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Your Time Is Now

7 Ways to fail as a Wireless Expert

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@Steven_Heinsius

Cisco live!

Agenda

- Introduction
- What we are going to do. And Why…
- The Baseline
- Fail #1 Forget about those Channels
- Fail #2 Maximum Power!
- Fail #3 2.4 GHz is still the most important
- Fail #4 Placements
- Fail #5 I ***am*** secure. (About Authentication & Encryption)
- Fail #6 Hype Versus Reality
- Fail #7 Of Course I did a Site Survey
- Bonus Fail…
- Conclusion

Introduction

@Steven_Heinsius

- 3 Years as an End User
- 5 Years as a Partner
- 6 Years as a Distributor
- 5 Years at Cisco
- 11 Years Instructor

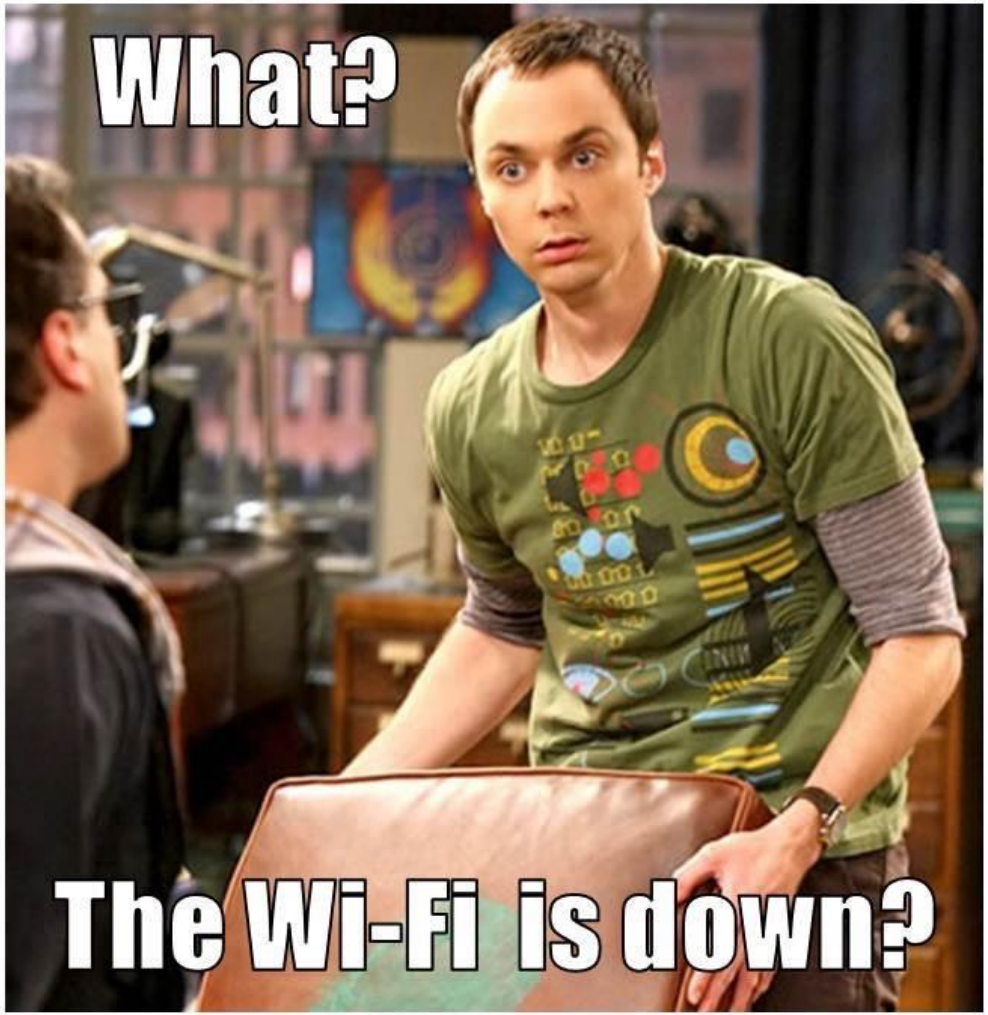
- Dad, husband, Runner, Cook, Mountain biking, Scuba diving, Snow boarding Wifi Enthusiast.

What we are going to do,

and why.

There’s 7 Ways to Fail

- Learn how ***NOT*** to #Fail
- It will be educational
- It will be interactive
- It will be fun

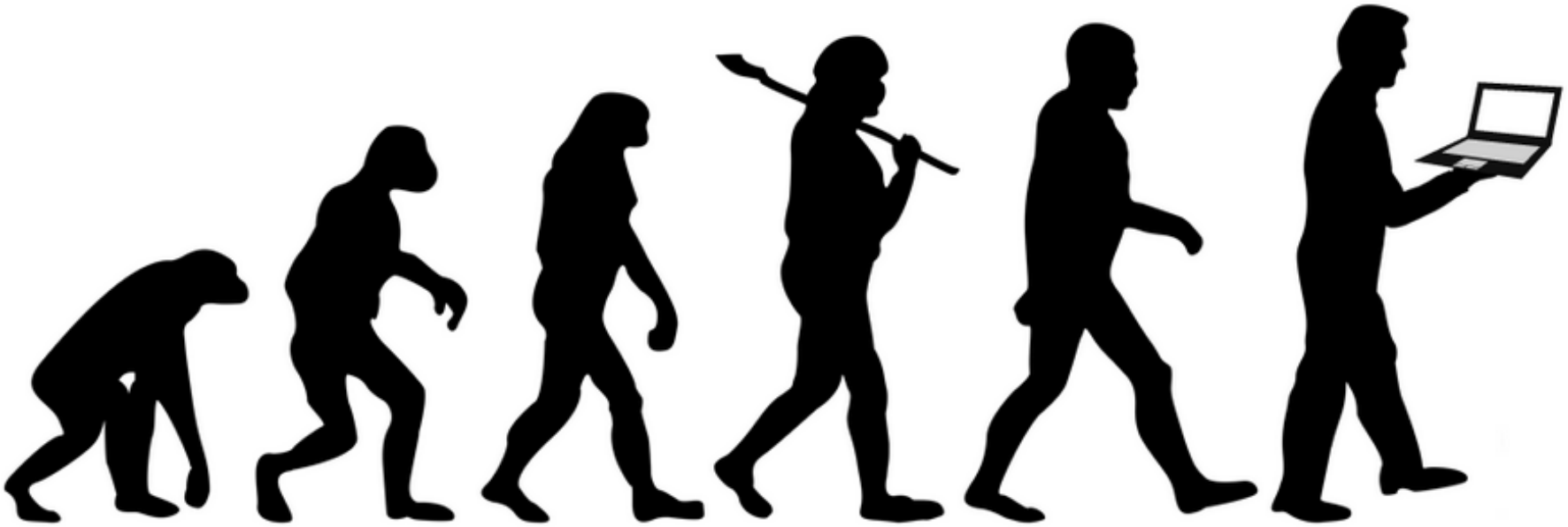


The Base Line

Some of the Basics

- ✓ How it all began
- ✓ Standards and characteristics
- ✓ Challenges in Wi-Fi

How it all began…



Let's say a 100 Employee Company… how many devices on the Wireless Network?

1 or 2

1999

Hotspot

5 or 10

25…

2005

System Management

2007

Scalable Performance 802.11n

150!

2010

Self Healing & Optimizing

> 200

2013

Gb Wireless HS2.0 HDX

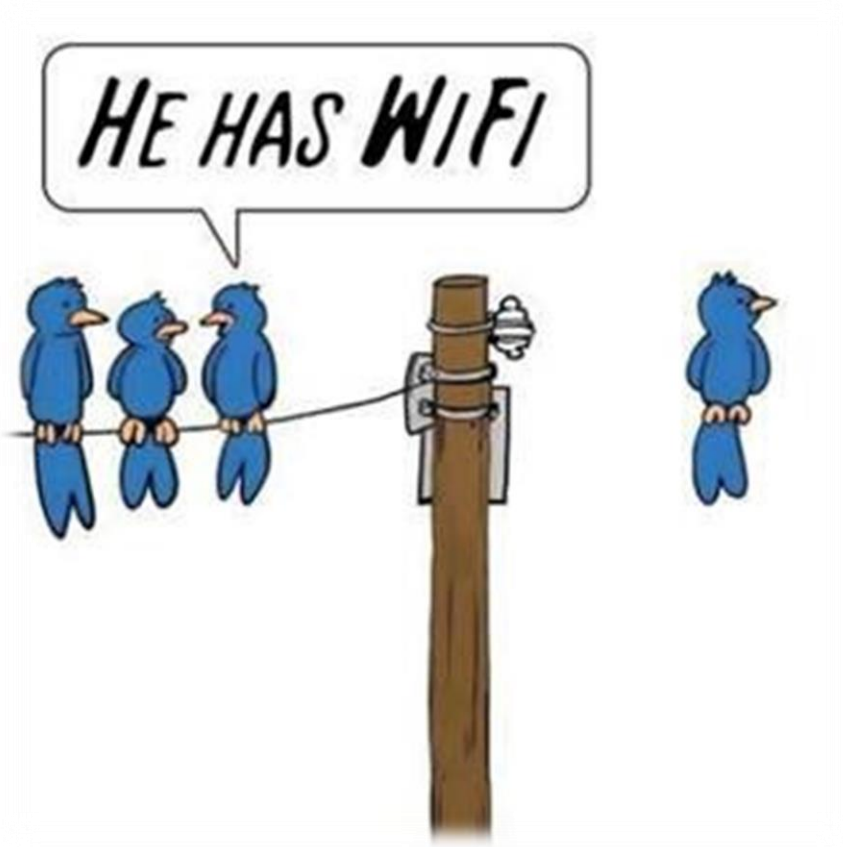
2016

802.11ac Wave2

> 300 !

The basics

L1 & L2
Frequency & Channels
Modulation
Bandwidth & Data Rate

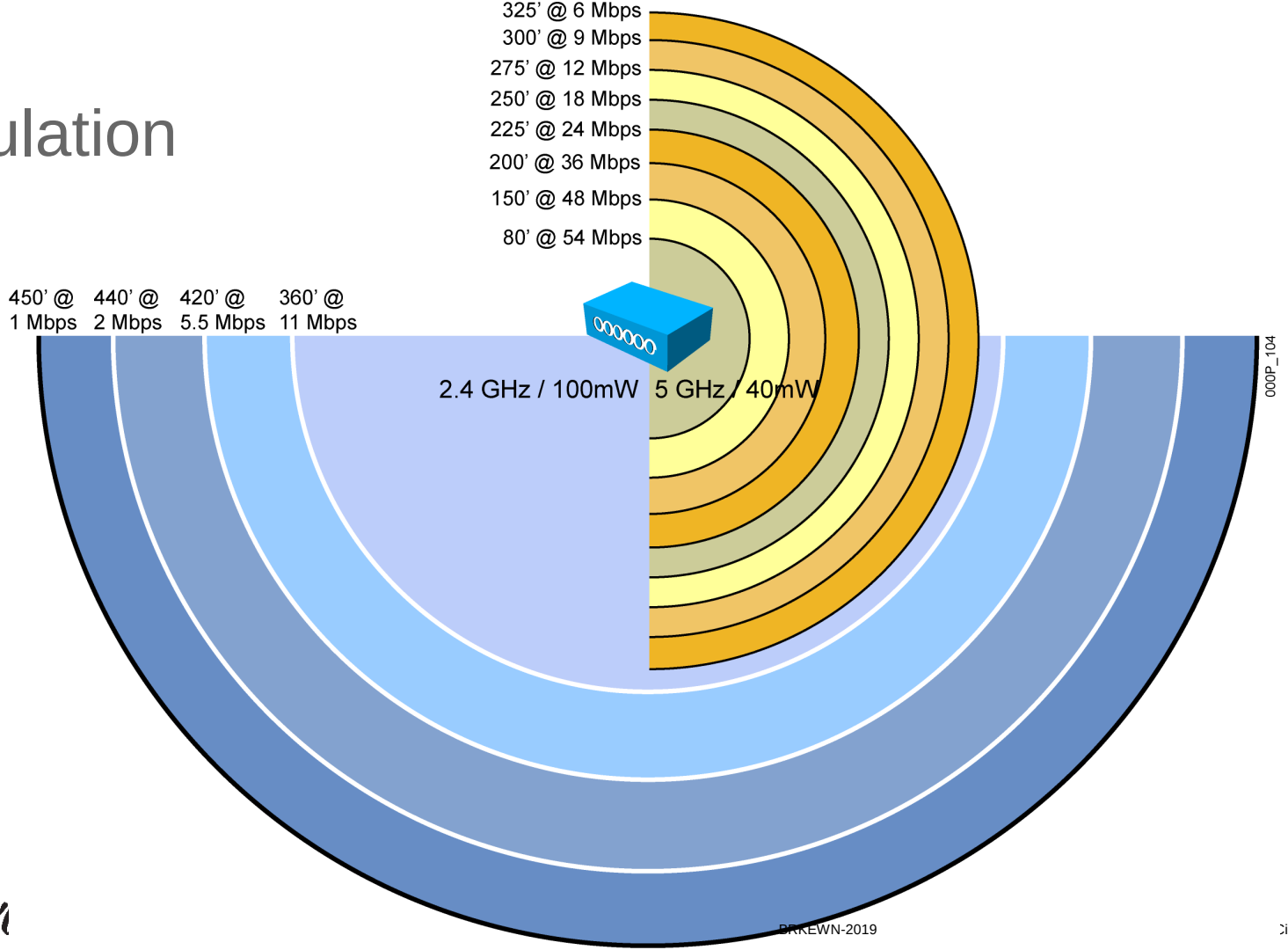


Bandwidth & Data rate

802.11	Frequency	Data rate	Channels	Channels 'usable'
a	5 GHz	54 Mbps	24	24
b	2.4 GHz	11 Mbps	13	3
g	2.4 GHz	54 Mbps	13	3
n	2.4 GHz & 5 GHz	(min) 65, 150, 300, 450, (max) 600 Mbps	2.4 GHz & 5 GHz Rules apply.	2.4 GHz & 5 GHz Rules apply.
ac	5 GHz	867 Mbps 1.3 Gbps, 1.7 Gbps* 3.5 Gbps* 6.9 Gbps*	24* 37**	24* 37**

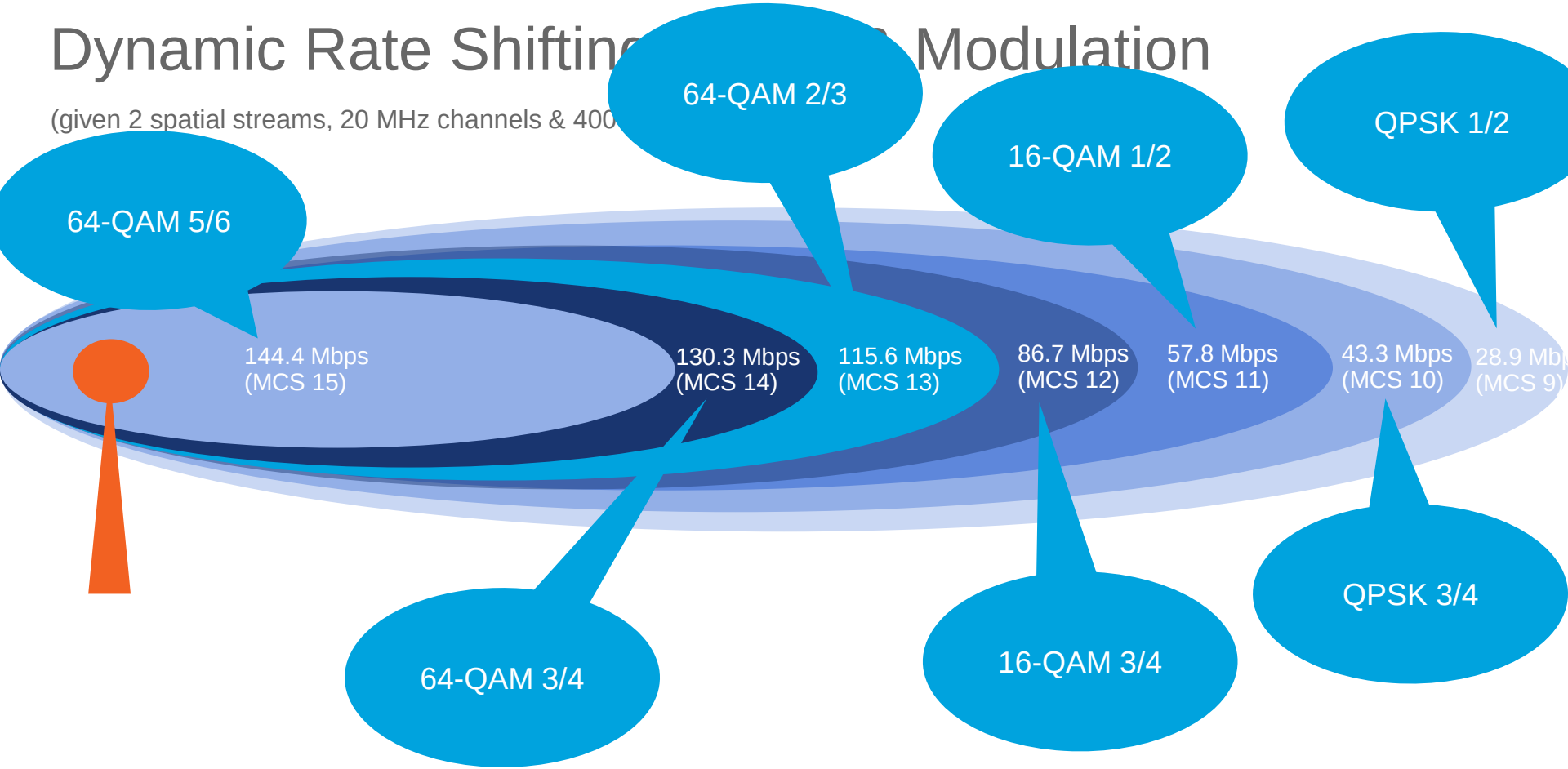
* = 802.11ac Wave 2
** = 802.11ac Wave 2 (US)

