Improve Enterprise WLAN Spectrum Quality using Cisco Advanced RF Features

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Platform TME

CiscoLive 2016 Las Vegas, NV. USA

BRKEWN-3010
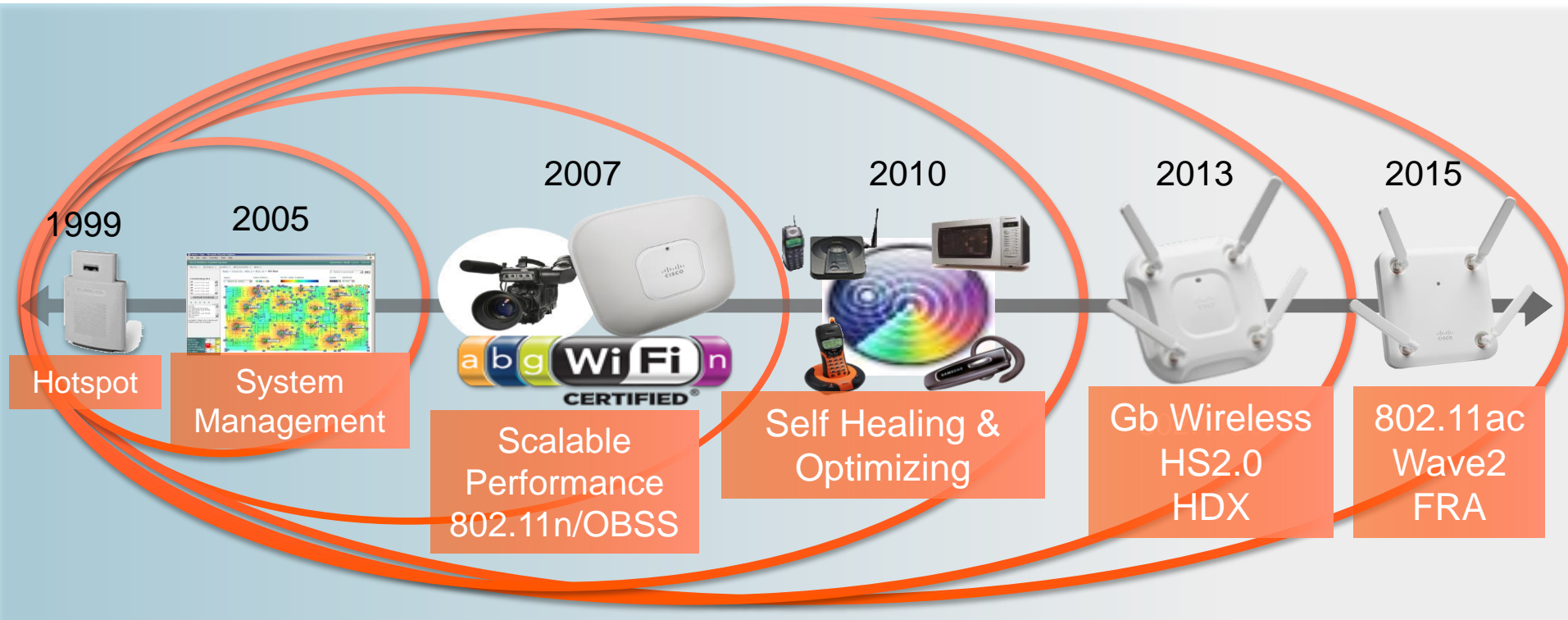
Cisco *live!*

What We're Going to Cover

- How important is the RF?
  - The Physical Layer – we will focus exclusively on the physical

- Site Survey
  - When was the last time a survey was done?
  - How was it done?
  - What has changed?
  - What's important

- Tools
  - A word about tools
  - Prime Planner, Ekahau, AirMagnet, Spectrum analysis

- What Are your Priorities?

- Flexible Radio Assignment – FRA
  - Redundant Interface Engine - REI
  - Macro/Micro Internal Antenna Models
  - Macro/Macro – External Antenna's

- RRM – Things you should know
  - NDP – Pruning Timer
  - DCA – Restart Behavior
  - Dynamic Bandwidth Selection for 20/40/80/160 MHz OBSS
  - Flex DFS

- US –B Regulatory Update

By The End of This Session

- ## You should understand
  - Where to get information
  - How to evaluate that information and use it
  - Understand New tools and techniques available to solve specific issues
  - Use the information presented to create an action plan for change
  - Improve your networks capacity and yours and users lives

Wireless Trends- What's Your Goal?

Wireless Evolution
## From Best Effort to Mission Critical

1999 — Hotspot

2005 — System Management

2007 — Scalable Performance 802.11n/OBSS

2010 — Self Healing & Optimizing

2013 — Gb Wireless HS2.0 HDX

2015 — 802.11ac Wave2 FRA

The changing RF landscape

Protocol	Date	Characteristics	Spatial Steams	20 MHz Channels
802.11	1997	1,2 Mbps, infra Red, spread and DSSS, 802.11FH 2.4 GHz	1	1
802.11b	1999	1,2,5.5,11 Mbps, DSSS 2.4 GHz	1	1
802.11a	1999	6,9,12,18,36,48,54 Mbps – OFDM – 5 Ghz	1	1
802.11g	2003	6,9,12,18,36,48,54 Mbps OFDM 2.4 GHz	1	1
802.11n	2005	MCS 1-15-23 1-3 SS, OFDM, 20,40 MHz, 2.4 and 5 GHz	1-3	1-2
802.11ac	2012	1-8 SS MCS 1-9, OFDM, 20-40-80-160 MHz, 5 GHz	1-8	1-8

# Key Reports – Cisco Prime

- Clean Air –
  - How much of your spectrum is being used by NON Wi-Fi devices?

- Client –
  - What protocols are your client using?
  - Unique Client Summary – should be a frequent reference

- Device –
  - Performance > Wireless Network Utilization
  - Channel Utilization – how much spectrum do you have?
  - AP Utilization – peak channel, retransmissions

- Security
  - Are Rogue Access points using your spectrum?
  - Which AP's hear them – how loud?

- The above reports will tell you what/who is using your spectrum, how efficiently you are using your spectrum and how much you have left
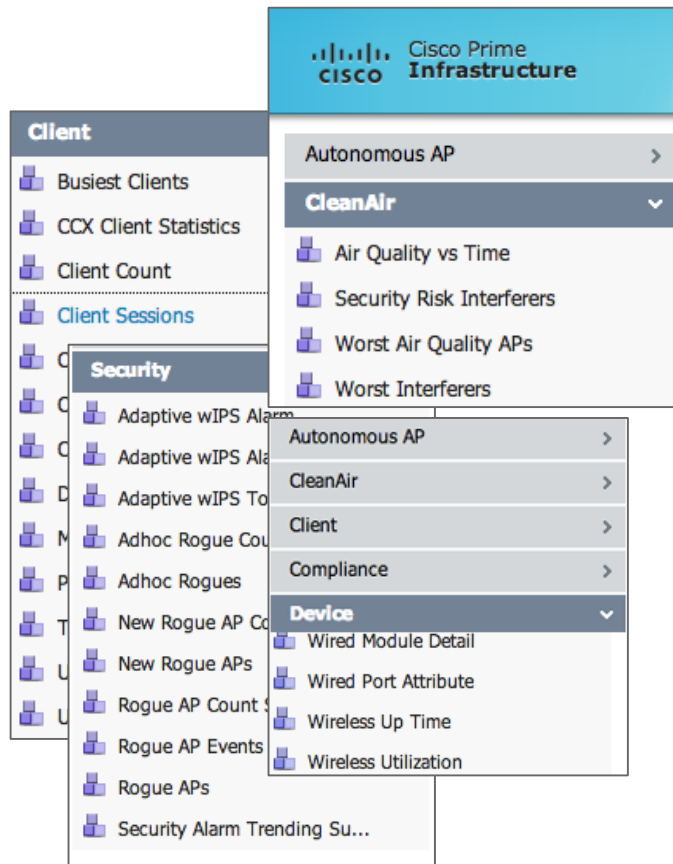
Spartan 8.2 Dashboards

- The Wireless Dashboard provides a quick and easy "Current" view of what's using the network and how.

- Client Performance shows connected protocols 2.4/5 GHz for accurate counts of client types

- Client Capabilities above shows the capabilities of the clients in terms of spatial streams and protocols
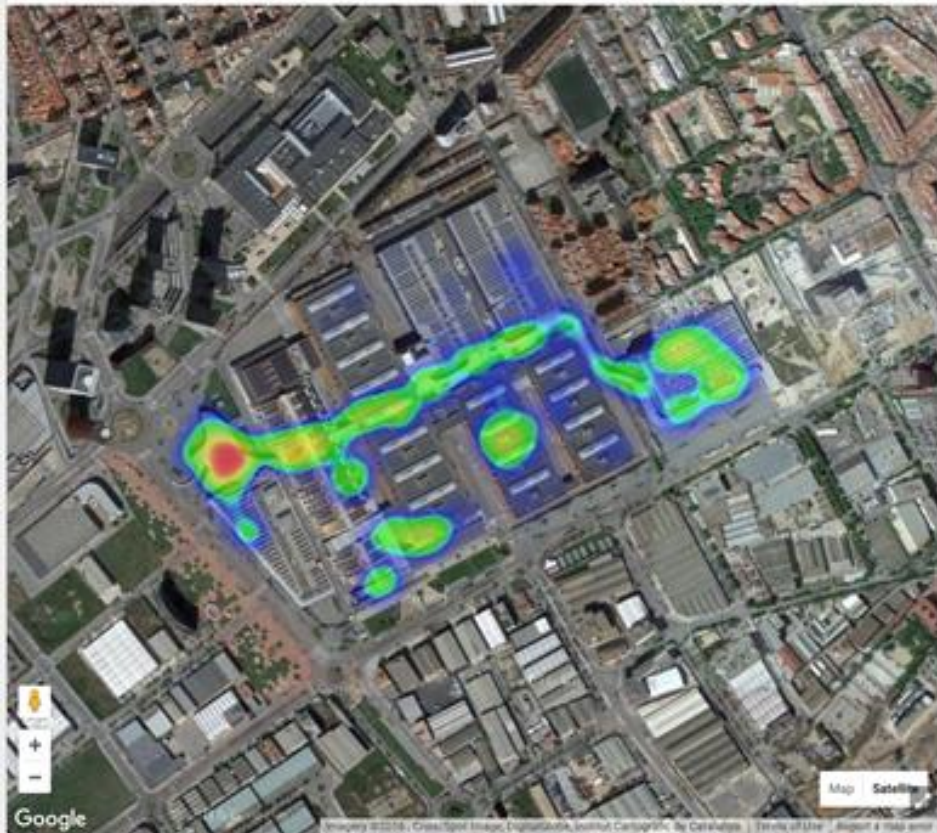
"Wireless Dashboard"
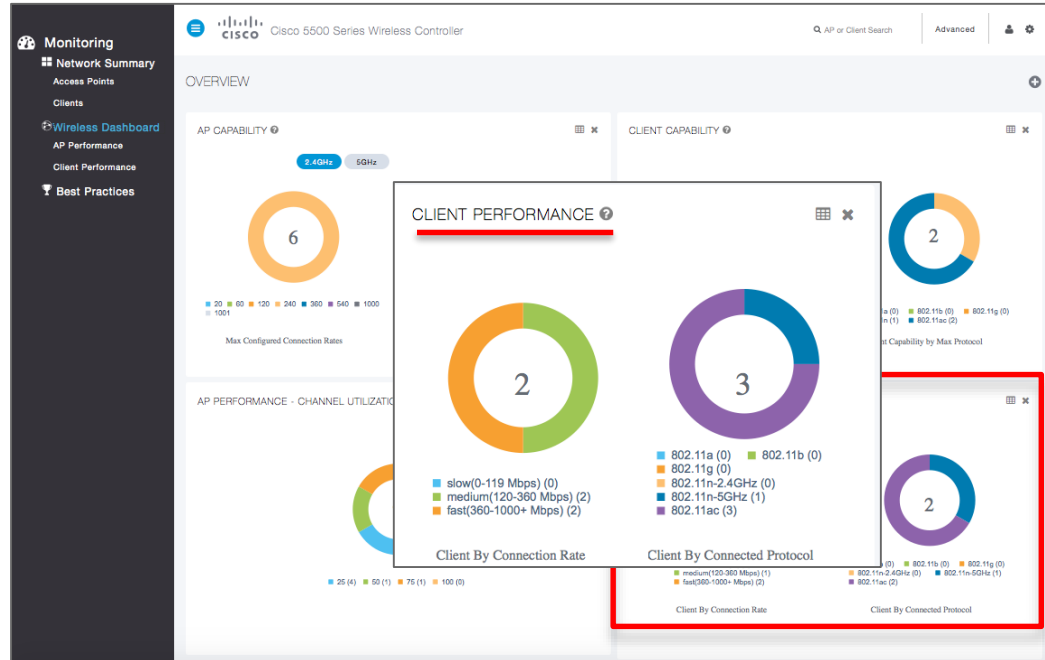
Summary Data for Cisco Live Berlin 2016

