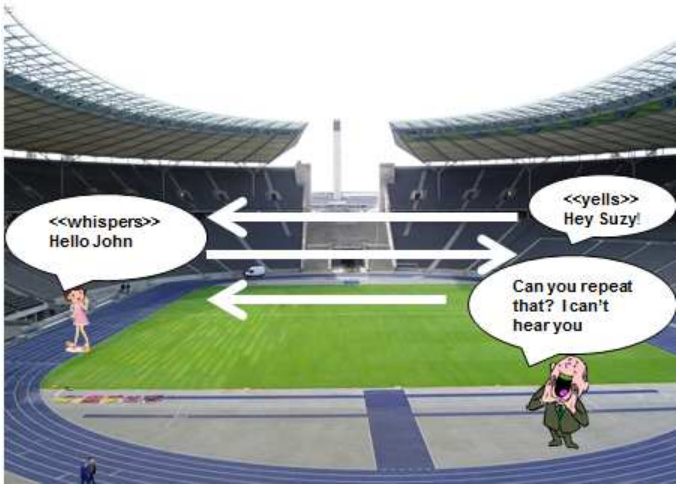
Basic 802.11 Wireless Communications
Fundamentals

- **What channel width should I be using?**
  - If you **ARE using DFS channels**
    - 80 MHz
      - 5 channels but some of your devices may not support 3 of them (4 in ETSI)
      - Less than 25-30 users per channel
      - High AP density to support SNR's higher than 35 (support the highest 802.11ac data rates)
      - Requires close monitoring of your user community for the first month to identify potential issues
      - Be prepared to drop back to 40 MHz channels
    - 40 MHz
      - 10 channels / 9 in ETSI
      - Any deployment where 80MHz channels are problematic because of more than 4 AP's with line of sight to each other or because of client side support issues
    - 20 MHz
      - 22 channels / 19 in ETSI
      - Large Public Venues
- **In EU / ETSI you probably will need to use the DFS channels**

Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

- **Transmit Power**
- Using high transmit power on access points doesn't create significantly increased usable coverage because of the two way nature of communications
  - Laptop Clients can only typically transmit at 30 milliwatts versus access points that can transmit at up to 200 milliwatts
  - You typically want to keep the AP to user power at no more than a 2 to 1 ratio to your highest powered client
  - Most laptops transmit around 30 milliwatts so you typically don't want your AP power higher than 60 milliwatts
  - Yes access points have better receive sensitivity but the CCI/ACI introduced by higher power negate the benefit of it



Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

Signal to Noise Ratio

- Relative measurement of the signal to the “noise floor” of the environment
- The “noise floor” is the environmental or ambient noise in the 2.5GHz or 5GHz frequency
  - Analogies:
    - Library – you can whisper since there is no noise at all
    - Office – you have to speak in a normal voice to be heard over the background noise
    - Concert – you have to shout to be heard
  - Remember that the 2.4 GHz and 5 GHz are unlicensed so any device can use them, adding to the noise floor and/or causing interference
- This noise floor is usually between -85 and -100 dB with 5GHz almost always having a lower noise floor
- The higher the noise floor, the stronger your signal needs to be and the more APs you need
- So if you have a -65 dBm signal at your device and the noise floor is -95dBm then you have a 30 signal to noise ratio which is excellent
- A minimum SNR of 25 will support the highest data rates between a 802.11n client and AP
- A minimum SNR of 35 will support the highest data rates between a 802.11ac client and AP
- Any SNR below that and the client or access point will slowly start to down rate to a lower megabits per second data rate
  - This happens rapidly and signal to noise ratios below 20 are practically unusable

Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

Signal to Noise Ratio

- The lower the signal to noise ratio, the more the device is susceptible to interference
- Remember the two way nature of communications
  - AP's usually transmit at a higher power level than the client(s)
  - AP's are better listeners than clients (what we call *receive sensitivity*)
    - Think of the AP as a dog and a client device as a human
    - Some devices have better antennas (ears) than others so they can hear better
  - The client may be transmitting at 30 mW and the AP at 60 mW so the signal to noise ratios will be different downstream versus upstream
    - The worse this power imbalance the worse the upstream signal to noise ratio, the lower the upstream data rate and the more susceptible the upstream is to interference
    - Therefore, the client signal to noise ratio (from client to AP) that the access point sees is almost always the limiting factor as it relates to performance
  - Signal to noise ratios below 20 are practically un-useable because of client performance expectations and this is about the point you want your devices to roam to a better AP

Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

- Remember that wireless devices are like using two way radios
  - There is the signal from the AP to the device
  - There is the signal from the device to the AP
  - The smaller the device, typically the lower the transmit power and the weaker the signal is to the AP
    - Laptop – 30 mW
    - Old IPad – 12 mW
    - Newer Ipad – 50 mW
    - Android device 10-13 mW
    - Vocera B3000 – 39 mW
    - Motorola Handhelds – 12 to 30 mW
  - AP's can transmit at very high power relative to the clients
    - Up to 200 mW(and up for outdoor)
- Power Levels
  - Usually an absolute measurement
  - Anything higher than -65dBm is considered an excellent signal
  - Anything higher than -50 to -55dBm would be consider too much signal which can issues by being too "loud" and causing issues with co-channel and adjacent channel interference
  - Analogy: It's best to have both parties speaking in a normal voice versus screaming or whispering

Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

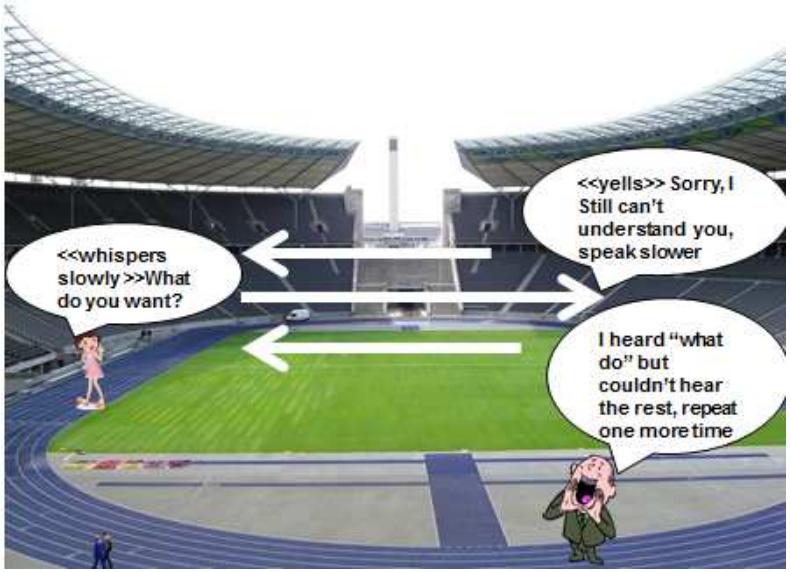
- **Transmit Power – Rule of 10's and 3's**
- For every 10dB of gain multiply the power by 10
- For every 10dB of loss divide the power by 10
- For every 3dB of gain multiply the power by 2
- For every 3dB of loss divide the power by 2

3dBm ----- 2mW
6dBm ----- 4mW
9dBm ----- 8mW
12dBm ----- 16mW
15dBm ----- 31mW
18dBm ----- 63mW
21dBm ----- 125mW
22dBm ----- 158mW
22.5dBm -- 177mW
23dBm ----- 200mW

Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

- **Down-rating**
  - If the client or access point can't successfully transmit to the other party they "down rate" and try using a slower mbps data rate. This can go down as low as 1, 2 or 5 Mbps which really means that the signal is all but unusable and will cause major customer satisfaction issues with the network
  - Once again, bringing the power levels more in balance with each other will sustain higher data rates and make happier users



Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

- **Down Rating Affects Faster Users on that Channel**
- Each channel is hub
  - Also, remember that each channel is in effect, a hub, and thus a very finite resource so having clients connected at lower data rates slows everyone down on that AP since they have to wait for those slow clients to get on and off the channel
    - So the further away a client is from an AP, the lower his signal to noise ratio and thus the client's data rate
    - Walls/Floors exacerbate this issue if AP's are not put in correct positions

Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

- **Trimming Data Rates**
  - Why Trim the Lower Rates?
    - If the client can't down rate any further, it must roam
    - Has a similar effect to lowering the power in that it effectively shrinks the effective range of each AP at which clients can connect. It does not shrink the RF range, so for CCI normal rules apply.
    - Get the slower users off the AP to let the faster users better utilize the channel/AP
  - Once the user down rates to a value lower 11 or so the connection is almost unusable so it makes sense, especially in typical office environments
  - The denser the AP deployment, the more trimming the rates helps
  - There are certain older devices that must see the lower data rates in order to connect
  - If the customer is using newer devices then it makes sense
    - What devices need to see the low data rates for connectivity?
      - Older gaming systems
      - Older handheld scanners but this is fine since low data rates really don't affect these devices negatively since they mostly use terminal applications.
      - Old VoIP Phones
      - Certain medical devices/monitors

Basic 802.11 Wireless Communications

Power, Signal to Noise Ratio and Data Rates

- **Trimming Data Rates**
  - How much should I trim?
    - Typically up to 11 Mbps and 12 Mbps respectively but can go as high as 18 or 24 with some experimentation, depending on the client devices
    - Certain Android devices need to see the 11 Mbps data rate

```
wlan ssid-profile “Test-GUEST-ssid_prof"
        a-basic-rates 12 18 24
        a-tx-rates 12 18 24 36 48 54
        g-basic-rates 11
        g-tx-rates 11 12 18 24 36 48 54
        g-beacon-rate 18
        a-beacon-rate 18
```

  - Why set the beacon rate
    - If you don’t then the beacons are sprayed out at the lowest data rate even if trimmed, following the 802.11 specifications
    - This means that devices can passively scan and then try and roam to an AP that they can’t connect to
    - Set the beacon rate to one value higher than your lowest supported and basic rates
    - Example – If the lowest supported data/basic rate is set to 12 Mbps then set the beacon rate to 18.

Don’t trim data rates in University, Medical Environments or any other connectivity critical environments without careful testing and monitoring

Access Point Planning and Placement

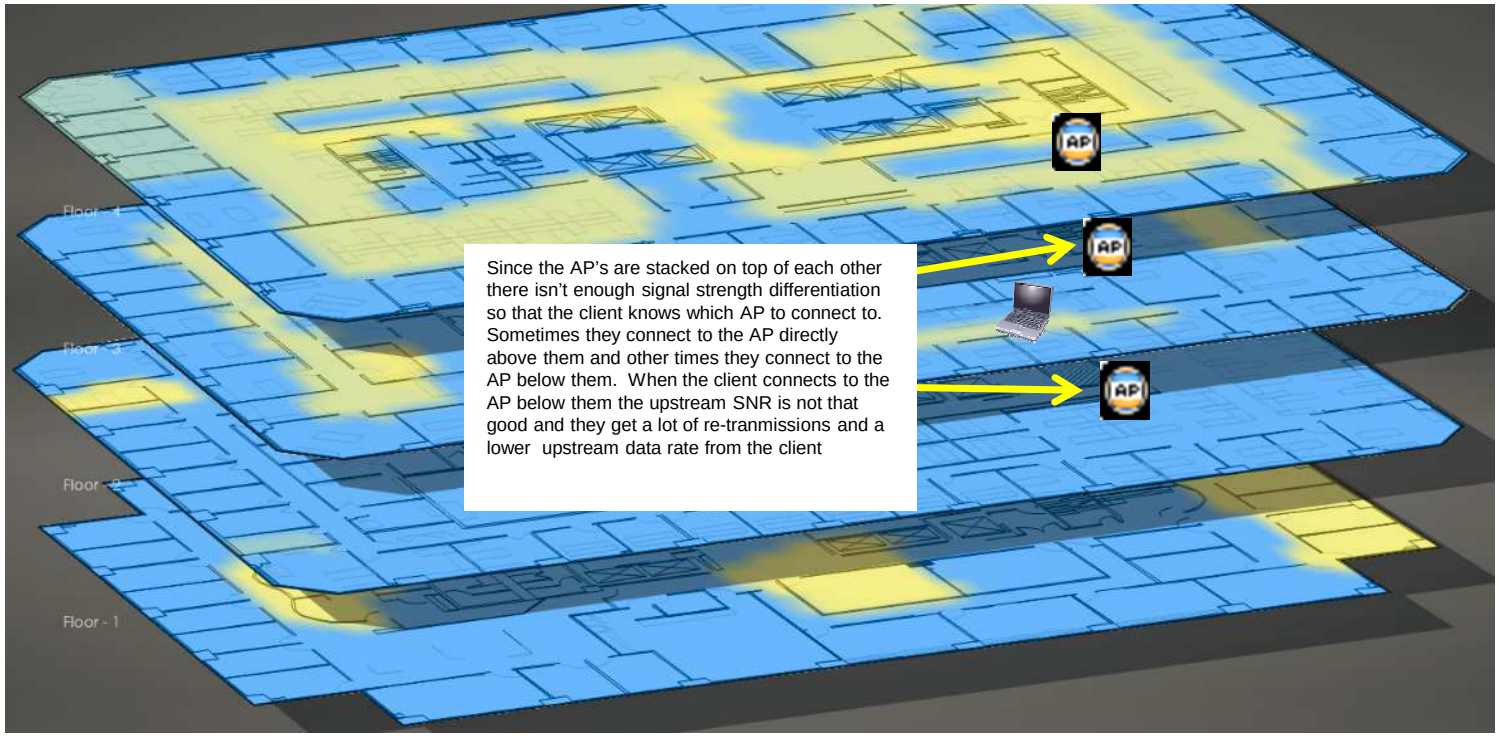
Access Point Planning and Placement

AP Placement is the single most important predictor of user satisfaction

- ARM is very effective but it can't defy the laws of physics and make up for poor AP placements
- Cabling is a very large expense when deploying network devices.
- Make poor AP placement decisions and you are going to live with them for a long time.
- Too many AP's for the building/users and you are going to be locked into 20 MHz channels if you can't use the DFS channels
- Too Few AP's and you are going to create bad coverage areas
  - ARM is going to want to put the AP power too high creating near/far issues
  - Client match will help with the near/far issues but it takes time to steer clients (typically about 60 seconds once stationary)
- Badly placed AP's are almost as bad as putting too many AP's and to few AP's
  - Avoid AP's having Line of Sight to each other if you can avoid It
    - In dense deployments you can't avoid this most of the time but the fewer AP's that have LOS to each other, the better.
    - Think about the number of channels in each band and how much overlap you have in dense areas
- A few feet can make a big difference in signal quality and the way that ARM reacts
- Don't stack AP's on top of each other floor to floor

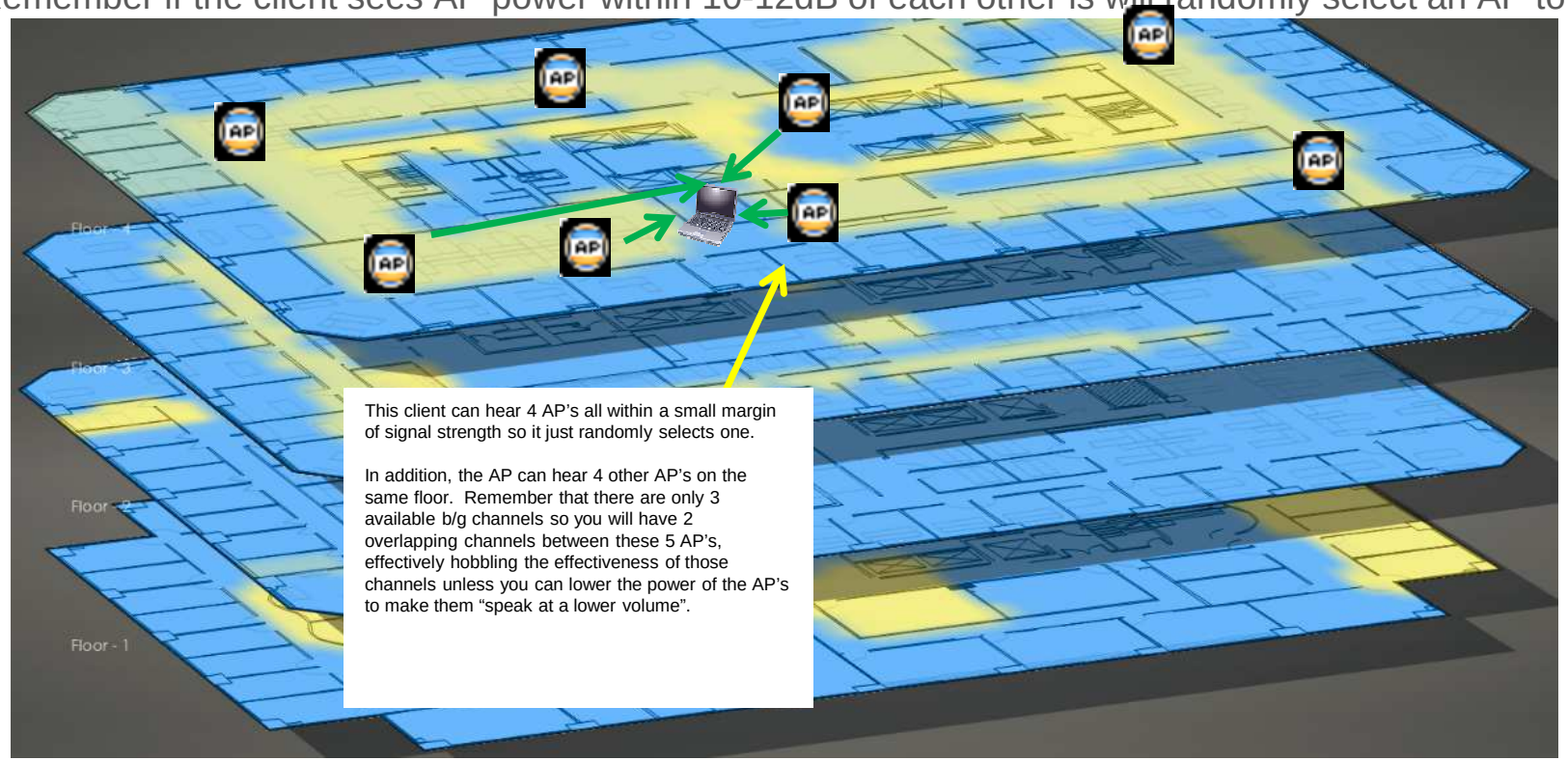
Access Point Planning and Placement

- **Stacking AP's Floor to Floor Usually Causes Major Issues**
  - Remember if the client sees AP power within 10-12dB of each other is will randomly select an AP to connect to and it might be the AP on the floor above or below