Modulation


325' @ 6 Mbps
300' @ 9 Mbps
275' @ 12 Mbps
250' @ 18 Mbps
225' @ 24 Mbps
200' @ 36 Mbps
150' @ 48 Mbps
80' @ 54 Mbps
450' @ 1 Mbps
440' @ 2 Mbps
420' @ 5.5 Mbps
360' @ 11 Mbps
2.4 GHz / 100mW
5 GHz / 40mW
000P_104

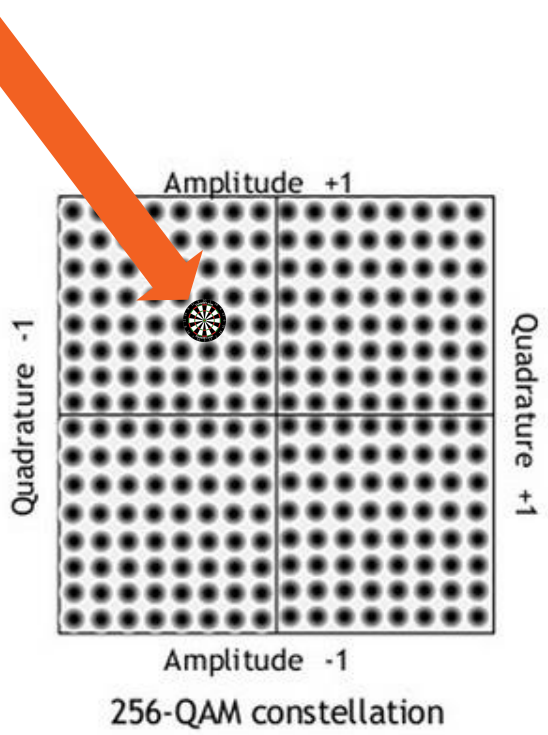
Dynamic Rate Shifting & Modulation

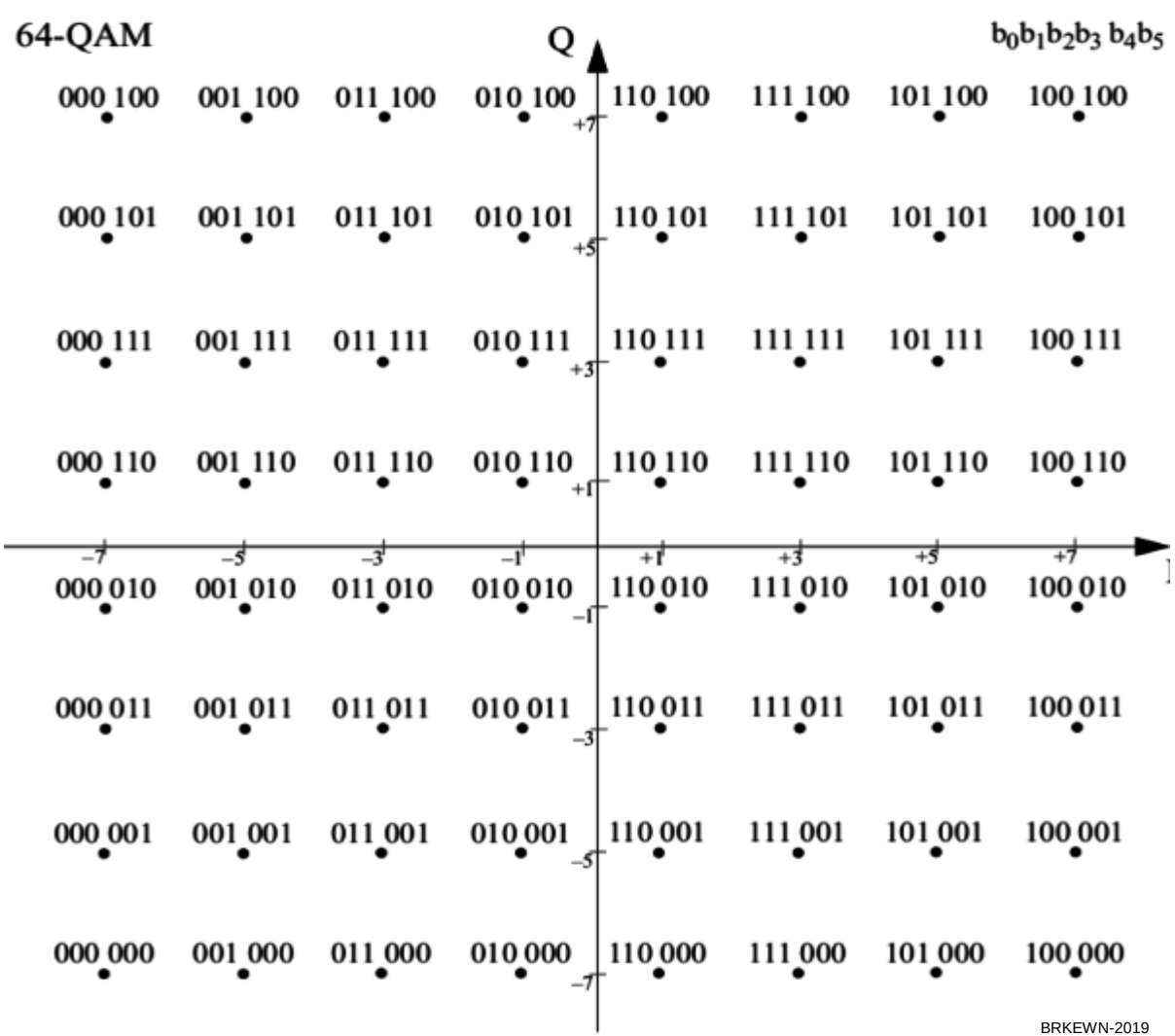
(given 2 spatial streams, 20 MHz channels & 400



Modulation

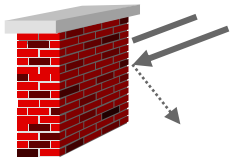
Modulation



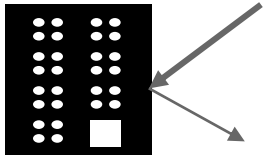



AWESOME!
betfair

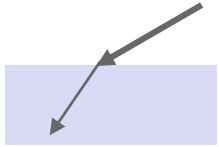
What happens in the air?



shadowing



reflection



refraction

scattering

diffraction

Challenges in Wi-Fi

- Slow
- Can’t connect
- Can’t roam
- Not secure
- BYOD
- Guest networks

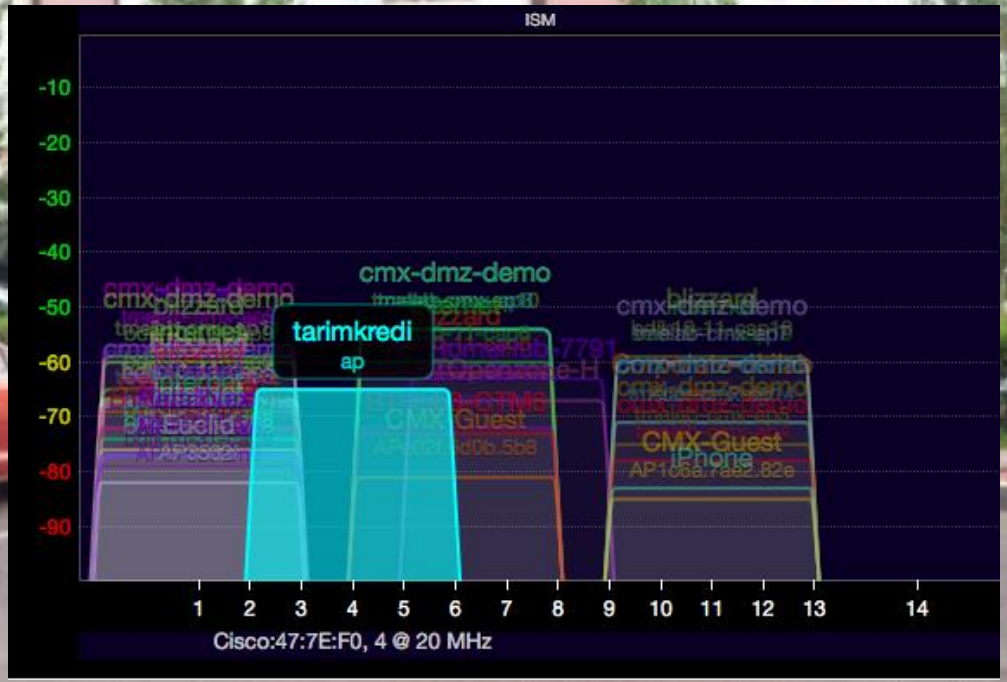
- Coverage
- Interference
- Changing environments
- Internet of Things
- 99.999% of availability
- Primary access method


FAIL
Time to look at some Fails!

Fail #1

"Forget those Channels"

I ALSO HAVE WI-FI IN MY CAR



SET TO CHANNEL 4

Fail #1: Incorrect Usage of Channels

All Networks

Filter

RESULTS

- Band
- Service Set 1
- Mode 1
- Radio 10
- Vendor 1
  - Proxim Wi...

Network Name	BSSID	Vendor	Signal	Avg Noise	SNR	Avg SNR	Channel	Width	Band	Streams	Stations	Channel Utilization	Mode	Max Rate	Security	
	00:20:A6...	Proxim Wireless	-48	-92	44 dB	40 dB	1	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-52	-83	31 dB	35 dB	10	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-64	-92	28 dB	28 dB	8	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-65	-84	19 dB	15 dB	11	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-65	-84	19 dB	19 dB	4	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-66	-92	26 dB	24 dB	2	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-68	-84	16 dB	11 dB	11	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-70	-84	14 dB	13 dB	4	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-78	-83	5 dB	3 dB	9	20 MHz	2.4 GHz	1			g	54 Mbps		3
	00:20:A6...	Proxim Wireless	-82	-92	10 dB	13 dB	1	20 MHz	2.4 GHz	1			g	54 Mbps		3

Network Details | Signal Strength | Channels | Advanced Details

Group networks by radio

Networks Found: 10, Displayed: 10 (100%)

All Networks

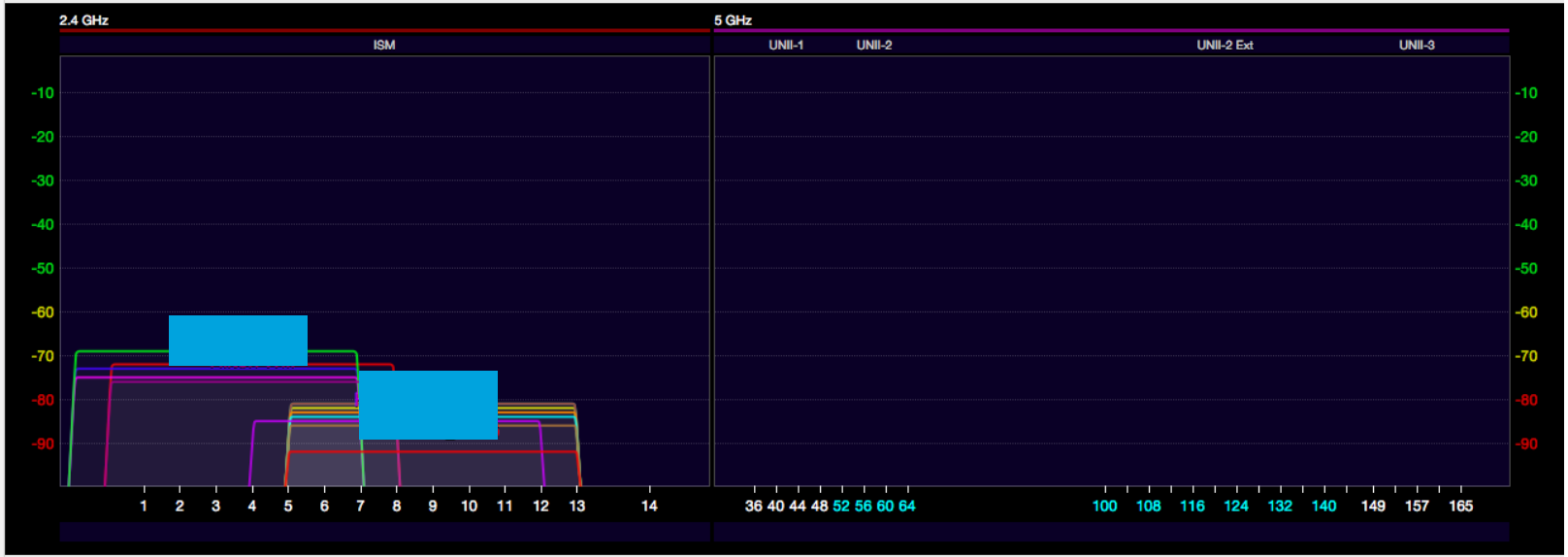
Filter

RESULTS

- Band
- Service Set 2
- Mode 1
- Radio 9
- Vendor 2
  - Huawei Te…
  - Senao Int…

Network Name	BSSID	Vendor	Signal	Avg Noise	SNR	Avg SNR	Channel	Width	Band	Streams	Stations	Channel Utilization	Mode	Max Rate	Security
Wifi	00:02:6F…	Senao International…	-69	-83	14 dB	9 dB	1,+1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-72	-81	9 dB	11 dB	6,-1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-73	-83	10 dB	11 dB	1,+1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-75	-83	8 dB	10 dB	1,+1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-76	-83	7 dB	6 dB	2,+1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-81	-83	2 dB	2 dB	11,-1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-81	-83	2 dB	0 dB	11,-1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-82	-83	1 dB	3 dB	11,-1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-83	-83	-1 dB	0 dB	11,-1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-84	-83	-1 dB	-1 dB	11,-1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-85	-81	-4 dB	-4 dB	6,+1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
Wifi	00:02:6F…	Senao International…	-86	-83	-3 dB	-1 dB	11,-1	40 MHz	2.4 GHz	1			b/g/n	150 Mbps	
one_0EA6	0C:96:BF…	Huawei Technologi…	-92	-83	-9 dB	-9 dB	11,-1	40 MHz	2.4 GHz	2			b/g/n	300 Mbps	WPA

Network Details | Signal Strength | Channels | Advanced Details



Group networks by radio

Networks Found: 13, Displayed: 13 (100%)

All Networks

Filter

RESULTS

- Band
- Service Set 4
- Mode 5
- Radio 38
- Vendor 3
  - Cisco Sys...
  - Linksys
  - Sierra Wir...

