Education Networks of America®

Myths and Realities of Wi-Fi

ACTEM Conference, April 2017

Michael McKerley, CTO

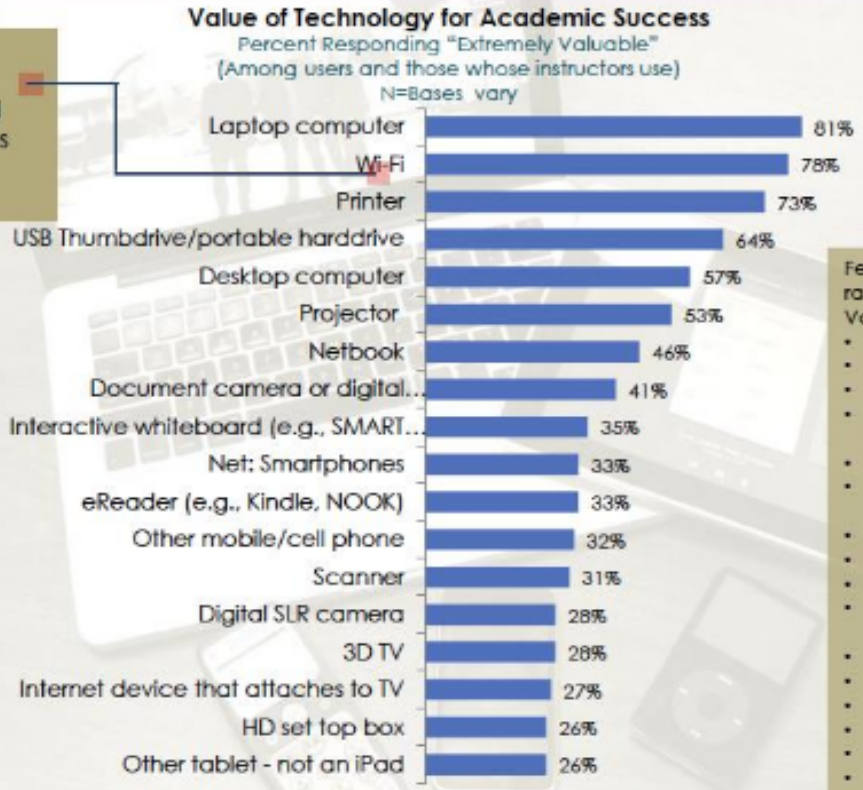
Digital natives are Wi-Fi savvy (technically speaking)

Importance of High Quality Wi-Fi

Value of technology: Students want access anywhere and everywhere

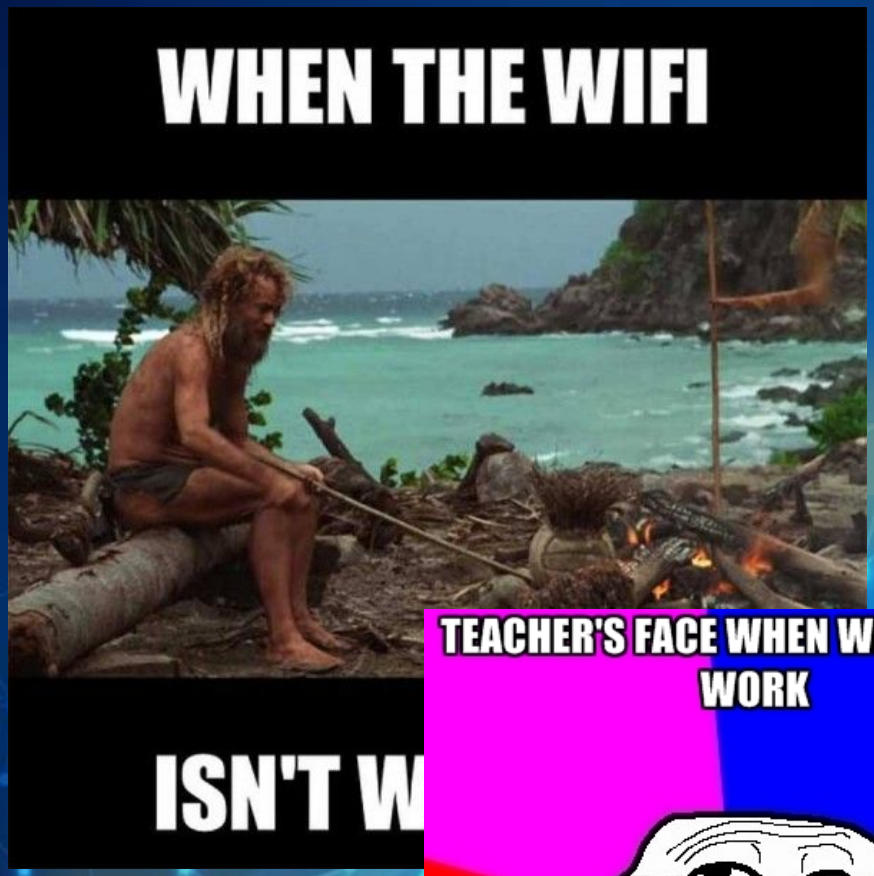
Computers and related devices top the list, but document cameras, interactive whiteboards, smartphones, eReaders, and tablets, while generally newer technologies, are also considered quite valuable when it comes to academic success.

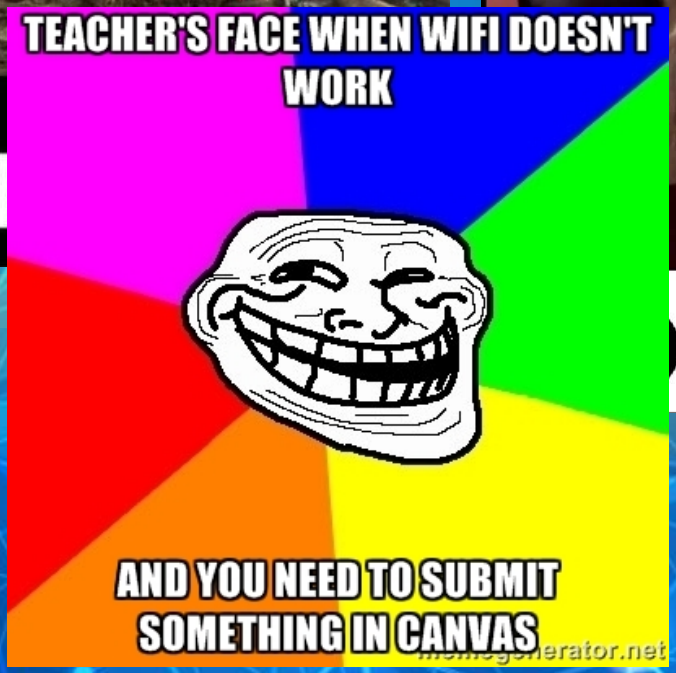
Wi-Fi access is instrumental to student success, and students want access from everywhere on campus.



Fewer than 25% of students rated these devices "Extremely Valuable":

- iPad
- Digital video camera
- DVR
- mp3 player/music device (other than iPod)
- Internet-ready TV
- Student clickers or student response systems
- Webcam
- Smartpen
- HDTV
- Digital point and shoot camera
- DVD player
- iPod
- Stationary gaming device
- Blu-ray player
- Flip video camera
- Handheld/portable gaming device