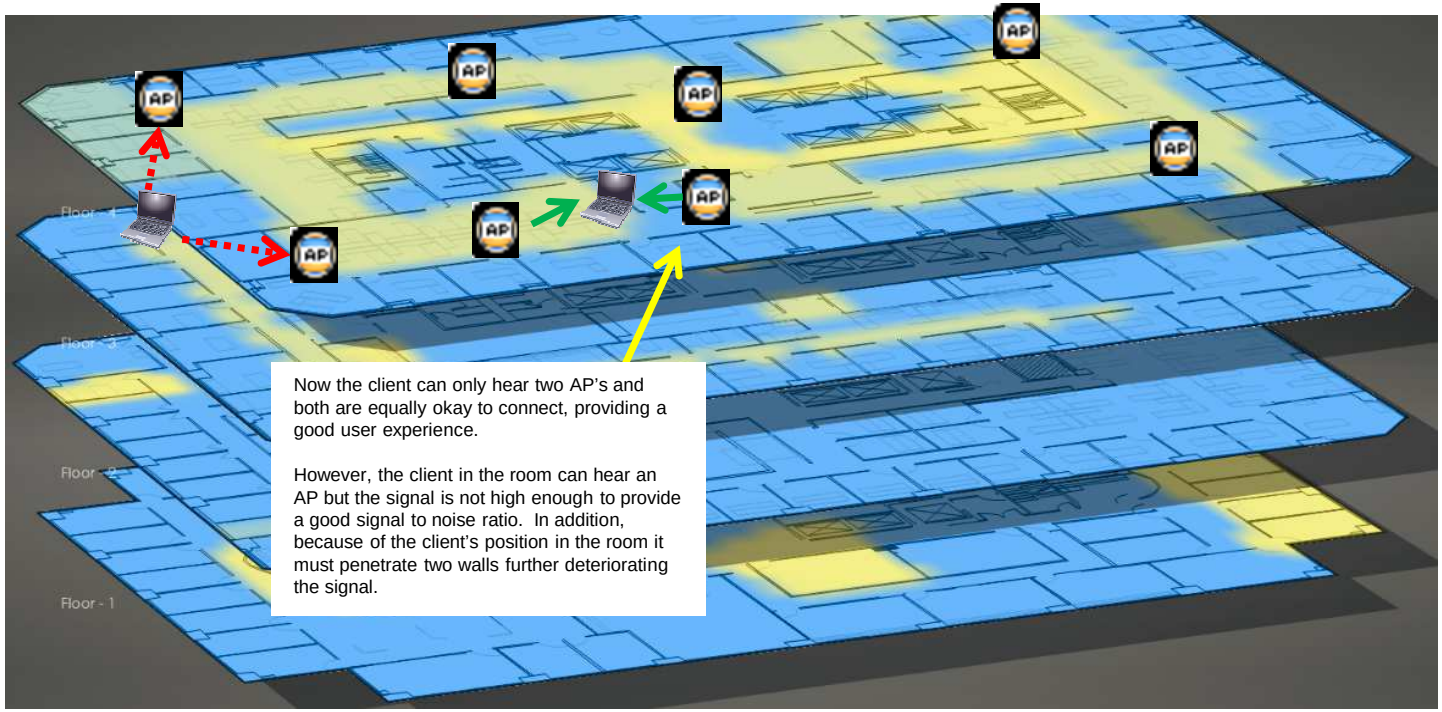
Access Point Planning and Placement

- **Having a too many AP's with line of sight to each may cause issues as well**
  - Remember if the client sees AP power within 10-12dB of each other is will randomly select an AP to connect to



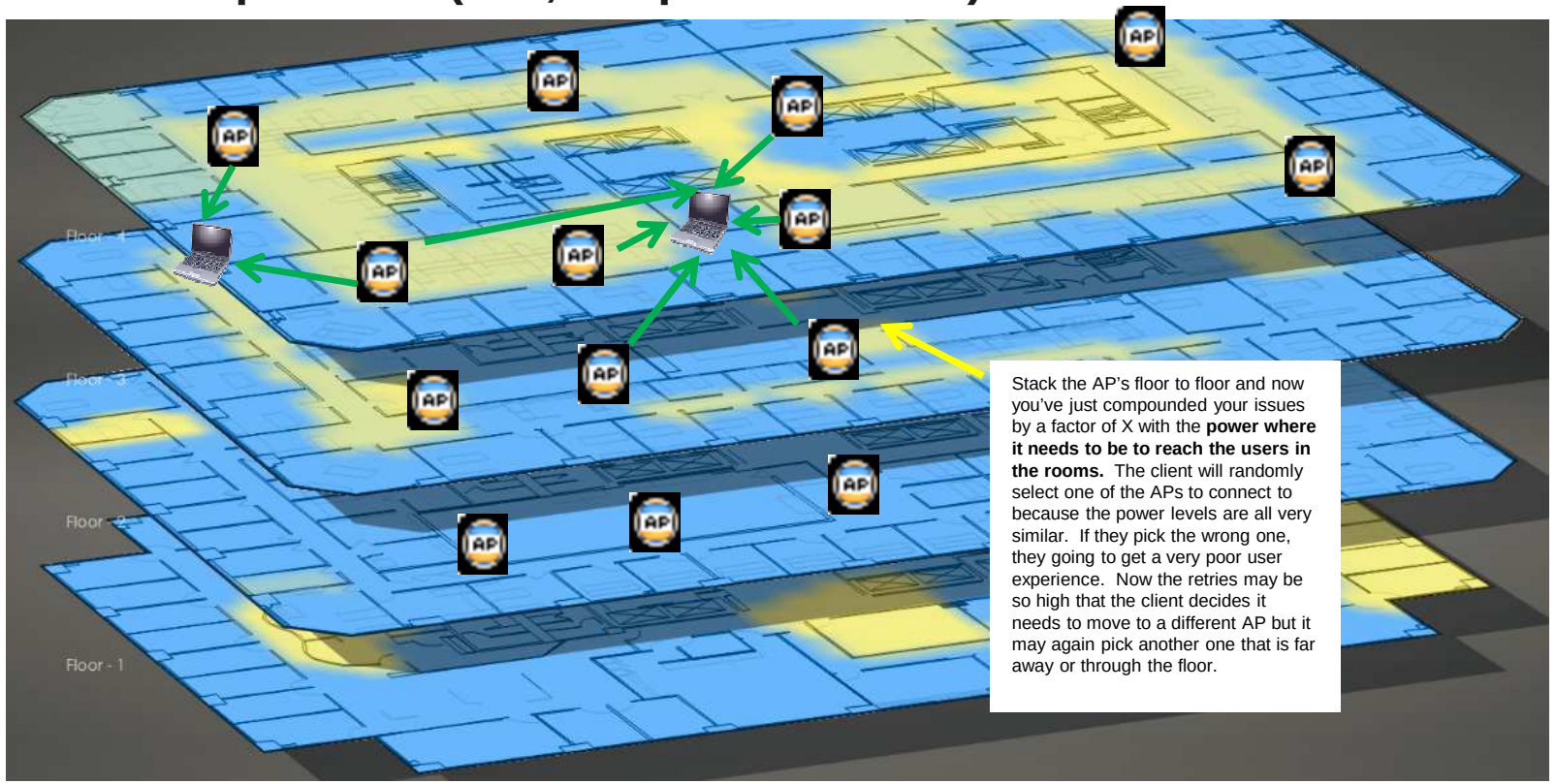
Access Point Planning and Placement

- **You can't lower power too much if you only have AP's in hallways**
  - Lower the power too much and it will not be enough to reach users in rooms where the signal has to go through walls
  - Raise the power enough to penetrate the walls and you have out of control co-channel interference



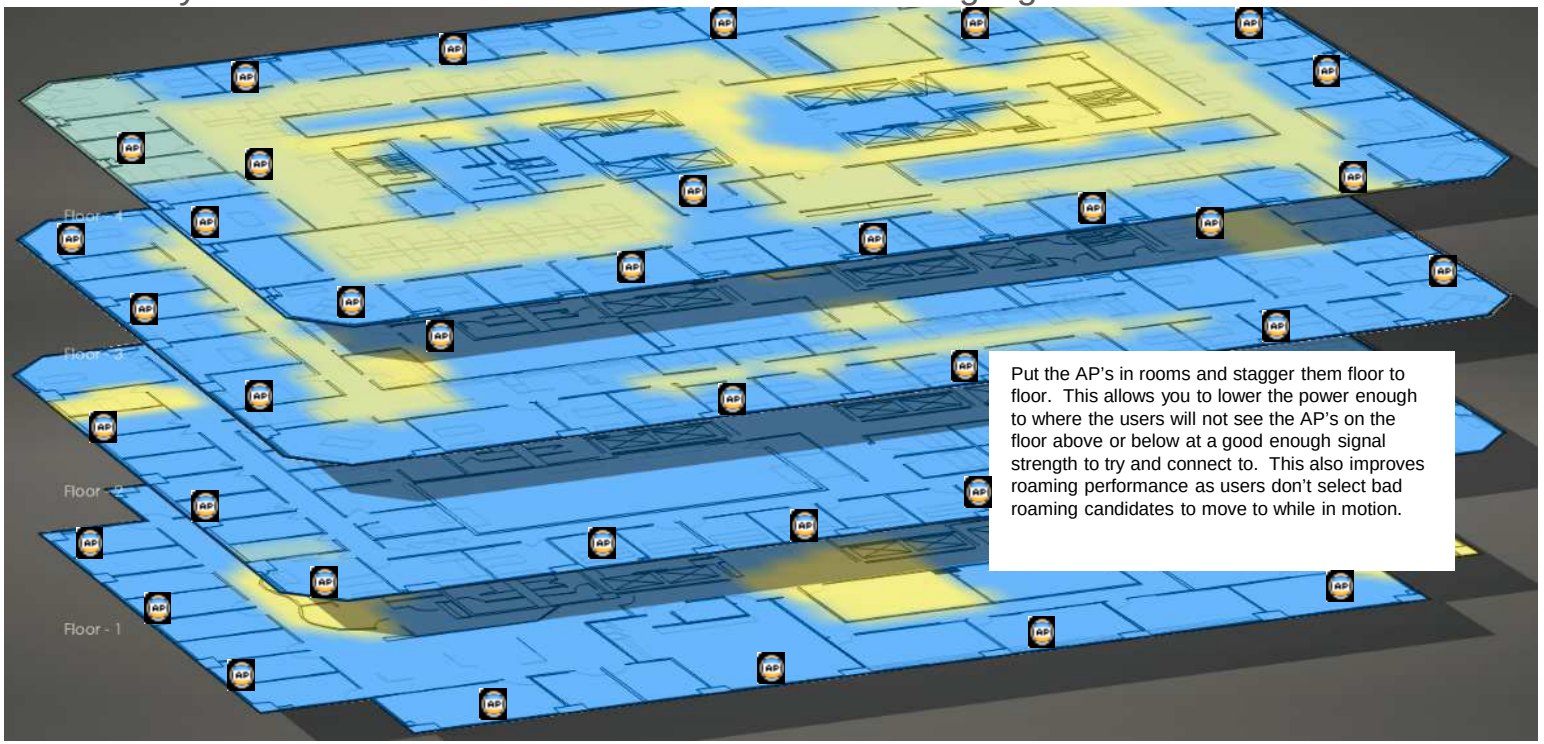
Access Point Planning and Placement

- **AP's with line of sight and stacked on top of each other leads to an extremely poor client experience (aka, the perfect storm)**



Access Point Planning and Placement

- **With a proper design you can lower the AP power to a point where the clients are encouraged to connect to the correct AP**
  - Now the client only will see AP's that it should connect to at strong signal levels



Access Point Planning and Placement

AP Density

- How many AP's does it take to cover typical areas without taking user density into account ?
  - The higher the down-tilt AP is mounted (Aruba AP 205, 215, 225) the larger the cone of coverage
  - If mounting a true omni (no down-tilt) don't mount too high

    Warehouse (terminal applications and no VoIP)
    - 1 AP every 7500 to 10,000 sq feet / 750-1000m^2 with 50% overlap so an AP every 85 to 100 feet / 30-35m

    Retail (open floors, eg. Grocery Store)
    - 1 AP every 5000 to 7500 sq feet / 500-750m^2 with 50% overlap so an AP every 70-85 feet / 25-30m

    Open Office Space (open floor/cubes with offices around periphery)
    - 1 AP every 2500 to 3600 sq 250-350m^2 feet with 50% overlap so an AP 50-60 feet / 15-20m

    Closed Office Space
    - Needs to be walked, depends on construction materials
- Why is more AP density needed
  - User Density
  - Device Density/Devices per use
  - All Wireless Offices

Access Point Planning and Placement

AP Density

- What is a dense deployment?
  - The most dense deployments are an AP every 1500-1600 sq feet /150m^2 so the AP's are anywhere between 35-40 feet / 12-15m apart
  - This is extreme and you must use 20 MHz channels in the A band to avoid too much CCI if you can't use the DFS channels
  - If you are deploying 802.11ac and you want to use 40 MHz or 80MHz channels you MUST use the DFS channels in dense deployments

Adaptive Radio Management

aruba
NETWORKS
an HP company

Adaptive Radio Management

- **An Aruba Feature That Automatically Adjusts AP Channels and Power Levels**
- The Aruba ARM technology uses a distributed channel reuse management algorithm where each AP makes decisions independently by sensing its environment and optimizing its local situation. The algorithm is designed so that this iterative process converges quickly on the optimum channel
  - ARM uses a distributed channel reuse management algorithm where each AP makes decisions independently by sensing its environment and optimizing its local situation. The algorithm is designed so that this iterative process converges quickly on the optimum channel (client aware is enabled by default)
  - So…if the AP doesn't see any other AP's on channel 40 it will use channel 40 and set it's power to the highest value allowed by the ARM profile assigned (within regulatory domain).
  - Remember that high default power can be as high as 200mW creating poor client roaming behavior and as a consequence near/far issues
  - Using our channel 40 example, If it sees other AP's on channel 40 that it's selected because it deems it to be the least interfering channel, it will balance it power with the other AP on that channel BUT you may end up with one AP at a very high power and the other at a very low power. This is especially true if the neighboring AP sees another AP on channel 40 but the AP that is coming up can't hear the 3rd AP
  - Bottom line, ARM is a great tool but bases it decisions on what each AP sees as neighbors, its not perfect!

  …….But, you can make it operate better!

What happens to the channels when you first start up a new system or assign a new ARM profile?