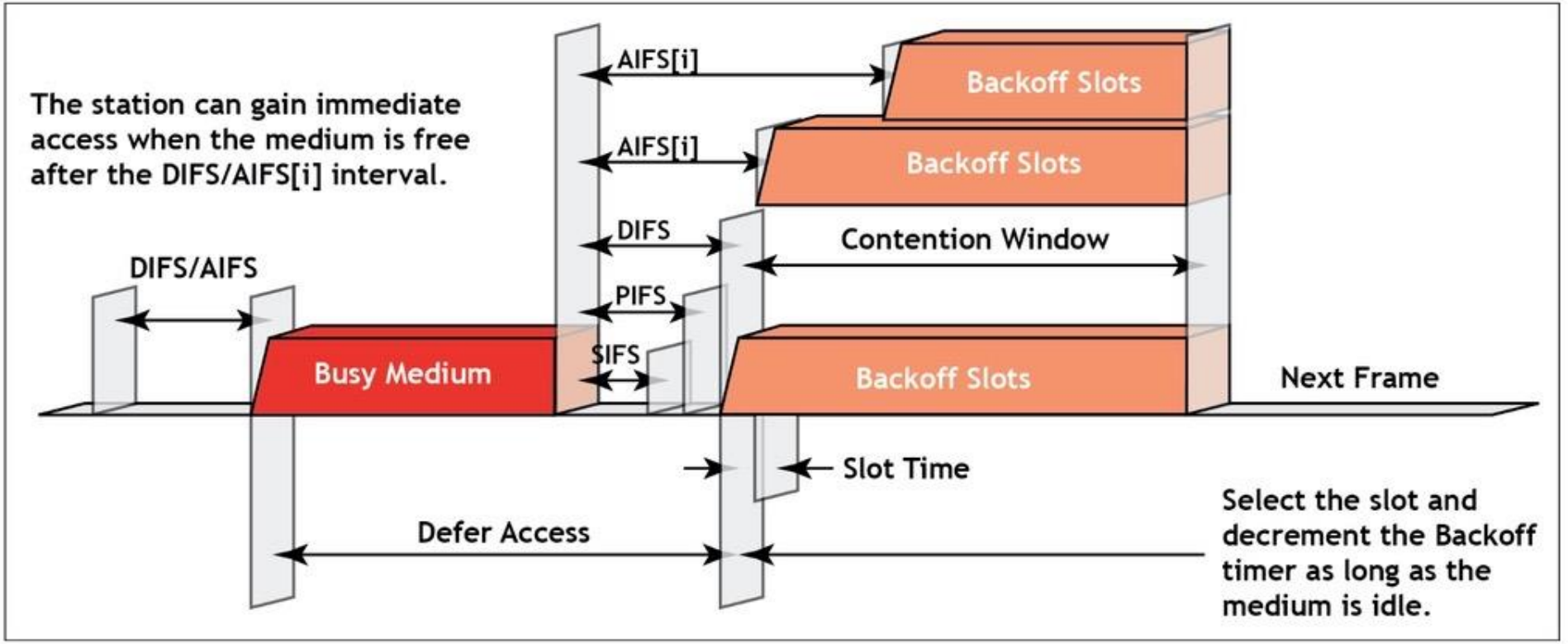
Network Name	BSSID	Vendor	Signal	Avg Noise	SNR	Avg SNR	Channel	Width	Band	Streams	Stations	Channel Utilization	Mode	Max Rate	Security
	00:1D:46...	Cisco Systems Inc.	-45	-92	47 dB	46 dB	5	20 MHz	2.4 GHz	1	4		b/g	54 Mbps	
	00:1D:46...	Cisco Systems Inc.	-46	-92	46 dB	46 dB	5	20 MHz	2.4 GHz	1	4		b/g	54 Mbps	
	00:1D:46...	Cisco Systems Inc.	-48	-92	44 dB	45 dB	5	20 MHz	2.4 GHz	1	0		b/g	54 Mbps	
	00:1D:46...	Cisco Systems Inc.	-49	-92	43 dB	45 dB	5	20 MHz	2.4 GHz	1	0		b/g	54 Mbps	
	00:11:93:...	Cisco Systems Inc.	-50	-92	42 dB	40 dB	1	20 MHz	2.4 GHz	1	6		b/g	54 Mbps	
	00:1C:F6...	Cisco Systems Inc.	-51	-92	41 dB	40 dB	4	20 MHz	2.4 GHz	1	1		b/g	54 Mbps	
	00:1C:F6...	Cisco Systems Inc.	-51	-92	41 dB	40 dB	4	20 MHz	2.4 GHz	1	1		b/g	54 Mbps	
	00:11:93:...	Cisco Systems Inc.	-52	-92	40 dB	35 dB	1	20 MHz	2.4 GHz	1	6		b/g	54 Mbps	
	00:1D:46...	Cisco Systems Inc.	-53	-92	39 dB	38 dB	8	20 MHz	2.4 GHz	1	1		b/g	54 Mbps	
	00:1D:46...	Cisco Systems Inc.	-54	-92	38 dB	38 dB	8	20 MHz	2.4 GHz	1	1		b/g	54 Mbps	
	00:1D:46...	Cisco Systems Inc.	-55	-92	37 dB	36 dB	4	20 MHz	2.4 GHz	1	0		b/g	54 Mbps	
	00:1D:46...	Cisco Systems Inc.	-55	-92	37 dB	36 dB	4	20 MHz	2.4 GHz	1	0		b/g	54 Mbps	
	00:0F:8F...	Cisco Systems Inc.	-55	-92	37 dB	36 dB	1	20 MHz	2.4 GHz	1	1		b	11 Mbps	

Network Details | Signal Strength | Channels | Advanced Details

Group networks by radio

Networks Found: 68, Displayed: 68 (100%)

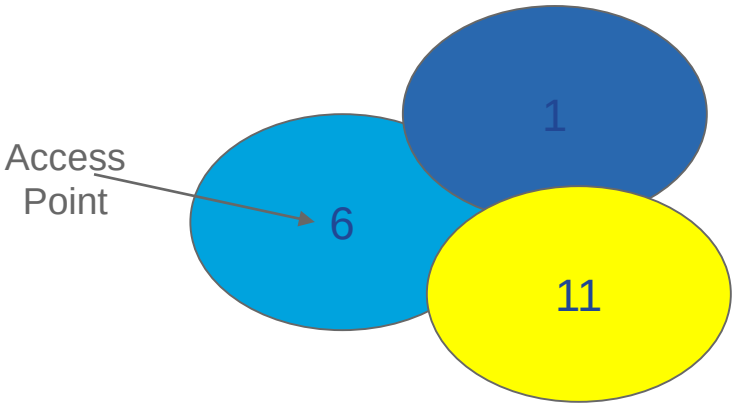
So what's wrong?



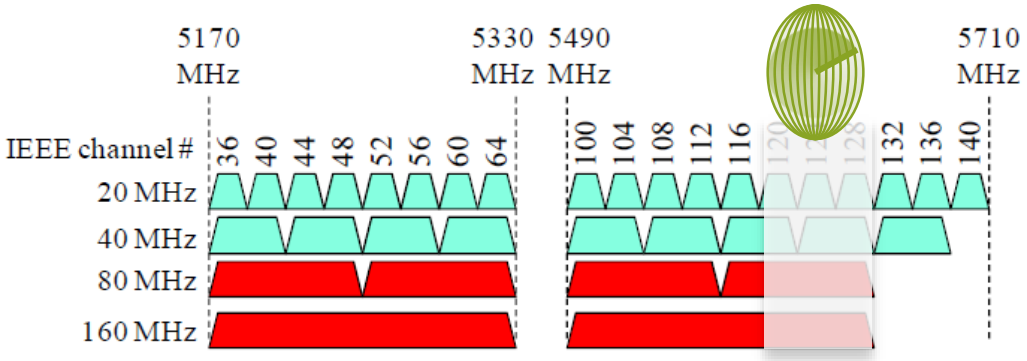
Channel reuse scheme in the Network

Neighboring APs use different channels to reduce interference.

On 2.4 GHz, the “Reuse cluster” size is equal to 3

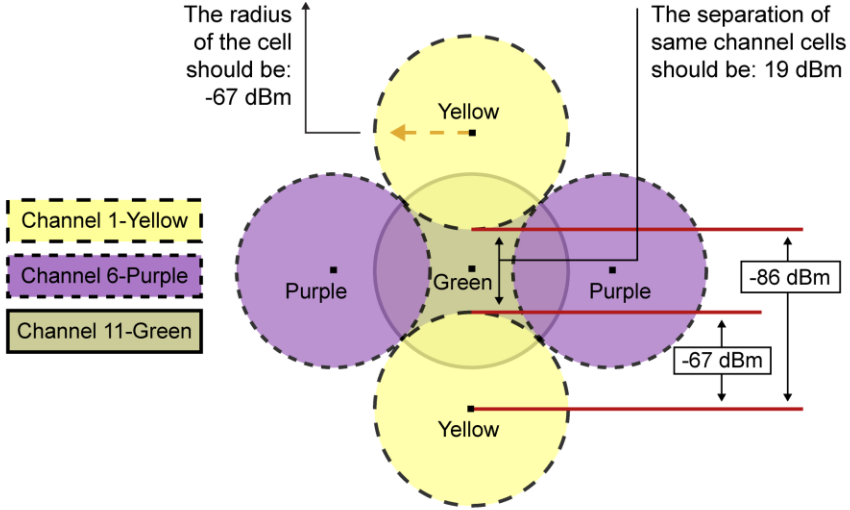


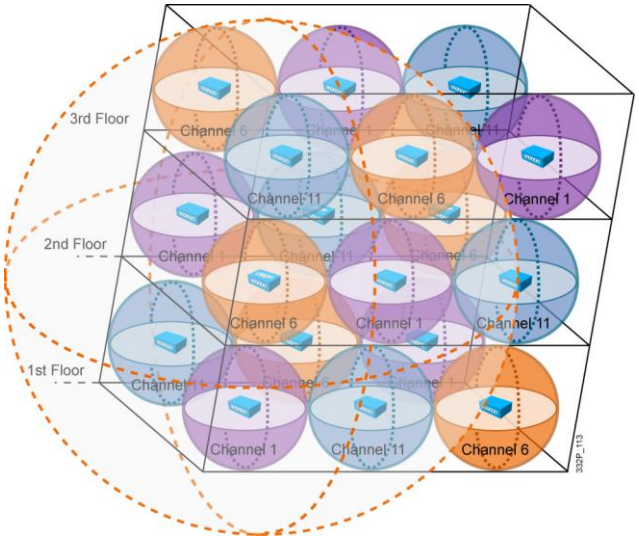
On 5 GHz, the “Reuse cluster” size varies depending on channel width:



2.4-GHz Network Design

- Conclusion: try to design small cells, with clever overlap…



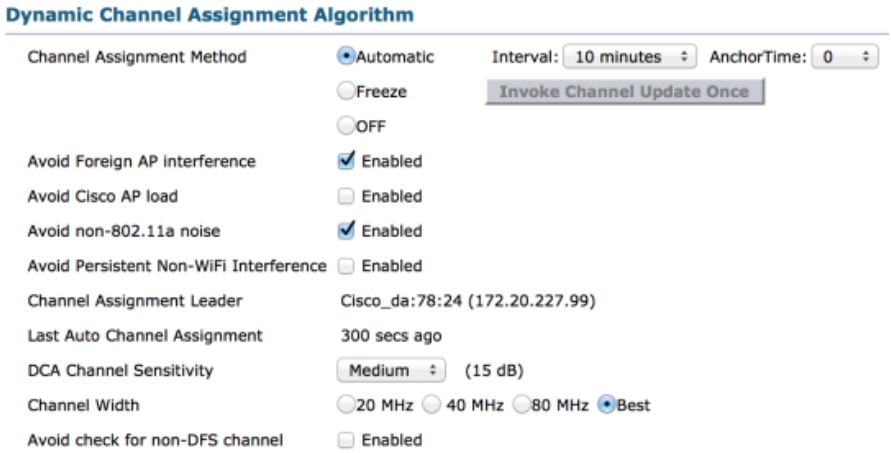


Channel best practices

Channel Best Practices

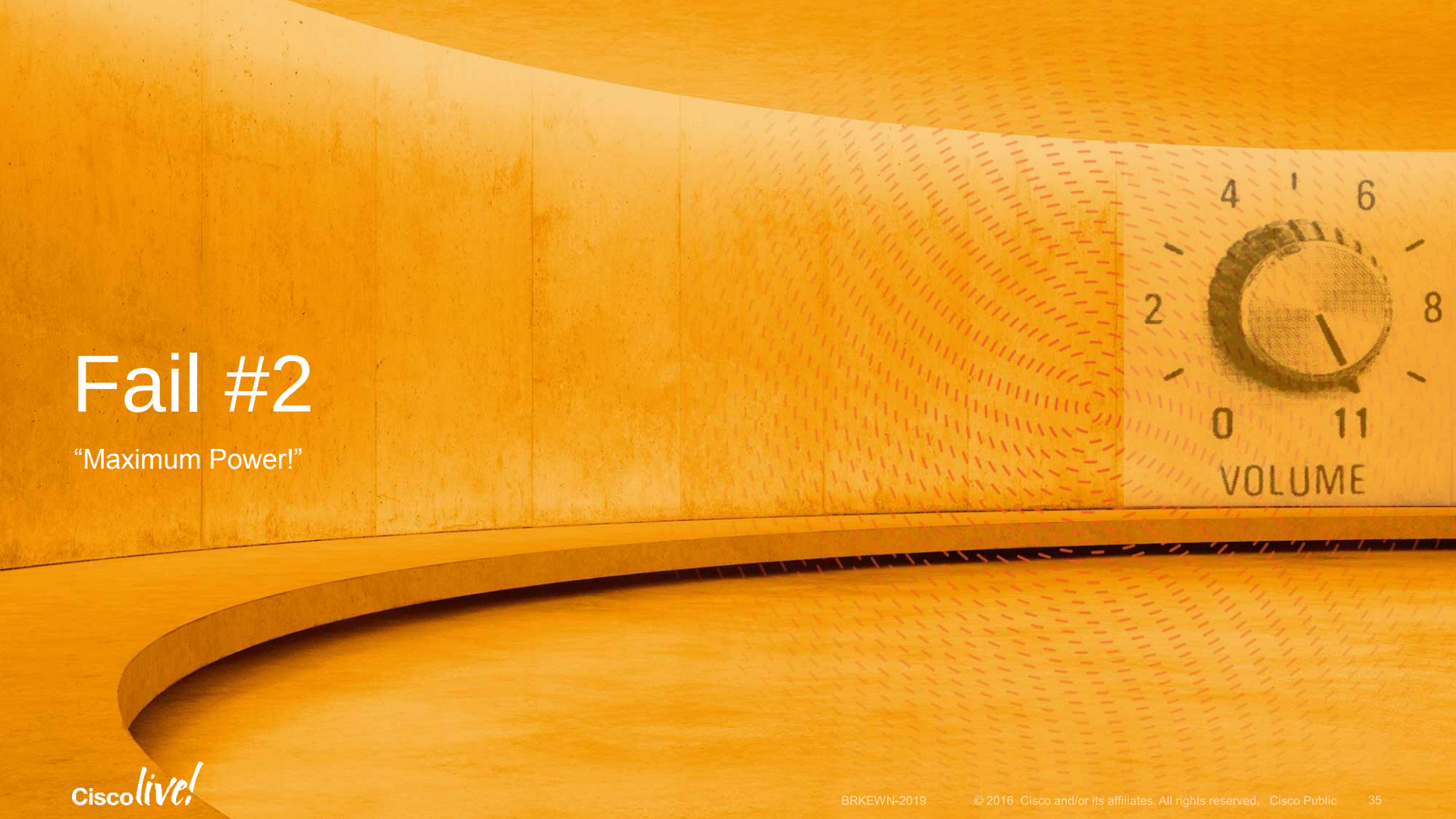
- ✓ Only 1, 6 and 11 on 2.4
- ✓ Use 5 GHz as much as possible
  - ✓ Lower 8 channels for Voice environments (36 – 64)
- ✓ Enable the DCA
- ✓ Enable Dynamic Bandwidth Selection
- ✓ Use the RRM algorithms.

- ✓ Don’t use ‘Maximum Power’….



Fail #2

"Maximum Power!"



I use Maximum Power because…

- ✓ I need less Access Points
- ✓ I'm designing for Coverage
- ✓ My Site survey tool says 'all green'
- ✓ It's the default…

Jussi Kiviniemi heeft geretweet

Jason Hintersteiner
@EmperorWiFi

Setting Tx power is like drinking scotch: The right amount is great, but "more" does not mean "better", & too much will make you sick...