- Peak wireless user count was 11,700 (Up 30% from Milan)
- 2.4/5GHz client mix   47% / 53%
- 2.4 GHz/5 GHz traffic 15% / 85%
- 31% of clients 802.11ac, (down 25%)
- 69% 802.11n, 31% 802.11ac = 100% 802.11n or better
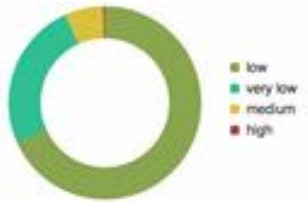- Apple, Samsung, Intel top 3 devices

Summary data for – Mobile World Congress - Barcelona - MWC2015

	Total / Peak	2015
Total Attendance	**101,000**	101,000
Data Exchanged	**65.38 TB (up 30.8%)**	**43 TB**
Wi-Fi Data Exchanged	**27.23 TB (up 36 %)**	**17.5 TB**
Total Wi-Fi Unique associated devices	**96,449 (up 6.5%)**	90,618
Peak concurrent associated devices	**29,669 (down 2.7%)**	**30,536**
2.4 GHz vs 5 GHz clients	**20% / 80%**	**13% / 87%**
802.11ac client max %	**40%**	35%
802.11ac average Traffic	57.15	**N/A**
IPv4 vs IPv6 (traffic)	**83% / 17%**	\
Wi-Fi Peak Internet traffic	**1 Gbps (limited to 1)**	**1.3 Gbps**
Peak Internet traffic	**3.98 Gbps (UP 31.4%)**	**3.0 Gbps**

Dual Band devices – 802.11ac

- As of June 14, 2016 and since Oct 2015 – 296 Smart Phones/tablets have certified Dual band for 802.11ac – 100% 802.11ac!
  - 591 in 2014/15 – all 802.11ac (all 80 MHz capable)
  - Total WFA certifications for the same period is 2.4 GHz only devices

Apple devices (59% of traffic at MWC)

- last 2.4 GHz only iPhone device was Iphone 4s Released Oct. 2011
- Iphone 5 released September 2012
- iPhone 6 released September 2014 with 802.11ac

Five things to know about today's Wi-Fi®

5 GHz is taking the world by storm.

Sales of **DUAL-BAND DEVICES SURPASSED** single-band 2.4 GHz in 2014

4 Today's Wi-Fi is **DUAL-BAND** Wi-Fi CERTIFIED™ n and ac.

IN 2015, **68%** OF WI-FI DEVICES WILL BE DUAL-BAND

BY 2019, THAT WILL RISE TO MORE THAN **96%**

3 You are **ALREADY USING** 5 GHz.

880 Million DUAL-BAND SMARTPHONES in 2015

2 Billion by 2019

2 Wi-Fi is a **MODEL of INNOVATION.** WI-FI PERFORMANCE HAS GROWN from 11 Mbps to 1 Gbps+ with no new spectrum.

2015 **100X** MORE CAPACITY 2000

1 Number one source of **CONNECTIVITY.**

Wi-Fi carries **1/2** OF ALL INTERNET TRAFFIC AND **10X** THE LOAD OF CELLULAR for billions of users worldwide

WiFi ALLIANCE — The worldwide network of companies that brings you Wi-Fi®

SOURCES: ABI Research, 2014 Cisco VNI

Get More Clients – on 5 GHz
Make your Life Easier – the case for 2 SSID's

- Look at your SmartPhone –

  - Can you tell – what Band are you connected to?

    - And – that's how much it matters to the phone….

- Deploy a seperate SSID's for 5 GHz and 2.4 GHz

- Make the 5 GHz familiar,different – and attractice –

  - Old main SSID= MWC_Free, new 5 GHz = MWC_HighSpeed_Free

- Why?

  - You have users all day long who's phones roam from 5 to 2.4 and vice versa – to them it is the same network and the network is just ok – sometimes good, sometimes bad.

  - Bad can be when they roam onto 2.4 GHz

So, why is this data important?

- It give's us some perspective on the market –
    - Why are we supporting the dwindling handful of legacy devices?
    - How does the actual user base differ from what we think?
    - How important is that legacy barcode reader in the loading doc? Wouldn't replacing it be far cheaper than damaging the airtime for the whole area?
    - How fast is 802.11ac penetrating the market, and what does that mean for my design decisions?

We don't know what we don't know and efficiency is still the name of the game, only one thing remains constant in wireless – the need for more

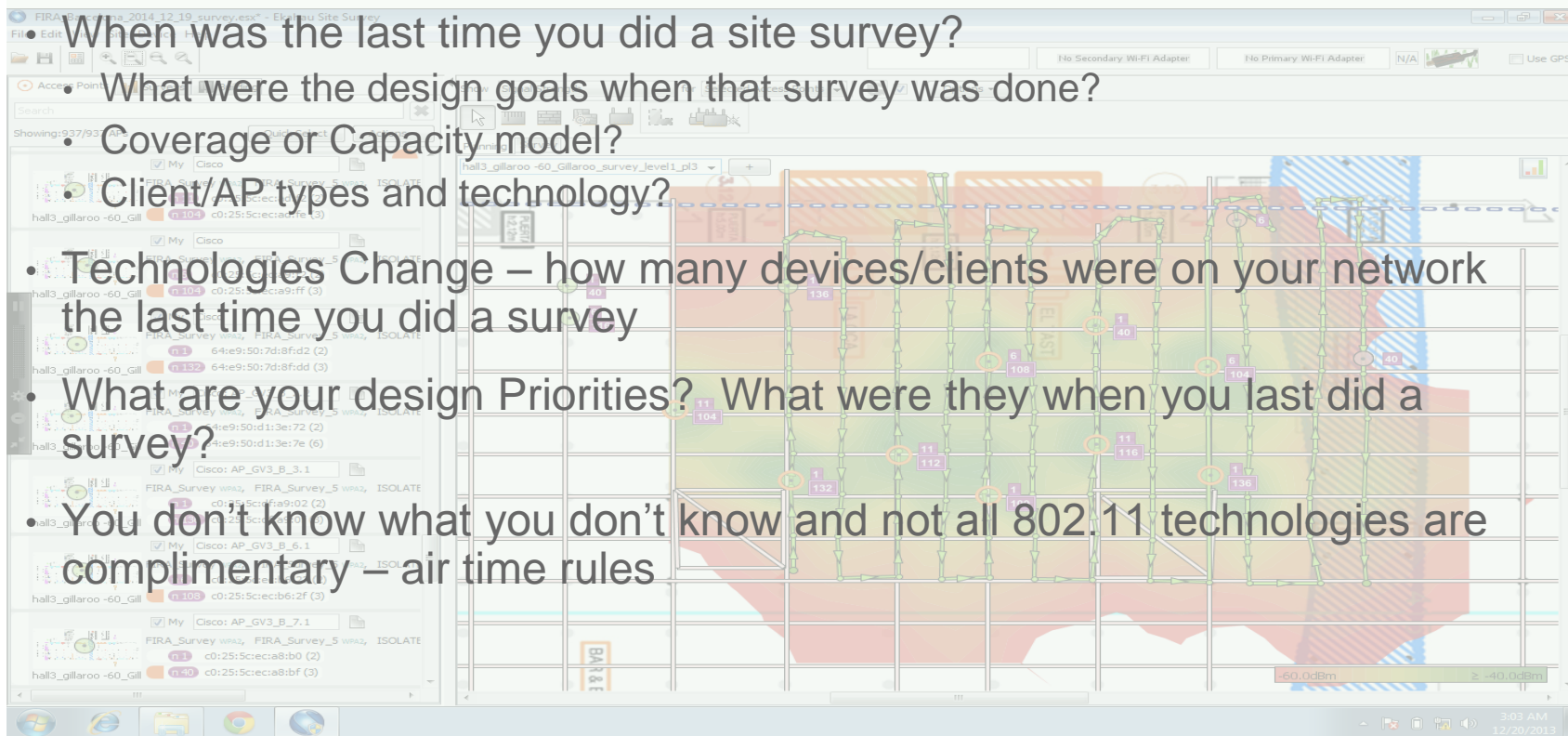# Deploying with Spectrum in Mind

Deploying with Spectrum in Mind

- Role of site survey is as important as ever—but has evolved

- Evaluate the existing application requirements, available spectrum and Client types/mix

- Focus should be on fixed infrastructure
  - AP placement
  - Density is important = capacity
  - Protocols supported
  - Rates supported
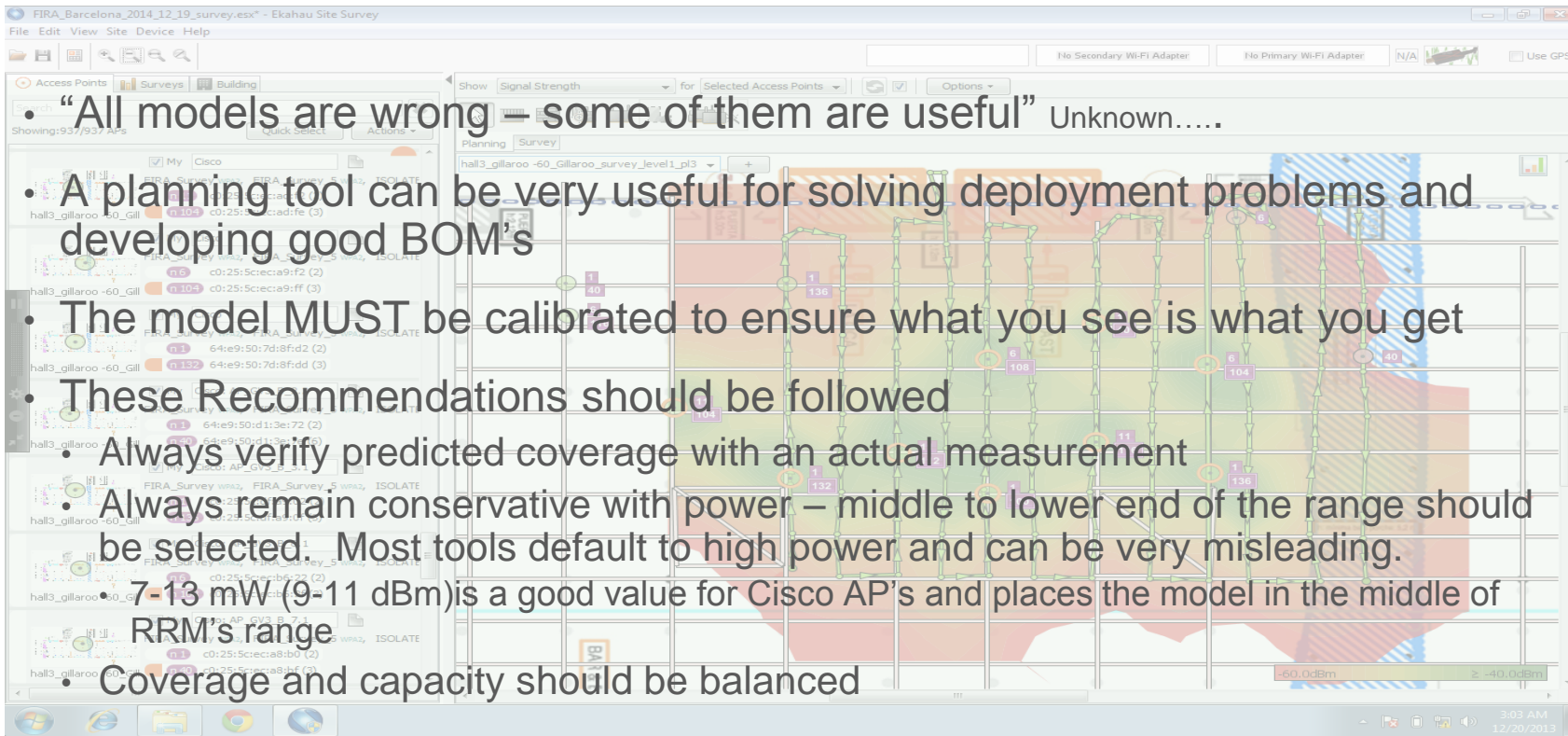 - Interference sources