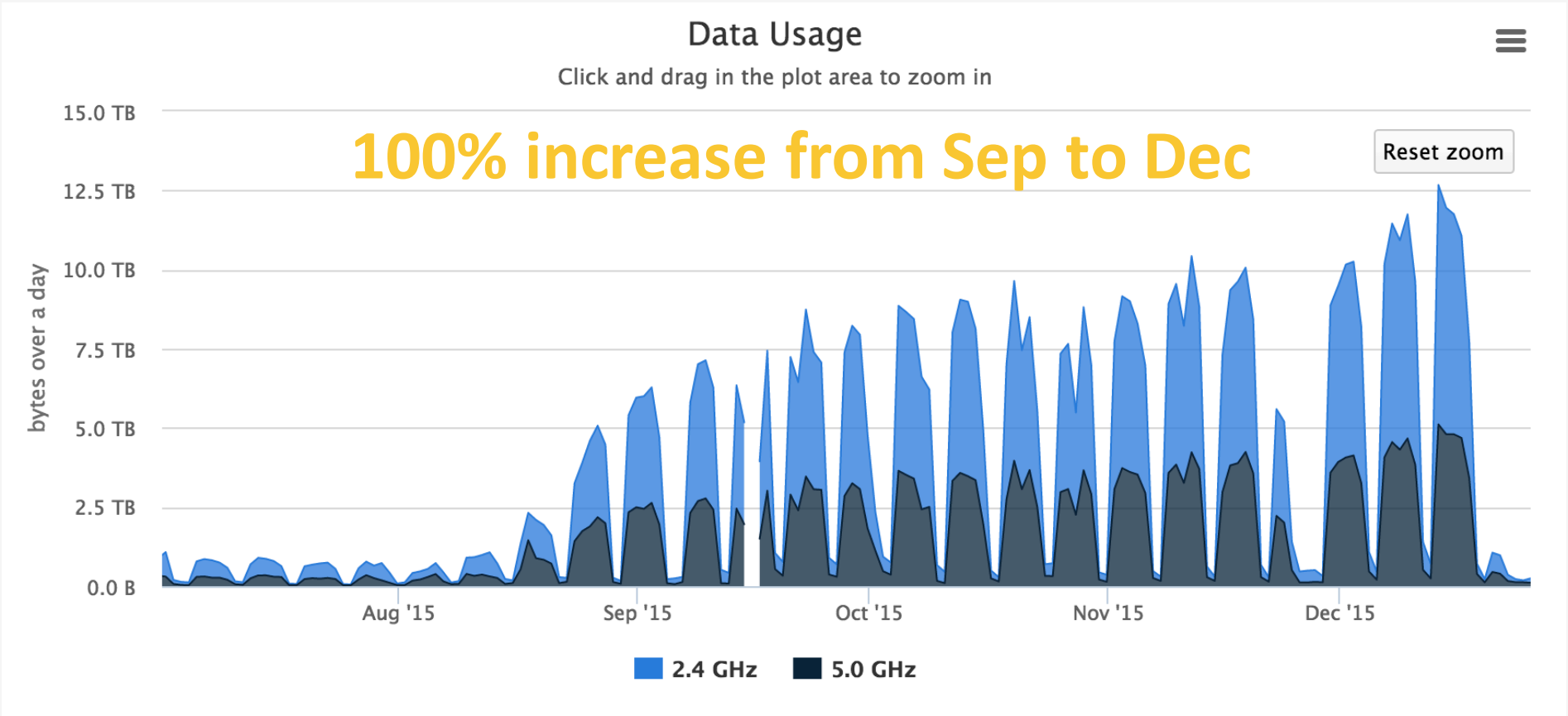

WHEN THE WIFI
ISN'T W


TEACHER'S FACE WHEN WIFI DOESN'T WORK
AND YOU NEED TO SUBMIT SOMETHING IN CANVAS


WHEN YOUR WIFI
PS WORKING

Wi-Fi: The Currency of Digital Education

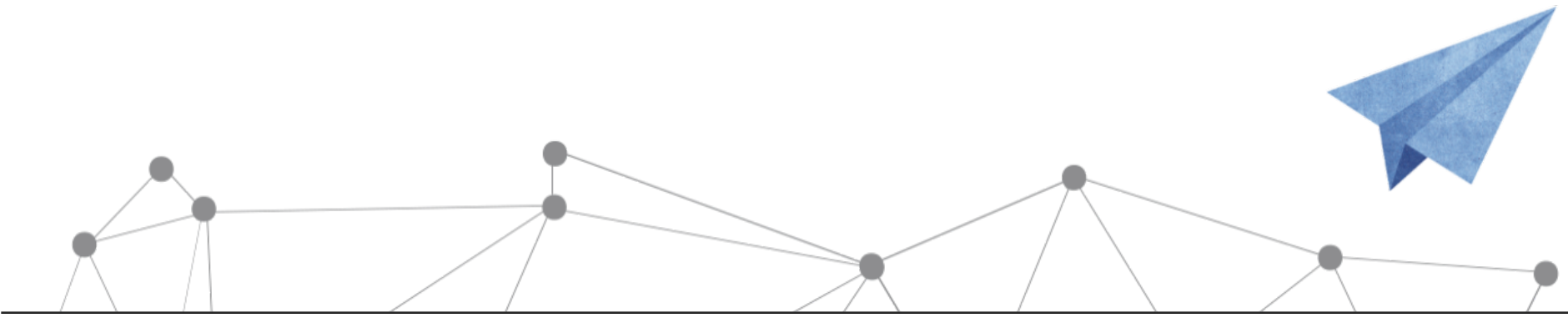
Wi-Fi Utilization at 170+ high schools in Idaho over one semester



Two Types of User Complaints

1. I can't get on

2. This Wi-Fi is terrible!

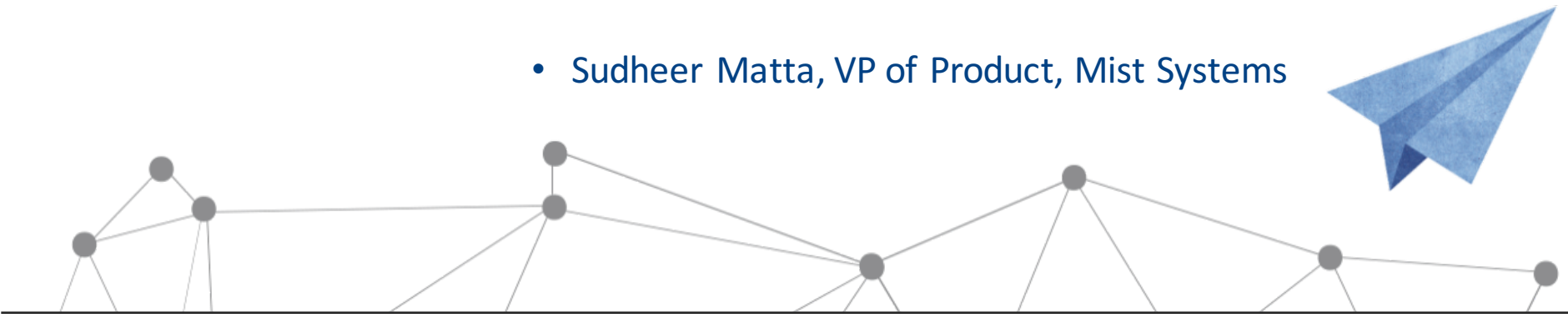


Difficulties of Good Wi-Fi Support

- In a 802.1X environment (as an example), there is essentially one way to get a properly authenticated session

- There are 139 ways for that process to go wrong

  - Sudheer Matta, VP of Product, Mist Systems

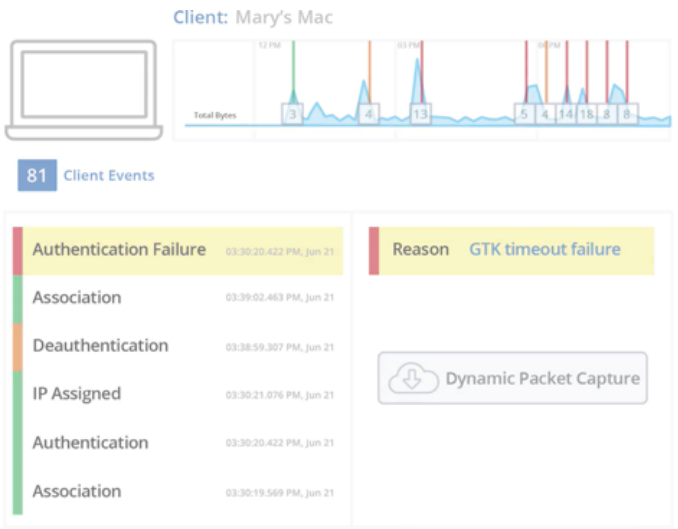


Takeaway

- Post list of self-troubleshooting steps in each classroom
- Post list of the information your users need to provide (and how to get that information) to expedite troubleshooting
- When evaluating solutions,

  If you will be managing and maintaining yourself, look for solutions that capture and provide per session KPI

  If you will be using a managed or co-managed Wi-Fi service, closely evaluate the SLA



The solution to your problem is adding more APs

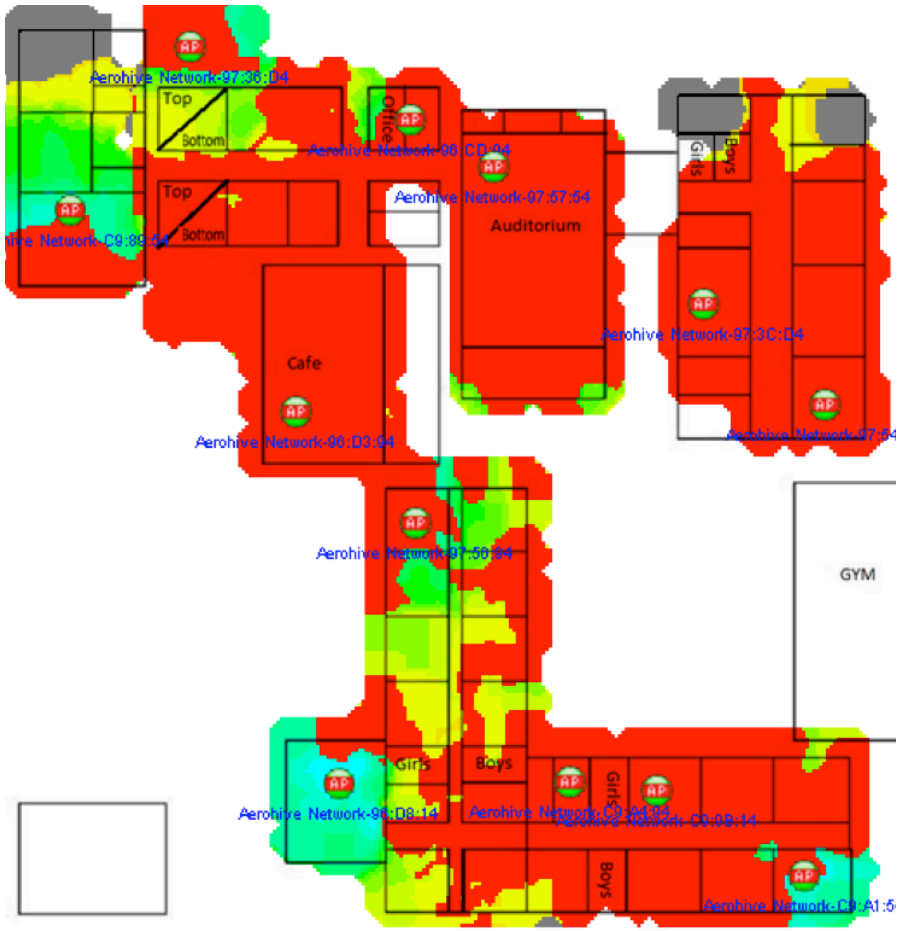
A proper Wi-Fi design is CRITICAL for digital learning

Capacity is driven by two main factors:

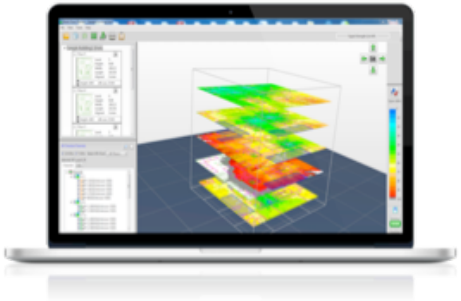
1. Frequency re-use
2. Available airtime

"Just adding APs" can exacerbate issues with both factors!

Takeaway:
RF design and validation can prevent underlying issues.