Fail#2

"Putting your AP's on Maximum Power"

Maximum Power (20dBm / 100mw) is a bad idea…

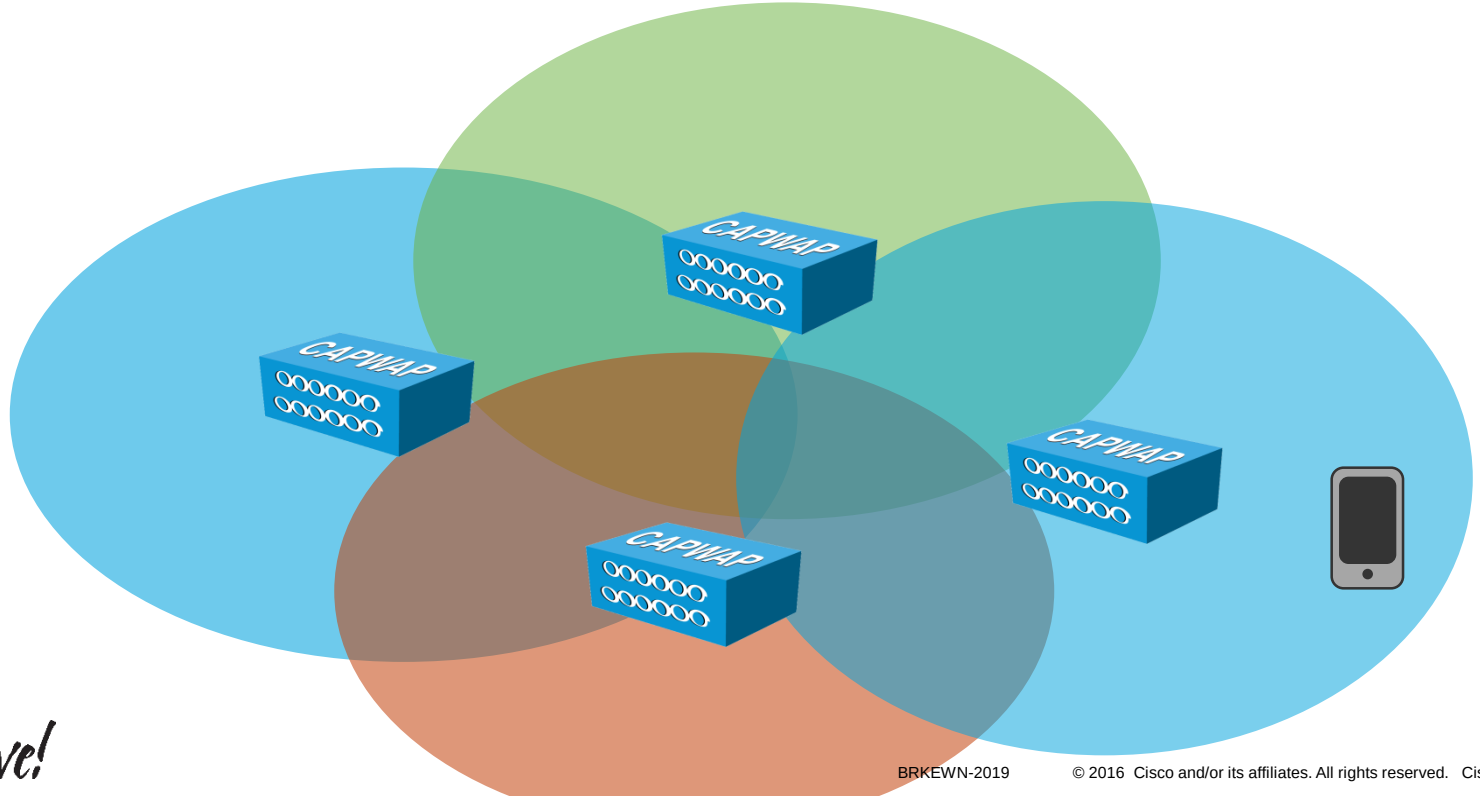
- ✓ Co Channel Interference (CCI)
- ✓ Clients are not Maximum Power

  (typically 14 dBm, which is a Quarter… (25mw))
- ✓ Reduced ‘fault tolerance’

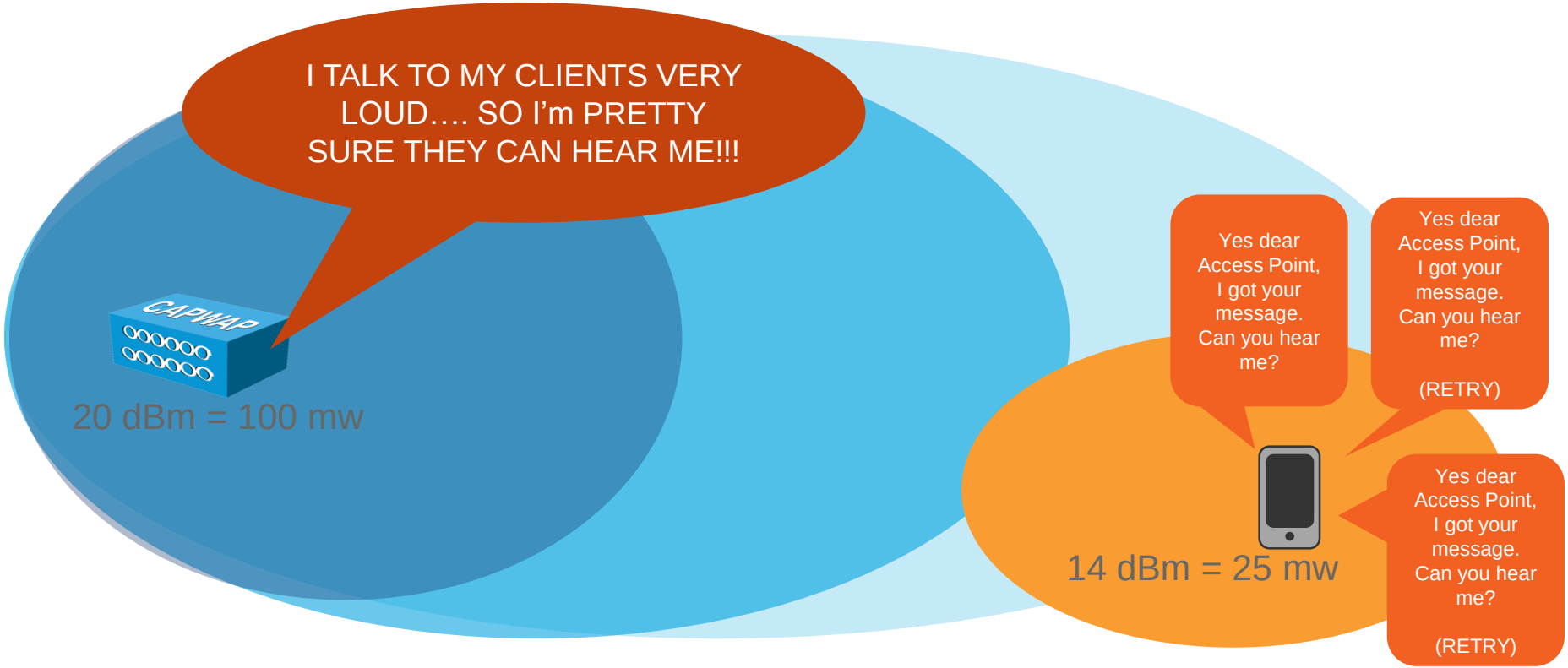
So what's wrong?

Co Channel Interference & Adjacent Channel Interference

The biggest sources of Interference are… your own Access Points…



Clients are not Maximum Power



Reduced Fault Tolerance

Radio Resource Management needs to scale power up and down to help in cases of Coverage holes

.

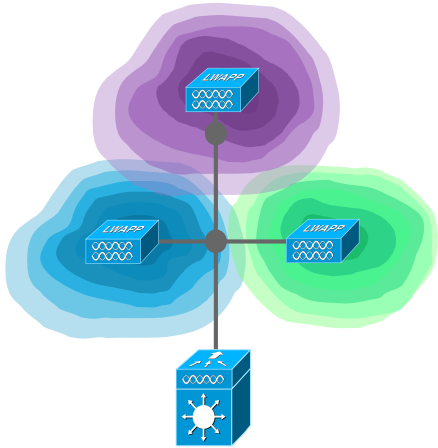
If already at Max Power…

nothing to scale…

Radio Resource Management

What's RRM

- DCA—Dynamic Channel Assignment
- TPC—Transmit Power Control
- CHDM—Coverage Hole Detection and Mitigation



For more info: http://www.cisco.com/en/US/tech/tk722/tk809/technologies_tech_note09186a008072c759.shtml

Power best practices

Power best practices

- ✓ Do *NOT* use 100% power
- ✓ USE the RRM with the max set to 17dBm and min 5dBm
- ✓ Enable Event Driven RRM (EDRRM) with Rogue Contribution.
- ✓ Keep Rogue Duty cycle to max 80%.
- ✓ Create Smaller cells

RRM best practices

RRM settings to auto for most deployments
(High Density is a special case)

Design for most radios set at mid power level (level 3 for example)

RRM ***does NOT*** replace the site survey and doesn't create spectrum

Fail #3

"2.4 GHz is still the most important"


Here Lies
Twopointfour Gigahertz
"1,6,11"
1997-2015
One Foot in the Grave
Grasping for 14

Fail #3

Only designing for 2.4 is NOT how to do it…

Design your network for 5GHz

- All those access points are Dual Radio
- They will support your 2.4 GHz clients
- Band Steering / Band Select
  to push clients to the 5 GHz band
- All developments are on the 5GHz band.
- Not on 2.4 GHz. (Not enough channels, too much interference, too much ‘other devices’.

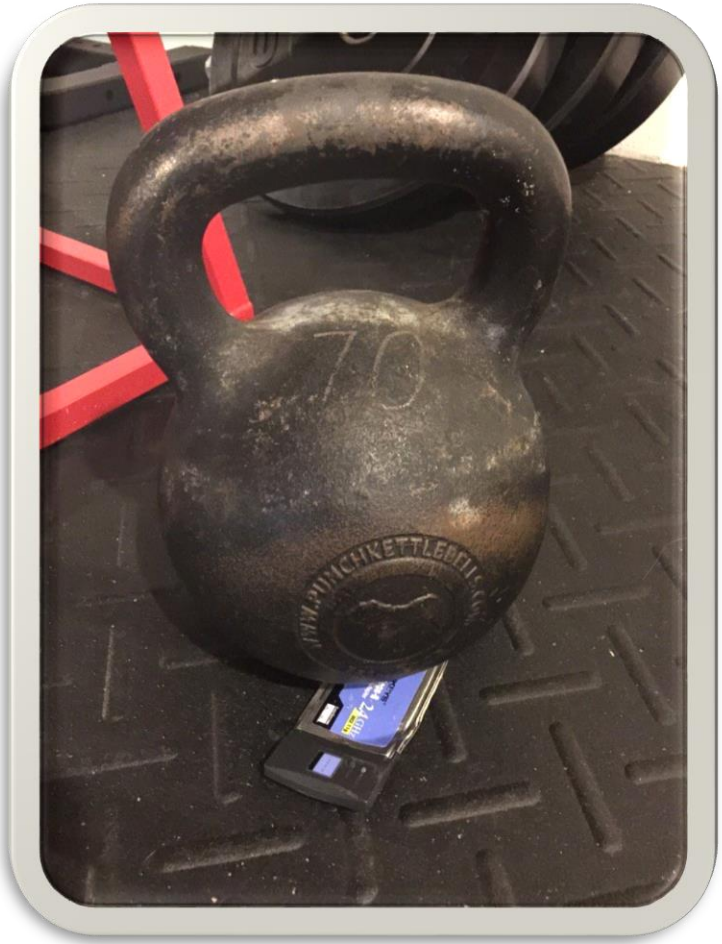
“and as a Specialist I pledge…”

“2.4 GHz single radio devices or access points”

2.4 GHz Best Practices

best practices

- ✓ Design your network for 5 GHz.
- ✓ If possible take out 2.4 GHz entirely
- ✓ Don’t buy ‘Single Radio AP’s'
- ✓ Don’t buy ‘Single Radio Clients'
- ✓ See if you have legacy clients that you can migrate



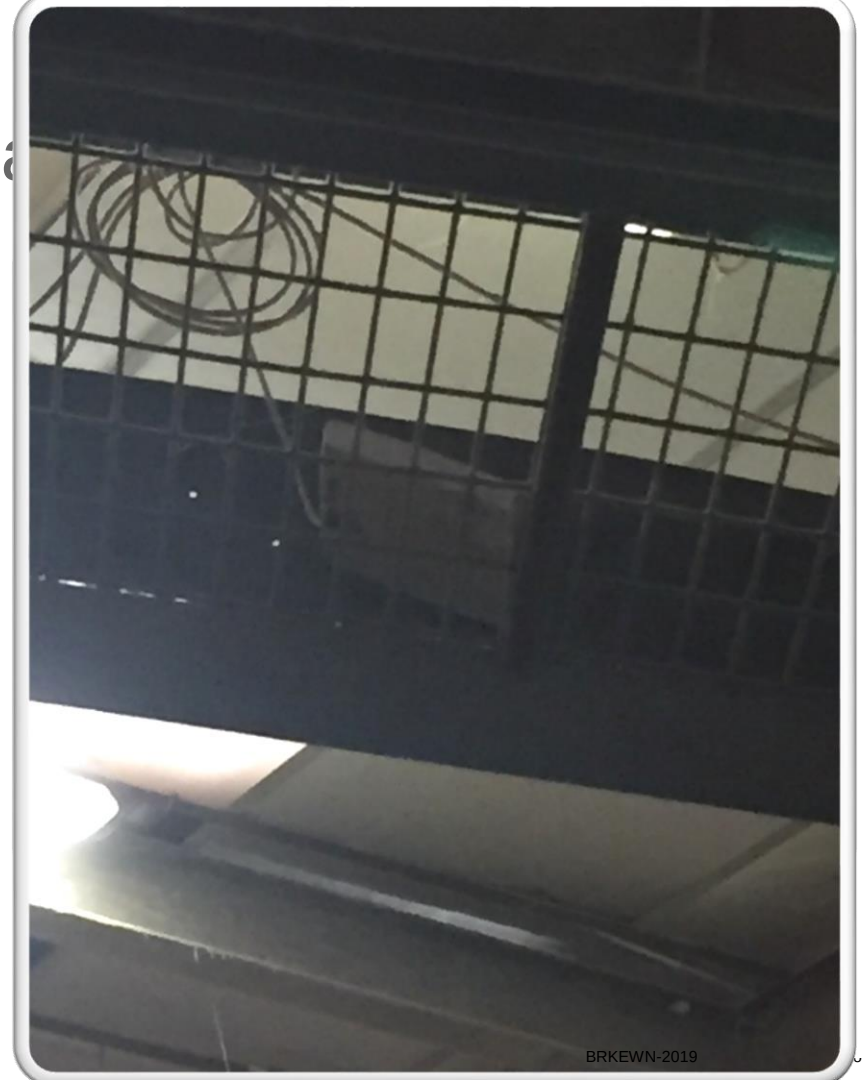
Placements. Really? Does it matter?

Source: www.bad-fi.com

Fail #4

Placing your Access Points… wrong…

Wrong installa



So what's wrong?

Integrated Antenna? External Antenna?

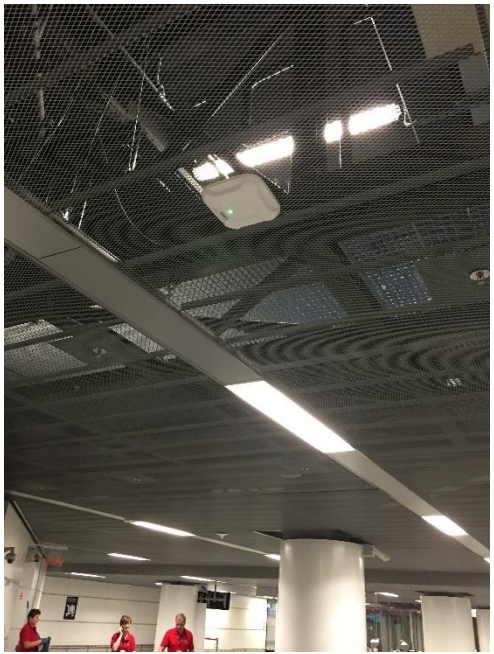
Carpeted areas

Integrated antenna versions are designed for mounting on a ceiling (carpeted areas) where aesthetics is a primary concern

Rugged areas

Use for industrial applications where external or directional antennas are desired and or applications requiring higher temperature ranges

Well done!



Not so well done…

Nothing to see here. Move along.

2 APs are better than one.

MacGruber!

Source: www.bad-fi.com

Wall mounting AP-1260, 3500e, 3600e, & 3700e

Orientation of the Dipoles if Wall Mounting

Note: The ceiling is usually higher and a better location for RF.

If using advanced features like location or voice try to locate the AP on the ceiling, or when mounting the AP on a wall orient the dipoles in this configuration.

Because dipoles on a wall can easily get orientated wrong as people touch and move them. Better still might be to use a Patch antenna or use the Oberon wall bracket. Be aware walls can add directional properties to the signal as they can have wiring, metal 2x4 construction and the wall attenuates the signal behind the AP limiting a nice 360 degree coverage.

Wall Mounting AP-1260e, 3500e, 3600e and 3700e

Orientation of the Dipoles if Wall Mounting

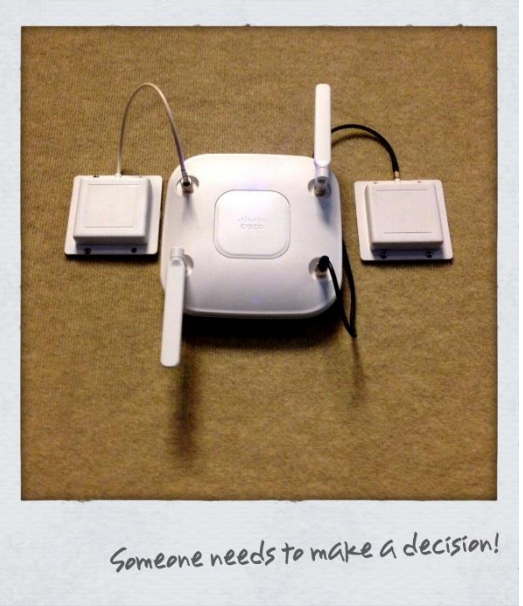
Dipoles pointing UP or Down
are in vertical polarity

This is ideal for uniform coverage.