- Mitigating issues

Designing for Sustainable Spectrum Management

About Site Surveys

- When was the last time you did a site survey?
  - What were the design goals when that survey was done?
  - Coverage or Capacity model?
  - Client/AP types and technology?
- Technologies Change – how many devices/clients were on your network the last time you did a survey
- What are your design Priorities? What were they when you last did a survey?
- You don't know what you don't know and not all 802.11 technologies are complimentary – air time rules
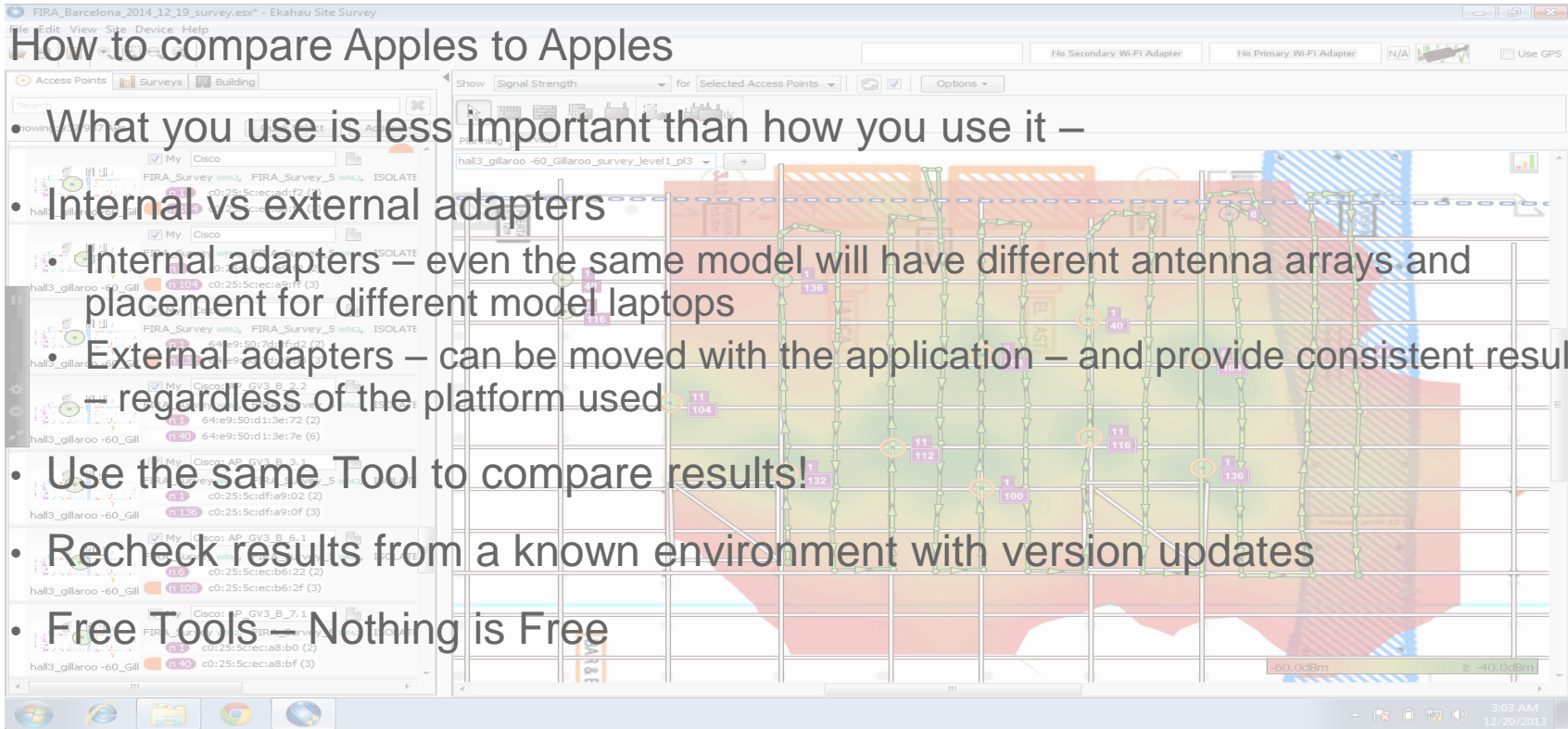
About Planning Tools

- "All models are wrong – some of them are useful" Unknown…..

- A planning tool can be very useful for solving deployment problems and developing good BOM's

- The model MUST be calibrated to ensure what you see is what you get

- These Recommendations should be followed
  - Always verify predicted coverage with an actual measurement
  - Always remain conservative with power – middle to lower end of the range should be selected. Most tools default to high power and can be very misleading.
    - 7-13 mW (9-11 dBm)is a good value for Cisco AP's and places the model in the middle of RRM's range
  - Coverage and capacity should be balanced

A Word About Tools

How to compare Apples to Apples

- What you use is less important than how you use it –

- Internal vs external adapters
  - Internal adapters – even the same model will have different antenna arrays and placement for different model laptops
  - External adapters – can be moved with the application – and provide consistent results – regardless of the platform used

- Use the same Tool to compare results!

- Recheck results from a known environment with version updates

- Free Tools – Nothing is Free

What has not changed?
802.11 and Duty Cycle – Channel Utilization – Air Time

- 802.11 error recovery is limited - Still
  - Retransmit a packet
  - Rate shift

- Duty Cycle of RF is logarithmically proportionate to Channel Utilization

- Channel Utilization is Capacity

- Busy network (more airtime needed) – less interference tolerance (air time lost)

- Less busy – might not even notice low levels of interference

- Bandwidth is like Money – the more you get the more you spend

- At a minimum – you have more users on your network this year than you did last year – and a lot more than you had 5 years ago….

Channel Utilization – what is it?

- Channel Utilization is the physical – and the logical Air Time consumed

- It is – physical signal in the air above CCA

- It is - the logical CW and NAV

- It is – All RF in the air – ours as well as rogues – if it's 802.11 and we hear it – it counts

- It is the metric which represents the AP's TX_op on the current channel

- And- it represents the whole channel – not the AP's utilization

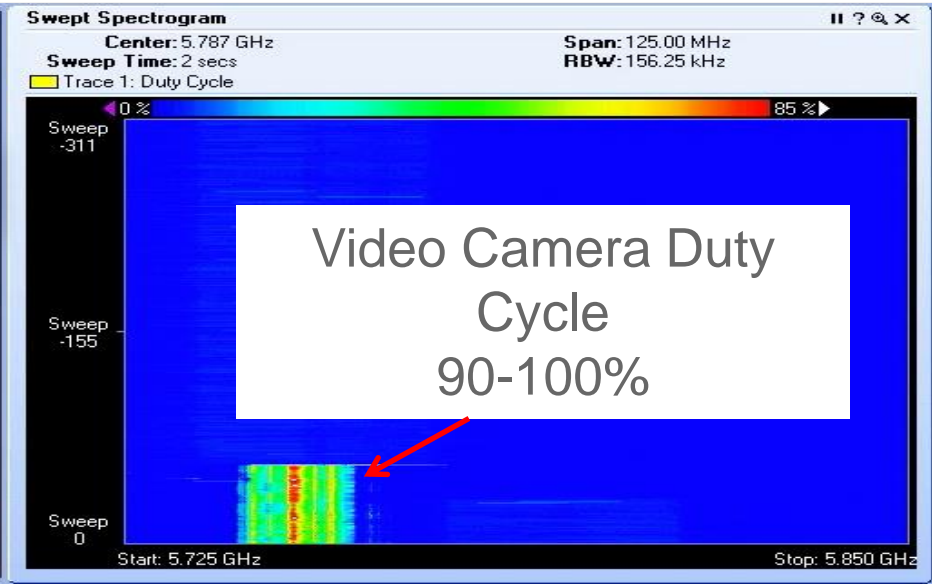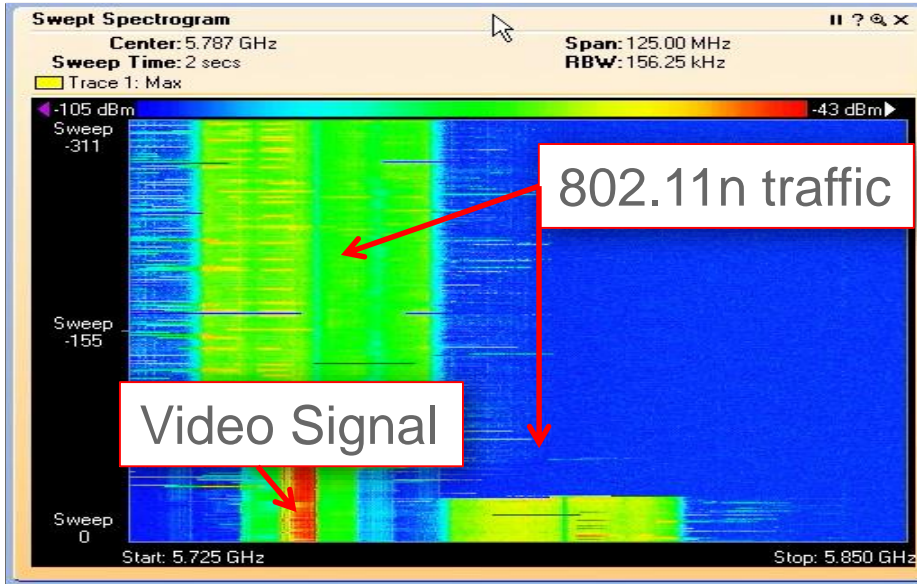 Root Cause for Channel Utilization must be isolated
  - Self Interference – SSID's, Data Rates, AP isolation vs Density – control with Configuration
  - Non – Wi-Fi interference – BlueTooth, DECT Phones, Cellular – possibly controllable
  - Rogue Devices/Networks – configuration management

How does Non – Wi-Fi Interference impact Wi-Fi? Separating the FUD from the Fact's

- **802.11a/b/g/n/ac** - CSMA/CA or LBT (listen Before Talk)

- Collision Avoidance – 802.11 very very polite – by design
  - CCA
  - Collisions
  - SNR

- CCA – Clear Channel Assessment
  - Energy Detect– quick – low power - prone to false positives
  - Preamble – takes time – power – less prone to false

- CCA threshold for 802.11b/g is -65 dBm

- CCA for 802.11a is different -65 dBm ED, if true then 20 dB lower for Preamble interrogation needs to be processed -85 dBm

CCA Blocked or High

Swept Spectrogram
Center: 5.787 GHz Span: 125.00 MHz
Sweep Time: 2 secs RBW: 156.25 kHz
Trace 1: Max