Adaptive Radio Management

- **Getting ARM to Settle Quicker**
  - Arm will not change channels when a client is connected to an AP (***client aware***, enabled by default)
  - When initially deploying an Aruba wireless network it's a good idea to adjust ARM so that it will settle quicker, otherwise it may take 24 to 48 hours to fully settle, depending on client density
  - Using these ARM settings will get it to settle within 2 hours
    - Aggressive Settings

```
rf arm-profile "default“
scan-interval 1
no client-aware
ideal-coverage-index 5
acceptable-coverage-index 2
backoff-time 120
min-scan-time 2
```

    - Default Settings (don't forget to revert back to defaults after 2 hours)

```
rf arm-profile "default“
scan-interval 10
client-aware
ideal-coverage-index 10
acceptable-coverage-index 4
backoff-time 240
min-scan-time 8
```

Adaptive Radio Management

- **Tuning ARM Profiles**
  - It's important to remember that there is ONE default ARM profile that is used in both the A and B/G radio profiles
  - You need to create one for the A band one for the B/G band so that you can use different settings in each
  - Recommendations on ARM Power Level Starting Points Prior to Testing/Tuning
    - B/G – 2.4 GHz
      - AP's 50-55 feet apart/open air - 12dBm to 15dBm
      - AP's closer than 50 feet apart/open air - 9dBm/12dBm
      - AP's closer than 43 feet apart/open air - 6dBm/9dBm
      - Chances are that most are going to be at 9dBm (fewer channels/more APs on an individual channel)
      - If most of the AP's go to minimum power after they settle then you might want to lower the values each by 3dBm, especially in denser environments
    - A – 5 GHz
      - AP's 50-55 feet apart/open air - 18dBm to 18dBm
      - AP's closer than 50 feet apart/open air 12dBm/15dBm
      - AP's closer than 43 feet apart/open air 9dBm/12dBm
      - You want the 5 GHz power at least 6dB higher than 2.4 GHz to make it more attractive for clients to initially connect to

Client Roaming

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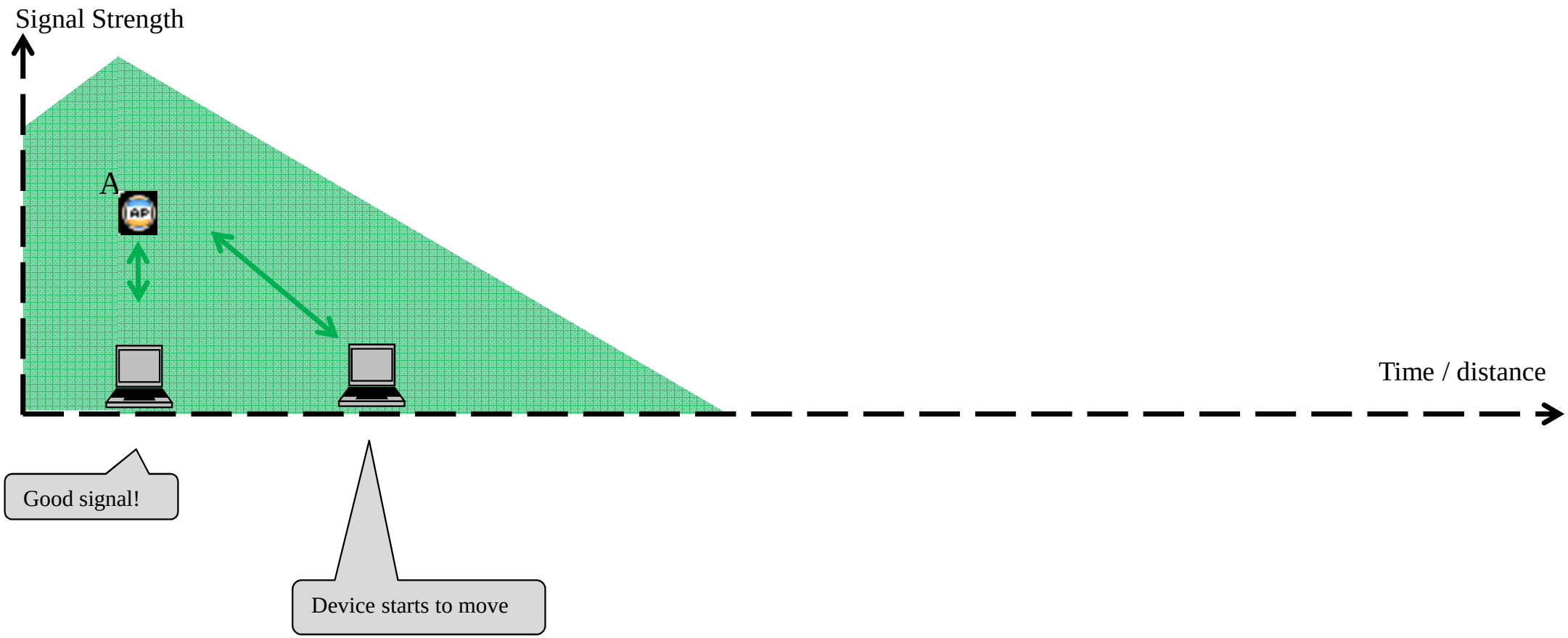
Client Roaming

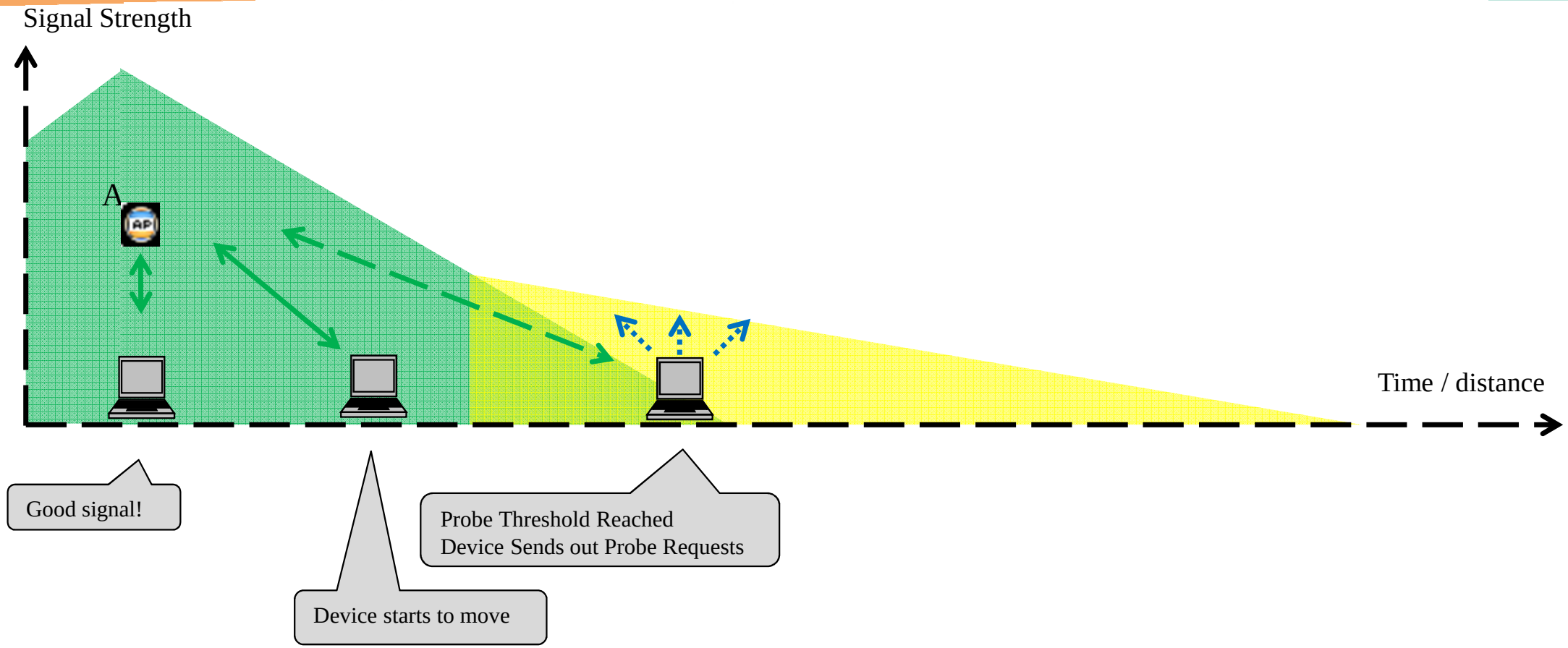
- **Clients are the ultimate decision maker of the best access point to initially connect to, as well as move to, when in motion**
  - Clients make connection decisions primarily based on power
  - … and/or 802.11k channel and neighbor reports (if supported)
  - Clients don't always make the right decision especially if the access points are not placed properly and/or access point power is too high (with the latter typically being a symptom of the former)
  - When moving, a client bases its roaming decisions on probe responses or beacons if they don't support probe requests on DFS channels

Client Roaming – Properly Designed and Tuned Network

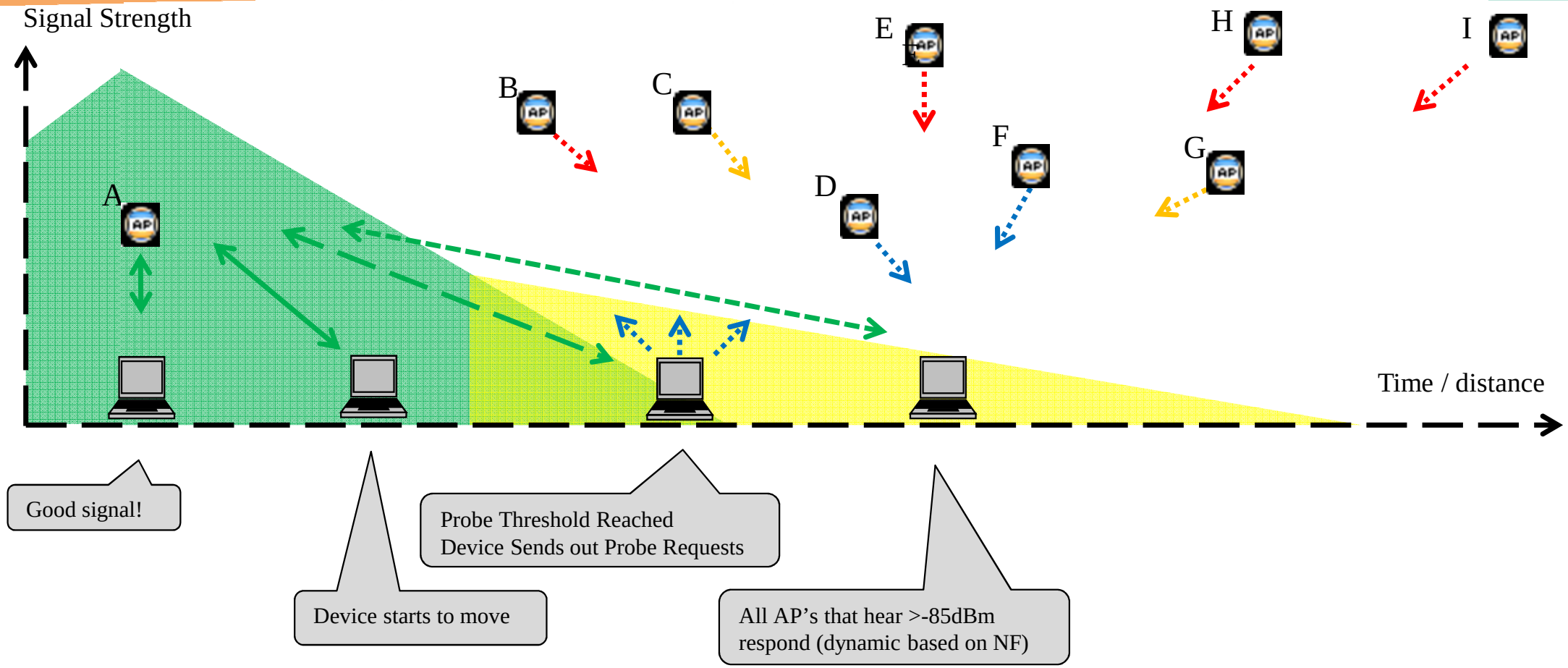
Client Roaming – Properly Designed and Tuned Network



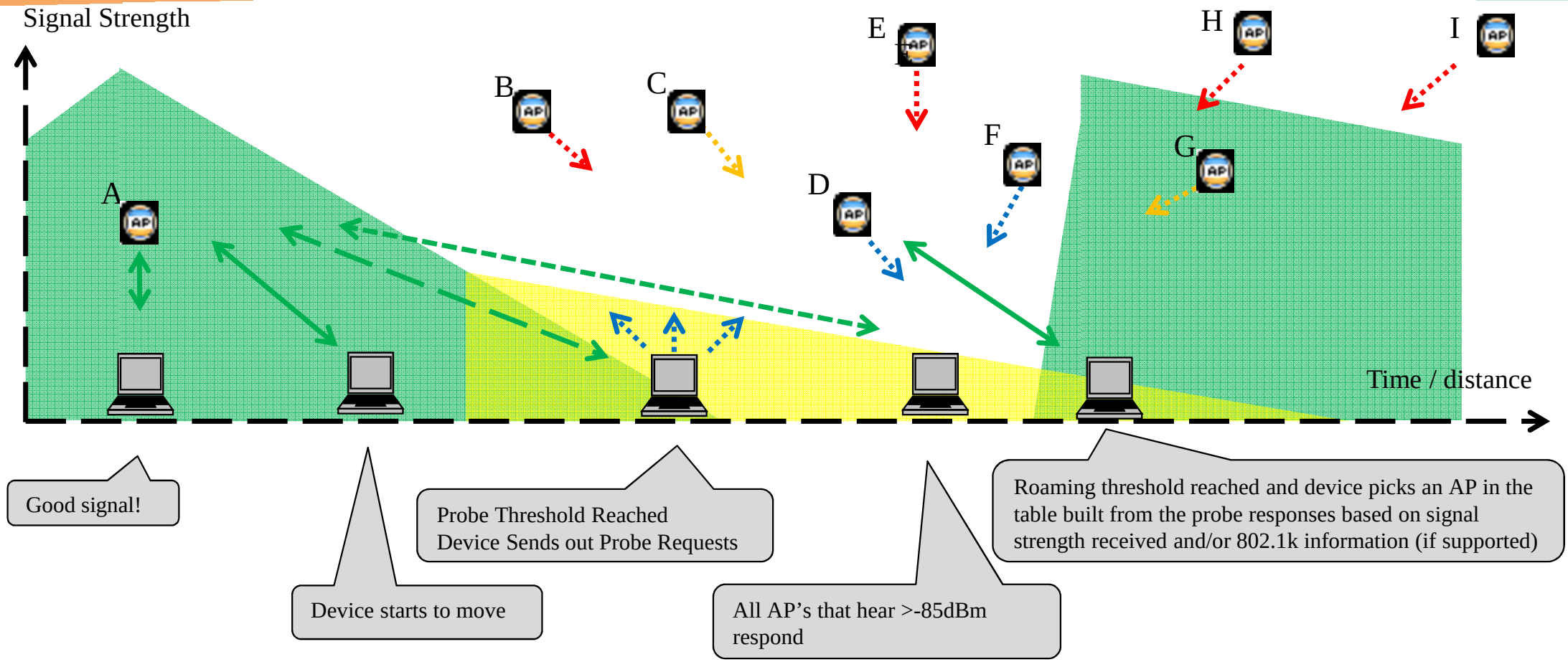
Client Roaming – Properly Designed and Tuned Network



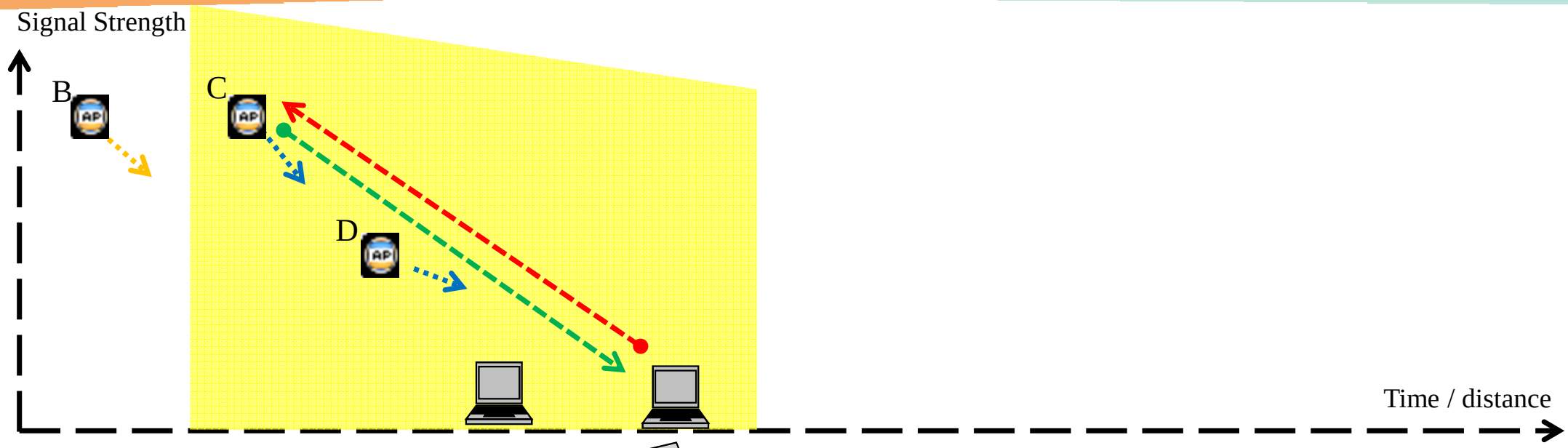
Client Roaming – Properly Designed and Tuned Network