Dipoles pointing sideways
are in horizontal polarity

Note: Cisco recommends transmitting antennas use vertical polarity

Not like this…



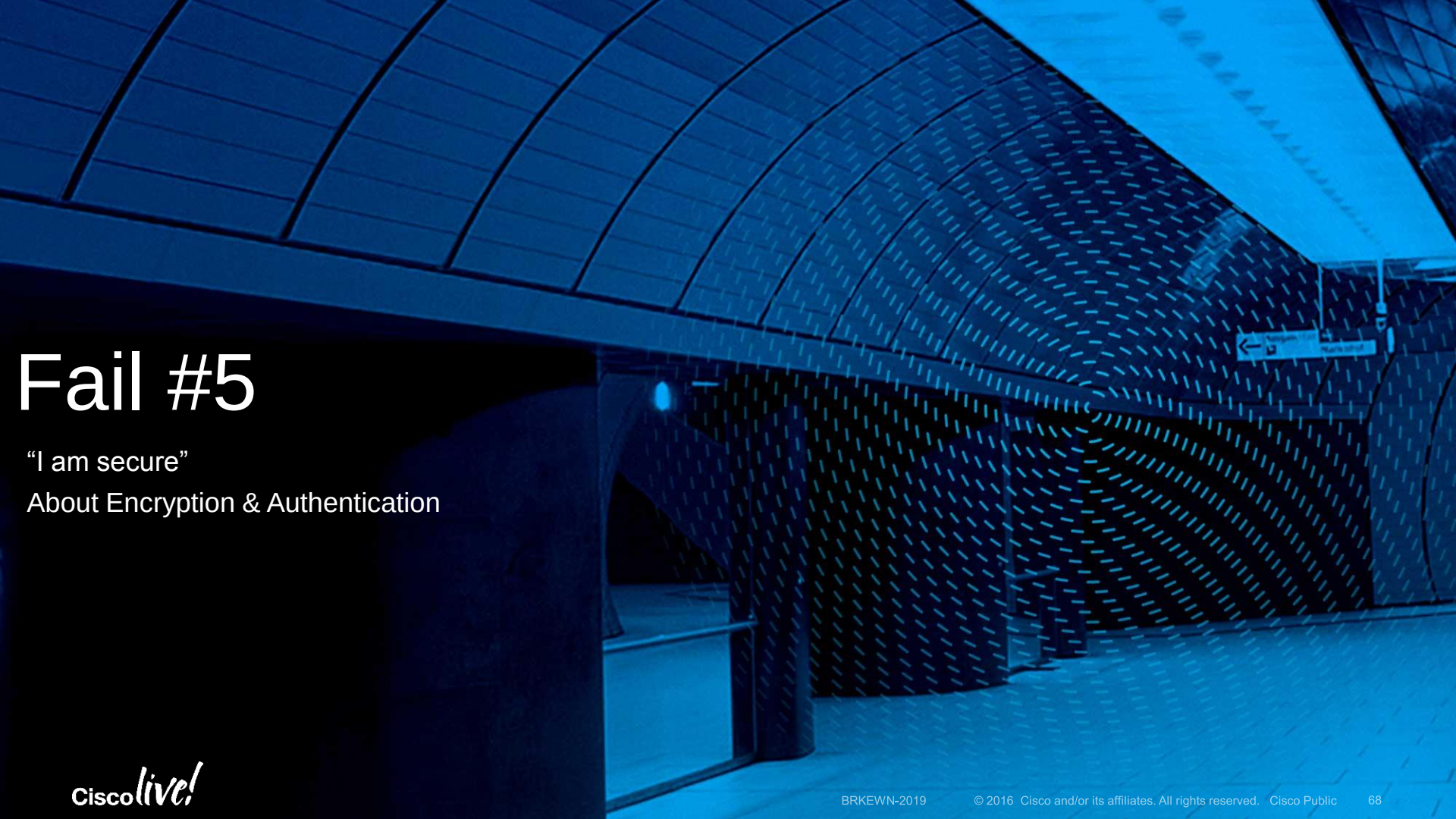
Source:

www.bad-fi.com

Placement Best Practices

Placement & Positioning best practices

- ✓ AP Horizontal (vertical Polarization)
- ✓ Below obstructions
- ✓ Minimal one meter (3ft) away from obstructions (Fresnel zone)
- ✓ The correct antennae, only 1 type of antenna
- ✓ Access Points minimal three meter (10ft) away from each other
- ✓ Not too high (after 4 meter (14ft) high special implementations)
- ✓ Don’t put behind a metal cage
- ✓ Use Outdoor AP’s for Outdoor Coverage…



Fail #5

"I am secure"

About Encryption & Authentication

Statistics

General | Personal | Groups | Android | SSID/Manufacturers | Octet/Channel/File | Geographic

Unique WiFi networks in DB:	228,657,368
Unique networks w/ location:	226,196,720
Unique WiFi locations in DB:	3,228,957,847
Unique Cell towers in DB:	5,946,883
Unique Cells w/ location:	5,916,700
Registered Users:	176,695

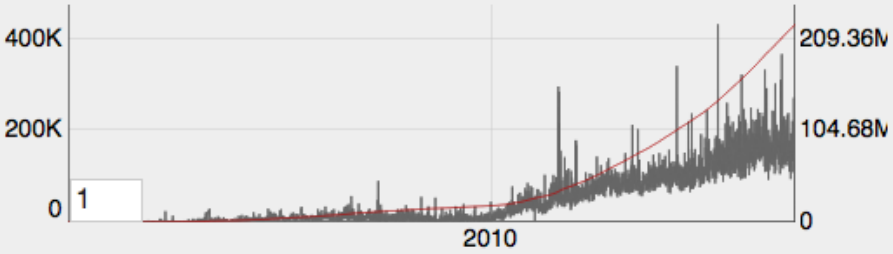
Networks with default SSID:	8,262,679	(3.61%)
New unique networks today:	16,268	
New today with location:	16,247	
New yesterday with location:	135,596	

Total Files parsed:	1,259,436
Files uploaded today processed:	63
Files 1 day ago / 2 days ago:	470 / 505
Files queued to process:	0

Wireless Encryption

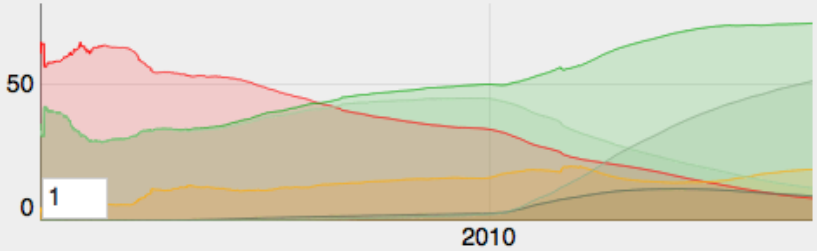
WPA2: 117,848,480 (51.54%)
WPA: 20,969,968 (9.17%)
WEP: 27,815,788 (12.16%)
????: 43,297,442 (18.94%)
None: 19,132,440 (8.37%)

WiFi Networks Over Time



[Full-screen Graph]

WiFi Encryption Over Time



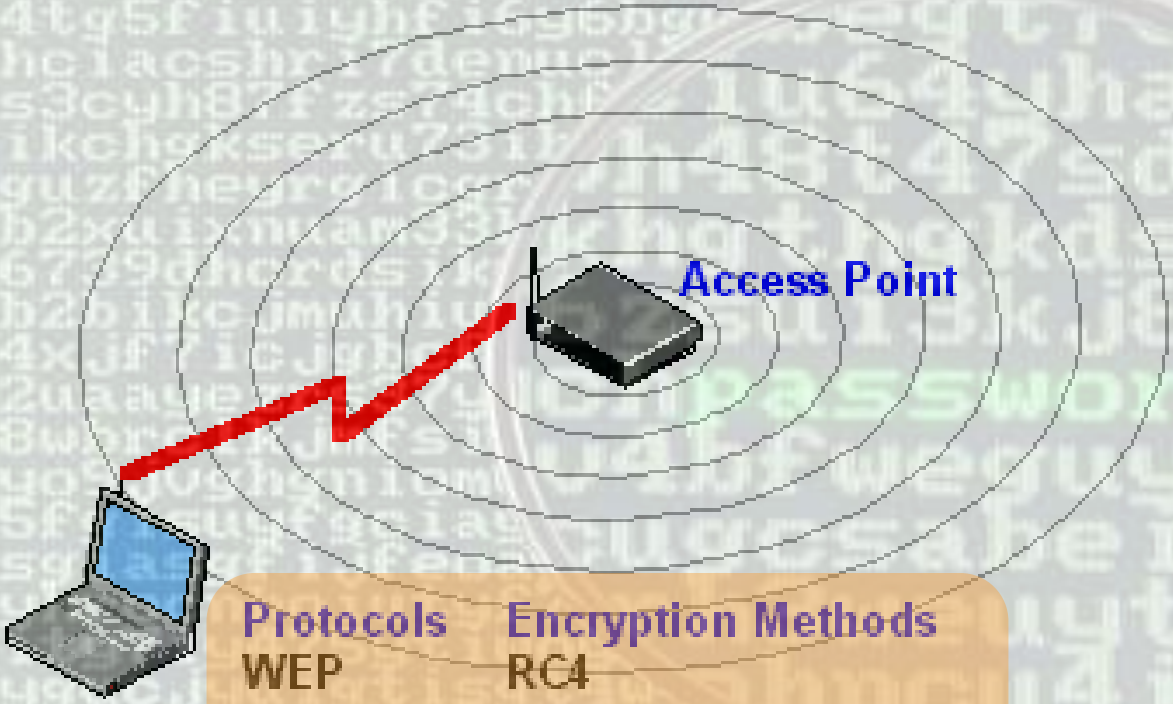
[Full-screen Graph] [2 Years only Graph]

Mouse-over graphs to interact with data. Select a range to zoom in, double click to zoom back out. Modify the number in the corner to smooth over multiple days. Full-screen graphs available!

Source: wigle.net

Fail #5

Not enough attention for Security…



Protocols	Encryption Methods
WEP	RC4
WPA	TKIP/RC4
WPA2	TKIP/RC4, AES-CCMP
802.11i	TKIP/RC4, AES-CCMP

Security Best Practices

Security best practices

- ✓ WPA2 is the bare minimum (with CCMP. Don't use TKIP)
- ✓ WPA2 Personal (PSK) is for… personal
- ✓ WPA2 Enterprise (802.1X) for businesses
- ✓ Use Role Based Access (RBA) with for instance ISE.
- ✓ Use a Wireless Intrusion Preventions (wIPS) solution
- ✓ Use VPN on Public Wireless Connections

Fail #6

"Hype versus Reality"

Expectations versus Reality…

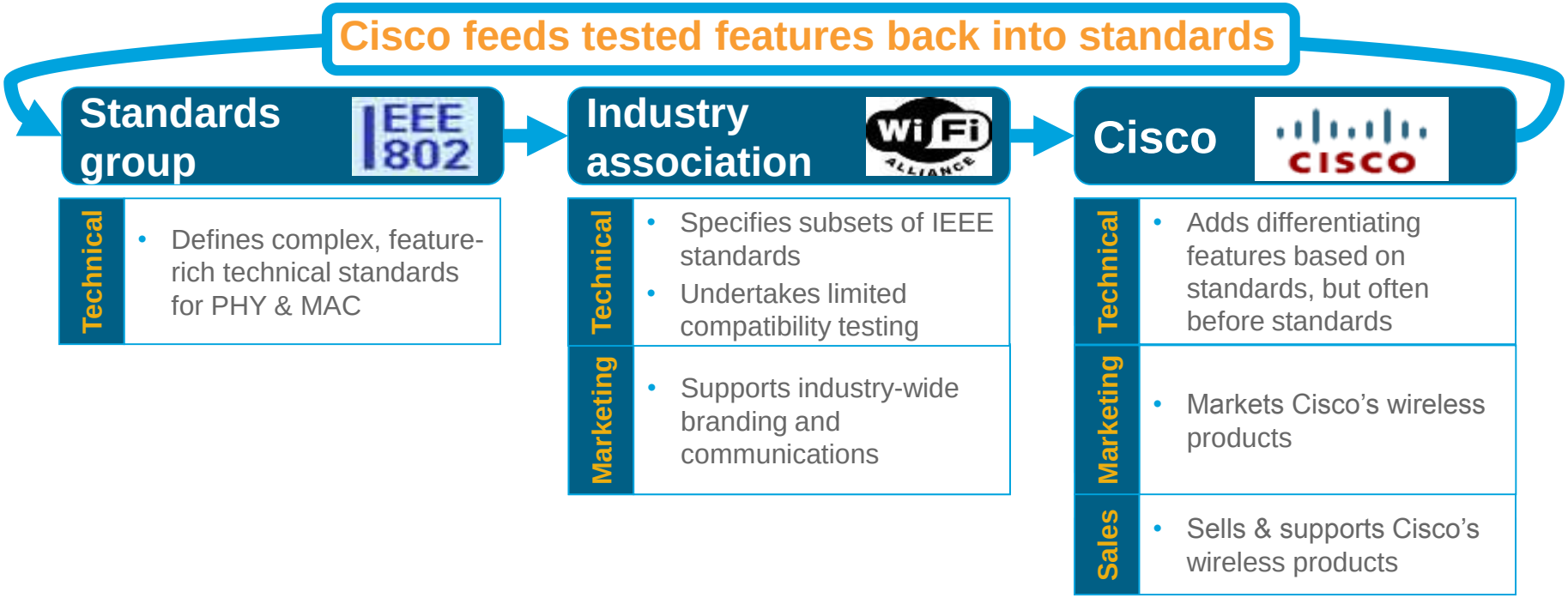
But in reality...

Fail #6

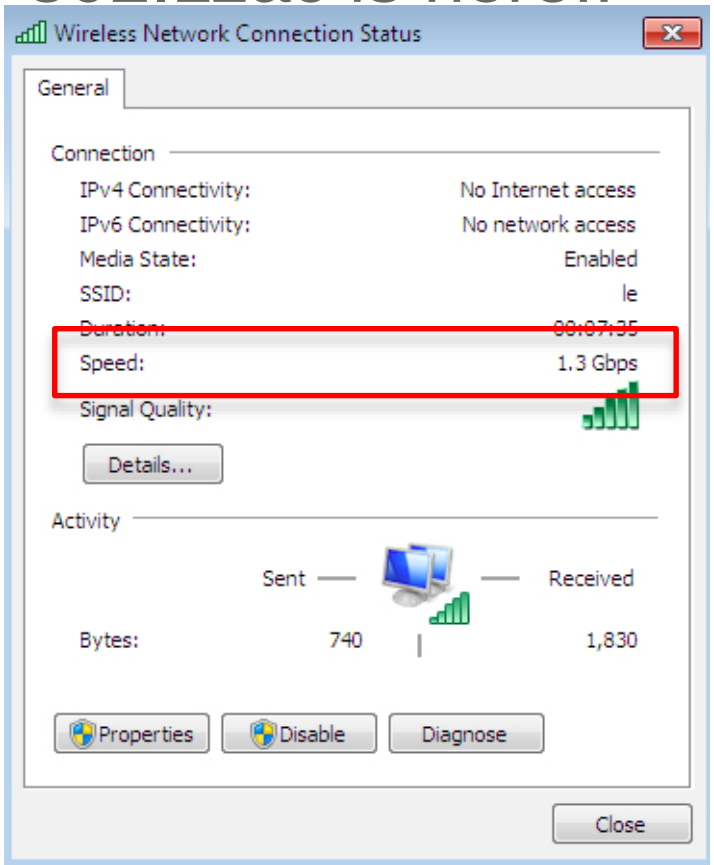
We want those big shiny numbers…
but how real is it?

The Wi-Fi ecosystem is mainly based on cooperation between three main stakeholders

Cisco innovates, and then contributes its innovations into the standards process

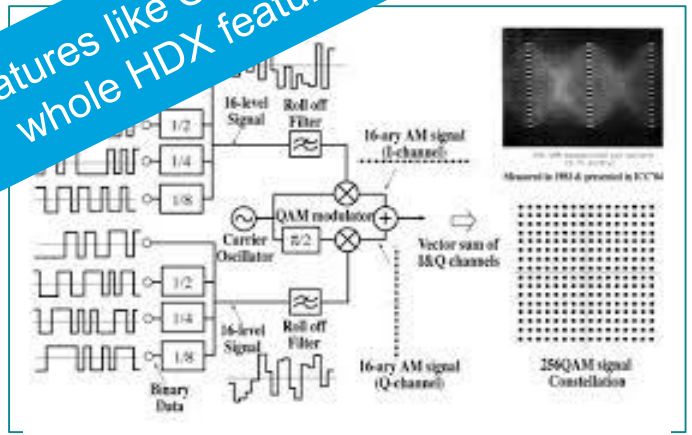


802.11ac is here!!



But it comes with a price

Features like CleanAir, ClientLink and the whole HDX features really matters!!