Wi-Fi Design Objectives



1. Coverage (Quality & Mobility)
2. Contention (Minimize Interference)
3. Capacity

Free

'Wi-Fi Design Poster'

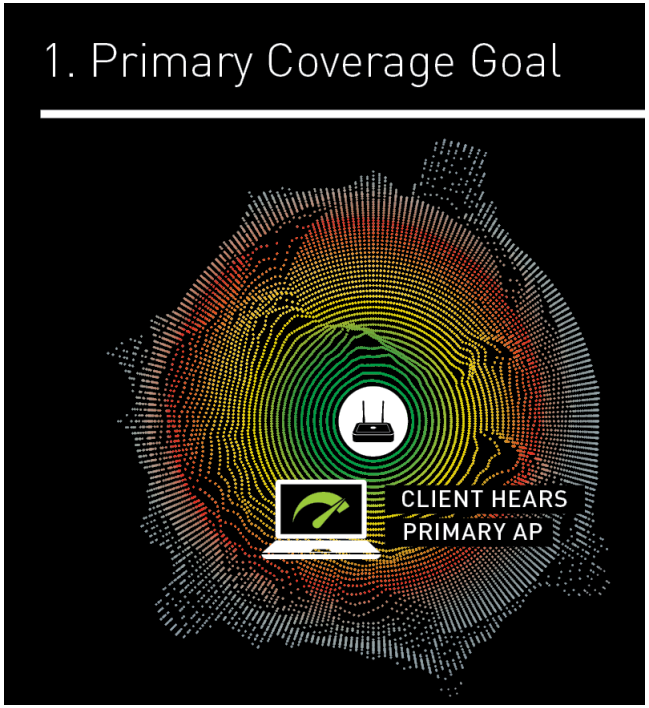
by

Andrew von Nagy

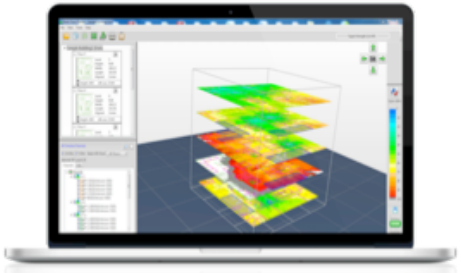
and

Ekahau, Inc.

http://www.revolutionwifi.net

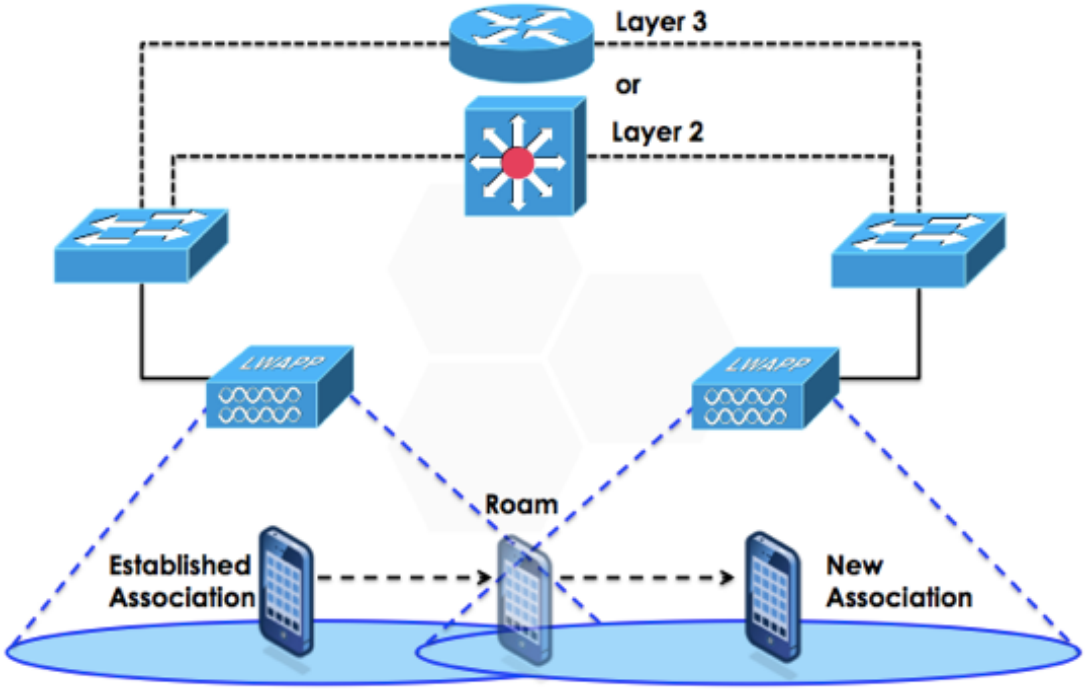


Coverage



Aspects:

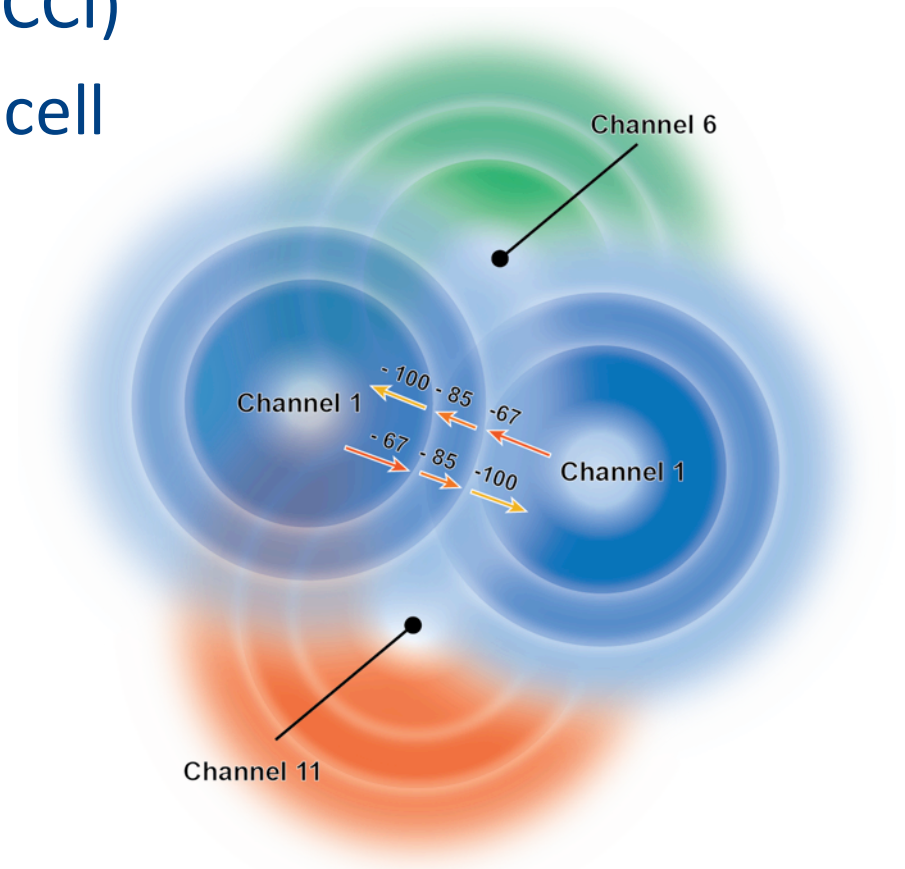
1. Primary coverage quality (RSSI / SNR)
2. Coverage overlap (mobility / roaming)



Contention

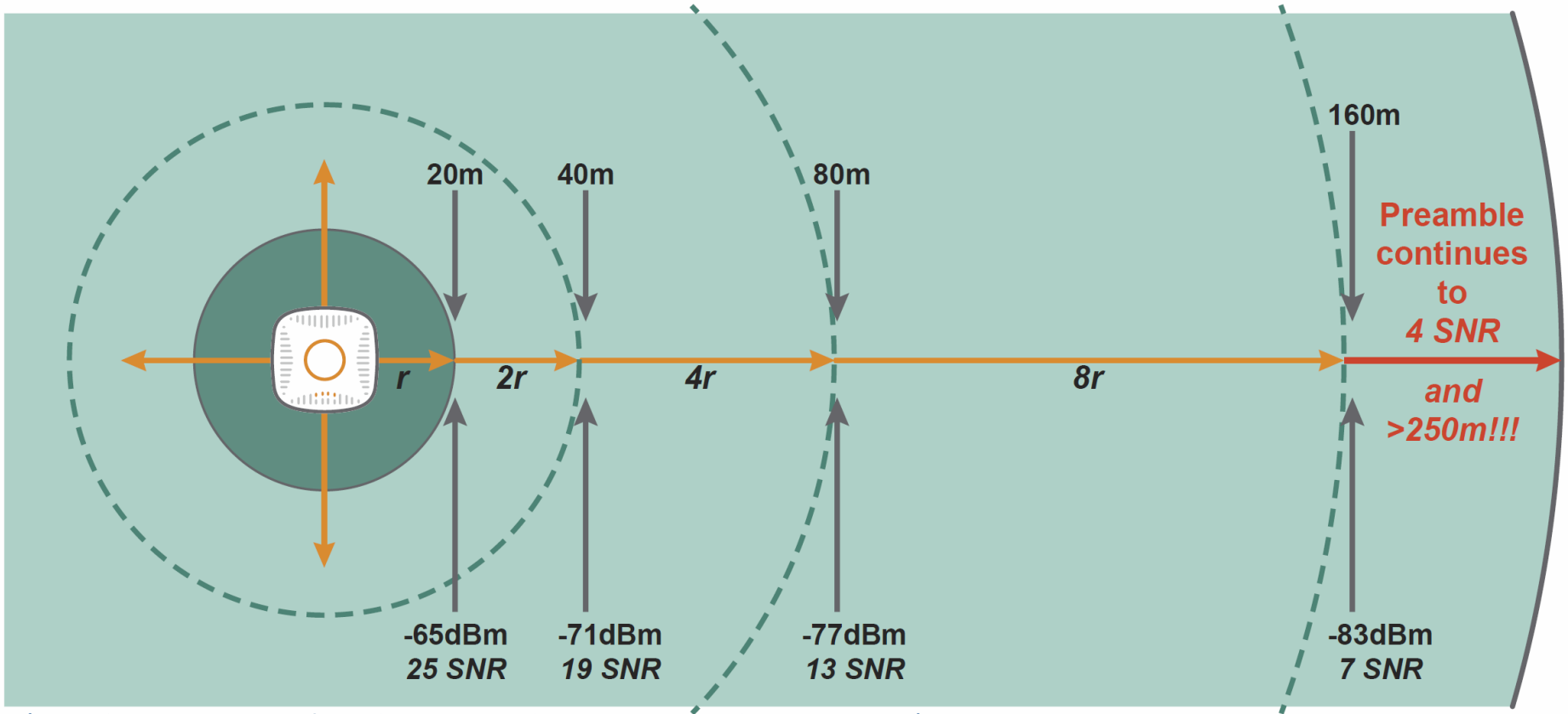
Two factors to consider with contention:

1. Co-channel interference (CCI)
2. Airtime demand within a cell



Interference goes a long way

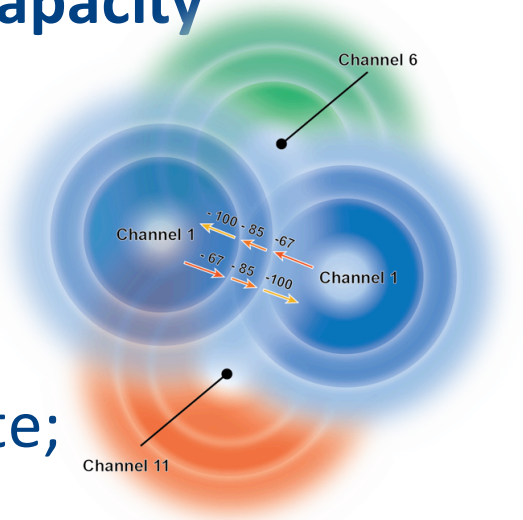
Up to **8x** the distance of the "desired" client coverage area in modern WLANs!
It's okay to disable radios, especially in 2.4 GHz



(Graphic courtesy of Aruba Networks VHD VRD Theory Guide)

Beware of Wider Channels

Wider channels are a reallocation of aggregate WLAN capacity, not *necessarily* an improvement in capacity



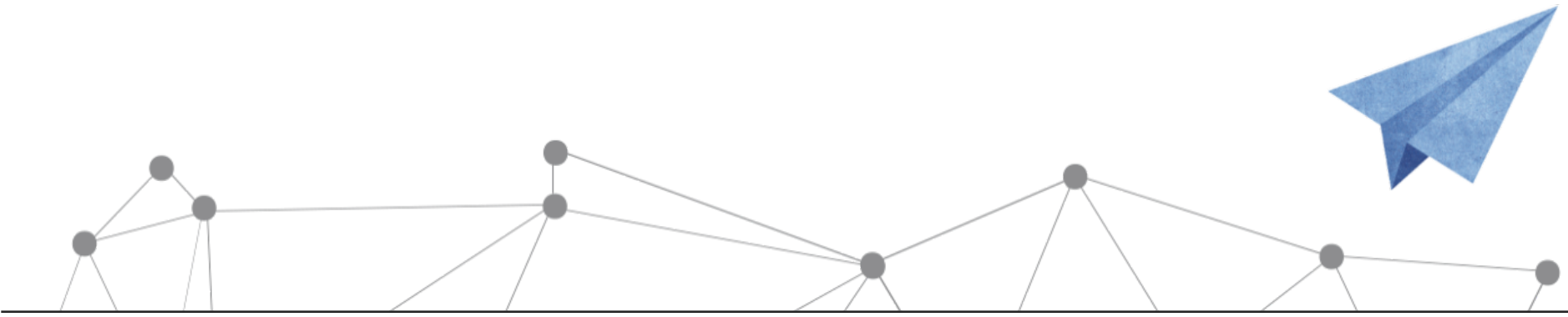
Wider Channel Realities:

1. Less channels to re-use
2. Higher risk of interference between APs
3. Higher noise floor reduces SNR and data rate; lowers efficiency
4. Clients that don't support larger channel widths reduce WLAN efficiency (spectrum goes unused at times)

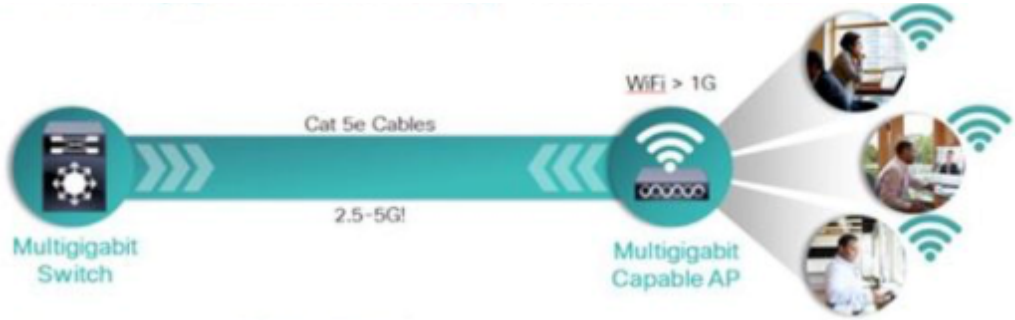
Takeaway: Focus on the appropriate channel width that minimizes interference in each unique facility

Gigabit+ Wi-Fi is here

(and you have to upgrade your switches)



Gigabit+ Hype

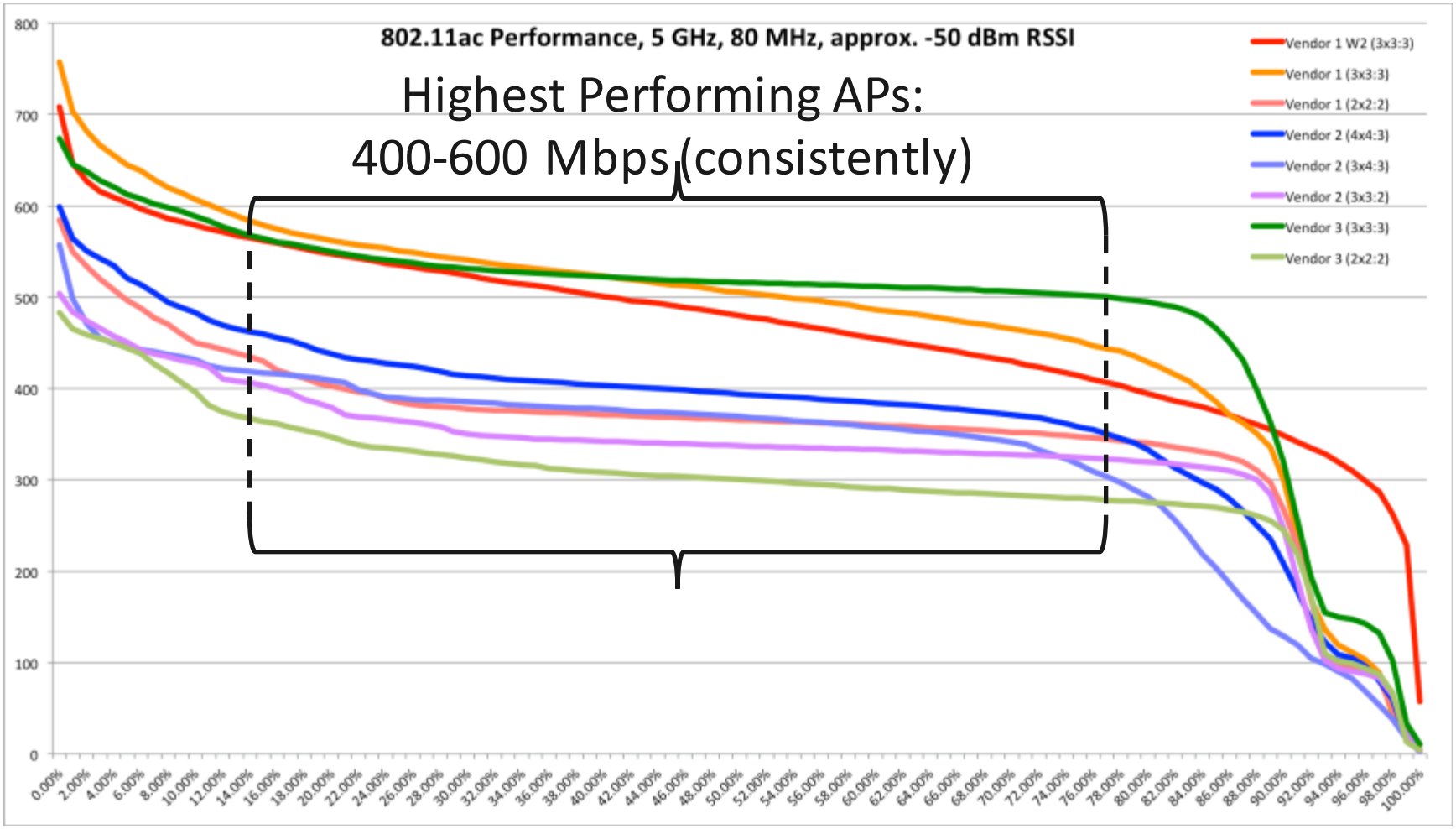


- Multi-Gigabit Hype:
  - Raw data rates 'sound' higher than 1 Gbps Ethernet
  - Confusion over IEEE 802.11 Standard and "waves" of APs
  - Preys on poor experiences customers have with poorly designed Wi-Fi networks
  - Plays to historical trend to "throw bandwidth at problems"