802.11n traffic

Video Signal

Start: 5.725 GHz Stop: 5.850 GHz

Swept Spectrogram
Center: 5.787 GHz Span: 125.00 MHz
Sweep Time: 2 secs RBW: 156.25 kHz
Trace 1: Duty Cycle

Video Camera Duty Cycle
90-100%
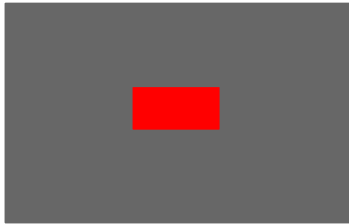
Start: 5.725 GHz Stop: 5.850 GHz
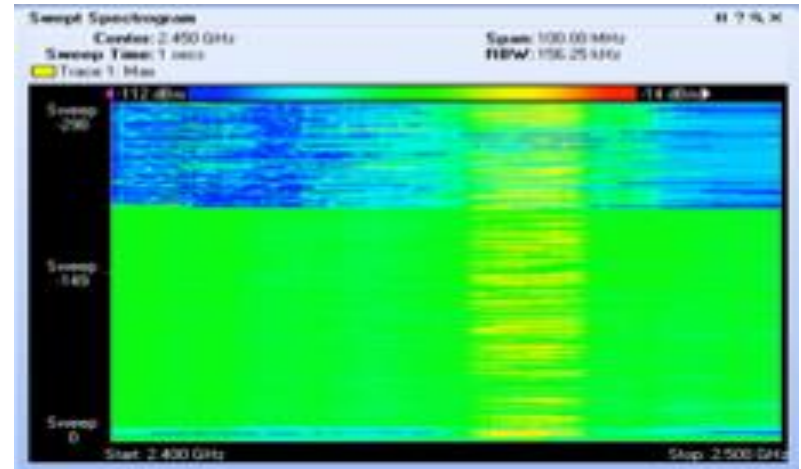
How does Interference impact Wi-Fi? Separating the FUD from the Fact's

- Collisions - Non Wi-Fi devices do not participate in our CA mechanism – they have their own

- No respect for Wi-Fi – results in:
  - Corrupted packets
  - Increased retransmissions
  - Increased Duty Cycle
  - Less available bandwidth

- SNR – Signal to Noise ratio

High SNR   Low SNR

Good – and Bad Spectrum

**33 dB delta
Peak to noise floor**

Good, Clean Channel separation

**3 dB delta
Peak to noise floor**

No Channel separation
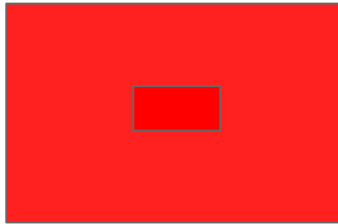
Microwave Oven – Convention Hall – all gone in 2.4 GHz
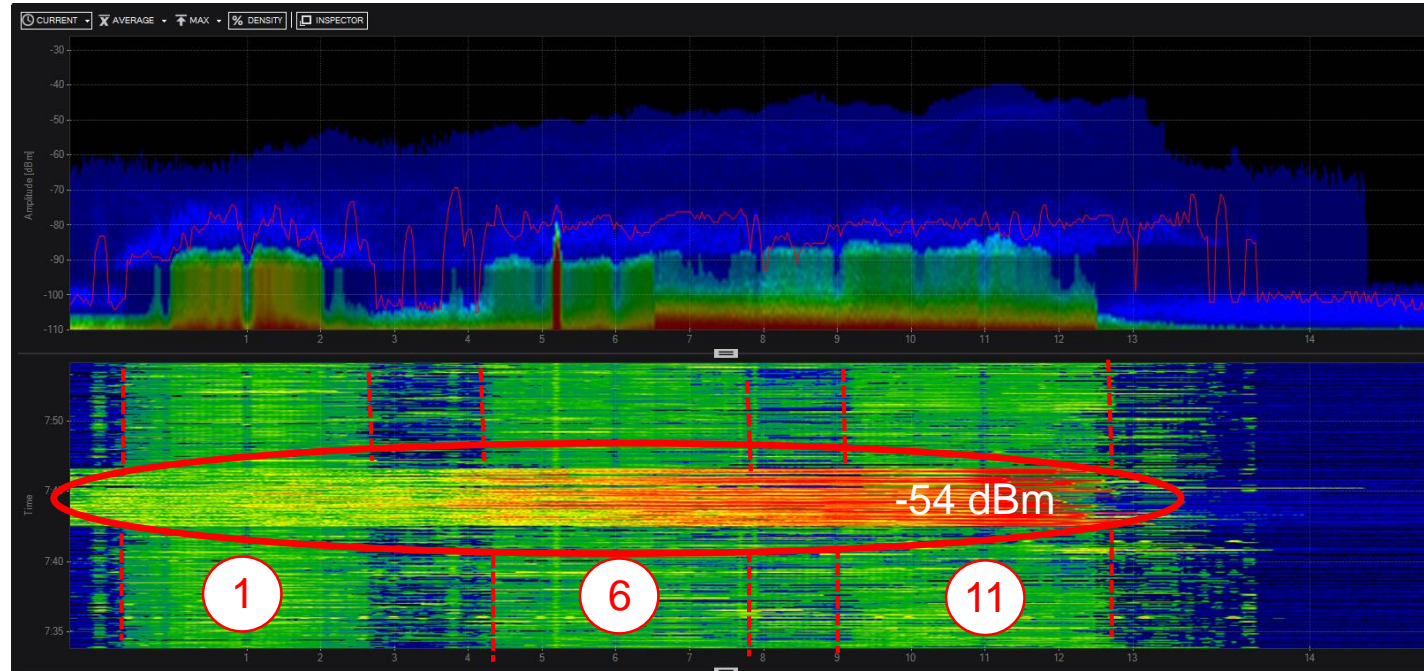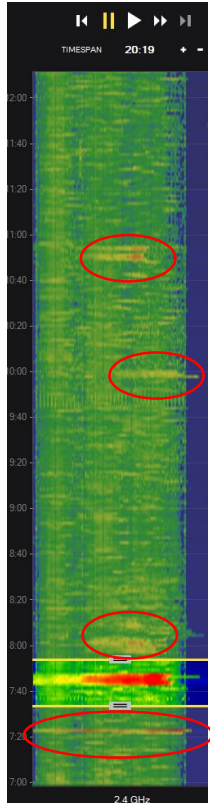

4 Mins – all 3 channels lost

For a deep dive on CleanAir and it's best in class features see –
BRKEWN-3010 Orlando, Fl. June 2013

Available on CiscoLive365.com with session recording

Flexible Radio Architecture

Flexible Radio Architecture - RRM
Flexible Radio Role Selection
Micro/Macro Operation details

What is a Flexible Radio (XOR)?

- 2.4 GHz and 5 GHz on the same silicon

- Allows selection of 2.4 GHz or 5 GHz for serving clients (default is 2.4 GHz)

- Allows Serial scanning of all 2.4 and 5 GHz channels (in monitor "WSM" Role)

- Role selection is Manual or Automatic (RRM-FRA)

- Previous (WSSI/WSM modules) for 3700 were XOR in design – Now integrated into 28/3800

What is a Micro/Macro cell Architecture?

- Not new, implemented for years in Cellular

- Method for addressing Non Linear Traffic requirements

- Allows more bandwidth and efficiency to be applied to an area within a larger coverage cell

- 2800/3800 will support "Dual 5GHz" from single access point – it's about Airtime Efficiency and Capacity

- Getting it all down with less cable pulls and installation costs
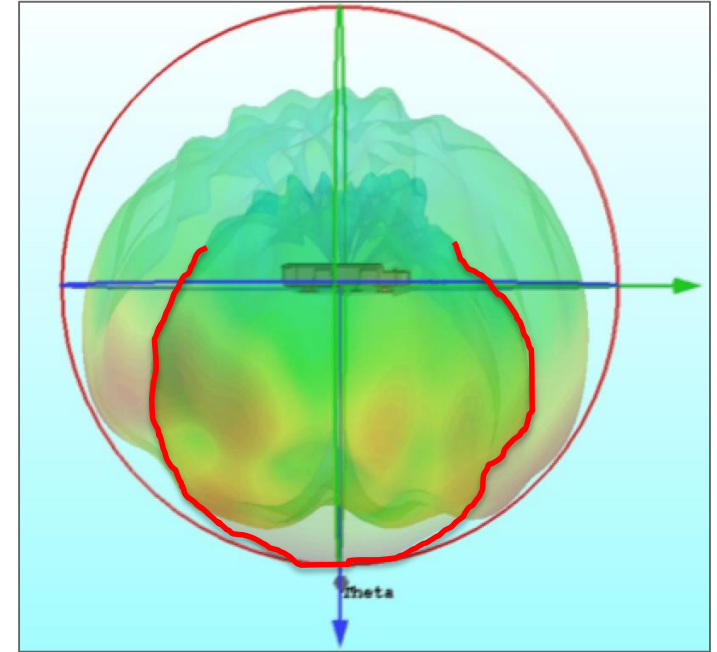
Flexible Radio Assignment

5GHz Serving	**2.4GHz Serving**	• Pervasive 2.4GHz and 5GHz coverage • Default operating Role
5GHz Serving	**5GHz Serving**	• Increase Network Capacity and Performance • Maximum over the air data rate up to 5.2Gbps • High Density Client Performance improvements
5GHz Serving	**Wireless Security Monitor**	• Secure Network from Non-Wi-Fi Interference, wIPS attackers, and Rogue Clients/Access Points • Scan both 2.4GHz and 5GHz for security threats
5GHz Serving	**Wireless Service Assurance***	• Proactively monitors the network performance and adjusts the overall network performance • Tracks and Corrects Performance Degradations
5GHz Serving	**Enhanced Location***	• Improves the client location accuracy • Serve Client on 5GHz

* Denotes feature availability post-FCS

3800/2800 Flexible Radio Assignment (FRA) Comparison to WSM Module

Functionality	3700	3700 + WSM module	3800 / 2800 (No Module Needed)
Dual 5GHz Serving Radios	-	-	●
Wireless Security Monitoring (2.4 and 5GHz) while serving clients	-	●	●
Location while serving client	Basic Location (10m)	Hyperlocation (1-3m)	Enhanced Location* (3-5m)
Wireless Service Assurance (WSA)* while serving clients	-	-	●

*Post-FCS

RRM's new Flexible Radio Assignment (FRA)

- ## Manage the Flexible Radio Hardware
  - Determine Coverage Overlap Factor (COF) at 2.4 GHz
  - Evaluate Radios as potentially Redundant
  - Determine best role for Flexible Radio
  - Assign

- Radio role determination and assignment is Automatic If radio's FRA Auto and FRA is enabled.