Client Roaming – Properly Designed and Tuned Network

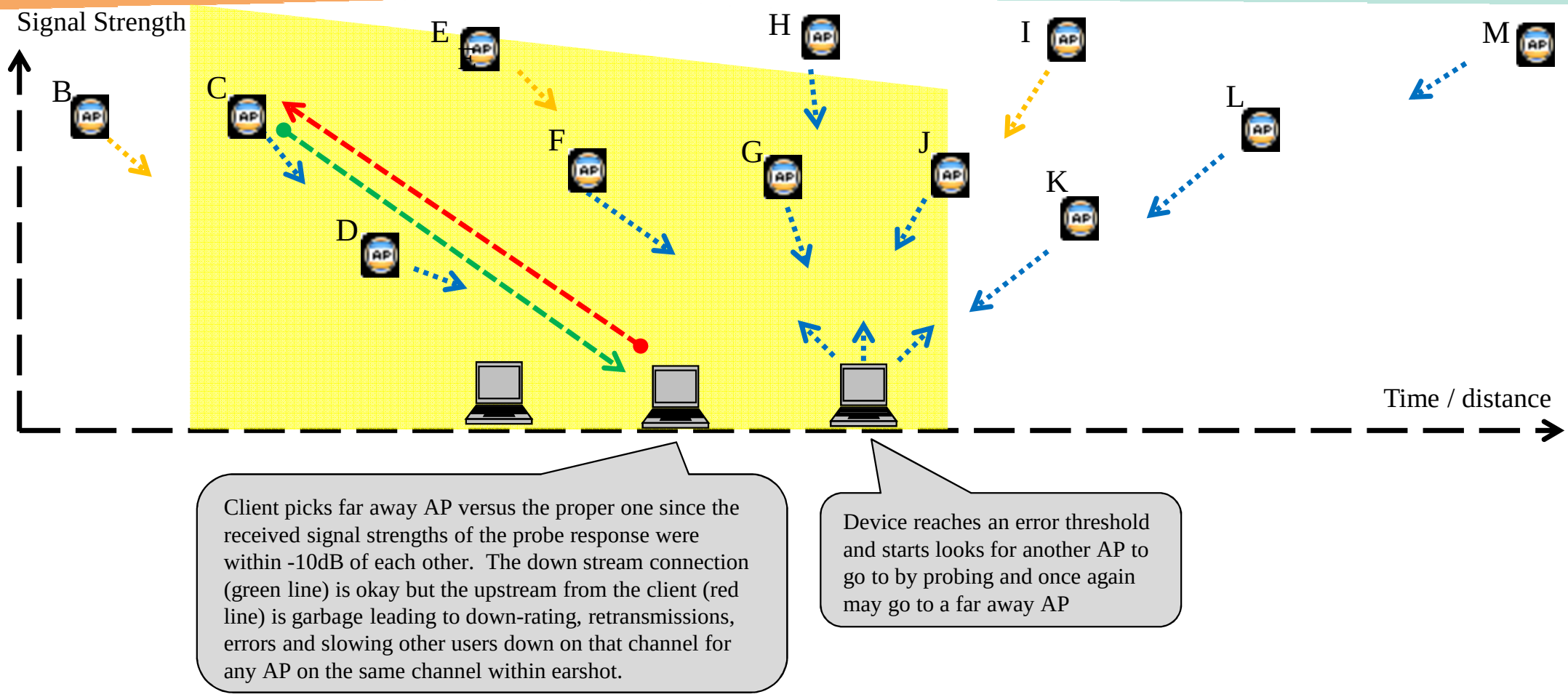


Client Roaming – AP Power Too High

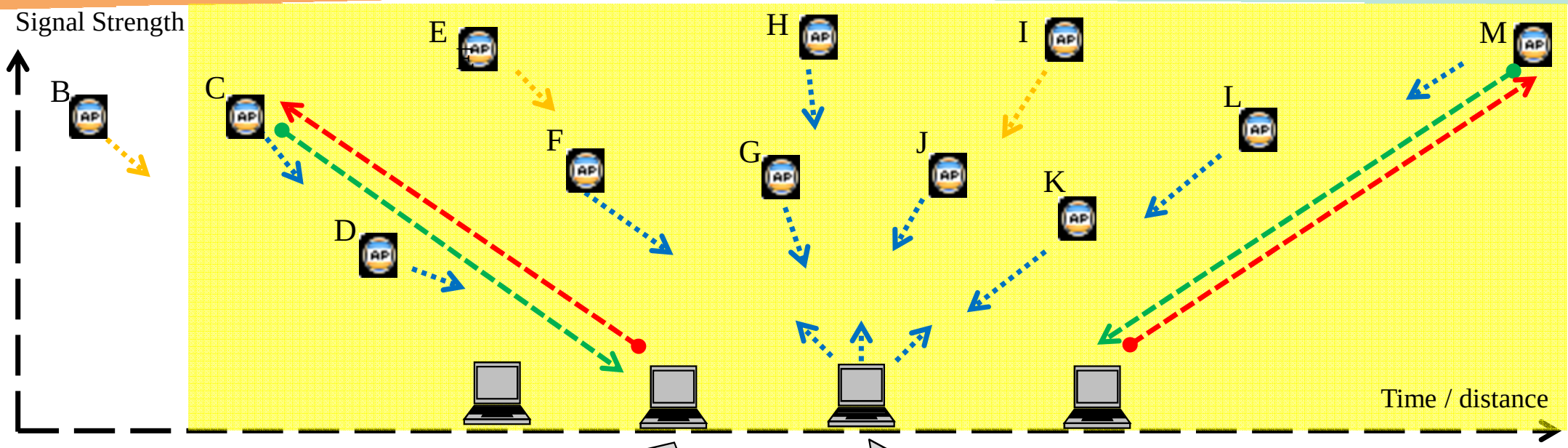


Client picks far away AP versus the proper one since the received signal strengths of the probe response were within -10dB of each other. The down stream connection (green line) is okay but the upstream from the client (red line) is garbage leading to down-rating, retransmissions, errors and slowing other users down on that channel for any AP on the same channel within earshot.

Client Roaming – AP Power Too High



Client Roaming – AP Power Too High



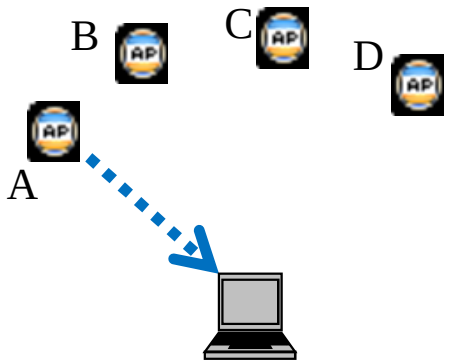
Client picks far away AP versus the proper one since the received signal strengths of the probe response were within -10dB of each other. The down stream connection (green line) is okay but the upstream from the client (red line) is garbage leading to down-rating, retransmissions, errors and slowing other users down on that channel for any AP on the same channel within earshot.

Device reaches an error threshold and starts looks for another AP to go to by probing and once again may go to a far away AP

802.11k,v if enabled and if client supports (802.11v iOS 8+ and SG5 today)

11k Neighbor report

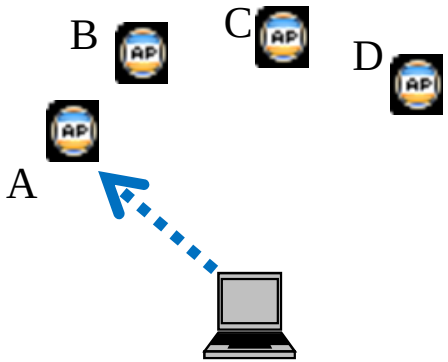
Information about other APs to help with handover candidate discovery



AP	chan	secy	key scope	beacon offset
B	6	WPA2	0	45
C	52	WPA2	0	12
D	161	WPA2	0	74

11k Beacon Report

Client reports how it hears (RSSI) the beacons of other APs



BSSID	RSSI
AP B	-65
AP D	-72
AP E	-65

Overlaps with neighbor report

11k Channel Report

AP informs client of channels used by the WLAN

Channel
6
52
161

11v BSS Transition Management

AP instructs client to move to another AP

Move to AP D

Client Match

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Client Match

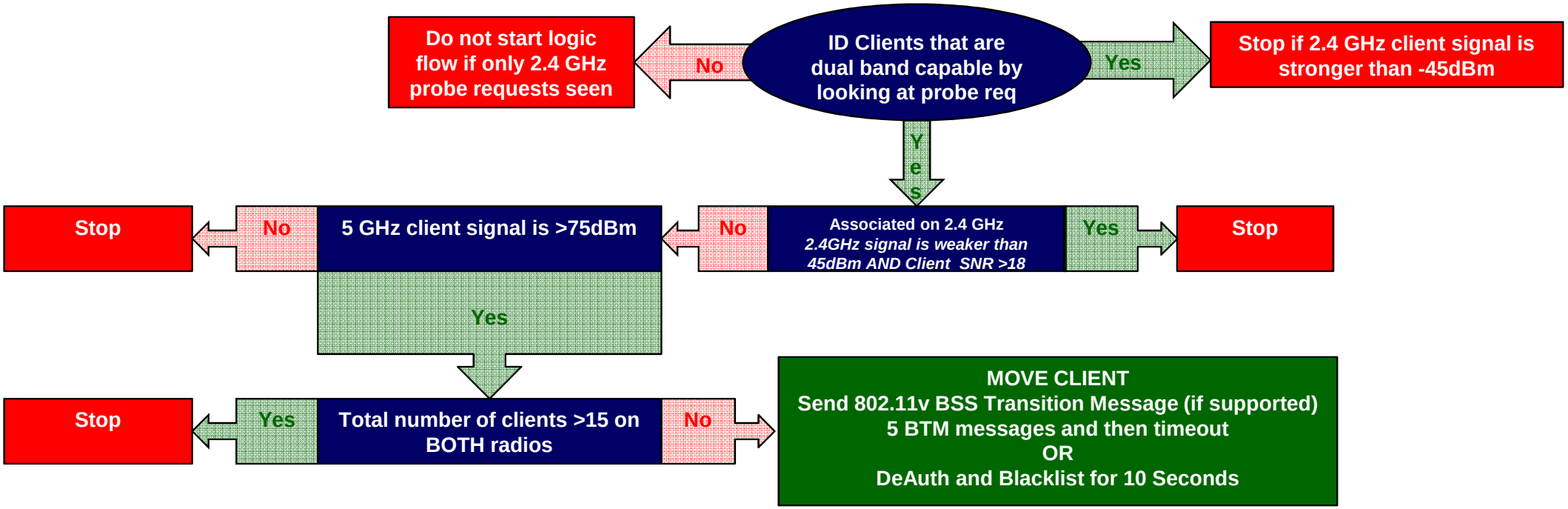
- **What is it?**
  - Client Match is a tool to get users to the best AP based on the client Signal to Noise ratio versus simply relying on clients to decide which AP to connect to
  - This is measured by signal strength/SNR of the client probe requests as they are heard at the AP's
  - Enhancements were added to also use the following frames to measure client signal strength which is a big step forward
    - Block ACK
    - Management frames
    - Probe Request
    - NULL data frame
    - Data frame with rate no higher than 36Mbps
  - The controller takes the client signals/SNR information and builds a "Virtual Beacon Report"
  - **Client match is NOT a roaming tool….it takes time to build the VBR and apply actions**

Client Match

- **What does it do with the “Virtual Beacon Report”?**
  - The controller takes this information and takes one of three actions provided that certain thresholds are met
    - Band Steer
    - Sticky
    - Load Balance
  - Steer through 802.11v
  - Sticky clients using too much airtime de-auth as an emergency measure

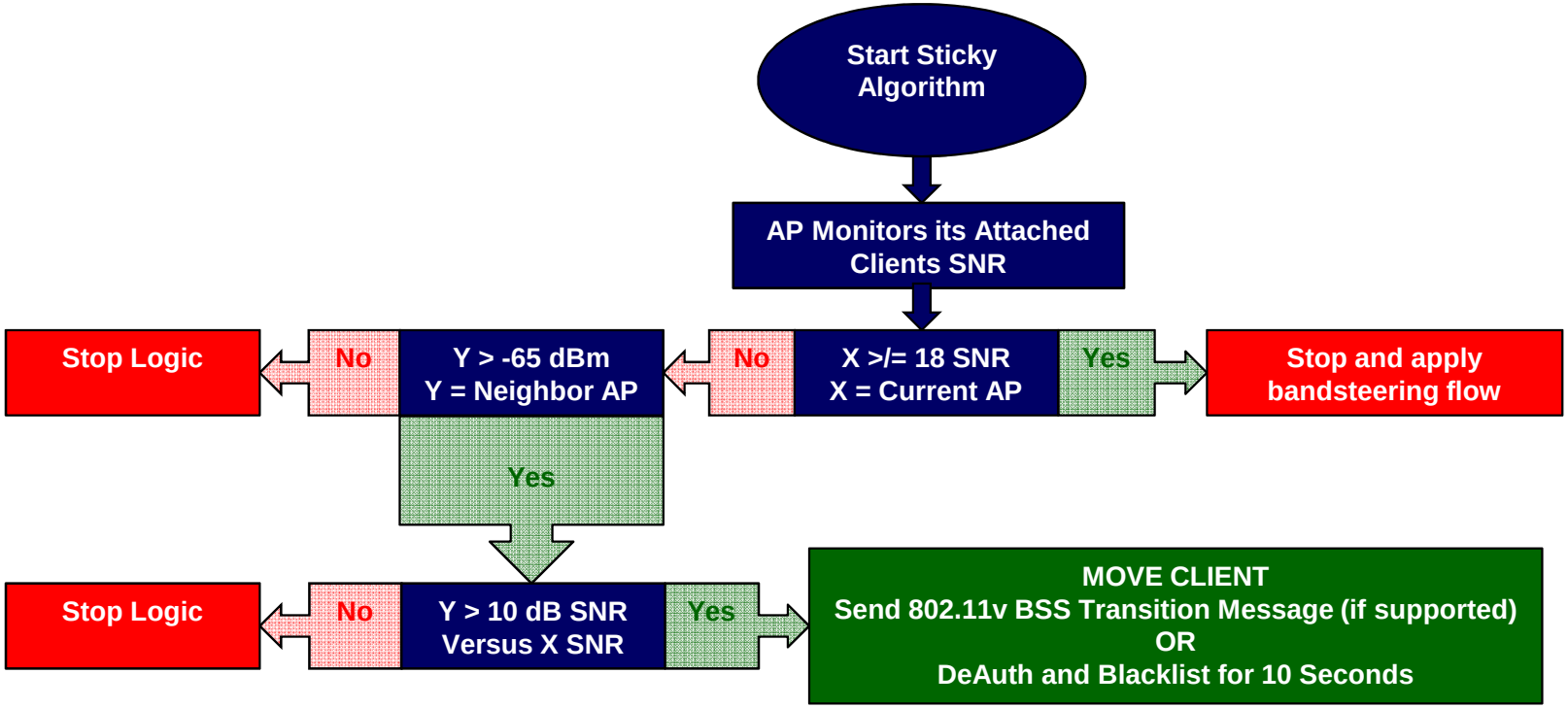
Client Match

- **Client Match Events – BandSteer**
  Pushing the client to 5 GHz from 2.4 GHz



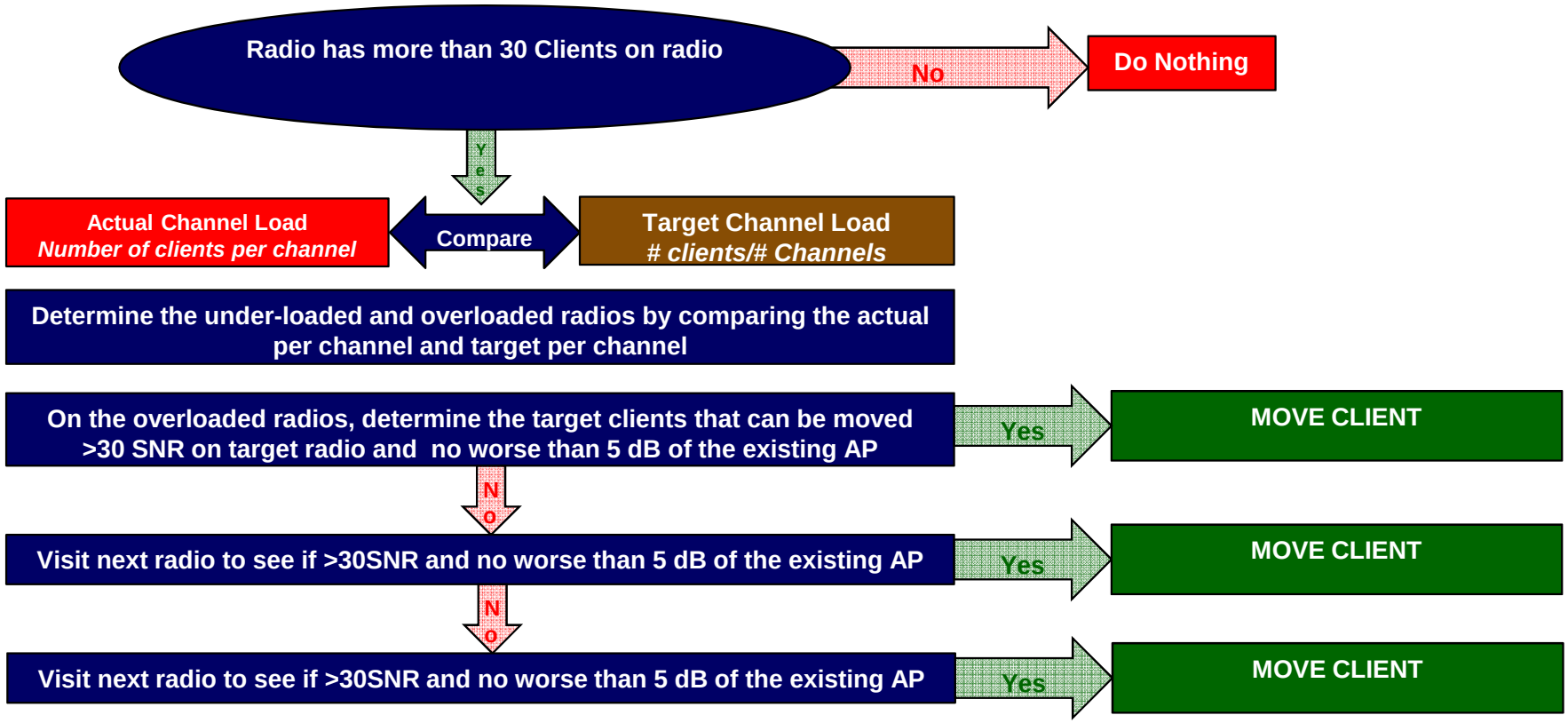
Client Match

- **Client Match Events – Sticky**
  Client is associated to an AP that is not receiving the client's signal above an SNR threshold