High Signal at the client for 256QAM

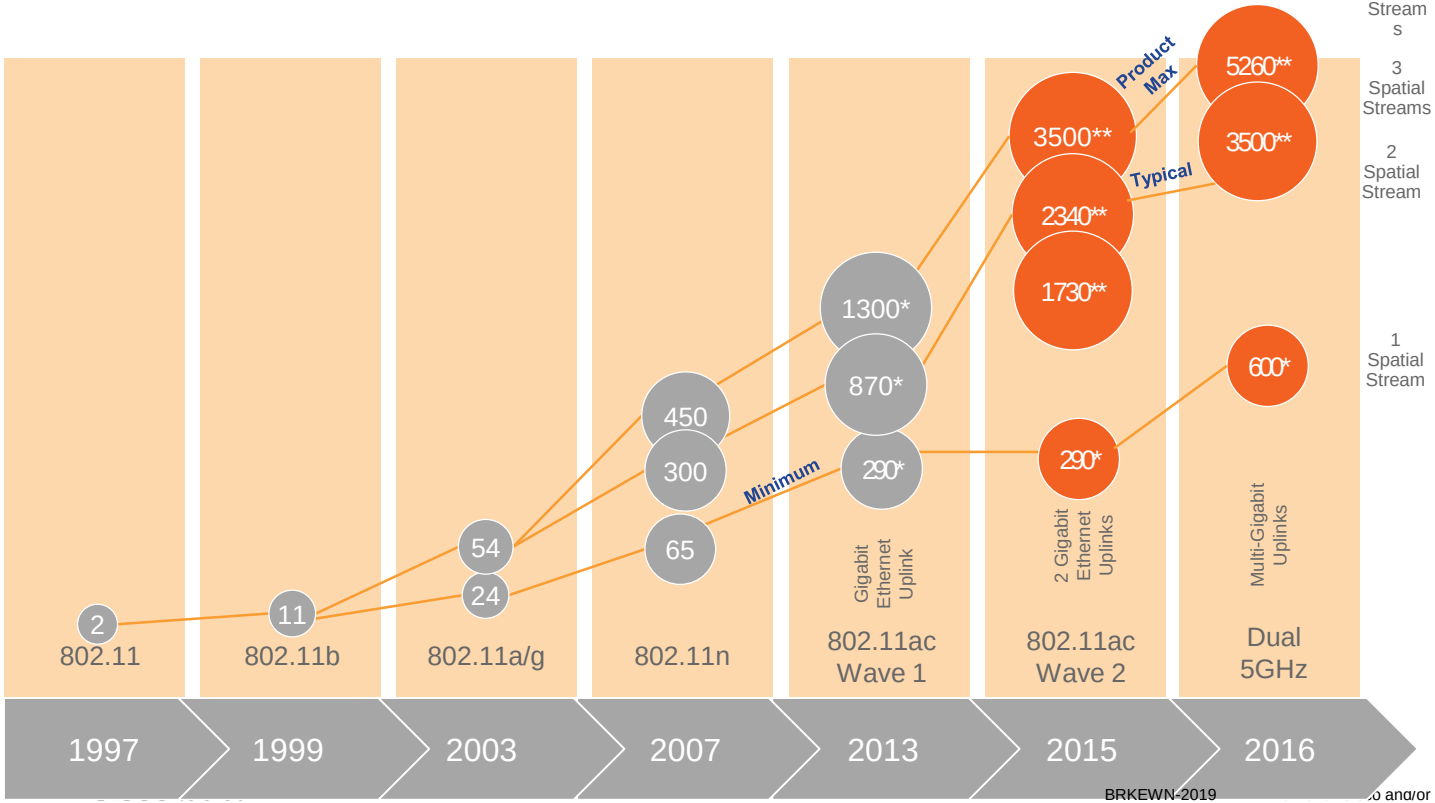
Wave 2 is here…

Wave 2 is about:

160 MHz wide channels
> 4 Spatial Streams
Multi-User-MIMO (MU-MIMO)

Wi-Fi Connectivity Speed Timeline

Gigabit Wi-Fi As Primary Access



4SS	Desktops / Infra
3SS	Desktops / Laptops
2SS	Laptops / Tablets
1SS	Tablets / Smartphones

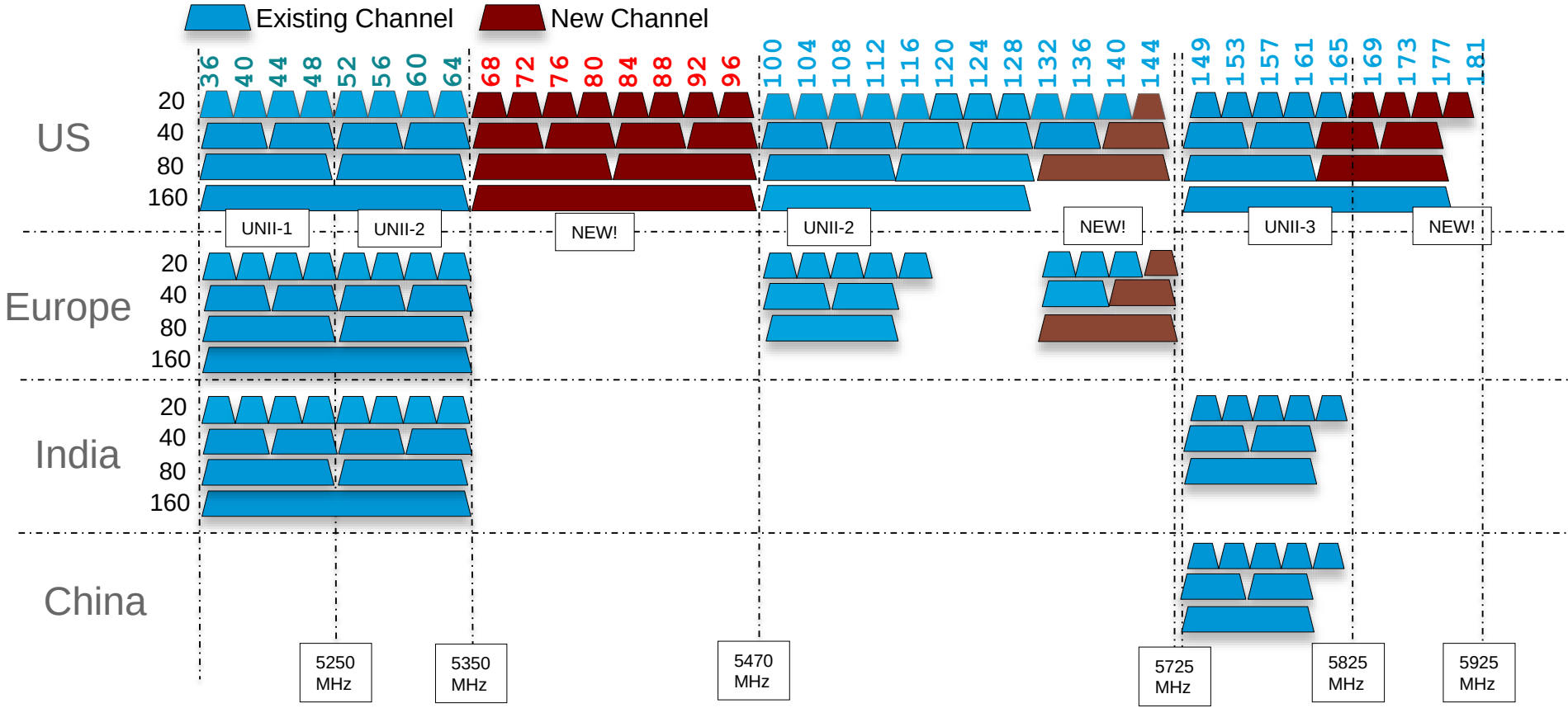
= Connect Rates (Mbps)

*Assuming 80 MHz channel is available and suitable

**Assuming 160 MHz channel is available and suitable

160 MHz wide Channels! the solution to our bandwidth problems?

5 GHz 20/40/80/160 MHz Channels



802.11ac can plausibly operate at up to ~3.5Gb/s (@PHY) or ~2.5Gb/s (@MAC)

80 MHz PHY rate	MCS (QAMr5/6)	
Spatial streams	**64**	**256**
1	290	430
	330	
2	650	870
3	980	**1300[1]**
4		**1700[2]**
8		3500

160 MHz PHY rate	MCS (QAMr5/6)	
Spatial streams	**64**	**256**
1	650	870
2	1300	1700
3	2000	2600[3]
4		3500
8		6900

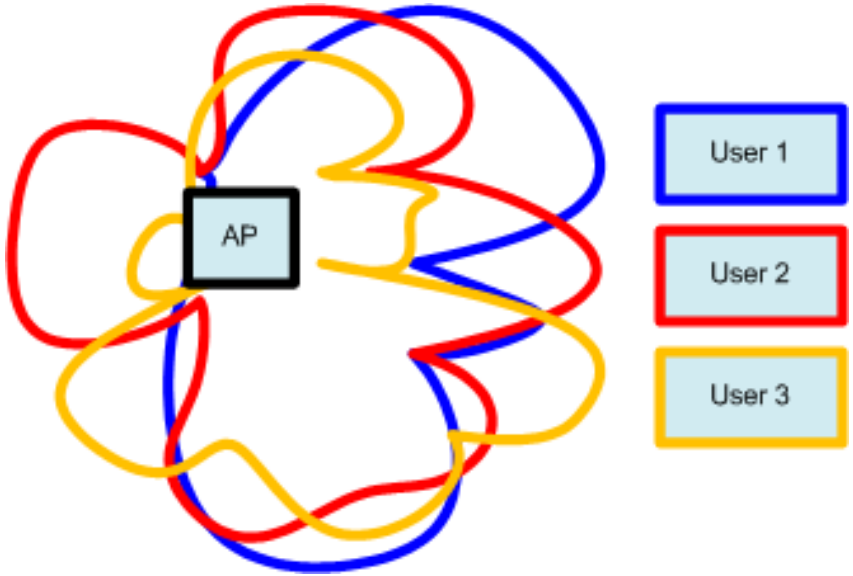
Easy | Plausible | Fantasy

[1] 2700 and 3700 max data rate

[2] 1850 max data rate

[3] 2800 / 3800 single radio max

MU-MIMO



Supported initially for max 3 x 1 SS (single spatial stream) clients

MU-MIMO – The solution to all our problems?

- The benefit of MU-MIMO is not as straight forward as it may seem.
  - moving from a hub to a switch-like process on one direction only

- MU-MIMO performance improvements relies on numerous and often dynamic factors:
  - Client mixture and spatial stream support
  - Client distance and location
  - Number of clients
  - Client data rates

- Further detailed information from Cisco Technical Leader, Matt Silverman in this great video:
  http://techfieldday.com/video/cisco-mu-mimo-deep-dive/


802.11ac Wave 2: what to do?

802.11ac Wave 2: what to do?

Some Facts:

- Wave 2 adds 3 main features:
  - 4 Spatial Streams – will be only be present in very high-end laptops
  - Multi User MIMO (MU-MIMO) - see the reality check in previous slides
  - 160 MHz channel – Difficult to use in Enterprise, esp in Europe…

- Wave1 clients cannot leverage Wave2 enhancements!
- Wave 2 clients will be a significant % on the network end of 2016

The World's Most Versatile Access Points

All The Benefits of 802.11ac Wave 2 + *a lot more*!

Wave 2

Highest Wi-Fi Performance Ever

- Higher Data Rate
- Wider Channels

Better End Device Efficiency

- Simultaneous Data Delivery
- Better Battery Life

Cisco Aironet 2800

Cisco Aironet 3800

Plus Cisco Innovations for High Density Environments

Self-Optimizing Network

- **New** Flexible Radio Assignment
- **New** Multi-Gigabit Uplinks
- **Improved** Modularity
- **Improved** CleanAir
- **New** Zero Impact AVC
- Flexible Dynamic Frequency Selection

Optimized Mobile User Experience

- **Improved** ClientLink
- Turbo Performance
- **New** Smart Antenna Connector
- **Improved** Enhanced Location*
- Optimized Roaming

*Near Future

Cisco Aironet Indoor Access Points Portfolio

Industry's Best 802.11ac Series Access Points

Enterprise Class

1810w

- 2x2:2SS 80 MHz; 867 Mbps
- Tx Beam Forming
- 1 GE Port uplink
- 3 GE Local Ports, including 1 PoE out
- Local ports 802.1x ready
- Integrated BLE Gateway*

OEAP1810

- 2x2:2SS 80 MHz; 867 Mbps
- 3 GE Local Ports downlink, including 1 PoE out
- One or Two Local Ports can be tunneled back to corporate

1830

- 3x3:2SS 80MHz; 867Mbps
- Spectrum Analysis*
- Internal antenna
- Tx Beam Forming
- 1 GE Port
- USB 2.0
- Centralized, FlexConnect and Mobility Express

1850

- 4x4:3SS 80Mhz; 1.7 Gbps
- Spectrum Analysis*
- Internal or External antenna
- Tx Beam Forming
- 2 GE Ports
- USB 2.0
- Centralized, FlexConnect and Mobility Express

Mission Critical

2800

- 4x4:3SS 160 MHz; 5 Gbps
- 2.4, 5GHz or Dual 5GHz
- 2 GE Ports
- Internal or External antenna
- Smart Antenna Connector
- Enhanced Location* (External Antenna)
- CleanAir 160MHz
- ClientLink 4.0
- USB 2.0
- Centralized, FlexConnect and Mobility Express*

Best in Class

3800

- 4x4:3SS 160 MHz; 5 Gbps
- 2.4, 5GHz or Dual 5GHz
- 2 GE or 1 GE + 1 mGig (5G)
- Internal or External antenna
- Smart Antenna Connector
- Enhanced Location* (External Antenna)
- CleanAir 160 MHz
- ClientLink 4.0
- Stadium Vision
- USB 2.0
- Modularity
- Centralized, FlexConnect and Mobility Express*

*Post-FCS

Hype vs Reality Best Practices

Hype versus reality best practices

- ✓ Transition to 802.11ac as part of your normal upgrade cycle
- ✓ Upgrade to the best Access Points that fit your need
- ✓ Look at Cisco's "value add features" that go on top of Wave 2

  - ❑ Industry best Wi-Fi with HDX (high density) features
  - ❑ HDX = CleanAir, ClientLink, ATF, Optimized Roaming, FlexDFS and so on…
  - ❑ Our 2700 & 3700 already outperform the Wave 2 AP's for competitors.
  - ❑ New 2800 & 3800 are Wave 2, and add those HDX features
  - ❑ Maximum flexibility
  - ❑ Adaptive radio band and mode of operation with Dynamic Bandwidth Selection (DBS)
  - ❑ Location Based Services with Wi-Fi based angle of arrival
  - ❑ Industry leadership with Nbase-T (mGig)
  - ❑ Mobility Express for smaller deployments (<25 AP's) on board controller

Fail #7

"Of course I did a Site Survey"


AT&T 3G
4:45 PM
Personal Hotspot: 1 Connection
Messages
Tuesday
7
Calendar
Photography
YouTube
Notes
280
Maps
Utilities

Fail #7

There's no Site Survey…
or there's no Good Site Survey

Survey Phase	Question
Predictive site surveys (network plan, simulation)	"How many APs? Where? What Power? Channels? Antennas"?
Pre-Deployment site surveys (AP on a stick)	"What does the real world RF look like"
Post-Deployment site surveys (validation)	"Does this network actually work?"
Periodic site surveys (health check)	"Does it **still** work? What has changed?"

Survey Type	The process	Result
Interference **Spectrum Survey** **Always!**	While walking, collect Wi-Fi energy data from a spectrum analyzer	Understand interference: Spectrum utilization, spectrum over time, …
Passive Survey	Walk around, collect beacons and probes, measure things like Signal strength, Interference, SNR for **all** APs.	SNR, RSSI, interference heatmaps for all APs
Connectivity **Active Survey**	While walking, stay connected to the network, test things like packet loss, RTT, association	Heatmaps and deeper analysis like roaming, …
Performance **Throughput Survey**	Measure throughput (Mbit/s, # of packets) and jitter, often spot checks	Momentary capacity analysis, voice analysis

Survey Happiness Scale

- No surveys

- Post-deployment validation

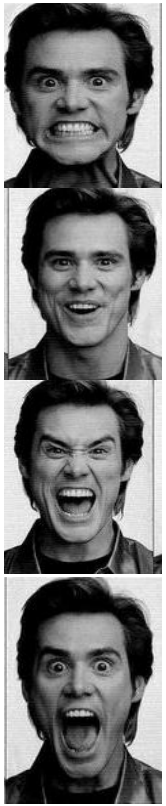
+

- Predictive

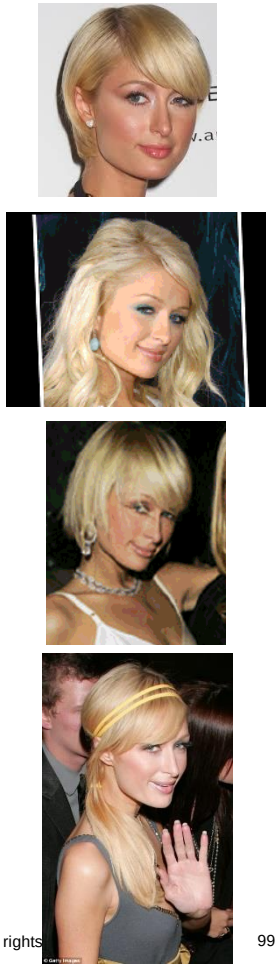
+

- AP on a stick

Jim Carrey



Paris Hilton



Use an external adapter for passive surveys!