- FRA calculates COF for Manual assigned radios and Administrator can make Role choices

Auto Radio Role Assignment

Wireless=> Dual-Band radios

Configure –

Dual-Band Radios

Current Filter: None

AP Name	Radio Slot#	Module Type
NOS_3600	2	AIR-XXXXXXXXXXXXXXXXXXXNNNNNNNNI
3802_e.BC80	0	-
AP_3800_i.D9A0	0	-

Entries 1 - 3 of 3

	Channel	CleanAir Admin Status	CleanAir Oper Status
		Enable	UP
	1 *	Enable	UP
	1 *	Enable	UP

Antenna

Internal	Configure
External	Detail
Internal	Dual Band TSM

Channel –
Current operating channel

Radio Role (NEW)
Shows the current
Role assignment

Power Level
Current operating
Power level

Radio Role Assignment – Auto/Manual

- Selecting a 2800/3800 802.11-abgn interface – config

- Auto (default) makes the radio available to FRA

- Manual, takes the Radio out of Global FRA Assignment

Dual 5 GHz operation – Custom Channel

- ## If you choose Custom for Channel
  - ### Still need 100 MHz between Slot 0 (XOR) and Slot 1 (dedicated 5 GHz)

Radio Role Assignment

○ Auto   ● Manual

● Client Serving   ○ Monitor

Band   5 GHz ⬍

RF Channel Assignment

Current Channel   36 *

Channel Width *   20 MHz ⬍

Channel width can be configured only based on channel configuration in custom

New Channel for Slot requires 100MHz Separation from the other 5GHz Radio. Dual 5GHz Valid Channels :36,40,44,48,52,56,60,64,149,153,157,161,165

☐ Prevent this page from creating additional dialogs

[OK]

Assignment Method   ● Global

○ Custom

FRA - Config

- FRA – is Disabled by Default

- Enable – and FRA is active

- Sensitivity=
  - Low (100%)
  - Medium (95%)
  - High (90%)

- Interval
  - 1-24 hours
  - 1 hour default

- COF calculated on Auto and Manual Radios
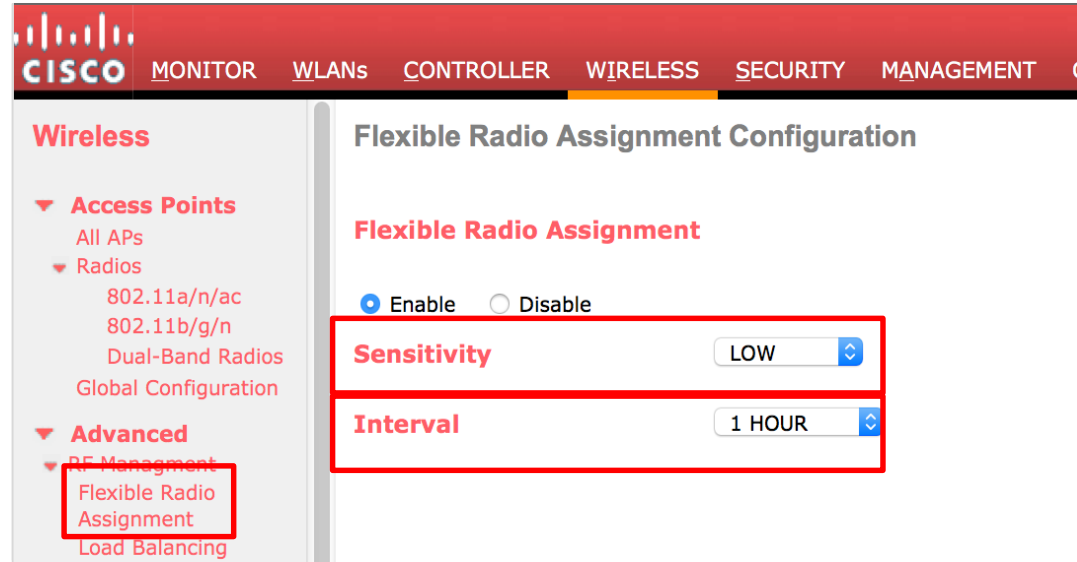
FRA Operation States

- AP's in Auto, Client Serving, 2.4 GHz will yield a COF regardless of FRA enable/disable

- FRA enabled, Allows FRA to assign Role

- No COF for Radios in Monitor or 5 GHz role's Auto or Manual

- Manual, will only calculate COF
  - If config is Client Serving, 2.4 GHz
  - No Role assignment by FRA

FRA State	AP Manual	AP Auto
Disabled	No Assignment *No COF	No assignment *No COF
Enabled	No Assignment COF	Role Assignment COF Calculated

* Manual config must be Client Serving, 2.4 GHz

FRA –RIE and COF, Coverage Overlap Factor

- 2.4 GHz Radios that are members of the "Same" AP Group will be calculated together

- Coverage Overlap is the percentage (%) of a given cell that is covered by other AP's at -65 dBm or greater

- All AP models considered in the coverage calculation

- Neighbors above -60 dBm will be used for coverage

- Only 2800/3800 can be marked as Redundant

Running –FRA
RIE - Redundant Identification Engine

- Richfield, Ohio competitive lab

- AP's 3800-1 to 3800-6
  - All Auto FRA, Client Serving 2.4 GHz

- AP's #1, 2, 4 and 5 are all in the same room

- Still just 3 channels
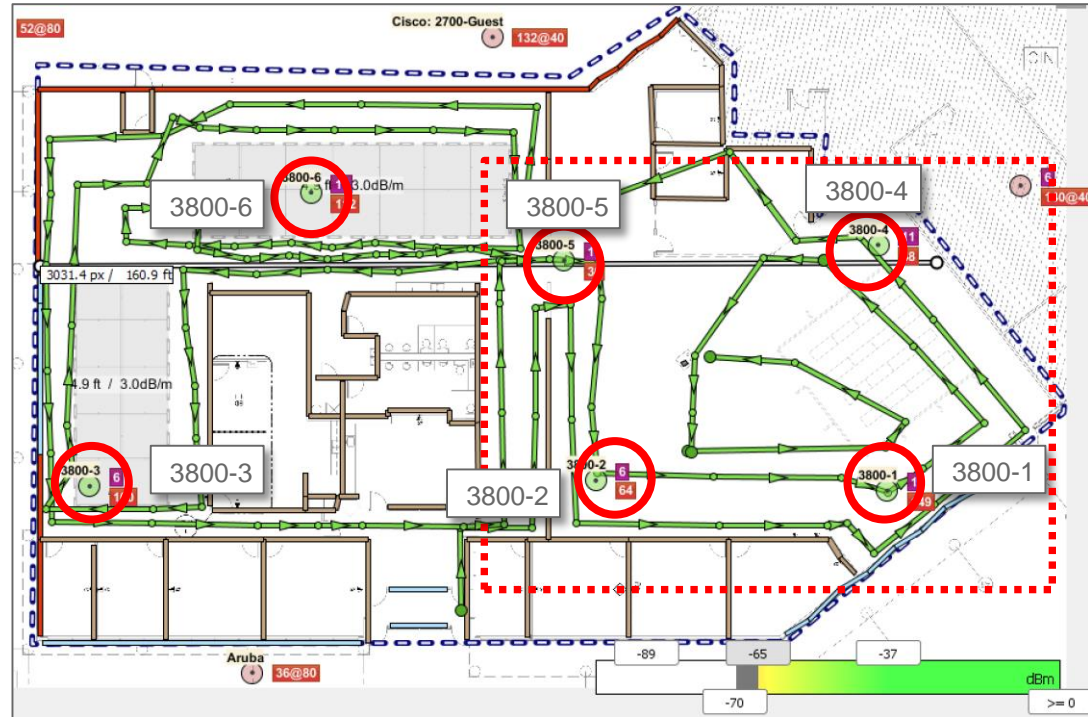
Redundant Radio Identification

- If you've designed a network for dense 5 GHz coverage, then you have too many 2.4 GHz radios

- 2.4 GHz has 1/7th the channels of 5 GHz spectrum in the –A regulatory and it propagates roughly 1.5x farther

- Prior to the 2800/3800 and 8.2 MR's release, your only option was to disable these radios.

- Disabling the radio provides no value -no location, rogue or other information is gathered.

- RRM-FRA algorithm to identify redundant radios, and assign one of multiple roles that add value to the network.
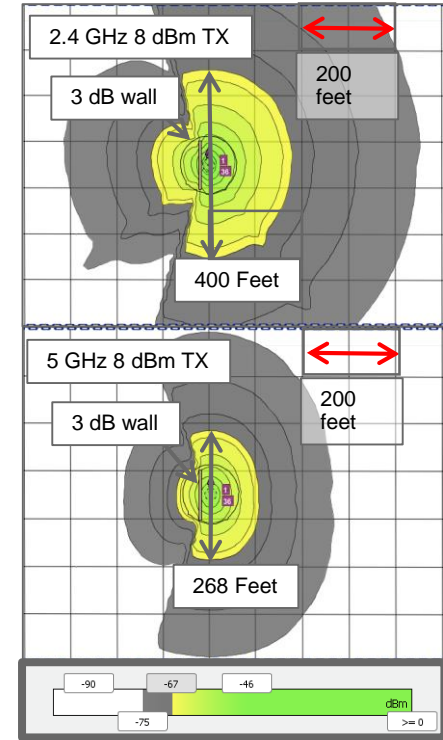
2.4 GHz 8 dBm TX

3 dB wall

200 feet

400 Feet

5 GHz 8 dBm TX

3 dB wall

200 feet

268 Feet

-90   -67   -46

-75

dBm

>= 0

Redundant Radio Identification

Per RF Neighborhood Coverage Analysis

- First an RF Neighborhood (different than an RF Group) is selected to solve

- Using reciprocal NDP messages, each AP is located relevant to one another another in RF Distance
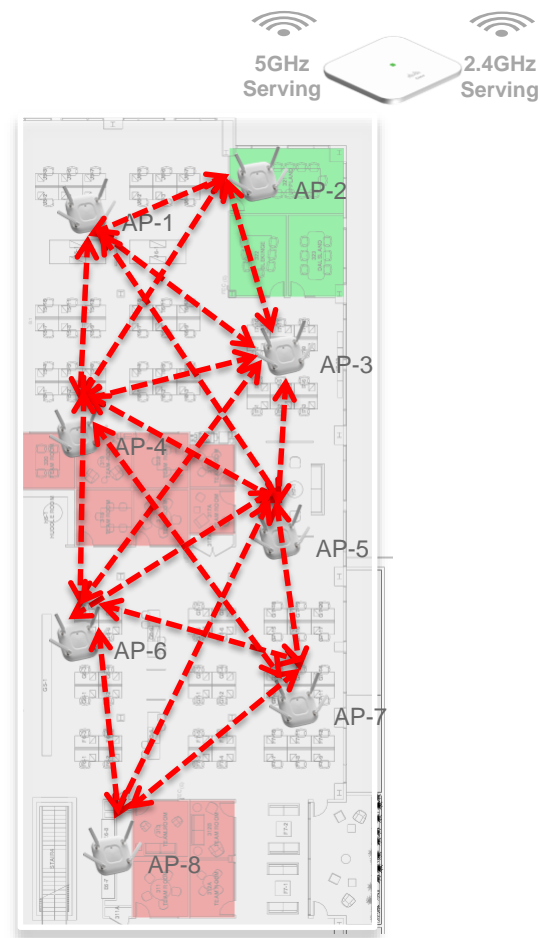
Redundant Radio Identification

Per RF Neighborhood Coverage Analysis

- First an RF Neighborhood (different than an RF Group) is selected to solve

- Using reciprocal NDP messages, each AP is located relevant to one another another in RF Distance

- Coverage area is represented by a circle around each AP

- Overlap will be assessed based on multi-points analysis within each AP's calculated coverage area

5GHz Serving

2.4GHz Serving
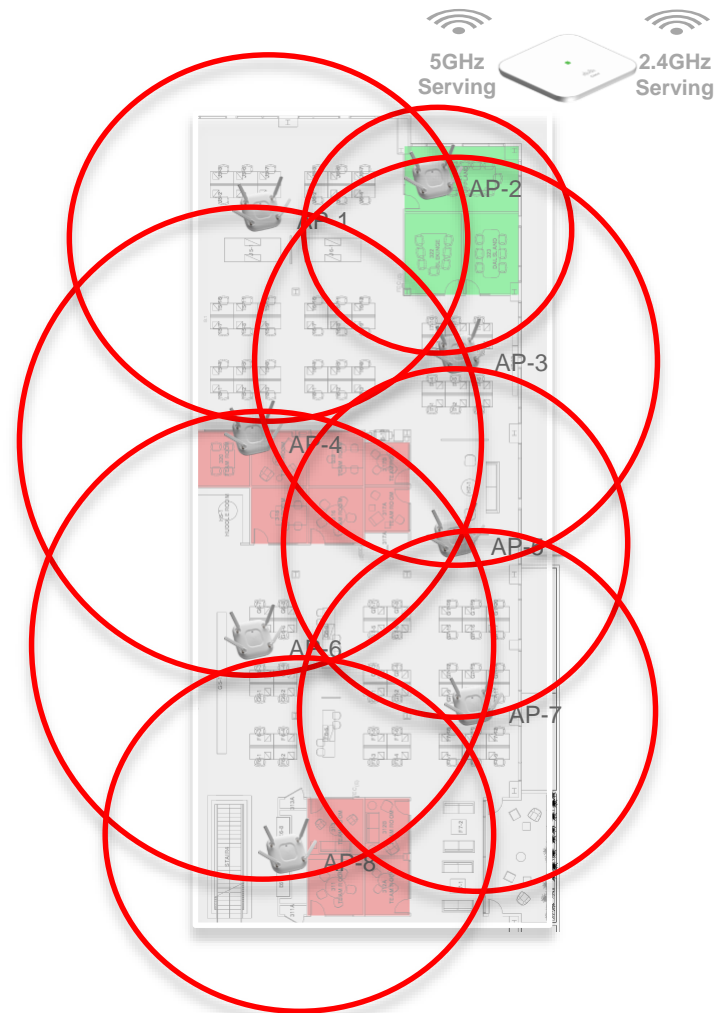
Redundant Radio Identification