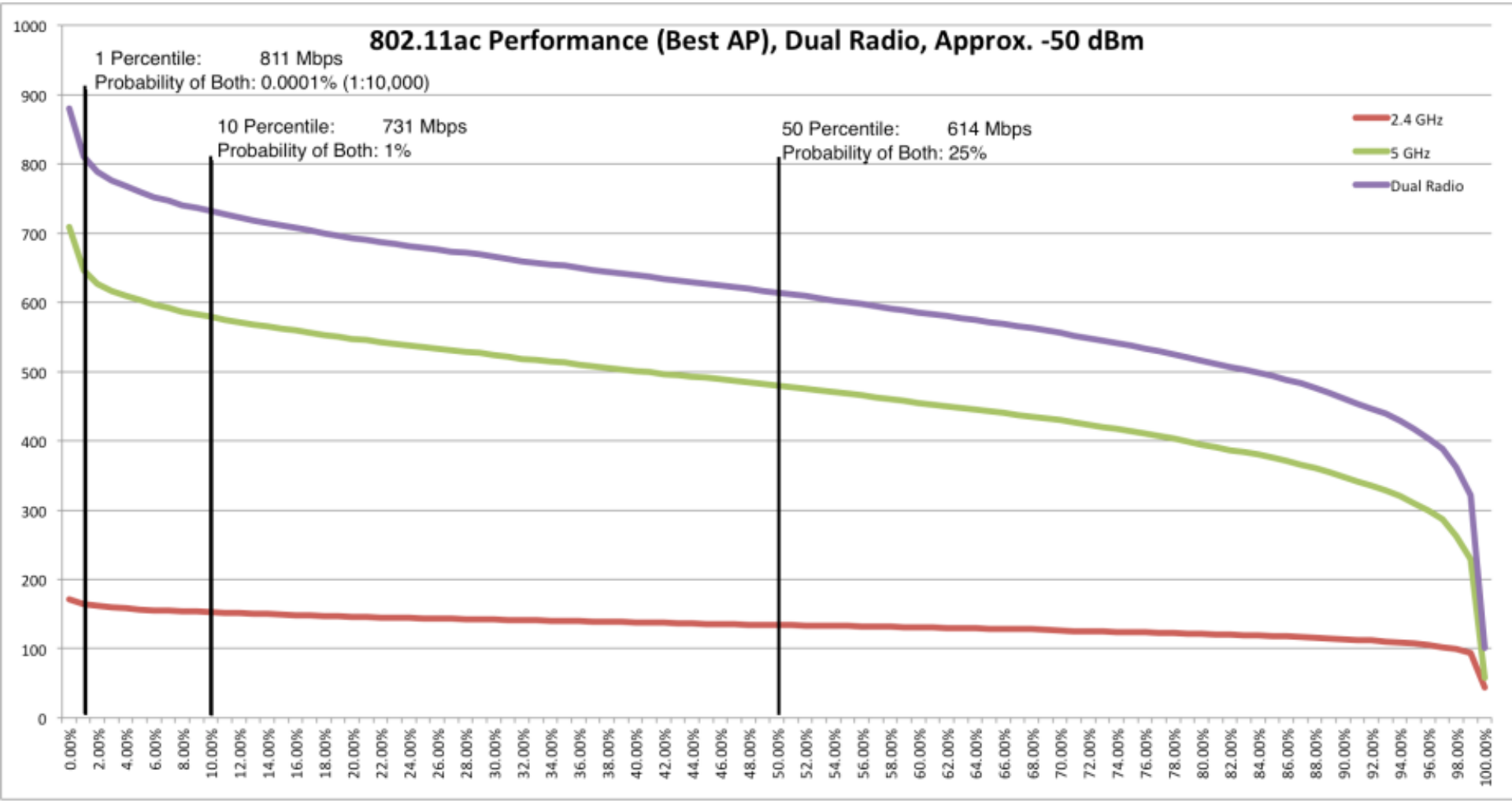
Multi-Gigabit Appeal:

- Leverage existing legacy cabling (Cat5e)
- Great to develop standard now, for future deployment (when it's really necessary)