Fairly accurate readings

Standardized measurements

Integrated adapter does active simultaneously

Multiple adapters = faster scanning

Examples:

1. One adapter for 2.4,

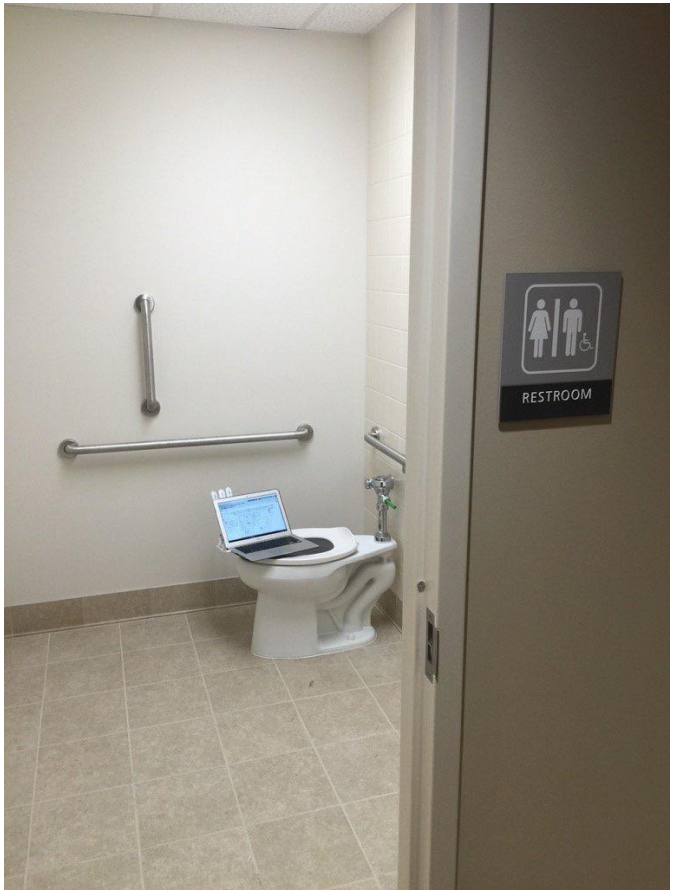
one for low 5, one for high 5

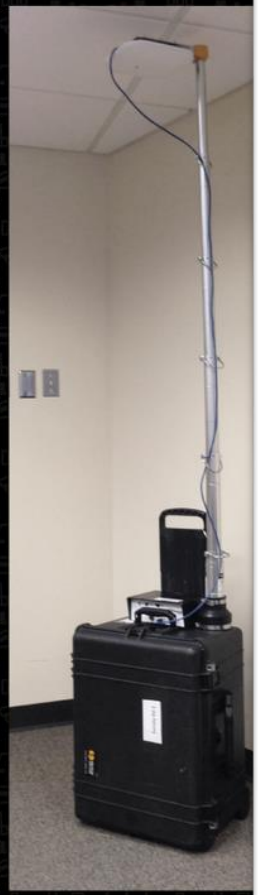
2. All adapters for all channels

= failover redundancy

How fast can I walk?

- **1 adapter** = Walking
- **2 adapters** = Fast walk / run
- **3 adapters =**





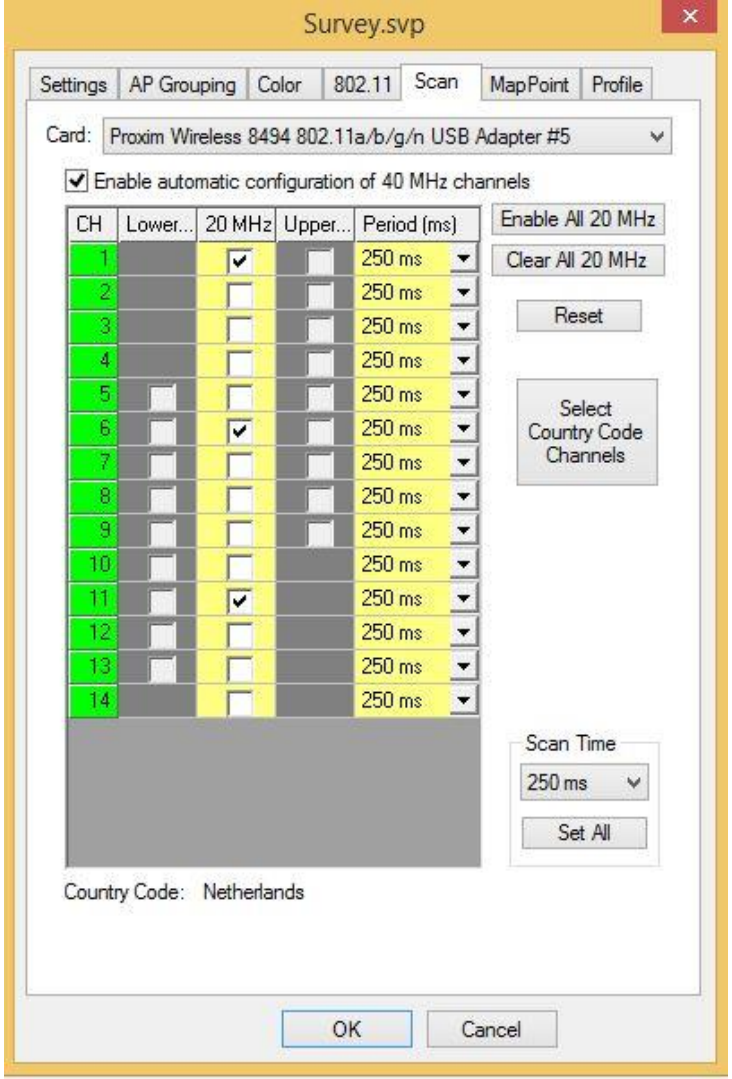
@ACCESSAGILIT

MOBILE SITE SURVEY R

Surveying…

Some common practices..

(or mistakes...)



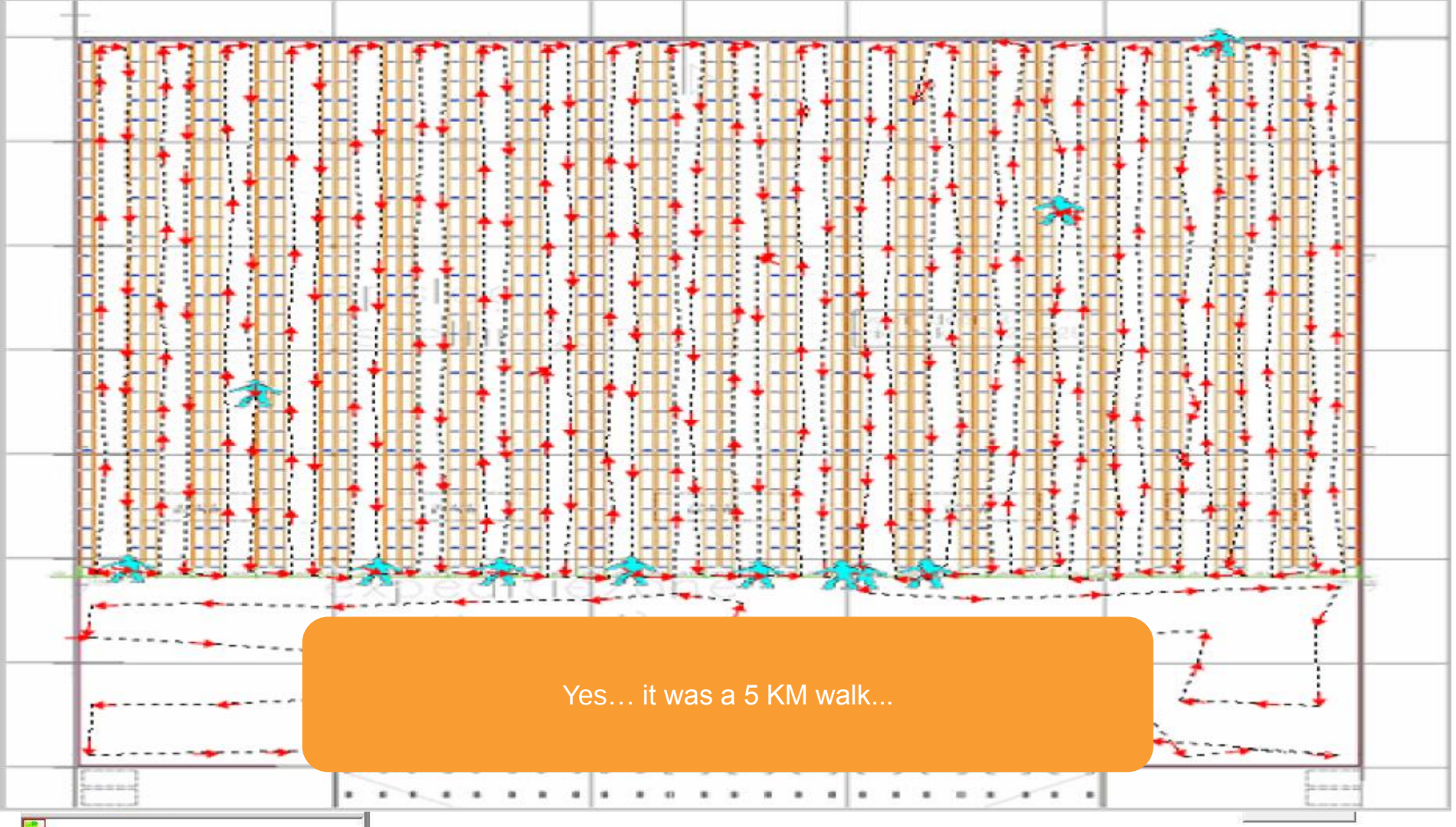
Survey ***only*** the Channels you will use

Walk slow enough for your Scanning period (default 250 ms)

If you want to scan
both 2.4 AND 5 GHz in one walk…

you have to walk Really slow.....
Really slow...

Better do two scan walks.
1x 2.4 GHz & 1x 5 GHz.


Yes… it was a 5 KM walk...

Spectrum Analyzer Test Hannu v3.esx* - Ekahau Site Survey

File Edit View Map Project Measurement Help

S.Str	SNR	Data	#APs	Ch.O	RTT	Loss
-50dBm	44dB	585Mbps	22APs	0APs	1.0ms	0%

Spectrum: 1-14 | Spectrum: 36-165 | Active: Ping 1ms | Passive -47dBm

Access Points | Surveys | Building

Search

Showing:73/73 APs | Quick Select | Actions

La La Land	My	Cisco: gameroom	ofi2 WPA2, testissid2 WEP, tikal WPA2, Unknown WPA2
		n 6	00:1f:9e:8d:20:80 (4)
La La Land	My	Cisco: hakala	ofi2 WPA2, testissid2 WEP, tikal WPA2, Unknown WPA2
		g 11	00:19:07:8c:5b:53 (4)
La La Land	My	Cisco: seppanen	ofi2 WPA2, testissid2 WEP, tikal WPA2, Unknown WPA2
		g 1	00:19:07:c5:58:13 (4)
La La Land	My	D-Link	MZT WPA
		n 11	c8:d3:a3:15:4c:18 (1)

Show Spectrum Utilization for My Access Points on 2.4 5 | Options | Use GPS

Planning | Survey

La La Land

0 % 100 %

Live Rec 2.4 5 Duration 60 seconds Radio Filter Any SSID

2.4 GHz Signals (1-13)

2.4 GHz Spectrum

Active Survey

Not Associated on this Band

120s 15:23:00 15:23:20 15:23:40 15:24:00 15:24:20

2.4 GHz Frequency Spectrum

Radios | Channels

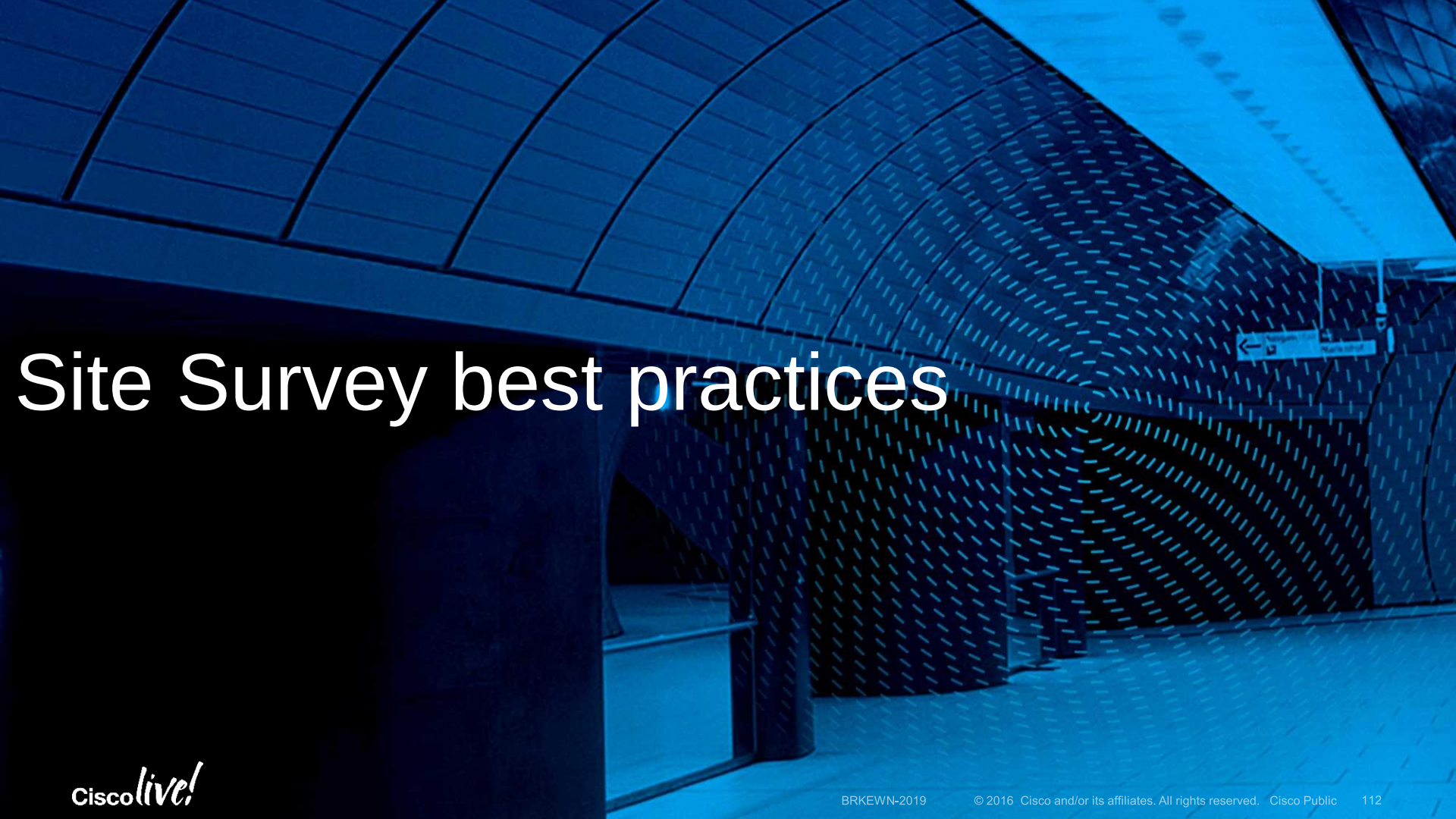
Radio	SSIDs	Tech.	Ch.	Signals
Linksys (91:2a)	AddValueWLAN	g 1-54M	6	-73
Zyxel (05:50)	ZyXELD30550	n 1-450M	11	-87
14:2d:27:a7:0c:02	HP-Print-02-Color LaserJet ...	n 1-364.5M	2@40	-64
Zyxel (8a:58)	ZyXELC98A58	n 1-144.4M	4	-84
Proxim (20:1e)	BATTTEST	b 1-11M	11	-44
Linksys (67:82)	intAKfi	g 1-54M	9	
Linksys (91:2c)	AddValueWLAN-guest	g 1-54M	6	-80
NetGear (87:d4)	microdebug	g 1-54M	11	-38
D-Link (c8:90)	Profiles	g 1-54M	11	
Apple (e9:46)	tetrasimdemo	n 1-216.7M	6	
Proxim (48:16)		b 1-11M	1	-61
ap-LL1894587-11	TechnoWLAN	n 11-144.4M	11	
Proxim (47:f5)		b 1-11M	1	-52
0e:41:58:00:9a:8d	EkaEkaActivateEMP_	n 1-300M	11@40	-55
Apple (52:87)	TimeC net	n 1-216.7M	1	-76
84:7a:88:32:7f:3f	HooTeeCee	ac	3	
hakala	3: ofi2, testissid2, tikal	g 9-54M	11	-61
fa:8f:ca:6c:dd:e8		n 1-72.2M	6	
D-Link (4c:18)	M2T	n 1-72.2M	11	-61
gameroom	3: ofi2, testissid2, tikal	g n 9-144.4M	6	-59
Apple (9e:11)	Wi-Fi-verkko (M2TI)	n 1-130M	11	-63

Spectrum Analysis (L1 troubleshooting)

- What's going on in the Spectrum
- There's a lot more then Wi-Fi
- Your CleanAir AP can be used for this

Wireless Troubleshooting, packet capturing (L2)

- AirPCap card (Riverbed)
- Wireshark is your friend
- For mac… ‘Airtool’
  (by the great Adrian Granados)



Site Survey best practices

For the best results…

- You need all Four…
  - Predictive
  - Passive
  - Active
  - Post Installation Survey

You need a design before you begin

- You need an On Site survey before you begin, preferable with Spectrum
- You need an On Site Survey After the installation to see if your design is met.
- You need a Spectrum analysis to see what interference is there after install
- You need the Post Installation to check if what you designed is actually there

BONUS FAIL

"Certifications are over rated…"

A Certificate shows that you know your stuff

And really…

Wireless is a specialty!