Per RF Neighborhood Coverage Analysis

- Using NDP messages, each AP has x and y coordinates calculated

- Coverage area is represented by an 18m circle around each AP

- The resulting Overlap will be assessed based on multiple points within each target AP's coverage area

- All Neighbors above -60 dBm are included for coverage

- COF - Coverage Overlap Factor – is the percentage of an AP's cell – that is covered by neighboring AP's

- A radio is only marked Redundant (and Re - assignable) if COF is above FRA Threshold
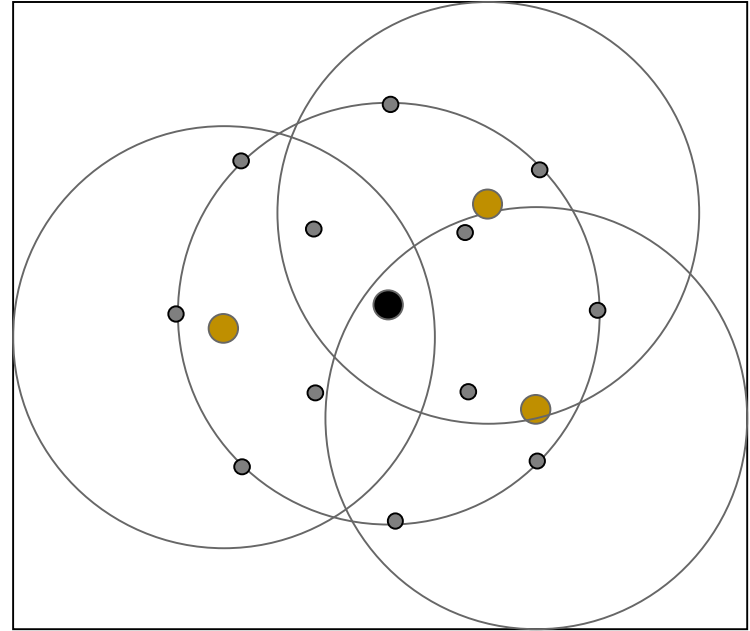
FRA –Back to Richfield
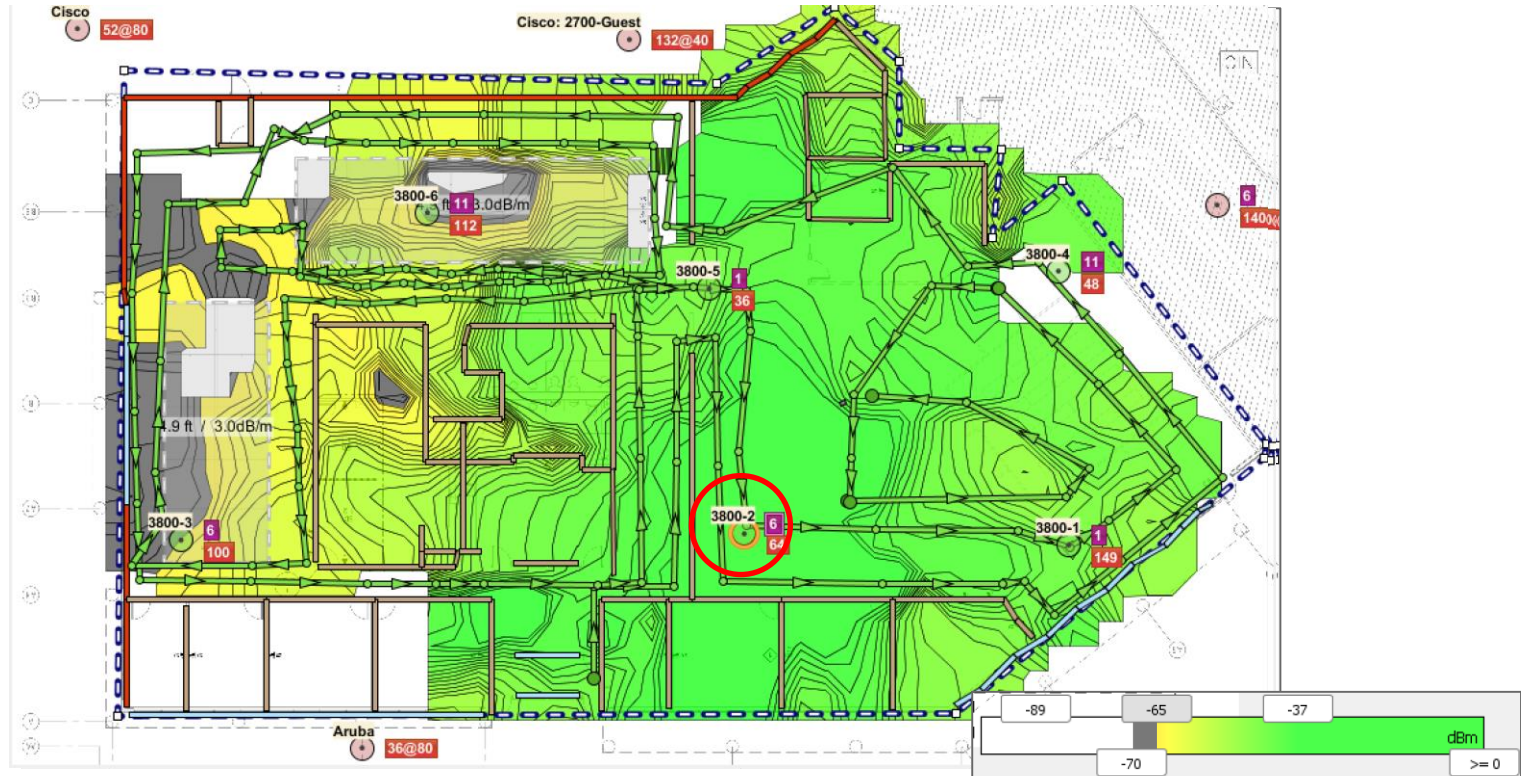
FRA's Opinion – *show advanced fra*

(Cisco Controller) >show advanced fra

FRA State... Enabled
FRA Sensitivity................................. high (90)
FAR Interval..................................... 1 Hour(s)
 Last Run... 2366 seconds ago
 Last Run Time.................................. 0 seconds

AP Name   MAC Address   Slot, Current Band Coverage, Overlap Factor %, Suggested Mode
-----------------------------   ----------------   --------------   --------
3800-4   58:ac:78:df:9f:70   0 2.4GHz   80   2.4GHz
3800-6   58:ac:78:df:9f:50   0 2.4GHz   76   2.4GHz
3800-2   58:ac:78:df:6b:50   0 2.4GHz   76   2.4GHz
3800-3   58:ac:78:df:9e:d0   0 2.4GHz   65   2.4GHz
3800-5   58:ac:78:df:9e:80   0 5GHz   96   5GHz
3800-1   58:ac:78:df:73:20   0 5GHz   92   5GHz
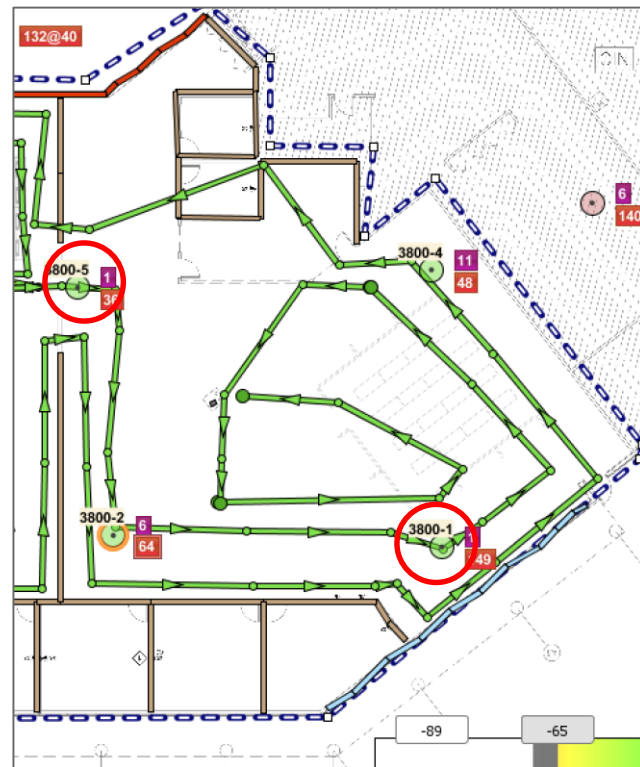
FRA –RRF – Redundant Radio Identification

- After FRA
- Coverag

Signal Strength Visualization Statistics

100% coverage above -60 dBm!
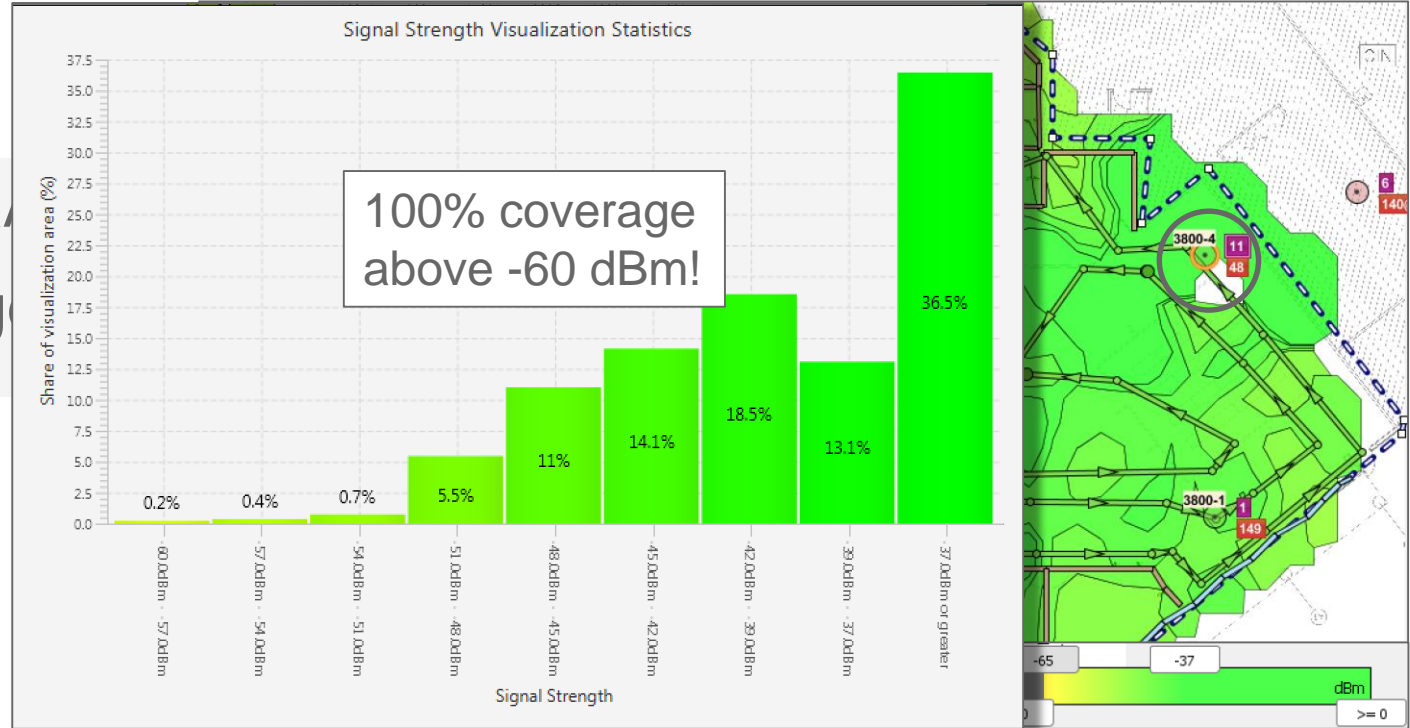
Integrating FRA