Client Match

- **Client Match Events – Load Balancing**
  Steering Clients to Under-loaded Radios



Client Match

- **Default Thresholds**

Client Match	Enabled ← Enabled by default starting in 6.3, please DO NOT DISABLE
Client Match report interval (sec)	30 ← How often the AP's send their VBR
Allows Client Match to automatically clear unsteerable clients after ageout	Enabled
Client Match Unsteerable Client Ageout (min)	2 Days 0 Hours ← Clients are deemed Unsteerable after 2 unsuccessful attempts
Client Match Band Steer G Band Max Signal (-dBm)	45 ← Signal level above which clients on B/G band will not be bandsteered
Client Match Band Steer A Band Min Signal (-dBm)	75 ← Signal level above which clients on A band will not be bandsteered
Client Match Sticky Client Check Interval (sec)	3 ← Frequency with which the AP runs the sticky algorithm
Client Match Sticky client check SNR (dB)	18 ← Minimum SNR under which a client will declared sticky
Client Match SNR threshold(dB)	10 ← Delta value between current AP and new AP SNR
Client Match Sticky Min Signal	65 ← Minimum signal level in RSSI over which a client will be declared sticky
Client Match Restriction timeout (sec)	10 ← Blacklist timeout for sticky move
Client Match Load Balancing threshold (%)	20 ← Threshold value for client distribution across channels
Client Match IOS Steer Backoff interval (sec)	300 ← Bandsteer backoff interval for IOS devices for failed bandsteer
Client Match VBR Stale Entry Age (sec)	120 ← How often stale VBR entries are aged out
Client Match Max steer failures	2 ← How many steer fails will trigger a client being classified as unsteerable
Client Match Load Balancing client threshold	30 ← Number of clients on an AP before the load balancing algorithm kicks in
Client Match Load Balancing SNR threshold (dB) event	30 ← Minimum SNR value of AP that is under loaded before a load balancing
Client Match Load Balancing signal delta bound (dB)	5 ← Target AP should not have weaker signal strength than source AP by this
Client Match 11v BSS Transition Management clients	Enabled ← 802.11v mechanisms will be tried first before using de-auth's to steer

Client Match

- **Client Match – Tuning**
  - Client Match forces users to other AP's typically after they are connected
    - In software versions >6.4.2.3 802.11v BSS transition messages are used if the client is 802.11v capable
    - Prior to 6.4.2.3 or if the client doesn't support 802.11v, the mechanism used is a 802.11 de-auth message
    - De-auth's force the user off an AP and can result is a less than desirable user experience in certain circumstances
    - Client Match is voice aware and will not issue a de-auth if a client is on a voice call
  - Based on this it desirable to have the client connect to the best AP on their own and avoid having Client Match having to guide them to a better AP if possible
  - The following default setting should be adjusted to make sure that clients are always bandsteered to the A band if possible

Client Match Band Steer G Band Max Signal (-dBm)	10	← Signal level above which clients on B/G band will not be bandsteered. We always want the client to be bandsteered to the A band if possible so this should be set to 10 to effectively disable. Default is 45.
Client Match Restriction timeout (sec)	3	← When a device is de-auth'ed, all the AP's except for the AP that we want them to go to temporarily blacklist the client. If a client is very stubborn and won't go were we want them to we don't want them disconnected for more than a few seconds. Default is 10
Client Match Sticky client check SNR (dB)	18-25	← Minimum SNR under which a client will declared sticky . Default is 18. The higher the AP density the higher value this should be

Client Match

- **Un-Steerable Clients**

  Non - IOS

  – Controller keeps track of successive steer failures for the respective steer reason to the desired destination radio
  – Upon 2 consecutive failed steer attempts the controller notifies the associated AP to mark the client as unsteerable (with reason)
  – AP will not attempt to band steer that client for that specific reason (SLB and Sticky are still in play)
  – To view unsupported clients “show ap arm client-match unsupported”
  – Default Unsteerable client ageout 2 days

  IOS Clients

  – IOS clients can get into a state where they will NOT try to reconnect after multiple de-authentications sent by the controller
  – To work around this we have implemented a backoff timer for IOS devices that is defaulted to 300 seconds/5 Minutes after an unsuccessful client steer
  – You will see an “I” flag with a “T” (temporary) if the 2 threshold has not been hit yet

Client Match

- **To view the VBR on the controller**
- ***Show ap virtual-beacon-report client-mac/ap-name/ip-addr/ip6-addr***

```
(Hejnar-7200) #show ap virtual-beacon-report client-mac 24:77:03:f9:5e:78


Client MAC :24:77:03:f9:5e:78
Current association :Primary-220 (9c:1c:12:88:63:d1)
Steer attempts/Success :9/9
Consecutive (Fails/BTM Rej/BTM Timeouts) :0/0/0
Bandsteer window (Steers/Start time/Expiry time) :2/Jan 21 05:17:50/Jan 21 05:47:50
Client Device Type :Win 7
Current state :Steerable
Client Supported Channels :{36,4}{52,4}{100,11}{149,4}{165,1}
Current Time :Jan 23 11:37:24 2015


STA Beacon Report
-----------------
AP             IP address   Radio              ESSID          Signal (dBm)  Last update      Add time         Channel/EIRP/Clients  Flag
--             ----------   -----              -----          ------------  -----------      --------         --------------------  ----
Primary-220    192.168.1.5  9c:1c:12:88:63:c0  H-Peripherals  -51           Jan 23 11:37:12  Jan 21 05:14:12  1/15/1
Primary-220    192.168.1.5  9c:1c:12:88:63:d0  H-Peripherals  -55           Jan 23 11:37:12  Jan 21 05:17:50  161/21/1              *
Secondary-220  192.168.1.6  9c:1c:12:88:63:90  H-Peripherals  -70           Jan 23 11:37:16  Jan 21 04:58:05  48/21/4
Secondary-220  192.168.1.6  9c:1c:12:88:63:80  H-Peripherals  -65           Jan 23 11:37:16  Jan 11 14:51:22  11/15/2
VBR Flags *-Associated S-Stale U-Unsupported Channel
```

  - Primary-220
    - The client's signal strength is -51dBm on B/G and -55dBm on A
    - The client's upstream SNR is 89-51 = 38 B/G and 97-55 = 42 on A
  - Secondary-220
    - The client's signal strength is -65dBm on B/G and -70dBm on A
    - The client's upstream SNR is 96-65 = 31 B/G and 93-70 = 23 on A

Client Match

– Looking the client match history for a client

Show ap arm client-match history/advanced/client-mac<mac>

```
(Hejnar-7200) #show ap arm client-match histor

S: Source, T: Target, A: Actual
Unit of Roam Time: second
Unit of Signal: dBm

ARM Client match History
-------------------------
Time of Change       Station            Reason       Status/Roam Time/Mode        Signal(S/T/A)  Band(S/T/A)      Radio Bssid(S/T/A)                                     AP Name(S/T/A)
--------------       -------            ------       ---------------------        -------------  -----------      ------------------                                     --------------
2015-02-02 07:32:47  00:a0:96:5c:4b:7e  Band-steer   Pending/202175/Deauth        -64/-68/-      2.4G/5G/-        9c:1c:12:88:63:80/9c:1c:12:88:63:90/-                  Secondary-220/Secondary-220/-
2015-02-04 15:03:26  24:77:03:f9:5e:78  Band-steer   Multiple-SSIDs/11/Deauth     -49/-60/-60    2.4G/5G/5G       9c:1c:12:88:63:c0/9c:1c:12:88:63:d0/9c:1c:12:88:63:d0  Primary-220/Primary-220/Primary-220
2015-02-04 14:59:21  24:77:03:f9:5e:78  Band-steer   Success/13/Deauth            -46/-55/-55    2.4G/5G/5G       9c:1c:12:88:63:c0/9c:1c:12:88:63:d0/9c:1c:12:88:63:d0  Primary-220/Primary-220/Primary-220
2015-02-03 22:28:26  9c:04:eb:b6:36:79  Band-steer   Success/5/Deauth             -62/-69/-69    2.4G/5G/5G       9c:1c:12:88:63:c0/9c:1c:12:88:63:d0/9c:1c:12:88:63:d0  Primary-220/Primary-220/Primary-220
2015-02-03 19:24:57  24:77:03:f9:5e:78  Band-steer   Success/9/Deauth             -48/-60/-60    2.4G/5G/5G       9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:90  Secondary-220/Secondary-220/Secondary-220
2015-02-03 18:28:34  24:77:03:f9:5e:78  Sticky       Success/1/Deauth             -74/-63/-63    5G/5G/5G         9c:1c:12:88:63:90/9c:1c:12:88:63:d0/9c:1c:12:88:63:d0  Secondary-220/Primary-220/Primary-220
2015-02-03 17:24:29  24:77:03:f9:5e:78  Band-steer   Multiple-SSIDs/25/Deauth     -61/-73/-61    2.4G/5G/5G       9c:1c:12:88:63:c0/9c:1c:12:88:63:d0/9c:1c:12:88:63:90  Primary-220/Primary-220/Secondary-220
2015-02-03 13:53:06  34:64:a9:44:7f:ff  Sticky       Success/3/Deauth             -68/-46/-46    2.4G/2.4G/2.4G   9c:1c:12:88:63:80/9c:1c:12:88:63:c0/9c:1c:12:88:63:c0  Secondary-220/Primary-220/Primary-220
2015-02-03 11:03:27  34:64:a9:44:7f:ff  Sticky       Success/1/Deauth             -67/-55/-55    2.4G/2.4G/2.4G   9c:1c:12:88:63:80/9c:1c:12:88:63:c0/9c:1c:12:88:63:c0  Secondary-220/Primary-220/Primary-220
2015-02-03 08:08:10  34:64:a9:44:7f:ff  Sticky       Success/0/Deauth             -67/-44/-44    2.4G/2.4G/2.4G   9c:1c:12:88:63:80/9c:1c:12:88:63:c0/9c:1c:12:88:63:c0  Secondary-220/Primary-220/Primary-220
2015-02-02 17:29:11  9c:04:eb:b6:36:79  Band-steer   Success/4/Deauth             -70/-74/-74    2.4G/5G/5G       9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:90  Secondary-220/Secondary-220/Secondary-220
2015-02-02 15:32:24  7c:ed:8d:c6:f2:03  Sticky       Success/6/Deauth             -65/-53/-53    2.4G/2.4G/2.4G   9c:1c:12:88:63:c0/9c:1c:12:88:63:80/9c:1c:12:88:63:80  Primary-220/Secondary-220/Secondary-220
2015-02-02 08:22:04  24:77:03:f9:5e:78  Sticky       Success/0/Deauth             -75/-61/-61    5G/5G/5G         9c:1c:12:88:63:90/9c:1c:12:88:63:d0/9c:1c:12:88:63:d0  Secondary-220/Primary-220/Primary-220
2015-02-02 07:42:00  34:64:a9:44:7f:ff  Sticky       Success/0/Deauth             -68/-47/-47    2.4G/2.4G/2.4G   9c:1c:12:88:63:80/9c:1c:12:88:63:c0/9c:1c:12:88:63:c0  Secondary-220/Primary-220/Primary-220
2015-02-02 02:56:32  24:77:03:f9:5e:78  Sticky       Success/0/Deauth             -72/-62/-62    5G/5G/5G         9c:1c:12:88:63:d0/9c:1c:12:88:63:90/9c:1c:12:88:63:90  Primary-220/Secondary-220/Secondary-220
2015-01-31 21:03:42  e0:f5:c6:36:33:76  Band-steer   Success/5/Deauth             -72/-72/-72    2.4G/5G/5G       9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:90  Secondary-220/Secondary-220/Secondary-220
2015-01-31 17:34:06  fc:c2:de:15:7a:08  Band-steer   Success/1/Deauth             -55/-72/-72    2.4G/5G/5G       9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:90  Secondary-220/Secondary-220/Secondary-220
2015-01-31 17:33:44  fc:c2:de:15:7a:08  Band-steer   Wrong-Radio/10/11v-BTM       -58/-72/-58    2.4G/5G/2.4G     9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:80  Secondary-220/Secondary-220/Secondary-220
2015-01-31 17:33:14  fc:c2:de:15:7a:08  Band-steer   Wrong-Radio/10/11v-BTM       -57/-71/-57    2.4G/5G/2.4G     9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:80  Secondary-220/Secondary-220/Secondary-220
2015-01-31 17:32:44  fc:c2:de:15:7a:08  Band-steer   Acceptable/10/11v-BTM        -61/-70/-57    2.4G/5G/2.4G     9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:80  Secondary-220/Secondary-220/Secondary-220
2015-01-31 17:32:14  fc:c2:de:15:7a:08  Band-steer   Wrong-Radio/10/11v-BTM       -61/-70/-61    2.4G/5G/2.4G     9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:80  Secondary-220/Secondary-220/Secondary-220
2015-01-31 17:31:44  fc:c2:de:15:7a:08  Band-steer   Wrong-Radio/10/11v-BTM       -54/-69/-54    2.4G/5G/2.4G     9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:80  Secondary-220/Secondary-220/Secondary-220
2015-01-31 14:21:02  00:a0:96:5c:4b:7e  Band-steer   Success/19/Deauth            -62/-71/-71    2.4G/5G/5G       9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:90  Secondary-220/Secondary-220/Secondary-220
2015-01-31 14:02:24  34:64:a9:44:7f:ff  Sticky       Success/0/Deauth             -67/-49/-49    2.4G/2.4G/2.4G   9c:1c:12:88:63:80/9c:1c:12:88:63:c0/9c:1c:12:88:63:c0  Secondary-220/Primary-220/Primary-220
2015-01-31 13:32:08  24:77:03:f9:5e:78  Band-steer   Multiple-SSIDs/10/Deauth     -58/-59/-59    2.4G/5G/5G       9c:1c:12:88:63:80/9c:1c:12:88:63:90/9c:1c:12:88:63:90  Secondary-220/Secondary-220/Secondary-220
```

Client Troubleshooting

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Client Troubleshooting

- **Association**
- **Authentication**
- **Network Connectivity**

Client Troubleshooting

- **Association**
  - Is the user associated
  - What AP is the user connected to?
    - Remember that the user is going to connect on their own to begin with before Client Match steers them anywhere
    - Does it makes sense where they are connected to?
      - Through walls, floors?
      - Farther AP via line of sight?
    - The user should connect to the closest unobstructed AP
  - Is it the correct/expected AP?
    - If not, why not?
  - Is Client Match pushing the user to the correct AP after 2-4 minutes?
    - If not, why not?