So begin

Take the time to learn and understand

802.11

Because we need it…

Get Certified

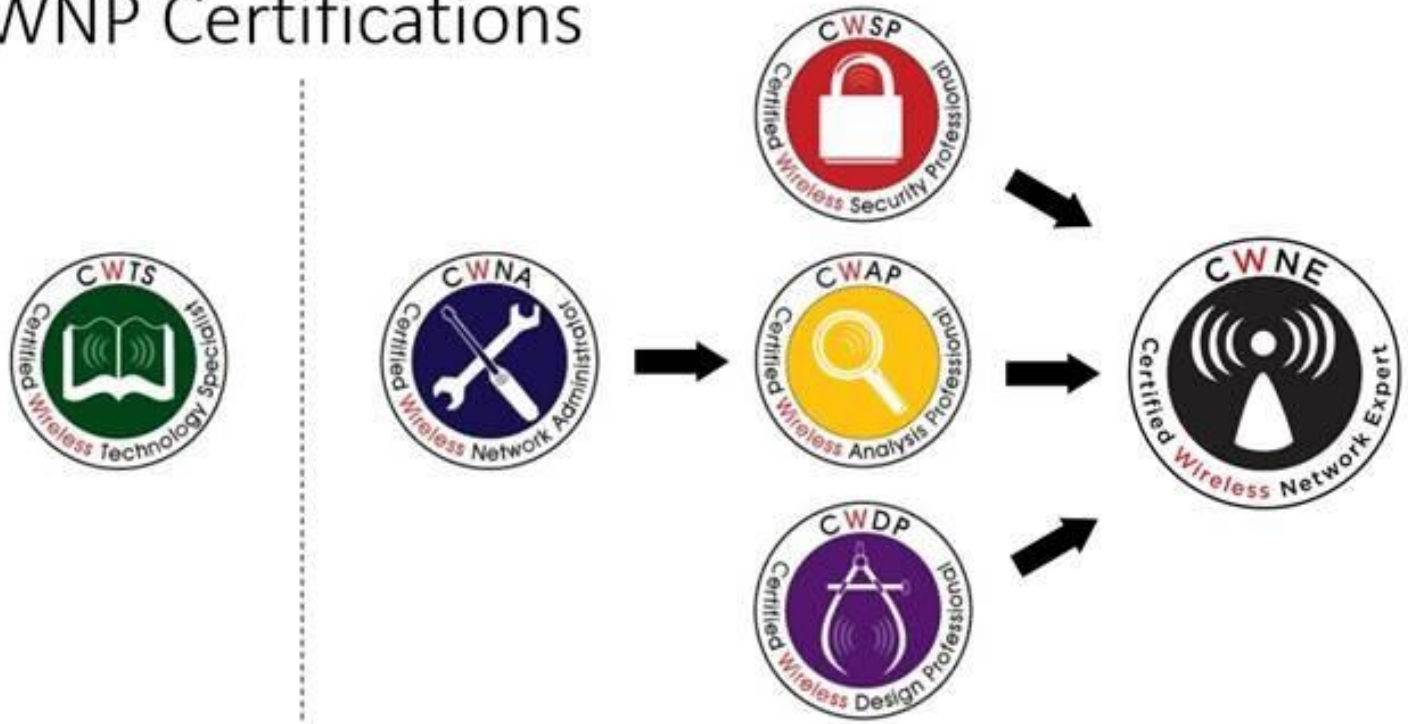
Cisco:

- CCNA and then CCNA Wireless
- If you want more knowledge CCNP Wireless

If you want to be a legend… *CCIE*

If you want to be vendor independent

CWNP Certifications



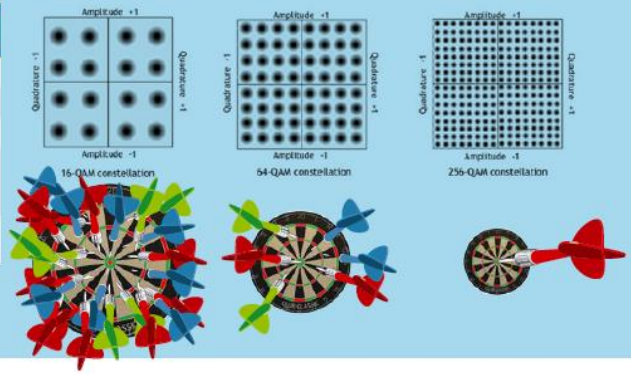
7 Ways to Fail Checklist

The Baseline

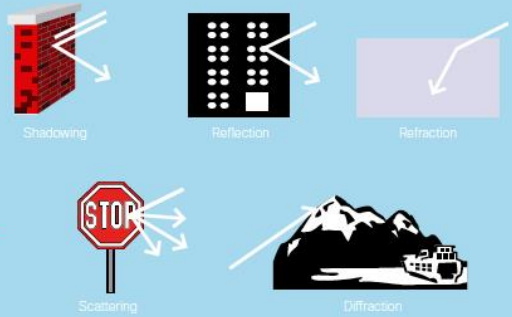
802.11	Frequency	Data rate	Channels	Channels 'usable'
a	5 GHz	54 Mbps	24	24
b	2.4 GHz	11 Mbps	13	3
g	2.4 GHz	54 Mbps	13	3
n	2.4 GHz & 5 GHz	(min) 65, 150, 300, 450, (max) 600 Mbps	2.4 GHz & 5 GHz Rules apply.	2.4 GHz & 5 GHz Rules apply.
ac	5 GHz	867 Mbps, 1.3 Gbps,1.7 Gbps*, 3.5 Gbps*, 6.9 Gbps*	24* 37**	24* 37**

* = 802.11ac Wave 2 ** = 802.11ac Wave 2 (US)

Modulation



What happens in the air?



Fail #1
Forget about those Channels

Channel Best Practices:

- Only 1, 6 and 11 on 2.4
- Use 5 GHz as much as possible
- Lower 8 channels for Voice environments (36 – 64)
- Enable the DCA
- Enable Dynamic Bandwidth Selection
- Use the RRM algorithms.
- Don't use 'Maximum Power'...

Fail #3
Designing just for 2.4 GHz is not how to do it.

Design Best Practices

- Design your network for 5 GHz.
- If possible take out 2.4 GHz entirely
- Use the 'Flexible Radio Assignment' (FRA) feature in new AP's
- Don't buy 'Single Radio AP's'
- Don't buy 'Single Radio Clients'
- Try to migrate Legacy clients as soon as possible. They degrade the quality of your network.
- If you can't migrate them, give them a separate SSID.

Fail #5
I **am** secure.

Security best practices:

- WPA2 is the bare minimum (with CCMP. Don't use TKIP)
- WPA2 Personal (PSK) is for... personal
- WPA2 Enterprise (802.1X) for businesses
- Use Role Based Access (RBA) with for instance ISE.
- Use a Wireless Intrusion Preventions (wIPS) solution
- Use VPN on Public Wireless Connections

Fail #7
Of Course I did a Site Survey

Survey Phases

Predictive site surveys
(network plan, simulation)
"How many APs? Where? Power? Channels? Antennas?*

Pre-Deployment site surveys
(AP on a stick)
"What does the real world RF look like"

Post-Deployment site surveys
(validation)
"Does this network actually work?"

Periodic site surveys
(health check)
"Does it still work? What has changed?"

Survey Types

Fail #2
Maximum Power!

Fail #4
Placements

Fail #6
Hype Versus Reality

In closure

You have learned 7 things to look at

* When you *are* an expert
* When you *hire* an expert

For your reference I've captured them in a Checklist.
(reach out on Twitter @Steven_Heinsius for the Checklist).

Remember…

THERE IS ALWAYS SOMEONE

WILLING TO DO IT CHEAPER

Thank you

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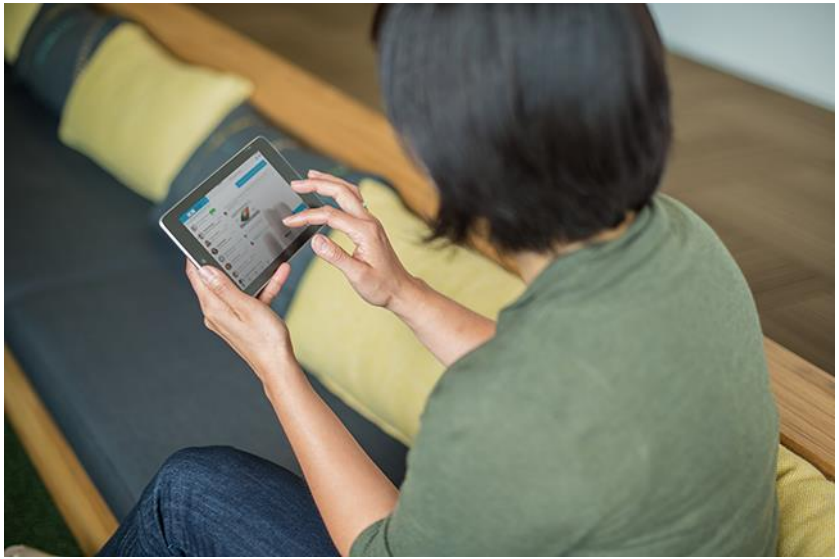
- Complete your session surveys through the Cisco Live mobile app or from the Session Catalog on CiscoLive.com/us.



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Best Practices
Channel Coverage Sizing

Coverage must be designed for your *Client Devices*

- Not all clients are created equal !!
  - Live call test with the actual client to determine its coverage
- *Removing legacy DSSS data rates* and slower OFDM data rates :
  1. Less Co-Channel Interference
  2. Better throughput in the cell
  3. More usage of ClientLink and MRC
  4. Smaller coverage cells
- Smaller Coverage Cell Sizes equals:
  1. More cells in a given coverage area
  2. More cells equals more call with better voice and video quality

Best Practices

- **Define Coverage Requirements**
  Before performing the survey, establish the minimum signal strength, minimum SNR, and desired AP coverage overlap requirements the network design must meet in all locations. Recommended values are a minimum -67 dBm RSSI, minimum 25 dB SNR, and 10-20 feet of overlap at these signal levels between APs. These values can be carried over from a predictive site survey, if performed.

- **Survey Both Frequency Bands**
  Perform the survey primarily on the 5 GHz frequency band to determine optimal AP placement, cell overlap, and co-channel separation. Use the 5 GHz band because at shorter distances between APs, which is typical in high-density environments, the coverage is nearly identical to the 2.4 GHz band. However, 5 GHz signals typically suffer greater attenuation through most RF obstructions and require adequate measurements to ensure sufficient coverage and capacity (no coverage holes!). The survey must also include signal measurements on the 2.4 GHz frequency band

Best Practices

- **Channel Scanning**
  When performing a passive site survey, configure the survey software to scan only the channels that the production WLAN will be using.

  The number of channels scanned can affect the accuracy of the sampled data. If you select too many channels, it can take a significant amount of time for the survey software to scan all of them.

  If you spend an insufficient amount of time at every physical location, then the sampled data will not accurately reflect the location where you recorded it.

  Monitor the survey software to ensure that you scan all the channels at every sampling location. If performing auto-sampling, also ensure that your walking pace allows sufficient time to scan all channels between each sampling location

Best Practices

- **Collect Sufficient Data Points**
  Related to the signal propagation assessment value, be sure to collect enough data points throughout the coverage area during the site survey. Collect them at distances that match the signal propagation assessment value, typically every 10-20 feet (3-6 meters).

- **Survey Both Sides of RF Obstructions**
  For site survey measurements to reflect the signal attenuation characteristics of an RF obstruction accurately, it is necessary to survey on both sides of the object. For example, how much coverage and interference will an AP mounted outside an auditorium provide inside the auditorium?

- **Access Point Hardware**
  Use the exact access point models, antennas, and accessories that will be installed in the production WLAN to ensure accurate measurements of signal propagation and performance characteristics. Access points should be placed in the correct locations, and at the appropriate height and orientation at which they will be used in production.

Best Practices

Know Your Noise Floor

- RSSI vs. SNR
- Clients have varying sensitivity to noise
- Get a feel for your noise floor during peak usage
  - Packet captures with a NIC that you trust (MacBook Pro, etc.)
  - Fluke AirCheck
  - Spectrum Expert
  - Metageek Chanalyzer for Clean Air

Sample receiver sensitivity table for CB21AG NIC

Data Rate	2.4 GHz Min RSSI	2.4 GHz Min SNR	5 GHz Min RSSI	5 GHz Min RSSI
1	-94	4	N/A	N/A
2	-91	6	N/A	N/A
5.5/6	-89	8	-85	5
11/12	-82	10	-82	7
24	-77	12	-77	12
36	-73	18	-73	14
48	-72	22	-71	17
54	-71	24	-68	20

Sample sensitivity table for MCS rates

Data Rate 20\40 MHz	2.4 GHz Min RSSI	2.4 GHz Min SNR	5 GHz Min RSSI	5 GHz Min RSSI
14.4\30	-82\	11\	\-79	\14
28.9\60	-79\	14\	\-76	\17
43.3\90	-77\	16\	\-74	\19
57.8\120	-74\	19\	\-71	\22
86.7\180	-70\	23\	\-67	\26
115.6\240	-66\	27\	\-63	\30
130\270	-65\	28\	\-62	\31
144.4\300	-64\	29\	\-61	\32

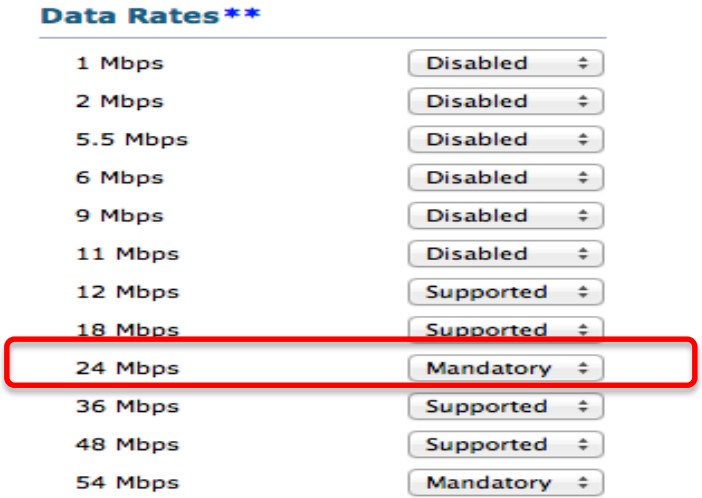
Data is intended to be an example only.

Rx sensitivity capabilities will vary based upon the receiver in use.

Best Practices

Every SSID Counts!

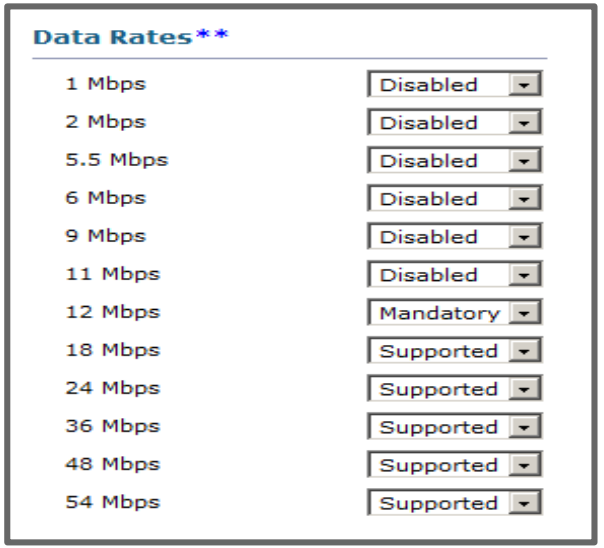
- Each SSID requires a separate Beacon
- Each SSID will advertise at the minimum mandatory data rate
- Disabled – not available to a client
- Supported – available to an associated client
- Mandatory – Client must support in order to associate
- Lowest mandatory rate is beacon rate
- Highest mandatory rate is default Mcast rate



Best Practices

Every SSID Counts!

- Disable low, unused rates (802.11b)
- Let RRM control channel and power levels
- If you can, use ClientLink and BandSelect:
  - BandSelect to push 5 GHz-able to the 5 GHz band
  - ClientLink to provide better throughput for 802.11a/g/n clients



Received Signal Strength Indication

- Best indicator of wireless performance
- Can be measured by various utilities and site survey software
- Measured in dBm
  - Usable range typically from -60 to -80 dBm
    - -55 dBm or greater is exceptional signal strength
    - -65 dBm for the highest data rate is supported
    - -85 dBm is poor signal strength

Reminders

- Every site is unique, do not assume two installations would be the same
- Think of the AP coverage area as a “reading light” you want to illuminate where the devices will be.
- Use the appropriated equipment for the need: e.g. 3600i/3700i for carpeted areas, 3600e/3700e for specific application, *antenna orientations*
- Validate that the coverage is as expected *after installation*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New

Next-Generation Wave 2 802.11ac Access Points

Cisco Aironet® 2800 Series

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- Dual radio, 802.11ac Wave 2, 160 MHz
- 2 x 5 GHz: 4x4: 3SS supporting
  - SU-MIMO / MU-MIMO
  - Flexible Radio Assignment: 2.4GHz, 5GHz, Wireless Security Module, or Wireless Service Assurance
- 2 x Gigabit Ethernet
- HDX Technology
- USB 2.0
- Internal and external antenna models

Gigabit Wi-Fi has fully arrived.

* Planning

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- Gigabit Ethernet and multi-Gigabit Ethernet (1G, 2.5G, 5G)
- HDX Technology
- USB 2.0
- Internal and external antenna models
- Modularity: Side Mount Modular

Gigabit Wi-Fi has fully arrived.

* Planning


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