- All 2800/3800's slot 0 in manual,
  - Client serving, 2.4 GHz role/band
- FRA – Enabled (to calculate COF)
- Use Monitor=> Dual-Band radios output to Identify Redundancy Candidates
- Check Coverage of Candidates
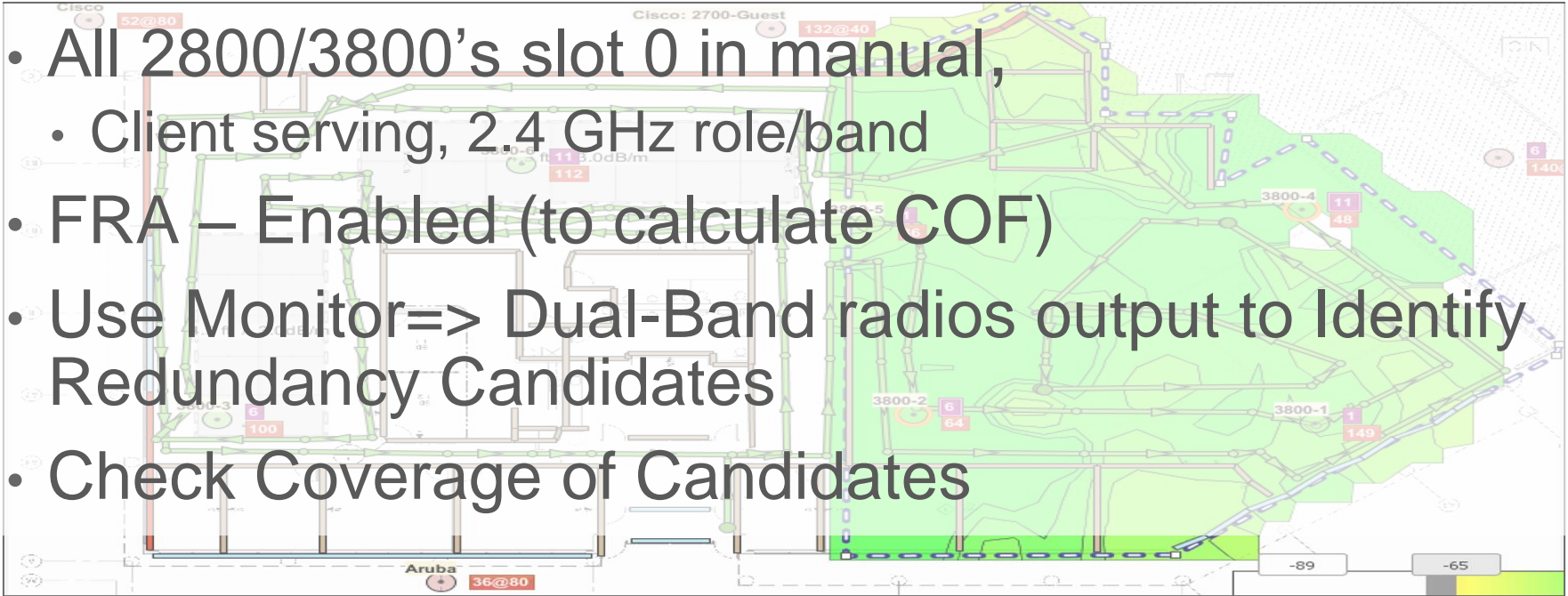
Manual FRA Validation – how to use

AP Name	Radio Slot#	Base Radio MAC	Current Role	Current Band	Coverage Overlap Factor	Suggested Mode	Operational Status	Load Profile	Noise Profile	Interference Profile	Coverage Profile	CleanAir Admin Status	CleanAir Oper Status
AP_3800_i.D9A0	0	58:ac:78:df:9c:20	Local	5GHz	91 %	5GHz	UP	NA	NA	NA	NA	Enable	UP
NOS_3600	2	64:d9:89:46:7f:b0	Monitor	NA	Unavailable	Unavailable	UP	NA	NA	NA	NA	Enable	UP
3802_e.BC80	0	58:ac:78:df:7e:e0	Local	2.4GHz	76 %	2.4GHz	UP	NA	NA	NA	NA	Enable	UP

Dual-Band Radios — Entries 1 - 3 of 3

Current Filter: None   [Change Filter] [Clear Filter]

MONITOR   WLANs   CONTROLLER   WIRELESS   SECURITY   MANAGEMENT   COMMANDS   HELP   FEEDBACK

Save Configuration | Ping | Logout | Refresh   Home

- Monitor=> AP=> Dual-Band Radios
- Shows COF

Validate COF and Make Informed Decisions - Manual

- Evaluate the AP's location on a map –

- Go to the AP location and measure coverage from other AP's to make an informed decision

- An AP against a wall – only needs 50 - 70% covered

- Likely if it is 76%, 80%, 85% COF and against a wall – It is covered

- Trust - BUT - Verify

AP Name	Coverage Overlap Factor
AP_3800_i.D9A0	91 %
NOS_3600	Unavailable
3802_e.BC80	76 %
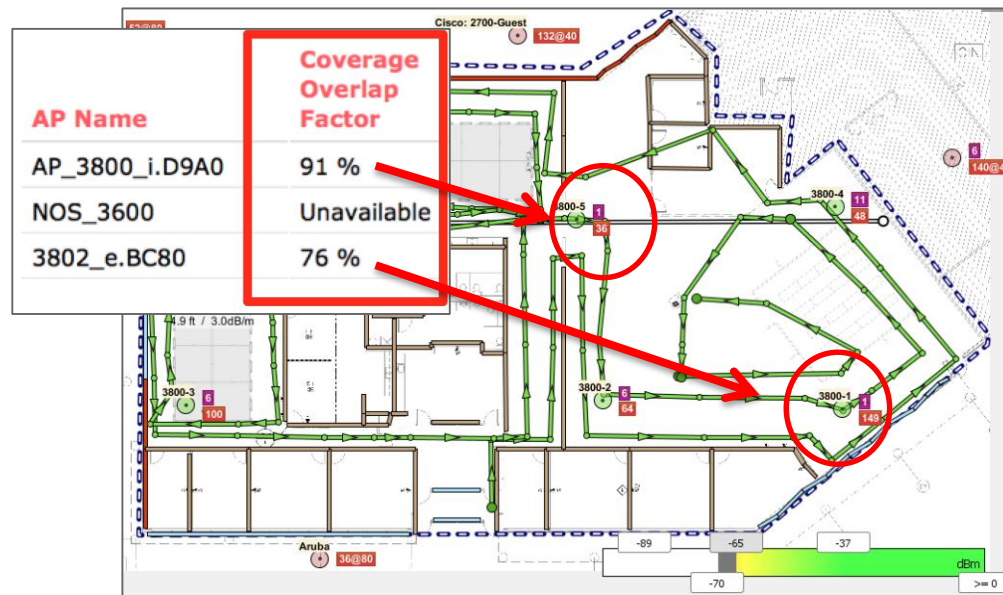
Marking an Interface "Redundant"

Exercising FRA

- FRA Sensitivity – designed to be VERY conservative – and That's good!

- The opposite of conservative is a coverage hole!

- Defaults – should be safe for a customer environment

- Low (100%), Medium (95%), High (90%)

- Hidden levels – *Be very very careful* – these are *persistent* commands -
  - higher (85%), evenhigher (80%), superhigh (75%), crazyhigh (70%), areyoukidingme (50%)

(Cisco Controller) >config advanced fra sensitivity <value>

Config Advanced fra revert

(Cisco Controller) >config advanced fra revert ?

auto-only   Revert only XOR radios currently in automatic band selection (Isolates only radios in Auto)
all   Revert all XOR radios   (and it means ALL)

(Cisco Controller) >config advanced fra revert auto-only ?

static   Put reverted XOR radios in static band selection
auto   Put reverted XOR radios in auto band selection

 (Cisco Controller) >config advanced fra revert all auto –

NOTE: selecting revert all – reverts every XOR radio even those in manual, the key word auto afterward places the radios in FRA Auto. Choosing to revert Auto-only with the key word Auto, places the radios that have been assigned another role – back in 2.4 GHz auto and ready for re-evaluation by FRA - will not re-assign *Manual assignments

Test Commands -

NEW!

> ## Warning!!!
> Test Commands Expose some of the DEV Shell commands at the CLI making them available to use specifically to demo features on the controller – **Never** – **Ever** run these in a live production environment, as most of these will enable hi impact processes within the controller. They are designed to be used specifically to support testing.
> ## Warning!!!

(Cisco Controller) >test rrm fra ?

run-once   Runs one instance of FRA, then one DCA in 5GHz, then disables FRA

mark-first   Marking the first AP in FRA list redundant

FRA - AP Solution Set rules

- FRA only runs against AP's in the same AP Group

- FRA is 2D, does not consider multiple floors

- Recommend at least one AP group per floor

- RF Profiles are used

- Neighbor Cut Off is -80

- FRA will use the 4 Loudest Neighbors when evaluating any single AP for redundancy

FRA – Suggested Roles

(Cisco Controller) >show advanced fra

FRA State.. Enabled
FRA Sensitivity.................................. high (90)
FRA Interval..................................... 1 Hour(s)
 Last Run....................................... 2366 seconds ago
 Last Run Time................................. 0 seconds

AP Name MAC Address Slot, Current BandCoverage, Overlap Factor %, Suggested Mode
-------------------------------- ---------------- ---- -------------- --------
3800-4   58:ac:78:df:9f:70   0 2.4GHz   80
3800-6   58:ac:78:df:9f:50   0 2.4GHz   76
3800-2   58:ac:78:df:6b:50   0 2.4GHz   76
3800-3   58:ac:78:df:9e:d0   0 2.4GHz   65
3800-5   58:ac:78:df:9e:80   0 5GHz   96
3800-1   58:ac:78:df:73:20   0 5GHz   92

Should say "Role"
Not "Mode"

- 2.4 GHz
- 5 GHz
- 5G/Monitor
- Monitor
- (Static)
- None

FRA – Assignment Priority

1 — 5GHz Serving / 2.4GHz Serving

Coverage too dense – Mark Redundant

2 — 5GHz Serving / 5GHz Serving

DCA will determine suitability, and
If Unsuitable – then Monitor

3 — 5GHz Serving / Wireless Security Monitor

Wireless monitoring of 2.4 and 5 GHz
Scan both 2.4GHz and 5GHz for security threats
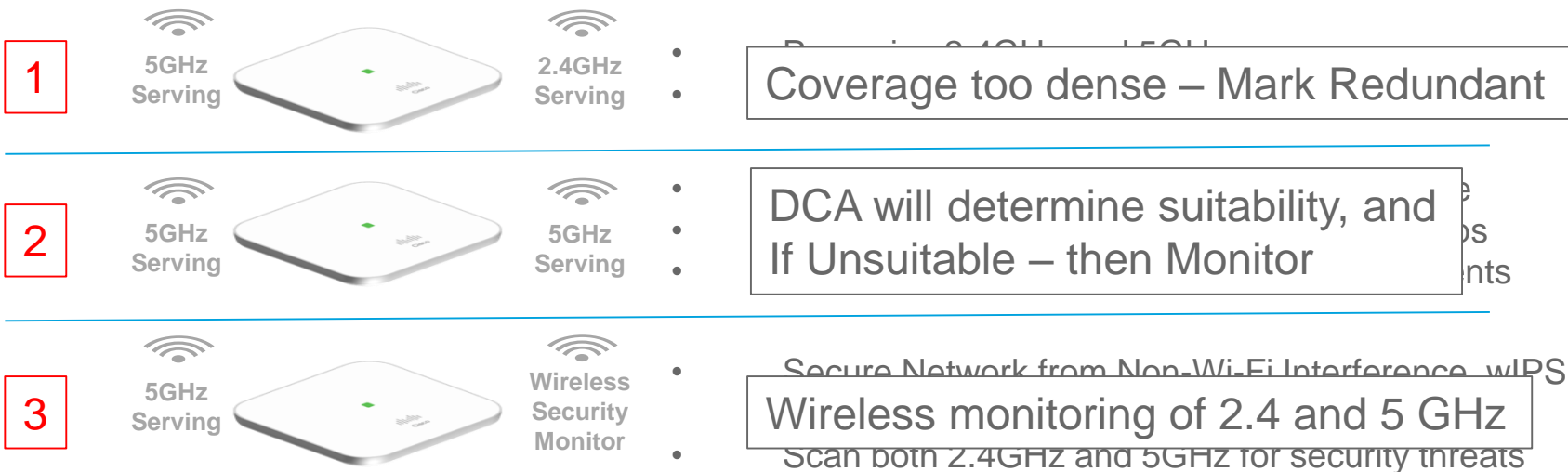
So, What Happens to The Clients?