Client Troubleshooting

- **Association**

  show ap association client-mac <mac address>

  – shows a lot of detailed information for a specific user including-
    - AP Name the user is connected to
    - BSSID the user is connected to
    - MAC address
    - ESSID
    - VLAN-ID – The vlan that the user traffic is being sent on once it hits the distribution system (aka., wired network)
    - Tunnel-id - Identification number of the AP's tunnel.
    - Assoc. time - Amount of time the client has associated with the AP, in the format hours:minutes:seconds.
    - Band steer moves (T/S) – Tries and Success
    - Channel – Channel number
    - Channel Frame Retry Rate – A high number indicates a busy channel ← Is the channel super busy >50%, why?
    - Channel Frame Error Rate – What percentage of traffic is errors ← High # needs to be looked at
    - Channel Bandwidth Rate(kbps) - at this point in time
    - Channel Noise – Noise Floor ← Is the noise floor high? > 85 for B/G or >90 for A
    - Client Frame Retry Rate – How many frames need to be transmitting as a percentage of all frames
    - Client Tx Packets
    - Client Rx Packets
    - Client Tx Bytes
    - Client Rx Bytes
    - Client SNR – Noise floor minus the RSSI of the client

      By far the most important piece of information besides the AP the client is connected to
      25 is bare minimum, 30 is a good target
      Below 25 and the client or AP will down rate the connection 802.11n
      > 33-35 is best for AC rates

Client Troubleshooting

- **Association**

  show ap association client-mac <mac address>

  – Other information that is not important in most circumstances –

  - Association and Authentication State (802.11) – Remember that there are two types of 802.11 authentication, Open System and Shared Key (aka., WEP). So, this should not be confused with network authentication like 802.1X (which uses 802.11 Open System authentication).
  - AID – Association Identifier. A client receives a unique 802.11 association ID when it associates to an AP
  - l-int – Number of beacons in the 802.11 listen interval. There are ten beacons sent per second, so a ten-beacon listen interval indicates a listen interval time of 1 second.
  - Num assoc – how many users are associated to this BSSID, including the user you are current viewing
  - Channel Frame Fragmentation Rate – 802.11 Fragmentation – only an issue is extremely high
  - Channel Frame Low Speed Rate - what percentage of traffic is sent at the lowest supported data rate
  - Channel Frame Non Unicast Rate – percentage of multicast/broadcast traffic. Note that this may be zero if using multicast optimization and broadcast filter arp/broadcast filter all.

  – **This command is really useful for doing roaming test and keeping an eye on the SNR for the client and when user roams (based on the AP name changing) in real time. Note that the information contained in the association table (top) of the output (AP Name, bssid, client mac, auth/assoc, assoc. time, flag, etc. is updated real time. <u>However, the information in the lower part of the output labeled as "stats" where you have the two columns, "parameter" and "value" is updated every 60 seconds.</u>**

Client Troubleshooting

- **Association**

  show ap association client-mac <mac address> **shows association information only**

```
(Hejnar-7200) #show ap association client-mac 24:77:03:f9:5e:78

The phy column shows client's operational capabilities for current association

Flags: A: Active, B: Band Steerable, H: Hotspot(802.11u) client, K: 802.11K client, R: 802.11R client, W: WMM client, w: 802.11w client V: 802.11v BSS trans capable

PHY Details: HT   : High throughput;      20: 20MHz;  40: 40MHz
             VHT  : Very High throughput; 80: 80MHz; 160: 160MHz; 80p80: 80MHz + 80MHz
             <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  Band steer moves (T/S)
----         -----             ---               ----  -----  ---  -----  -----         -------  ---------  ---            -----------  ---------  -----  ----------------------
Primary-220  9c:1c:12:88:63:d1  24:77:03:f9:5e:78 y     y      1    100    H-Peripherals 1        0x10014    a-HT-40sgi-3ss 7m:36s       1          WAB    3/3

24:77:03:f9:5e:78-9c:1c:12:88:63:d1 Stats
----------------------------------------
Parameter                          Value
---------                          -----
Channel                            161
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)       0
Channel Noise                      97
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)        0
Client Tx Packets                  2838
Client Rx Packets                  1155
Client Tx Bytes                    305375
Client Rx Bytes                    505144
Client SNR                         42
A2c_SM SeqNum, Old SeqNums         750 0
```

Client Troubleshooting

- **Is the client 802.11v capable (steerable)**
  show ap association

```
**************************************************************************************************************
 10/28/2015 8:05:27 AM    Target: IAP205H-00:04    Command: show ap association
**************************************************************************************************************

The phy column shows client's operational capabilities for current association

Flags: A: Active, B: Band Steerable, H: Hotspot(802.11u) client, K: 802.11K client, R: 802.11R client, W: WMM client, w: 802.11w client V: 802.11v BSS trans capable

PHY Details: HT   : High throughput;      20: 20MHz;  40: 40MHz; t: turbo-rates (256-QAM)
             VHT  : Very High throughput; 80: 80MHz; 160: 160MHz; 80p80: 80MHz + 80MHz
             <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  DataReady
----           -----             ---               ----  -----  ---  -----  -----      -------  ---------  ---              -----------  ---------  -----  ---------
IAP205H-00:04  04:bd:88:75:b0:f2  bc:f5:ac:fb:23:d9 y     y      1    10     WLAN_SPLT  1234     0x0        a-VHT-20sgi-1ss  2h:37m:7s    1          W      Yes (Implicit)
IAP205H-00:04  04:bd:88:75:b0:f1  5c:c5:d4:03:3e:b9 y     y      1    250    WLAN_BR    3333     0x0        a-VHT-20sgi-2ss  2m:45s       1          W      Yes (Implicit)
IAP205H-00:04  04:bd:88:75:b0:f2  d8:50:e6:7d:b1:60 y     y      2    1      WLAN_SPLT  1234     0x0        a-HT-20sgi-1ss   42m:59s      1          WV     Yes (Implicit)
Num Clients:3
```

Client Troubleshooting

- **Association – Windows**
  netsh wlan show interfaces (or all which shows everything)

```
C:\Users\U-Know-Who-2>netsh wlan show interfaces

There is 1 interface on the system:

    Name                   : Wireless Network Connection
    Description            : Intel(R) Centrino(R) Ultimate-N 6300 AGN #3
    GUID                   : 857bf127-71cf-48aa-a2fb-c333ab0ab749
    Physical address       : 24:77:03:f9:5e:78
    State                  : connected
    SSID                   : HyattMeeting
    BSSID                  : 8c:0c:90:00:a1:0c
    Network type           : Infrastructure
    Radio type             : 802.11n
    Authentication         : Open
    Cipher                 : None
    Connection mode        : Profile
    Channel                : 48
    Receive rate (Mbps)    : 300
    Transmit rate (Mbps)   : 300
    Signal                 : 91%
    Profile                : HyattMeeting

    Hosted network status  : Not started
```

Don't trust these numbers, The controller shows much more accurate information

Client Troubleshooting

- **Association – Mac**

  airport –s and ***airport –I***

```
-MacBook-Air-2:~$ airport -s
            SSID BSSID             RSSI CHANNEL HT CC SECURITY (auth/unicast/group)
                 -1X 6c:f3:7f:af:81:30 -74  52,+1   Y  US WPA2(PSK/AES/AES)
                 -1X 6c:f3:7f:af:81:20 -62  11      Y  US WPA2(PSK/AES/AES)
                 -1X 9c:1c:12:8b:e6:20 -71  11      Y  US WPA2(PSK/AES/AES)
                 -1X 9c:1c:12:8b:9f:a0 -42  1       Y  US WPA2(PSK/AES/AES)
                 -1X 9c:1c:12:8b:9f:b0 -59  149,+1  Y  US WPA2(PSK/AES/AES)

-MacBook-Air-2:~$ airport -I
     agrCtlRSSI: -62
     agrExtRSSI: 0
    agrCtlNoise: -91
    agrExtNoise: 0
          state: running
        op mode: station
     lastTxRate: 405
        maxRate: 450
lastAssocStatus: 0
    802.11 auth: open
      link a
         BSSID: 9c:1c:12:8b:9f:b0
          SSID: Gr1ff1n-1X
           MCS: 23
       channel: 149,1
```

Client Troubleshooting

- **Association**

  show ap debug client-table ap-name Primary-220

  This is a critical command for viewing the upstream data rates from the client to the AP and vice versa

```
(Hejnar-7200) #show ap debug client-table ap-name Primary-220

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)
---  ------------  -----       -----------  --------  ---  --------  -----          -------  -------  -------  ----------  -------  -------  ------------  -----------  ---------  ------------
24:77:03:f9:5e:78  H-Peripherals  9c:1c:12:88:63:d1  Associated   WGSsMb    0x1  Awake     (0,0,0,0,N/A,0)  3725     4229     0        201         450      450      41            35           3[0x7]     Fri Jan 23 12:40:18 20
15  Fri Jan 23 12:40:18 2015  (0,0)            0          84/84
34:64:a9:44:7f:ff  H-Peripherals  9c:1c:12:88:63:c1  Associated   Qs        0x1  Awake     (0,0,0,0,N/A,0)  8        25       0        7           72       65       45            43           3[0x7]     Fri Jan 23 12:37:54 20
15  Fri Jan 23 12:39:21 2015  (0,0)            57         100/100

UAPSD:(VO,VI,BK,BE,Max SP,Q Len)
HT  Flags: A - LDPC Coding; W - 40MHz; S - Short GI 40; s - Short GI 20
         D - Delayed BA; G - Greenfield; R - Dynamic SM PS
         Q - Static SM PS; N - A-MPDU disabled; B - TX STBC
         b - RX STBC; M - Max A-MSDU; I - HT40 Intolerant
VHT Flags: C - 160MHz; c - 80MHz;  V - Short GI 160; v - Short GI 80
                E - Beamformee; e - Beamformer
HT_State shows client's original capabilities (not operational capabilities)
```

Make sure there is not a large disparity between the transmit rate (from the AP) and the received rate (from the client)

Remember that data rates are dynamic and will fluctuate

Client Troubleshooting

- **Roaming – Where has the client been did the controller do something to force a roam?**
  show ap client trail-info <mac>

```
(Hejnar-7200) #show ap client trail-info 24:77:03:f9:5e:78

Client Trail Info
-----------------
MAC                BSSID              ESSID          AP-name        VLAN  Deauth Reason  Alert
---                -----              -----          -------        ----  -------------  -----
24:77:03:f9:5e:78  9c:1c:12:88:63:91  H-Peripherals  Secondary-220  1     Client Match   Client Match

Deauth Reason
-------------
Reason                        Timestamp
------                        ---------
Client Match                  Apr 23 15:44:01
STA has roamed to another AP  Apr 23 15:43:32
Client Match                  Apr 23 15:03:22
Client Match                  Apr 23 15:02:59
STA has roamed to another AP  Apr 23 14:25:22
Internal deauth               Apr 23 14:24:28
Client Match                  Apr 23 14:23:55
STA has roamed to another AP  Apr 23 14:23:17
Internal deauth               Apr 23 14:22:49
Client Match                  Apr 23 14:22:13
Num Deauths:10

Alerts
------
Reason                        Timestamp
------                        ---------
Client Match                  Apr 23 15:44:01
STA has roamed to another AP  Apr 23 15:43:32
Client Match                  Apr 23 15:03:22
Client Match                  Apr 23 15:02:59
STA has roamed to another AP  Apr 23 14:25:22
Internal deauth               Apr 23 14:24:28
Client Match                  Apr 23 14:23:55
STA has roamed to another AP  Apr 23 14:23:17
Internal deauth               Apr 23 14:22:49
Client Match                  Apr 23 14:22:13
Num Alerts:10

Mobility Trail
--------------
BSSID              ESSID          AP-name        Timestamp
-----              -----          -------        ---------
9c:1c:12:88:63:91  H-Peripherals  Secondary-220  Apr 23 15:44:01
9c:1c:12:88:63:81  H-Peripherals  Secondary-220  Apr 23 15:44:01
9c:1c:12:88:63:81  H-Peripherals  Secondary-220  Apr 23 15:43:32
9c:1c:12:88:63:d1  H-Peripherals  Primary-220    Apr 23 15:43:32
9c:1c:12:88:63:d1  H-Peripherals  Primary-220    Apr 23 15:03:22
9c:1c:12:88:63:c1  H-Peripherals  Primary-220    Apr 23 15:03:22
9c:1c:12:88:63:c1  H-Peripherals  Primary-220    Apr 23 15:02:59
9c:1c:12:88:63:81  H-Peripherals  Secondary-220  Apr 23 15:02:59
9c:1c:12:88:63:81  H-Peripherals  Secondary-220  Apr 23 14:25:22
9c:1c:12:88:63:91  H-Peripherals  Secondary-220  Apr 23 14:25:22
Num Mobility Trails:10
```

Client Troubleshooting

- **Authentication**
  - 802.1X used as part of WPA2/AES is the source of most authentication issues in wireless networks, especially with client roaming
    - Remember that are a LOT of radius transactions that occur during initial connectivity and/or roaming between access points unless PMK caching or OKC is utilized by the client and AP.
    - Server issues
      - Where is the radius authentication server? What is the latency to that server?
      - Does this radius server have to do a backend authentication requests to another AA repository like Active Directory? What is the latency between the radius front end and backend AA database?
      - Are there any timeouts occurring
    - Client driver issues
      - Key exchanges not happening properly as seen in the “show auth-tracebuf”?
      - Other client transactions not happening properly as seen in the “show auth-tracebuf”?

Client Troubleshooting

- **Authentication - 802.1X**
  - 802.1X authentication happens when
    - The user initially connects
    - **The user roams between access points**
      - Pairwise Master Key (PMK) Caching
        - Enabled by default and cannot disable but you can disable validation of the PMKID **BUT DON'T!!!**
        - Enables 4 way key exchange versus going through a full authentication
        - Is done when a user roams back to an access point that the user has been to in the last 8 hours (timer is configurable)
        - Doesn't always work, key can be invalidated by either party

From IEEE 802.11i section 8.4.1.2.1 - A STA (AP) can retain PMKs for APs (STAs) in the ESS to which it has previously performed a full IEEE 802.1X authentication. If a STA wishes to roam to an AP for which it has cached one or more PMKSAs, it can include one or more PMKIDs in the RSN information element of its (Re)Association Request frame. An AP whose Authenticator has retained the PMK for one or more of the PMKIDs can skip the 802.1X authentication and proceed with the 4-Way Handshake. The AP shall include the PMKID of the selected PMK in Message 1 of the 4-Way Handshake. If none of the PMKIDs of the cached PMKSAs matches any of the supplied PMKIDs, then the Authenticator shall perform another IEEE 802.1X authentication. Similarly, if the STA fails to send a PMKID, the STA and AP must perform a full IEEE 802.1X authentication."

      - Opportunistic Key Caching (OKC)
        - Enabled by default
        - Enables 4 way key exchange versus going through a full authentication
        - Not all clients support
    - Based on all this the radius server MUST be local or available over a very low latency link
      - Remember that there are 20+ radius transactions per user authentication if no PMK caching or OKC

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Radius Authentication Server

  – Common issue when radius servers are not local (or even when they are because of overutilization)

  – To view radius server timeouts and look for a high percentage of timeouts relative to the overall number of requests

  – *show aaa authentication-server radius statistics*

  (sort of hidden command since if you type show aaa authentication<space>? It won't show up)

```
([redacted]) #show aaa authentication-server radius statistics

RADIUS Server Statistics
------------------------
Server        Acct Rq  Raw Rq   PAP Rq  CHAP Rq  MSCHAP Rq  MSCHAPv2 Rq  Mismatch Rsp  Bad Auth  Acc     Rej    Acct Rsp  Chal     Ukn Rsp  Tmout  AvgRspTm  Tot Rq   Tot Rsp  Rd Err  Uptime   SEQ
------        -------  ------   ------  -------  ---------  -----------  ------------  --------  ---     ---    --------  ----     -------  -----  --------  ------   -------  ------  ------   ---
[redacted]    0        0        119     0        0          0            0             0         0       0      0         0        0        476    0         119      0        0       1:5:58   255/255
              607      10470    660     0        0          0            1353          77        1156    26     330       8688     0        6124   2129      11737    11630    0       2:17:10  255/255
              125578   4424599  172924  0        0          0            10423         36        721957  11656  125405    3862539  0        35816  486       4723101  4732016  0       0:16:37  255/250

*AvgRspTm is in msec, Uptime is in d:h:m, SEQ is in Total/Free

Orphaned requests = 0
```

Average response times should be below 100ms and the timeouts should not be incrementing

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  If the radius server statistics look good but the user is not authenticating properly or having trouble roaming do the following….