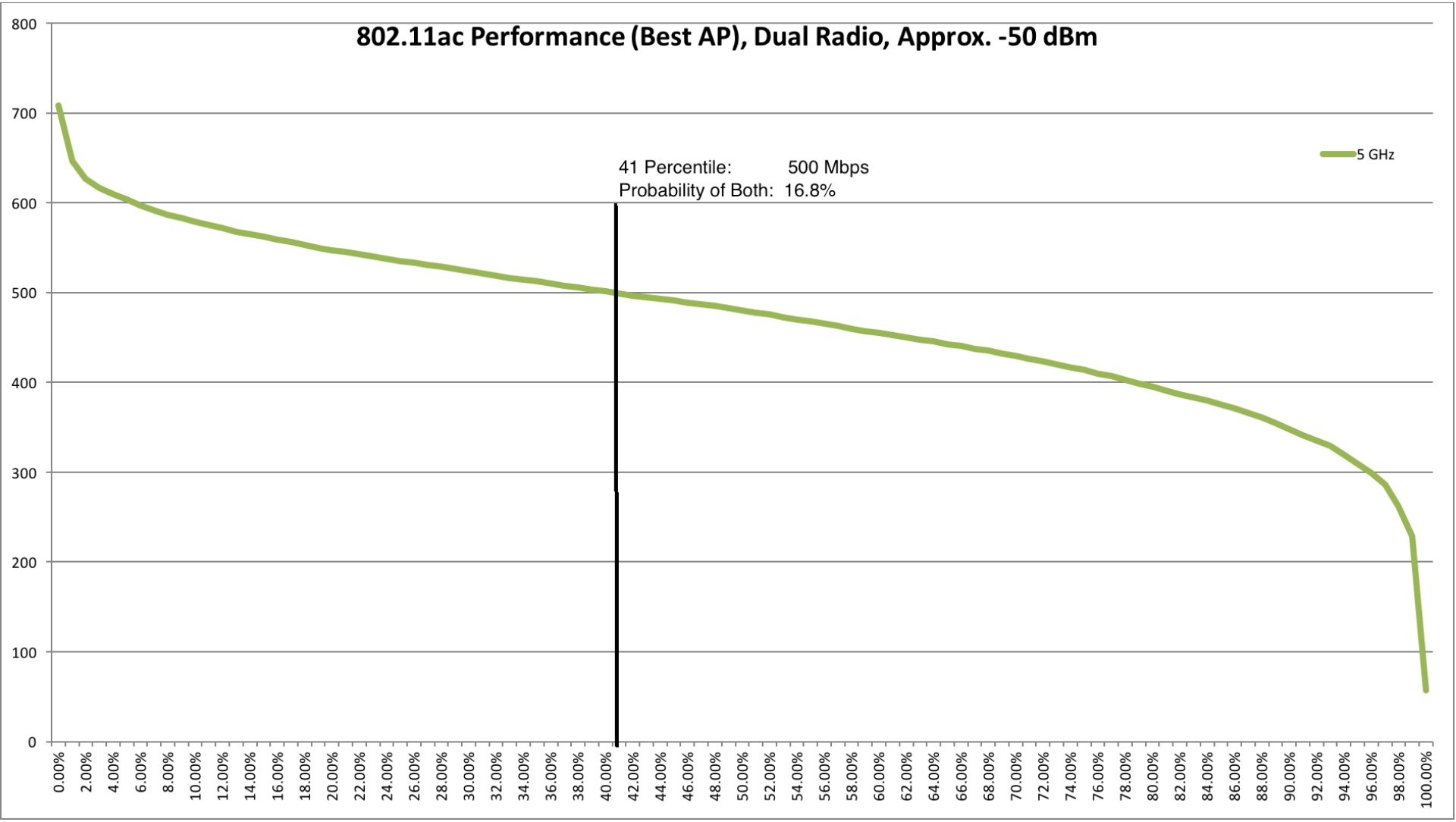
802.11ac Performance Reality



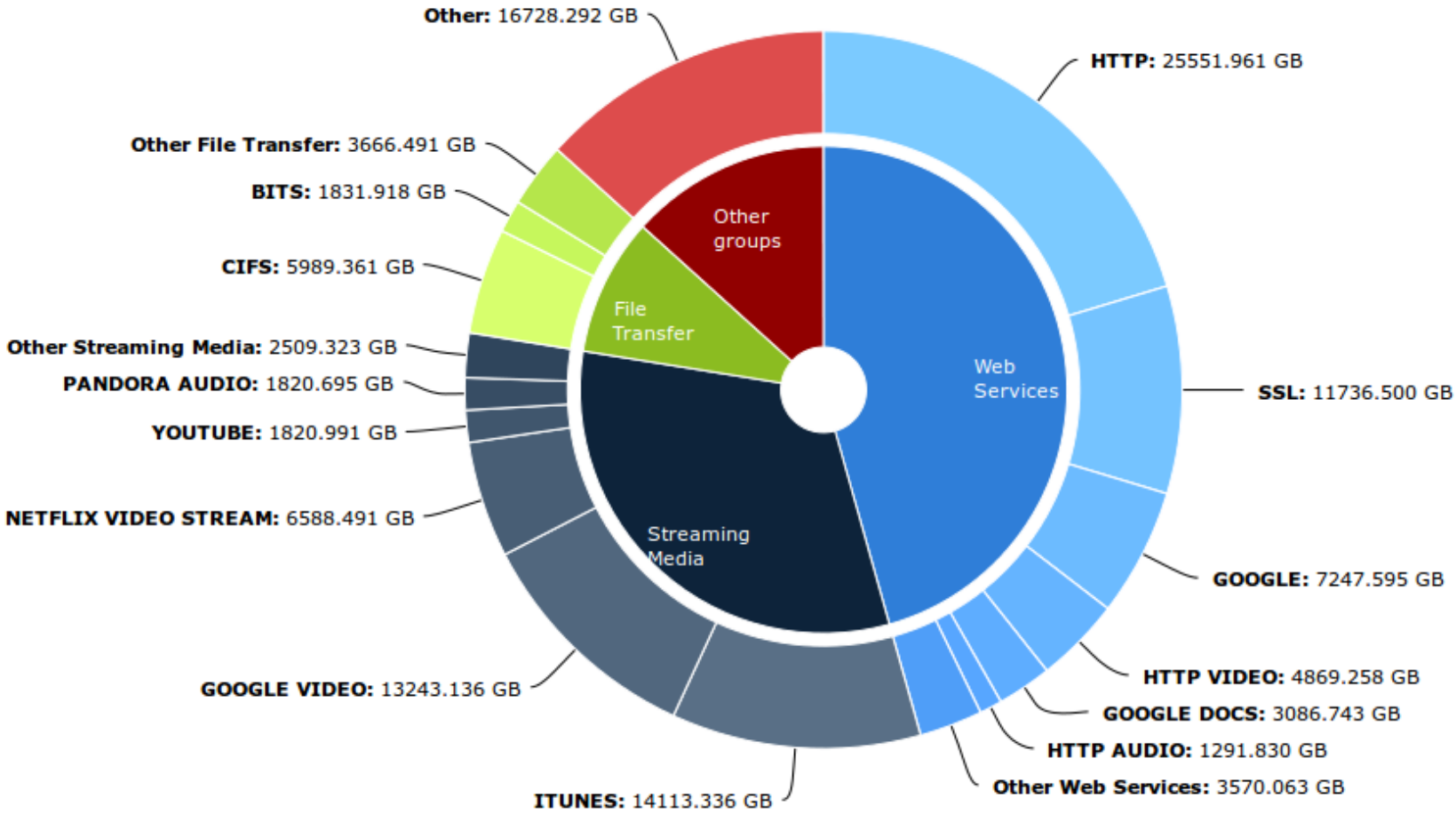
Dual-Radio Performance Reality



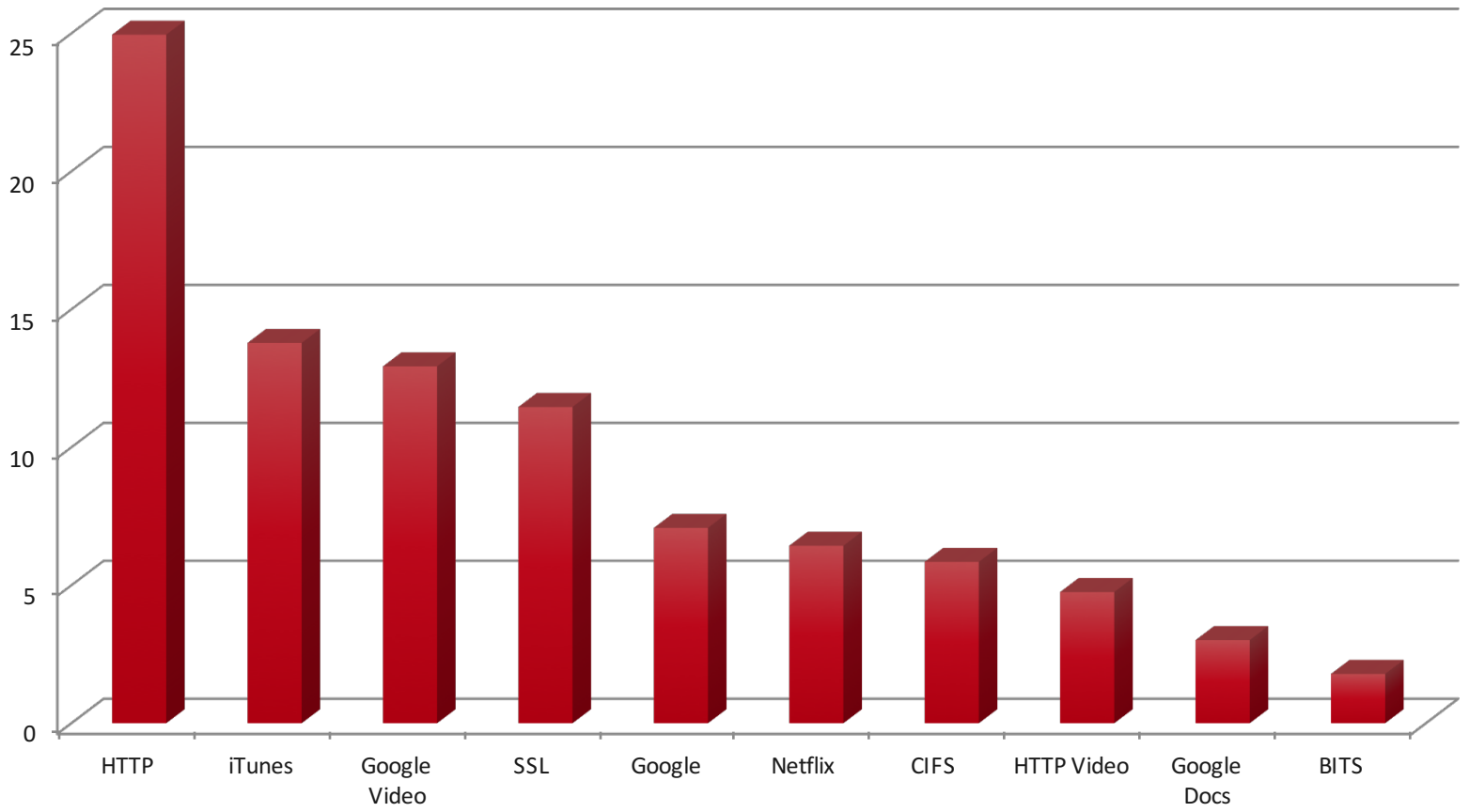
Dual 5 GHz Performance Reality



High School Application Utilization



Application Breakdown

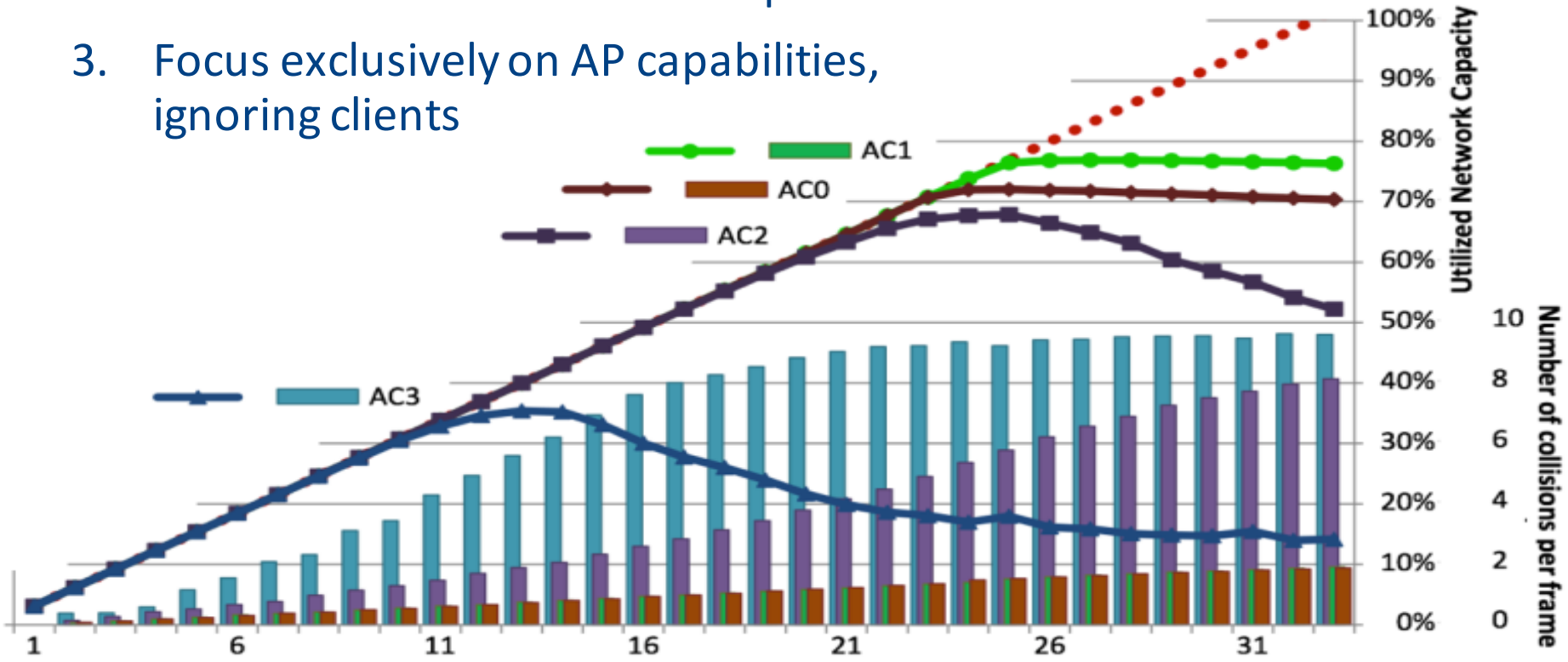


Peak throughput determines WLAN performance

Capacity Myth

False Premises:

1. Buy from the vendor with the highest tested throughput
2. Use the widest channel width possible
3. Focus exclusively on AP capabilities, ignoring clients



Throughput is a POOR Metric for Wi-Fi

Switched Ethernet	Wi-Fi
• Consistent link data rate • Consistent client capabilities • No contention • Little overhead	• Adaptive link data rate • Variable client capabilities • Contention prevalent • Significant overhead • Positive ack, retransmissions, etc.
• Throughput ≈ Link utilization	• Throughput != Link utilization • Airtime = Link utilization