  – Enable debugging for their mac address
    - ***logging level debugging user-debug <mac address>***
  – Have them try to authenticate or roam to re-create the issue
  – Look at the auth-tracebuf on the controller to see what the issue is
    - ***Show auth-tracebuf | inc <mac address>***
    - Note that this is a rolling buffer that is FIFO so don't wait too long to view
    - Also, when you are done troubleshooting make sure you disable the debug logging on the controller
      - ***Config t no logging level debugging user-debug <mac address>***

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Viewing the auth-tracebuf – Almost Normal Full 802.1X Authentication

```
(XYZ Company) #show auth-tracebuf | include 38:aa:3c:12:dd:32
May 29 20:16:47  station-down        *  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          -     -
May 29 20:16:50  station-up          *  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          -     -    wpa2 aes
May 29 20:16:50  eap-id-req          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          1     5
May 29 20:16:50  eap-id-resp         →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          1     26    northamerica\user-X
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          65517  214
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65517  90
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          2     6
May 29 20:16:50  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          2     240
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65526  466
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65526  1188
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          3     1096
May 29 20:16:50  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          3     6
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65535  232
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65535  1188
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          4     1096
May 29 20:16:50  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          4     6
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  3     232
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  3     781
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          5     693
May 29 20:16:50  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          5     220
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65486  446
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65486  153
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          6     69
May 29 20:16:50  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          6     6
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  4     232
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  4     127
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          7     43
May 29 20:16:50  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          7     96
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65475  322
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65475  143
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          8     59
May 29 20:16:50  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          8     96
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  5     322
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  5     159
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          9     75
May 29 20:16:50  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          9     160
```

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Viewing the auth-tracebuf – Almost Normal Full 802.1X Authentication Continued

```
May 29 20:16:50  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65512  386
May 29 20:16:50  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  65512  175
May 29 20:16:50  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          10     91
May 29 20:16:53  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          10     91    ←user supplicant timed out here and server had to make another EAP-ID request
May 29 20:16:53  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          10     80
May 29 20:16:53  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  6      306
May 29 20:16:53  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  6      191
May 29 20:16:53  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          12     107
May 29 20:16:53  eap-resp           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          12     144
May 29 20:16:53  rad-req            →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  8      370
May 29 20:16:53  rad-accept         <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc/RADIUS-2  8      356
May 29 20:16:53  eap-success        <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          12     4
May 29 20:16:53  station-data-ready   *  38:aa:3c:12:dd:32  00:00:00:00:00:00          851    -
May 29 20:16:53  wpa2-key1          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          -      117
May 29 20:16:53  wpa2-key2           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          -      135
May 29 20:16:53  wpa2-key3          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          -      151
May 29 20:16:53  wpa2-key4           →  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc          -      95
```

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Viewing the auth-tracebuf – Normal Full 802.1X Authentication After Roam

```
May 29 20:17:27  station-down       *  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc         -    -   ← User roams here 40 seconds later
May 29 20:17:27  station-up         *  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         -    -   wpa2 aes
May 29 20:17:27  eap-id-req         <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         1    5
May 29 20:17:27  eap-id-resp        ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         1    26   northamerica\User-X
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         17   214
May 29 20:17:27  rad-resp          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  17   90
May 29 20:17:27  eap-req           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         2    6
May 29 20:17:27  eap-resp          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         2    240
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  19   466
May 29 20:17:27  rad-resp          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  19   1188
May 29 20:17:27  eap-req           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         3    1096
May 29 20:17:27  eap-resp          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         3    6
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  18   232
May 29 20:17:27  rad-resp          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  18   1188
May 29 20:17:27  eap-req           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         4    1096
May 29 20:17:27  eap-resp          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         4    6
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  23   232
May 29 20:17:27  rad-resp          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  23   1188
May 29 20:17:27  eap-req           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         5    1096
May 29 20:17:27  eap-resp          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         5    6
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  27   232
May 29 20:17:27  rad-resp          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  27   1188
May 29 20:17:27  eap-req           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         6    1096
May 29 20:17:27  eap-resp          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         6    6
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  28   232
May 29 20:17:27  rad-resp          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  28   132
May 29 20:17:27  eap-req           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         7    48
May 29 20:17:27  eap-resp          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         7    220
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  26   446
May 29 20:17:27  rad-resp          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  26   153
May 29 20:17:27  eap-req           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         8    69
May 29 20:17:27  eap-resp          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         8    6
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  1    232
May 29 20:17:27  rad-resp          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  1    127
May 29 20:17:27  eap-req           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         9    43
May 29 20:17:27  eap-resp          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8         9    96
May 29 20:17:27  rad-req          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  31   322
```

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Viewing the auth-tracebuf – Normal Full 802.1X Authentication After Roam

```
May 29 20:17:27  rad-req            ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  31     322
May 29 20:17:27  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  31     143
May 29 20:17:27  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           10     59
May 29 20:17:28  eap-resp           ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           10     96
May 29 20:17:28  rad-req            ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  65528  322
May 29 20:17:28  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  65528  159
May 29 20:17:28  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           11     75
May 29 20:17:28  eap-resp           ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           11     160
May 29 20:17:28  rad-req            ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  25     386
May 29 20:17:28  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  25     175
May 29 20:17:28  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           12     91
May 29 20:17:28  eap-resp           ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           12     80
May 29 20:17:28  rad-req            ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  33     306
May 29 20:17:28  rad-resp           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  33     191
May 29 20:17:28  eap-req            <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           14     107
May 29 20:17:28  eap-resp           ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           14     144
May 29 20:17:28  rad-req            ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  30     370
May 29 20:17:28  rad-accept         <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8/Radius-2  30     356
May 29 20:17:28  eap-success        <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           14     4
May 29 20:17:28  station-data-ready   *  38:aa:3c:12:dd:32  00:00:00:00:00:00           851    -
May 29 20:17:28  wpa2-key1          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           -      117
May 29 20:17:28  wpa2-key2          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           -      117
May 29 20:17:28  wpa2-key3          <-  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           -      151
May 29 20:17:28  wpa2-key4          ->  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8           -      95
```

  All good with this exchange and user roam

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**
  Viewing the auth-tracebuf – PMK Caching After Roaming Back to Original BSSID

```
May 29 20:18:04  station-down          *  38:aa:3c:12:dd:32  d8:c7:c8:96:4b:b8        -    -   ← User roams here 36  seconds later
May 29 20:18:04  station-up          *  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc        -    -   wpa2 aes
May 29 20:18:04  station-data-ready    *  38:aa:3c:12:dd:32  00:00:00:00:00:00       851   -
May 29 20:18:04  wpa2-key1           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc        -    117
May 29 20:18:04  wpa2-key2           ->  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc        -    135
May 29 20:18:04  wpa2-key3           <-  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc        -    151
May 29 20:18:04  wpa2-key4           ->  38:aa:3c:12:dd:32  d8:c7:c8:96:70:bc        -    95
```

Note the abbreviated authentication since PMK caching has kicked in here

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**
  Viewing the auth-tracebuf – User Supplicant Not Responding to EAP-ID Request

•May 29 20:21:17 station-down * 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc - - **← User roams here**
•May 29 20:21:17 station-up * 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc - - wpa2 aes
•May 29 20:21:17 eap-id-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 1 5 **← Appears that the AP no longer has the PMK cached so a full re-auth is started**
•May 29 20:21:17 eap-id-resp -> 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 1 26 northamerica\User-X
•May 29 20:21:17 rad-req -> 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 65425 214
•May 29 20:21:17 rad-resp <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc/Radius-2 65425 90
•May 29 20:21:17 eap-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 2 6
•May 29 20:21:21 eap-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 2 6 **← Houston we have a problem…the client is not responding to the eap requests, see the next 3 requests and the timestamps. Our timeout (which is configurable) is 5 seconds by default which is more than enough time.**
•May 29 20:21:24 eap-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 2 6
•May 29 20:21:27 eap-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 2 6
•May 29 20:21:30 eap-failure <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 2 4 server timeout **← Remember that these EAP messages are between the client and the server so the server decides to timeout and force the client to try again.**
•May 29 20:21:30 eap-failure <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 3 4 station timeout **← The station didn't respond to the last message so it's timed out and the process starts over**
•May 29 20:21:30 eap-id-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 3 5
•May 29 20:21:33 eap-id-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 3 5
•May 29 20:21:36 eap-id-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc 4 5
•May 29 20:21:36 station-down * 38:aa:3c:12:dd:32 d8:c7:c8:96:70:bc - -
•May 29 20:21:36 station-up * 38:aa:3c:12:dd:32 d8:c7:c8:96:4b:b8 - - wpa2 aes
•May 29 20:21:36 eap-id-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:4b:b8 1 5
•May 29 20:21:39 eap-id-req <- 38:aa:3c:12:dd:32 d8:c7:c8:96:4b:b8 1 5
•May 29 20:21:39 eap-id-resp -> 38:aa:3c:12:dd:32 d8:c7:c8:96:4b:b8 1 26 northamerica\User-X **← On the next try the user responds to the second EAP ID request and then things proceed normally.**

Note that this ended up to be a client driver/supplicant issue that was reported to the appropriate manufacturer

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Viewing the auth-tracebuf – Bad Client Driver

```
(7200-xyz) #show auth-tracebuf | include 3c:a9:f4:32:da:bc
Jan 29 07:04:36  station-down        *  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -    -
Jan 29 07:14:55  station-up          *  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -    -    wpa2 aes
Jan 29 07:14:55  eap-id-req         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   1    5
Jan 29 07:14:57  eap-start         ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -    -
Jan 29 07:14:57  eap-id-req         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   1    5
Jan 29 07:14:59  eap-id-req         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   1    5
Jan 29 07:15:00  eap-id-resp        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   1    11   nmdq87
Jan 29 07:15:00  rad-req           ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  65515  211
Jan 29 07:15:00  rad-resp          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65515  77
Jan 29 07:15:00  eap-req           <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   45    6
Jan 29 07:15:00  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   45    227
Jan 29 07:15:00  rad-req           ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65516  458
Jan 29 07:15:00  rad-resp          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65516  1089
Jan 29 07:15:00  eap-req           <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   46    1012
Jan 29 07:15:00  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   46    6
Jan 29 07:15:00  rad-req           ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65517  237
Jan 29 07:15:00  rad-resp          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65517  1085
Jan 29 07:15:00  eap-req           <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   47    1008
Jan 29 07:15:00  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   47    6
Jan 29 07:15:00  rad-req           ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65518  237
Jan 29 07:15:00  rad-resp          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65518  1085
Jan 29 07:15:00  eap-req           <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   48    1008
Jan 29 07:15:00  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   48    6
Jan 29 07:15:00  rad-req           ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65519  237
Jan 29 07:15:00  rad-resp          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65519  1085
Jan 29 07:15:00  eap-req           <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   49    1008
Jan 29 07:15:00  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   49    6
Jan 29 07:15:00  rad-req           ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65520  237
Jan 29 07:15:00  rad-resp          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65520  266
Jan 29 07:15:00  eap-req           <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   50    195
Jan 29 07:15:00  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   50    1310
Jan 29 07:15:00  rad-req           ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65521  1551
Jan 29 07:15:00  rad-resp          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65521  77
Jan 29 07:15:00  eap-req           <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   51    6
Jan 29 07:15:00  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                   51    895
Jan 29 07:15:00  rad-req           ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65522  1132
```

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Viewing the auth-tracebuf – Bad Client Driver

```
Jan 29 07:15:00  rad-resp          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65522  140
Jan 29 07:15:00  eap-req           <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  52     69
Jan 29 07:15:00  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  52     6
Jan 29 07:15:00  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65523  237
Jan 29 07:15:00  rad-accept        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  65523  204
Jan 29 07:15:00  eap-success       <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  52     4
Jan 29 07:15:00  wpa2-key1        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -      117
Jan 29 07:15:00  wpa2-key2        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -      117
Jan 29 07:15:00  wpa2-key3        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -      151
Jan 29 07:15:00  wpa2-key4        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -      95
Jan 29 07:15:28  station-down      *   3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -      -
Jan 29 07:15:30  station-up        *   3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -      -      wpa2 aes
Jan 29 07:15:30  wpa2-key1        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -      117
Jan 29 07:15:30  wpa2-key2        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -      135
Jan 29 07:15:30  wpa2-key3        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -      151
Jan 29 07:15:30  wpa2-key4        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -      95
Jan 29 07:23:53  station-down      *   3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -      -
Jan 29 07:23:53  station-up        *   3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -      -      wpa2 aes
Jan 29 07:23:53  eap-id-req       <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  1      5
Jan 29 07:23:54  eap-start        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -      -
Jan 29 07:23:54  eap-id-req       <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  1      5
Jan 29 07:23:57  eap-id-req       <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  1      5
Jan 29 07:23:57  eap-id-resp      ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  1      11     nmdq87
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  3      211
Jan 29 07:23:57  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  3      77
Jan 29 07:23:57  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  81     6
Jan 29 07:23:57  eap-resp         ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  81     227
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  4      458
Jan 29 07:23:57  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  4      1089
Jan 29 07:23:57  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  82     1012
Jan 29 07:23:57  eap-resp         ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  82     6
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  5      237
Jan 29 07:23:57  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  5      1085
Jan 29 07:23:57  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  83     1008
Jan 29 07:23:57  eap-resp         ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  83     6
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  6      237
Jan 29 07:23:57  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  6      1085
```

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Viewing the auth-tracebuf – Bad Client Driver

```
Jan 29 07:23:57  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  84    1008
Jan 29 07:23:57  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  84    6
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  7     237
Jan 29 07:23:57  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  7     1085
Jan 29 07:23:57  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  85    1008
Jan 29 07:23:57  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  85    6
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  8     237
Jan 29 07:23:57  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  8     266
Jan 29 07:23:57  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  86    195
Jan 29 07:23:57  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  86    1310
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  9     1551
Jan 29 07:23:57  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  9     77
Jan 29 07:23:57  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  87    6
Jan 29 07:23:57  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  87    895
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  10    1132
Jan 29 07:23:57  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  10    140
Jan 29 07:23:57  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  88    69
Jan 29 07:23:57  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  88    6
Jan 29 07:23:57  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  11    237
Jan 29 07:23:57  rad-accept        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0/Radius-2  11    204
Jan 29 07:23:57  eap-success       <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  88    4
Jan 29 07:23:57  wpa2-key1        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -     117
Jan 29 07:23:57  wpa2-key2        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -     117
Jan 29 07:23:57  wpa2-key3        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -     151
Jan 29 07:23:57  wpa2-key4        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -     95
Jan 29 07:24:25  station-down      *   3c:a9:f4:32:da:bc  9c:1c:12:8a:75:c0                  -     -
Jan 29 07:24:27  station-up        *   3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -     -     wpa2 aes
Jan 29 07:24:27  wpa2-key1        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -     117
Jan 29 07:24:28  wpa2-key1        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -     117
Jan 29 07:24:29  wpa2-key2        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -     135
Jan 29 07:24:29  wpa2-key3        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -     151
Jan 29 07:24:29  wpa2-key4        ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -     95
Jan 29 07:25:36  station-up        *   3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -     -     wpa2 aes
Jan 29 07:25:36  eap-id-req       <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  2     5
Jan 29 07:25:37  eap-start       ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  -     -
Jan 29 07:25:37  eap-id-req       <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  2     5
Jan 29 07:25:37  eap-id-resp      ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                  2     11    nmdq87
```

Client Troubleshooting

- **Authentication – Troubleshooting 802.1X Auth Issues**

  Viewing the auth-tracebuf – Bad Client Driver

```
Jan 29 07:25:37  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                    96    6
Jan 29 07:25:38  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                    96    895
Jan 29 07:25:38  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0/Radius-2  28    1132
Jan 29 07:25:38  rad-resp         <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0/Radius-2  28    140
Jan 29 07:25:38  eap-req          <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                    97    69
Jan 29 07:25:38  eap-resp          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                    97    6
Jan 29 07:25:38  rad-req          ->  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0/Radius-2  29    237
Jan 29 07:25:38  rad-accept        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0/Radius-2  29    204
Jan 29 07:25:38  eap-success       <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                    97    4
Jan 29 07:25:38  wpa2-key1        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                    -     117
Jan 29 07:25:39  wpa2-key1        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                    -     117
Jan 29 07:25:41  wpa2-key1        <-  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0                    -     117
Jan 29 07:25:44  station-down      *  3c:a9:f4:32:da:bc  9c:1c:12:8a:75:d0
```

  Ubuntu Linux Driver Issue with Intel 6300

  Resolution was to disable 40 MHz channels on the client

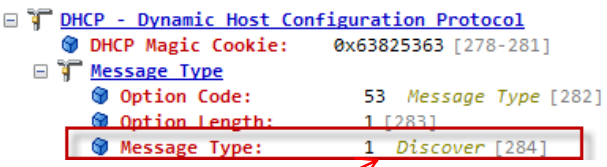
Client Troubleshooting

- **Network Connectivity**
  - DHCP
    - Is the server getting overloaded?
      - DHCP NACKs happen during roams (client checking to make sure it can still use the address)
    - Is the controller the DHCP server?
      - If greater than X number of clients then an external DHCP needs to be used
    - Use debug logging on the controller for DHCP
      - ***conf t logging level debugging network subcat dhcp***
  - User VLAN
    - Is the user vlan being switched/routed properly

Client Troubleshooting

- **Network Connectivity – DHCP Normal Release/Renew**
  - Viewing DHCP requests in the controller after enabling debug logging

show log network 100 (| inc dhcp)