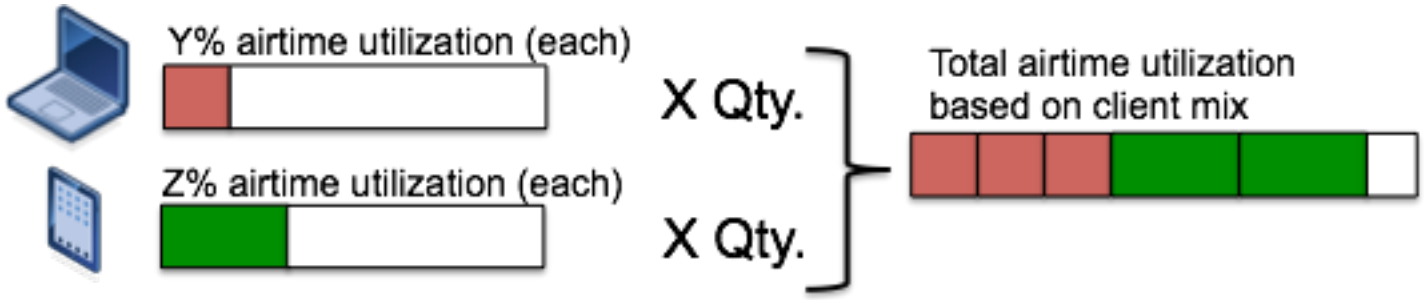
Throughput is not a consistent measure of WLAN performance or capacity

Wi-Fi Capacity is Airtime (throughput is a byproduct)

Airtime utilization determines ***latency*** and ***capacity***

$$Airtime\ Utilization = \frac{Application\ Throughput}{Device\ Throughput\ Capability}$$

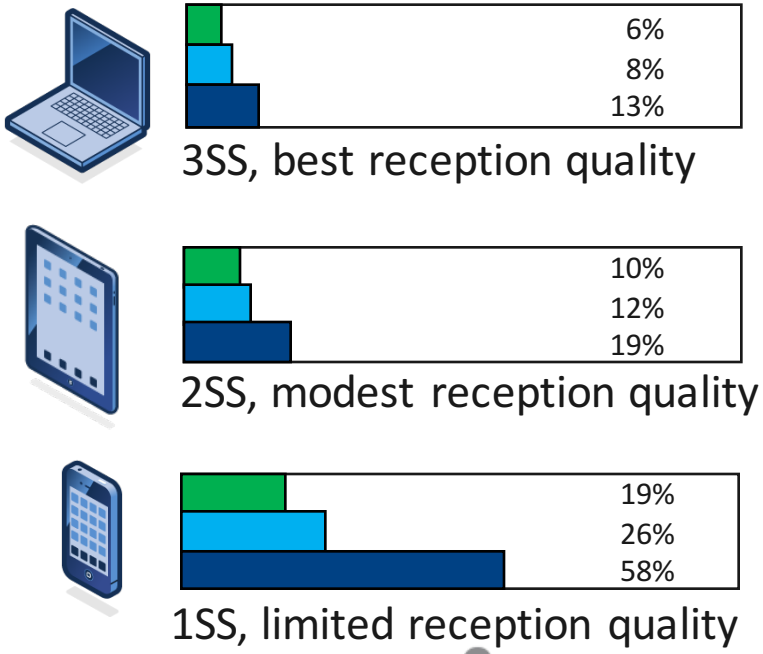
Capacity demand is the aggregate of all clients:



Client Impact on Capacity

Airtime Utilization Example:

10 Mbps offered load by three latest-gen 802.11ac clients on a 20 MHz channel:



Maximum Signal Quality: > -50 dBm

High Signal Quality: -67 dBm

Basic Coverage Signal Quality: -75 dBm

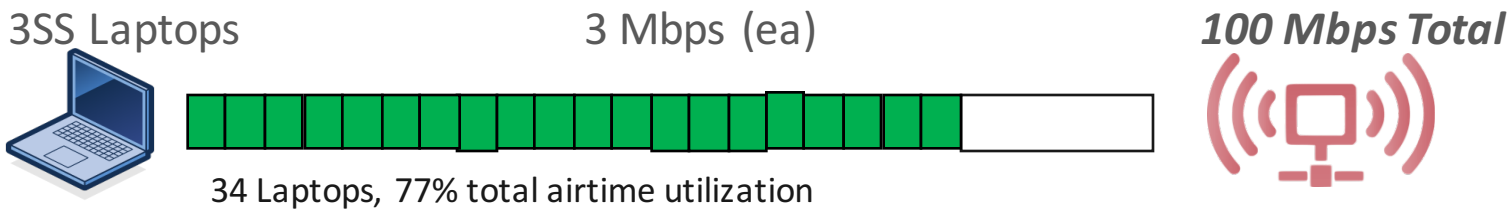
** Represented as Airtime Utilization % with maximum of 100%*

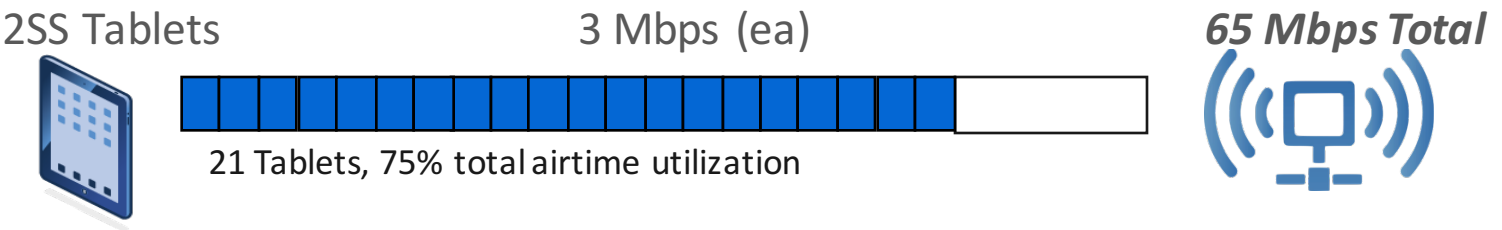
Clients Shape WLAN Performance

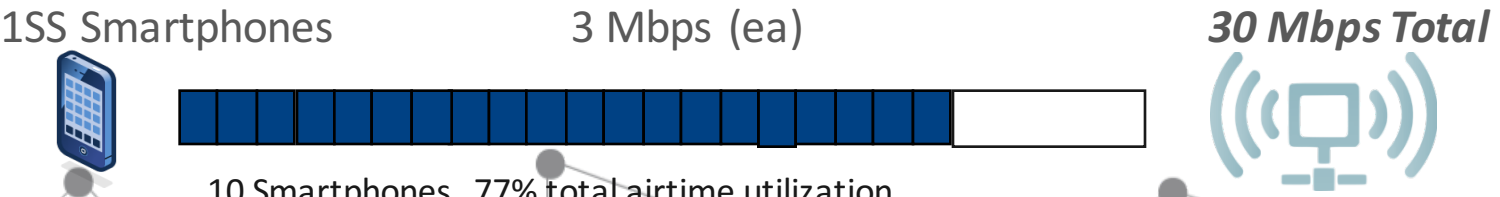
Advertised AP data rates are only half the equation! (e.g. 1.3 Gbps)

Examples: What 1 AP can support with clients at -67 dBm, 5 GHz, 20 MHz

**Note: 75-80% airtime utilization is maximum, 100% not achievable due to overhead*







Wi-Fi Capacity Considerations

Client Mix Heavily Affects Wi-Fi Capacity

1. Clients have different system design objectives
   - Mobile clients optimized for battery life and smaller form-factor
   - Mobile clients have different system board design and layout, often resulting in restricted antenna design options
2. Clients have different capabilities
   - Spatial streams (bandwidth multiplier for highest data rates)
   - Receive sensitivity (quality of signal reception)
   - Rule of thumb: the smaller the device the fewer the spatial streams and the lower the signal quality

You don't see this

Skilled Wi-Fi Engineering is unnecessary because modern Wi-Fi networks are self-healing

Things you may have heard…

1. Predictive modeling auto-places APs and optimizes channel plans - Don't worry
2. Our product automatically adjusts for optimal performance. It's "self-healing."
3. No really, it's magic…

Importance of Good Engineering

WLANs are critical, and good engineers design good WLANs

Evaluate vendors & integrators on the rigor of their WLAN design, installation, and validation process:

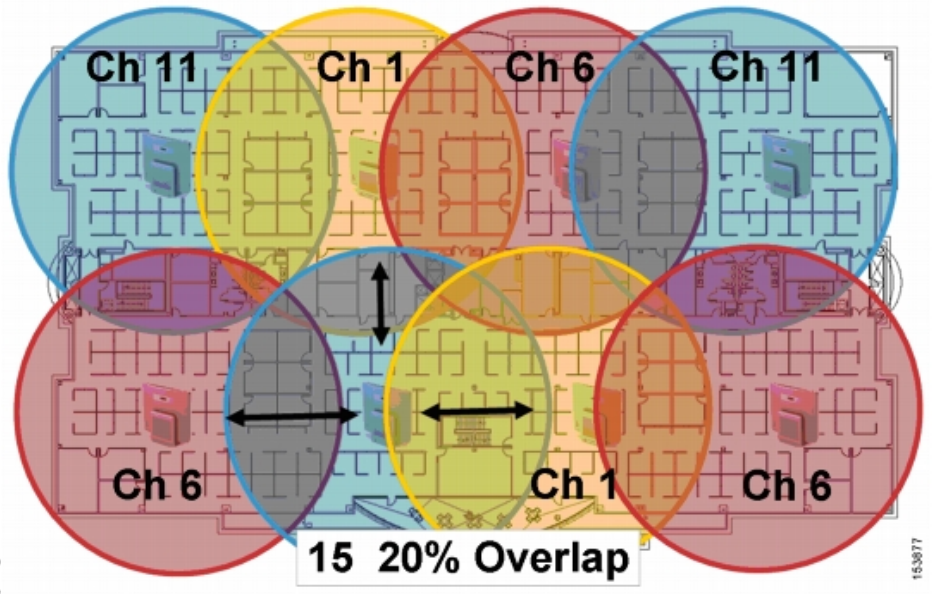
1. Take time to listen & understand your criteria for success (technical & business, specific for your use case)
2. Experienced, credentialed, and skilled staff
3. Up-front assessment & site visit
4. Thorough design using professional tools
5. Rely too much on manufacturer product marketing (e.g. product features handle it so they don't design)
6. Post-installation validation and tuning
7. Documentation and training

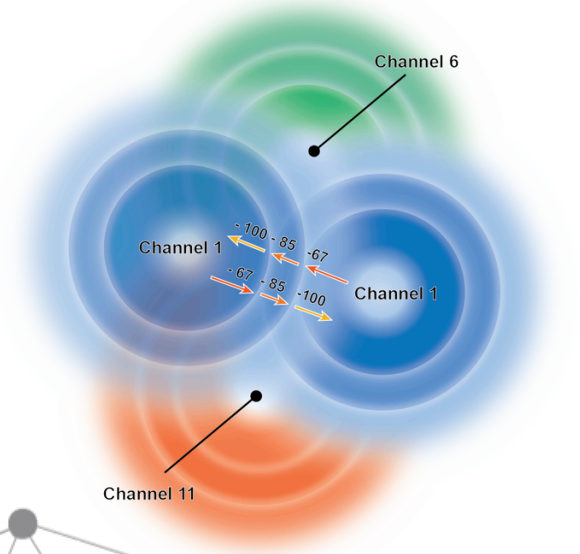
Takeaway: Evaluate the vendor / integrator AS MUCH if not more than the Wi-Fi product manufacturer. Find a partner you trust.