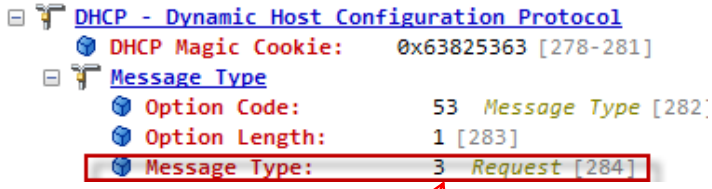
20	192.168.1.9	68	192.168.1.1	67		346	0.000000	19:03:50.231691	DHCP	C RELEASE
50	0.0.0.0	68	255.255.255.255	67		346	2.817386	19:03:53.049077	DHCP	C DISCOVER 192.168.1.9 U-Know-Who-PC
63	192.168.1.1	67	255.255.255.255	68		346	4.479506	19:03:54.711197	DHCP	R OFFER 192.168.1.9
64	0.0.0.0	68	255.255.255.255	67		368	4.479974	19:03:54.711665	DHCP	C REQUEST 192.168.1.9 U-Know-Who-PC
65	192.168.1.1	67	255.255.255.255	68		346	4.560519	19:03:54.792210	DHCP	R ACK
219	192.168.1.9	68	255.255.255.255	67		346	8.137184	19:03:58.368875	DHCP	C INFORM U-Know-Who-PC
220	192.168.1.200	67	255.255.255.255	68		351	8.138719	19:03:58.370410	DHCP	R ACK

```
Feb 3 18:58:30 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x40 opcode 0x5a ingress 0x1000b vlan 1 egress 0x2100 src mac 24:77:03:f9:5e:78
Feb 3 18:58:30 :202538:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: RELEASE 24:77:03:f9:5e:78 Transaction ID:0x29b46f40 clientIP=192.168.1.9
Feb 3 18:58:37 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x40 opcode 0x5a ingress 0x1000b vlan 1 egress 0x1 src mac 24:77:03:f9:5e:78
Feb 3 18:58:37 :202534:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: DISCOVER 24:77:03:f9:5e:78 Transaction ID:0xb80bf648 Options 3d:01247703f95e78 0c:552d4b6e6f772d57686f2d5043 3c:4d53465420352e30 37:010f03062c2e2f1f2179f92b
Feb 3 18:58:37 :202523:  <DBUG> |dhcpdwrap| |dhcp| dhcprelay: dev=eth1, length=300, from_port=68, op=1, giaddr=0.0.0.0
Feb 3 18:58:37 :202532:  <DBUG> |dhcpdwrap| |dhcp| got 0 relay servers
Feb 3 18:58:38 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x42 opcode 0x5a ingress 0x2100 vlan 1 egress 0x1 src mac 18:1b:eb:ad:5a:1b
Feb 3 18:58:38 :202546:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: OFFER 24:77:03:f9:5e:78 Transaction ID:0xb80bf648 clientIP=192.168.1.9
Feb 3 18:58:38 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x40 opcode 0x5a ingress 0x1000b vlan 1 egress 0x1 src mac 24:77:03:f9:5e:78
Feb 3 18:58:38 :202536:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: REQUEST 24:77:03:f9:5e:78 Transaction ID:0xb80bf648 reqIP=192.168.1.9 Options 3d:01247703f95e78 36:c0a80101 0c:552d4b6e6f772d57686f2d5043 51:000000552d4b6e6f7
72d57686f2d5043 3c:4d53465420352e30 37:010f03062c2e2f1f2179f92b
Feb 3 18:58:38 :202523:  <DBUG> |dhcpdwrap| |dhcp| dhcprelay: dev=eth1, length=322, from_port=68, op=1, giaddr=0.0.0.0
Feb 3 18:58:38 :202532:  <DBUG> |dhcpdwrap| |dhcp| got 0 relay servers
Feb 3 18:58:38 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x42 opcode 0x5a ingress 0x2100 vlan 1 egress 0x1 src mac 18:1b:eb:ad:5a:1b
Feb 3 18:58:38 :202544:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: ACK 24:77:03:f9:5e:78 Transaction ID:0xb80bf648 clientIP=192.168.1.9
Feb 3 18:58:42 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x42 opcode 0x5a ingress 0x2100 vlan 1 egress 0x1 src mac 3c:97:0e:79:74:e3
Feb 3 18:58:42 :202534:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: DISCOVER 3c:97:0e:79:74:e3 Transaction ID:0xd5994605 Options 3d:013c970e7974e3 0c:552d4b6e6f772d57686f2d5043 3c:4d53465420352e30 37:010f03062c2e2f1f2179f92b
Feb 3 18:58:42 :202523:  <DBUG> |dhcpdwrap| |dhcp| dhcprelay: dev=eth1, length=300, from_port=68, op=1, giaddr=0.0.0.0
Feb 3 18:58:42 :202532:  <DBUG> |dhcpdwrap| |dhcp| got 0 relay servers
Feb 3 18:58:43 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x42 opcode 0x5a ingress 0x2100 vlan 1 egress 0x1 src mac 3c:97:0e:79:74:e3
Feb 3 18:58:43 :202536:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: REQUEST 3c:97:0e:79:74:e3 Transaction ID:0xd5994605 reqIP=192.168.1.10 Options 3d:013c970e7974e3 36:c0a80101 0c:552d4b6e6f772d57686f2d5043 3c:4d53465420352e30
 37:010f03062c2e2f1f2179f92b
Feb 3 18:58:43 :202523:  <DBUG> |dhcpdwrap| |dhcp| dhcprelay: dev=eth1, length=304, from_port=68, op=1, giaddr=0.0.0.0
Feb 3 18:58:43 :202532:  <DBUG> |dhcpdwrap| |dhcp| got 0 relay servers
Feb 3 18:58:46 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x40 opcode 0x5a ingress 0x1000b vlan 1 egress 0x1 src mac 24:77:03:f9:5e:78
Feb 3 18:58:46 :202542:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: INFORM 24:77:03:f9:5e:78 Transaction ID:0x7360ba23 clientIP=192.168.1.9
Feb 3 18:58:46 :202523:  <DBUG> |dhcpdwrap| |dhcp| dhcprelay: dev=eth1, length=300, from_port=68, op=1, giaddr=0.0.0.0
Feb 3 18:58:46 :202513:  <DBUG> |dhcpdwrap| |dhcp| Could not find interface and/or vlan for ip=192.168.1.9, could be reply to mobility message.
Feb 3 18:58:46 :202532:  <DBUG> |dhcpdwrap| |dhcp| got 0 relay servers
Feb 3 18:58:46 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x42 opcode 0x5a ingress 0x2100 vlan 1 egress 0x1 src mac 00:0c:f1:bd:01:9b
Feb 3 18:58:46 :202544:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: ACK 24:77:03:f9:5e:78 Transaction ID:0x7360ba23 clientIP=192.168.1.9
Feb 3 18:58:47 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x42 opcode 0x5a ingress 0x2100 vlan 1 egress 0x1 src mac 3c:97:0e:79:74:e3
Feb 3 18:58:47 :202542:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: INFORM 3c:97:0e:79:74:e3 Transaction ID:0x99c81181 clientIP=192.168.1.10
Feb 3 18:58:47 :202523:  <DBUG> |dhcpdwrap| |dhcp| dhcprelay: dev=eth1, length=300, from_port=68, op=1, giaddr=0.0.0.0
Feb 3 18:58:47 :202513:  <DBUG> |dhcpdwrap| |dhcp| Could not find interface and/or vlan for ip=192.168.1.10, could be reply to mobility message.
Feb 3 18:58:47 :202532:  <DBUG> |dhcpdwrap| |dhcp| got 0 relay servers
```

Client Troubleshooting

- **Network Connectivity – DHCP Normal Roam**
  - Viewing DHCP requests in the controller after enabling debug logging

show log network 100 (| inc dhcp)



Packet	Source	Source Port	Destination	Dest. Port	Flags	Size	Relative Time	Absolute Time	Protocol	Summary
732	0.0.0.0	68	255.255.255.255	67		362	0.000000	16:07:19.036154	DHCP	C REQUEST 192.168.1.9 U-Know-Who-PC
733	192.168.1.1	67	255.255.255.255	68		346	0.007660	16:07:19.043814	DHCP	R ACK

```
Feb 4 16:07:16 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x40 opcode 0x5a ingress 0x10012 vlan 1 egress 0x1 src mac 24:77:03:f9:5e:78
Feb 4 16:07:16 :202536:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: REQUEST 24:77:03:f9:5e:78 Transaction ID:0x558e820c reqIP=192.168.1.9 Options 35:01247703f95e78 0c:552d4b6e6f772d57686f2d5043 51:000000552d4b6e6f772d57686f2
043 3c:4d53465420352e30 37:010f03062c2e2f1f2179f92b
Feb 4 16:07:16 :202523:  <DBUG> |dhcpdwrap| |dhcp| dhcprelay: dev=eth1, length=316, from_port=68, op=1, giaddr=0.0.0.0
Feb 4 16:07:16 :202532:  <DBUG> |dhcpdwrap| |dhcp| got 0 relay servers
Feb 4 16:07:16 :202541:  <DBUG> |dhcpdwrap| |dhcp| Received DHCP packet from Datpath, sos msg hdr flags 0x42 opcode 0x5a ingress 0x2100 vlan 1 egress 0x1 src mac 18:1b:eb:ad:5a:1b
Feb 4 16:07:16 :202544:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: ACK 24:77:03:f9:5e:78 Transaction ID:0x558e820c clientIP=192.168.1.9
```

Client Troubleshooting

- **User Role(s)**
  - What user roles are assigned to the user both pre-authentication (captive portal) and post authentication? Do the respective roles have the correct ACLs?

show user mac <mac>

```
(Hejnar-7200) #show user mac 24:77:03:f9:5e:78


Name: , IP: 192.168.1.9, MAC: 24:77:03:f9:5e:78, Role: authenticated, ACL: 64/0, Age: 00:01:25
Authentication: No, status: not started, method: , protocol: , server:
Role Derivation: AAA profile default role
VLAN Derivation: Default VLAN
Idle timeout (global): 300 seconds, Age: 00:00:00
Mobility state: Wireless, HA: Yes, Proxy ARP: No, Roaming: No Tunnel ID: 0 L3 Mob: 0
Flags: internal=0, trusted_ap=0, l3auth=0, mba=0, vpnflags=0, u_stm_ageout=1
Flags: innerip=0, outerip=0, vpn_outer_ind:0, download=1, wispr=0
IP User termcause: 0
phy_type: a-HT-40, l3 reauth: 0, BW Contract: up:0 down:0, user-how: 14
Vlan default: 1, Assigned: 1, Current: 1 vlan-how: 1 DP assigned vlan:0
Mobility Messages: L2=0, Move=0, Inter=0, Intra=0, Flags=0x0
SlotPort=0x2100, Port=0x10012 (tunnel 18)
Role assigment - L3 assigned role: n/a, VPN role: n/a, Dot1x cached role: n/a
    Current Role name: authenticated, role-how: 10, L2-role: authenticated, L3-role: authenticated
Essid: H-Peripherals, Bssid: 9c:1c:12:88:63:91 AP name/group: Secondary-220/Hejnar Phy-type: a-HT-40
RadAcct sessionID:n/a
RadAcct Traffic In 6338/1182790 Out 7675/4304765 (0:6338/0:0:18:3142,0:7675/0:0:65:44925)
Timers: L3 reauth 0, mac reauth 0 (Reason: ), dot1x reauth 0 (Reason: )
Profiles AAA:H-Peripherals-aaa_prof, dot1x:dot1x_prof-lnb78, mac: CP: def-role:'authenticated' sip-role:'' via-auth-profile:''
ncfg flags udr 0, mac 0, dot1x 1, RADIUS interim accounting 0
IP Born: 1423083806 (Wed Feb  4 15:03:26 2015)
Core User Born: 1423083805 (Wed Feb  4 15:03:25 2015)
Upstream AP ID: 0, Downstream AP ID: 0
User Agent String: N360/21.6.0.32 MID/{Mj6JgEBKbBChJL6qfY8yrGclDYo} SID/eJjSVAAAAAA LUE/1.10.0.52 (Windows;6.1;SP1.0;X64;ENU)
HTTP based device-id info - Index: 40, Device: Windows
Overall device-id info - Index: 27, Device: Windows
L3-Auth Session Timeout from Radius: 0
Mac-Auth Session Timeout Value from Radius: 0
Dot1x Session Timeout Value from Radius: 0
CoA Session Timeout Value from Radius: 0
Dot1x Session Term-Action Value from Radius: Default
Reauth-interval from role: 0
Number of reauthentication attempts: mac reauth 0, dot1x reauth 0
mac auth server: N/A, dot1x auth server: N/A
Address is from DHCP: yes
Per-user-log pointer 0xf2a03c (id 224), num logs 23
```

Client Troubleshooting

- **User Role(s) – What ACLS are applied?**
- ***Show rights <role name>***

```
(Hejnar-7200) #show rights authenticated

Derived Role = 'authenticated'
 Up BW:No Limit   Down BW:No Limit
 L2TP Pool = default-l2tp-pool
 PPTP Pool = default-pptp-pool
 Periodic reauthentication: Disabled
 DPI Classification: Enabled
 Web Content Classification: Enabled
 ACL Number = 64/0
 Max Sessions = 65535

 Check CP Profile for Accounting = TRUE

Application Exception List
--------------------------
Name  Type
----  ----

Application BW-Contract List
----------------------------
Name  Type  BW Contract  Id  Direction
----  ----  -----------  --  ---------

access-list List
----------------
Position  Name                     Type     Location
--------  ----                     ----     --------
1         global-sacl              session
2         apprf-authenticated-sacl session
3         ra-guard                 session
4         allowall                 session

global-sacl
-----------
Priority  Source  Destination  Service  Application  Action  TimeRange  Log  Expired  Queue  TOS  8021P  Blacklist  Mirror  DisScan  ClassifyMedia  IPv4/6  Contract
--------  ------  -----------  -------  -----------  ------  ---------  ---  -------  -----  ---  -----  ---------  ------  -------  -------------  ------  --------
apprf-authenticated-sacl
------------------------
Priority  Source  Destination  Service  Application  Action  TimeRange  Log  Expired  Queue  TOS  8021P  Blacklist  Mirror  DisScan  ClassifyMedia  IPv4/6  Contract
--------  ------  -----------  -------  -----------  ------  ---------  ---  -------  -----  ---  -----  ---------  ------  -------  -------------  ------  --------
ra-guard
--------
Priority  Source  Destination  Service          Application  Action  TimeRange  Log  Expired  Queue  TOS  8021P  Blacklist  Mirror  DisScan  ClassifyMedia  IPv4/6  Contract
--------  ------  -----------  -------          -----------  ------  ---------  ---  -------  -----  ---  -----  ---------  ------  -------  -------------  ------  --------
1         user    any          icmpv6 rtr-adv               deny                            Low                                                          6
allowall
--------
Priority  Source  Destination  Service  Application  Action  TimeRange  Log  Expired  Queue  TOS  8021P  Blacklist  Mirror  DisScan  ClassifyMedia  IPv4/6  Contract
--------  ------  -----------  -------  -----------  ------  ---------  ---  -------  -----  ---  -----  ---------  ------  -------  -------------  ------  --------
1         any     any          any                  permit                          Low                                                          4
2         any     any          any-v6               permit                          Low                                                          6

Expired Policies (due to time constraints) = 0
```

Client Troubleshooting

- **User Role(s) – Is the user hitting the ACL**
- ***Show datapath session | inc <user ip address>***
- ***or***
- ***Show datapath session | include "Source IP,Flags,no syn,set ToS,mirror,Real-Time,Deep inspect,Media Deep,Application Firewall,<user ip>"*** to show column headers and flag definitions

```
(Hejnar-7200) #show datapath session | include "Source IP,Flags,no syn,set ToS,mirror,Real-Time,Deep inspect,Media Deep,Application Firewall,192.168.1.9"
Flags: F - fast age, S - src NAT, N - dest NAT
       D - deny, R - redirect, Y - no syn
       H - high prio, P - set prio, T - set ToS
       C - client, M - mirror, V - VOIP
       Q - Real-Time Quality analysis
       I - Deep inspect, U - Locally destined
       E - Media Deep Inspect, G - media signal
       A - Application Firewall Inspect
Source IP       Destination IP  Prot SPort DPort Cntr  Prio ToS Age Destination TAge Packets    Bytes      Flags
192.168.1.9     192.168.1.24    6    53847 22    0/0   0    24  0   tunnel 18   385  26         2496       TC
104.36.248.94   192.168.1.9     6    443   53827 0/0   0    24  1   tunnel 18   468  0          0
104.36.248.94   192.168.1.9     6    443   53808 0/0   0    24  1   tunnel 18   495  0          0
104.36.248.94   192.168.1.9     6    443   53814 0/0   0    24  0   tunnel 18   494  1          105
104.36.248.94   192.168.1.9     6    443   53820 0/0   0    24  3   tunnel 18   47e  0          0
192.168.1.9     104.36.248.192  6    53761 443   0/0   0    24  2   tunnel 18   4e3  0          0          TC
209.191.96.199  192.168.1.9     6    443   53786 0/0   0    24  1   tunnel 18   4d8  0          0
192.168.1.9     104.36.248.94   6    53812 443   0/0   0    24  1   tunnel 18   494  1          142        TC
192.168.1.9     104.36.248.94   6    53815 443   0/0   0    24  0   tunnel 18   494  1          52         TC
192.168.1.9     104.36.248.94   6    53821 443   0/0   0    24  2   tunnel 18   47e  0          0          TC
192.168.1.9     104.36.248.94   6    53814 443   0/0   0    24  0   tunnel 18   494  1          52         TC
192.168.1.9     104.36.248.94   6    53820 443   0/0   0    24  2   tunnel 18   47e  0          0          TC
192.168.1.9     104.36.248.94   6    53808 443   0/0   0    24  1   tunnel 18   495  0          0          TC
```

What we covered

- **Design for roaming:**
  - Channel planning for roaming
  - Access Point Planning and Placement
  - Adaptive Radio Management (ARM)
- **Client Roaming**
- **Client Troubleshooting**

THANK YOU

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