Best Practices

Wi-Fi Design Objectives

1. Coverage quality (RSSI / SNR) at -67 dBm in 5 GHz, -70 dBm in 2.4 GHz
2. Coverage overlap (mobility / roaming) at -75 dBm in transient areas
3. Capacity (AP density) based on user density and device types (unique to areas)
4. Minimize interference by tailoring AP density, placement and radio configurations (channel width, channel reuse, transmit power and disabling AP radios when necessary)

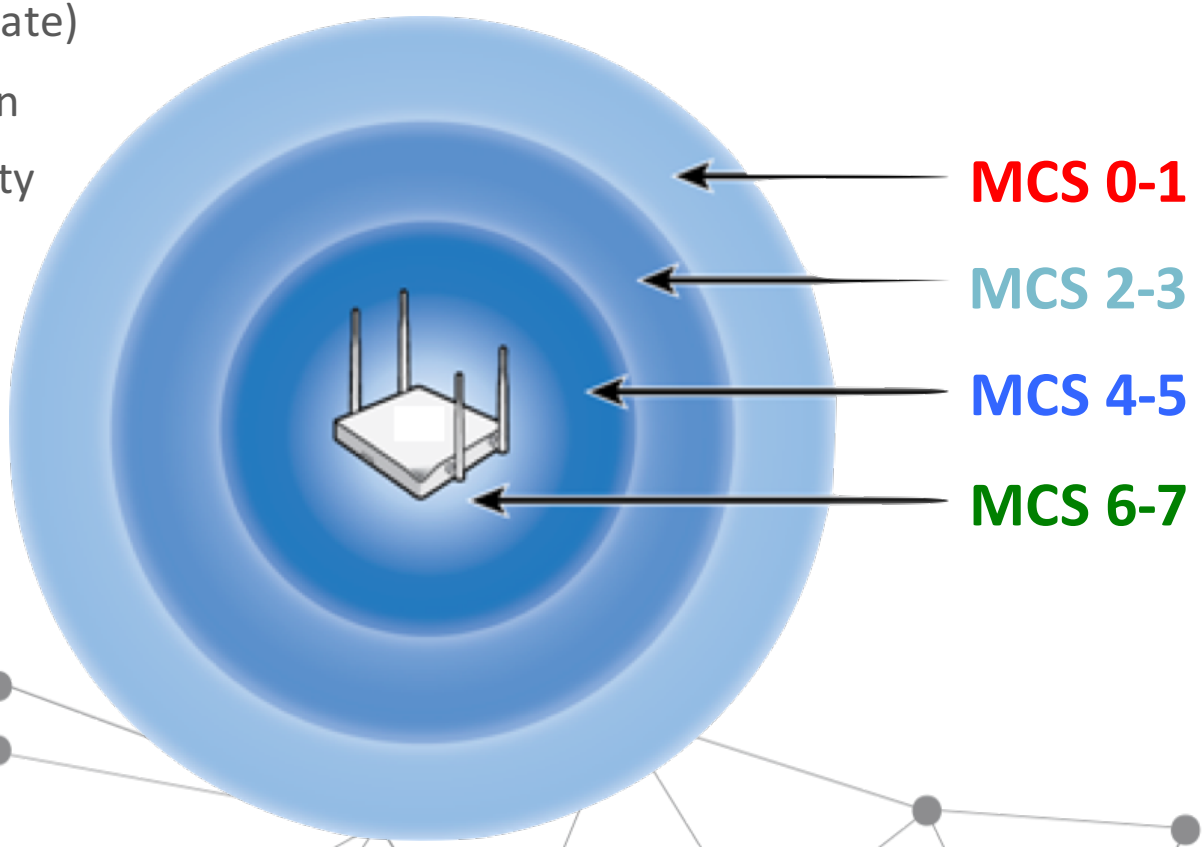




Coverage Quality

Keep Clients at High Quality Signal – typically -65 to -67 dBm

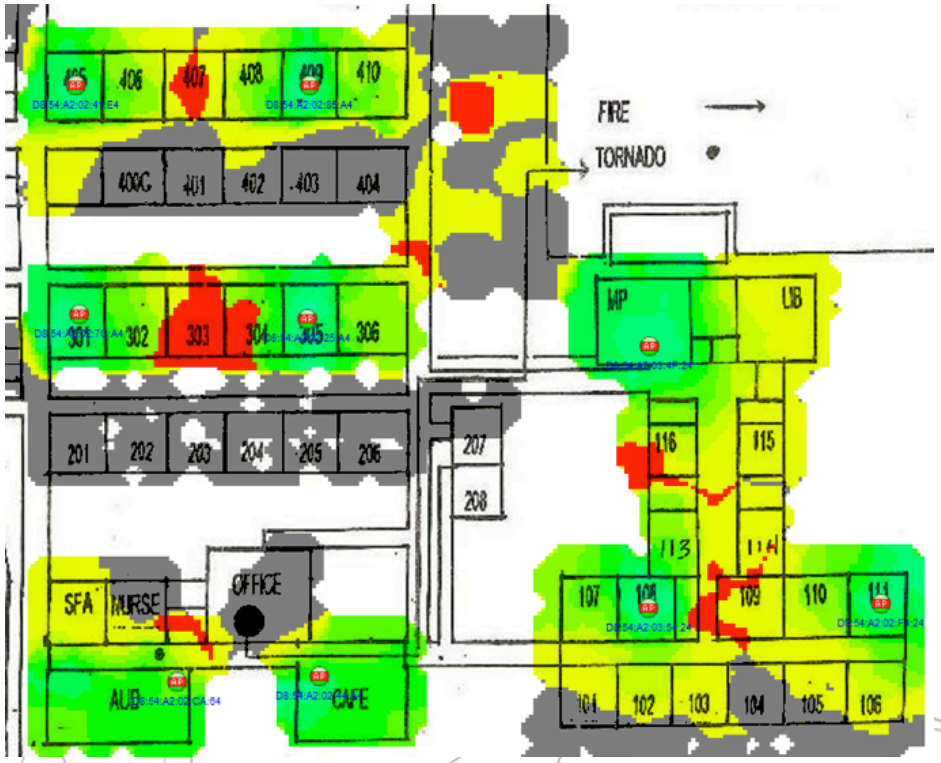
- Higher Data Rate (MCS Rate)
- Less Airtime Consumption
- Higher Aggregate Capacity



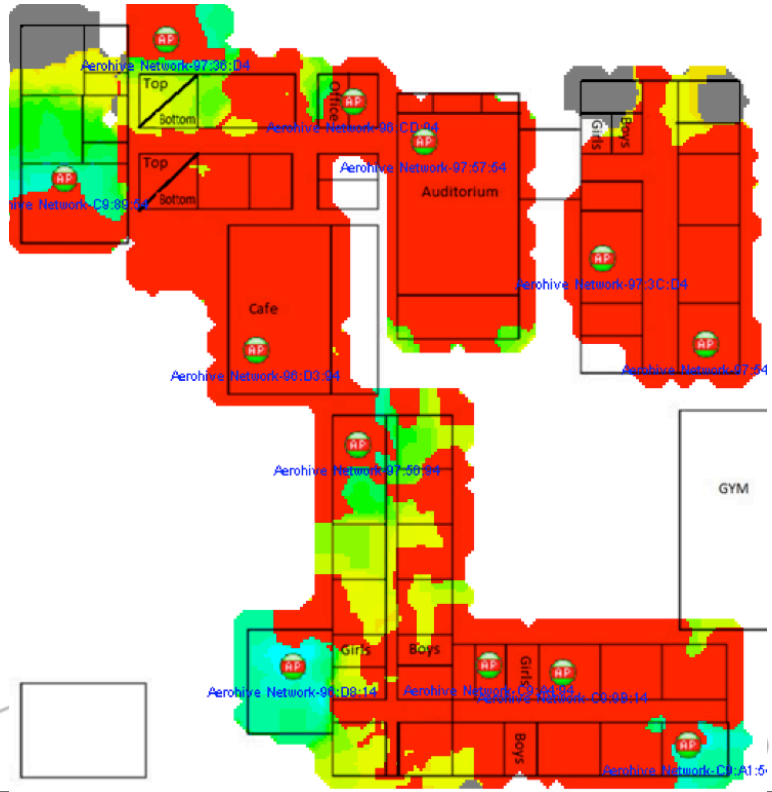
Co-Channel Interference (CCI)

When APs can hear each other and are on the same channel they cause co-channel interference (CCI), which results in shared capacity.

Good Design – minimal CCI (in red)



Bad Design – CCI prevalent (in red)



Solution Evaluation

- Evaluate solutions and/or service providers based their ability to support your users and increase educational outcomes

- Evaluate your partners based on their own W-Fi skillsets as much (if not more) than the manufacturers they sell

Questions