- So -you have Clients already associated to the 2.4 GHz Radio when FRA determines it's redundant

- What Happens to the Clients

- New command for 8.2 MR1

(Cisco Controller) >*config/show advanced 802.11a/b client-network-preference ?*

connectivity   Preference on Connectivity
default   No Client Network Preference Applied
throughput   Preference on Throughput

NEW! – Client Network Preference
A Personality adjustment for your network

RRM Algorithm	Connectivity	Throughput	Default
DCA	Higher Bias on current Channel Low Sensitivity for DCA (override in DCA) Prefer current channel when Voice/Video	Less bias on current channel High DCA Sensitivity (override in DCA) All 11n capable clients	No Change from Current DCA behavior
DTPC	DTPC should not reduce power when weak signal clients detected (<-79)	DTPC will not increase power when number of clients is over the configured max threshold	No Change from current TPC behavior
DBS	Prefer Current bandwidth Prefer current Primary channel Lower bias on client type Voice/Video clients increased contribution	Favor Higher Channel Widths Higher bias for high capacity (11n,11ac) client types present	No Change from current DBS behavior
FlexDFS/ED-RRM	Priority on maintaining primary channel Voice/Video client increased contribution	Priority on higher bandwidth channel width	No Change from current flexDFS/ED-RRM behavior
FRA	No Band/Role switching when more than 3 clients exist	Band-s clients	

Defaults to Connectivity profile

Flexible Radio Assignment
Micro/Macro Operation details
Intra-Cell Roaming

2800/3800 I model – Have 2 antenna sets
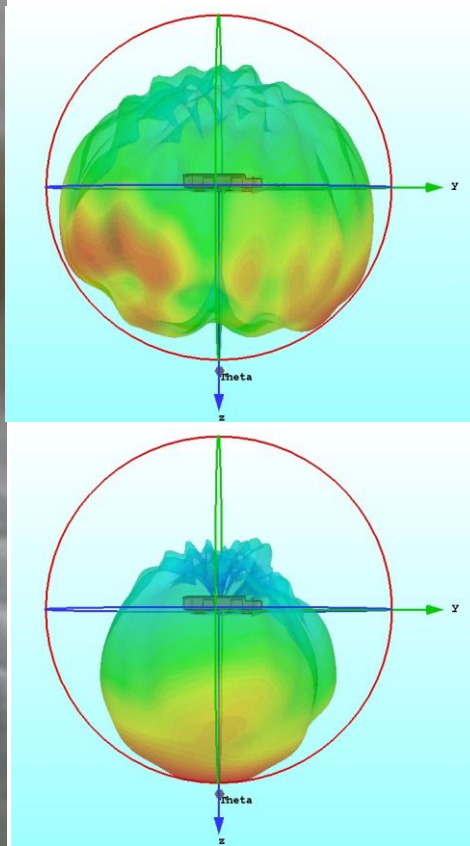
Conventional AP footprint (Macro-Cell) uniform 360 Degree coverage

By using spatially-efficient and compact antenna design along with Polarity & Tx RF power differences **BOTH radios co-exist internally**

Smaller AP footprint (Micro-Cell) uniform 360 Degree but for smaller coverage area for higher density deployments

2800/3800i Antenna Patterns 5 GHz

5 GHz Normalized Azimuth Patterns

Macrocell Antenna
Microcell Antenna
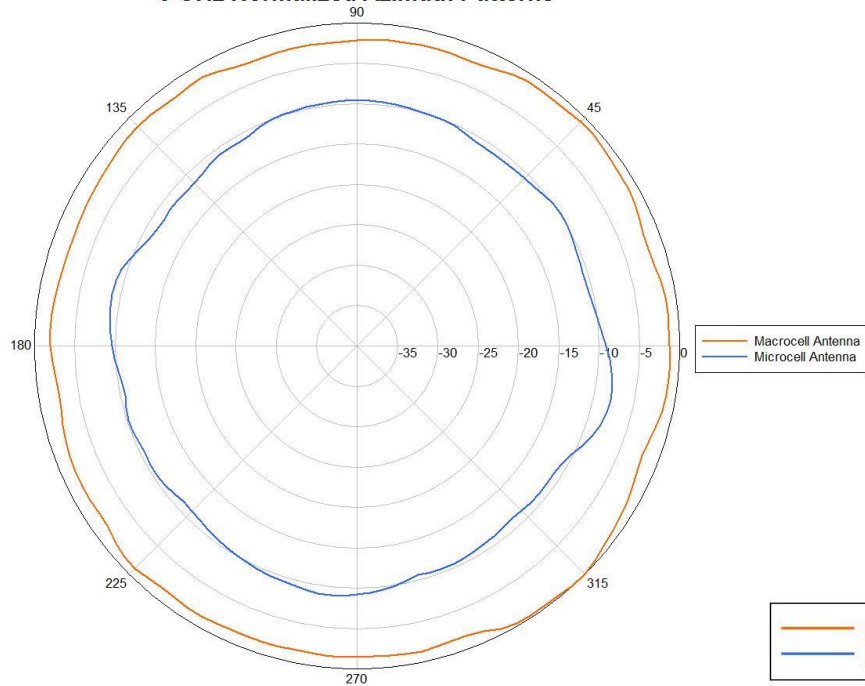
5 GHz Normalized Elevation Patterns

Macrocell Antenna
Microcell Antenna
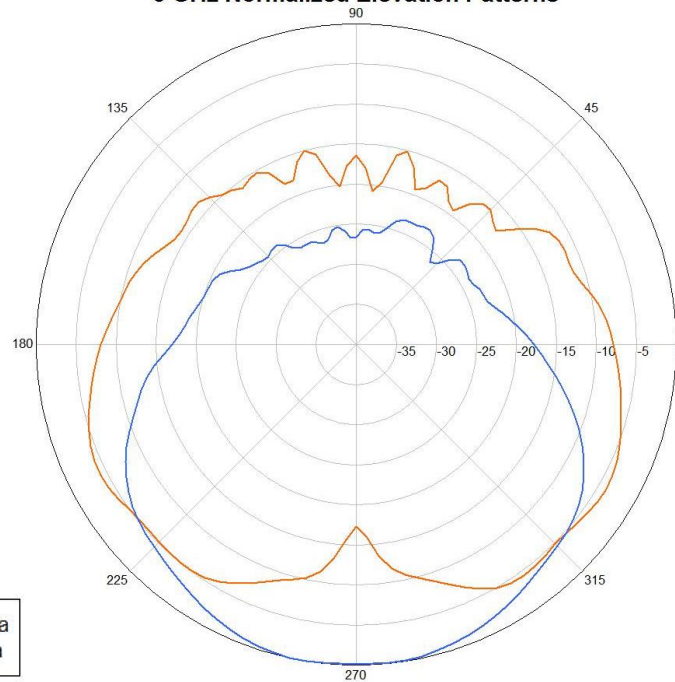
2800/3800i Antenna Patterns 2.4 GHz
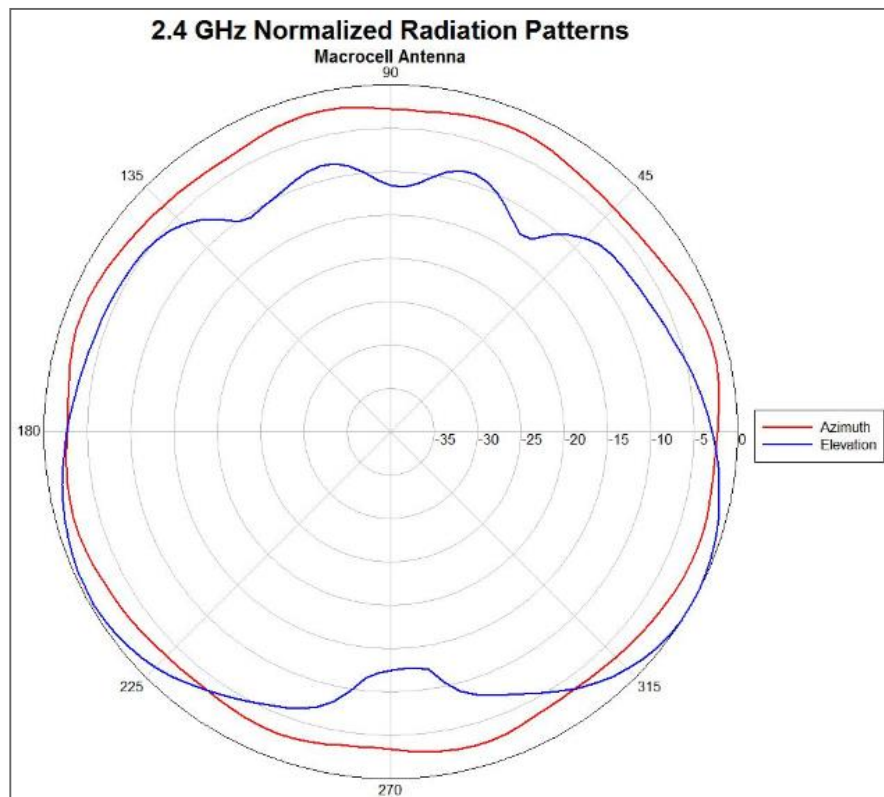
2800i/3800i Implementation Rules

- ## If Dual 5 GHz Role Selected
  - Operation "IS" Macro/Micro
  - Micro Radio (Slot 0)
    - TX Pwr – *Minimum allowed power
    - Channel must be *100 MHz separated
  - Macro Radio (Slot 1)
    - TX Pwr – adjusted by TPC/Manual
  - Macro to Micro transition and back – Always maintained by FRA
  - Same SSID's will be broadcast on both cells
  - Same AP Group and RF Profile apply to Both radios

  * Enforced by Software

Cisco AP 3800

RF Center of Excellence
Aironet – Richfield Ohio
Antenna System (cover removed)

5 GHz Band
(Micro-Cell)

Status LED

2.4/5GHz
Dual Band
(Macro-Cell)

Cisco Live
2016

2800/3800 "I" Coverage – Measured
Dual 5 GHz – Macro/Micro operation

Tx-Pwr 2 dBm

149

63.0 px / 56.0 ft

50'/16m

-65 dBm Cutoff

MICRO - Cell

-90   -65   -32

-80   >= 0   dBm

Tx-Pwr 17 dBm

100

63.0 px / 56.0 ft

50'/16m

-65 dBm Cutoff

MACRO - Cell

-90   -65   -32

-80   >= 0   dBm
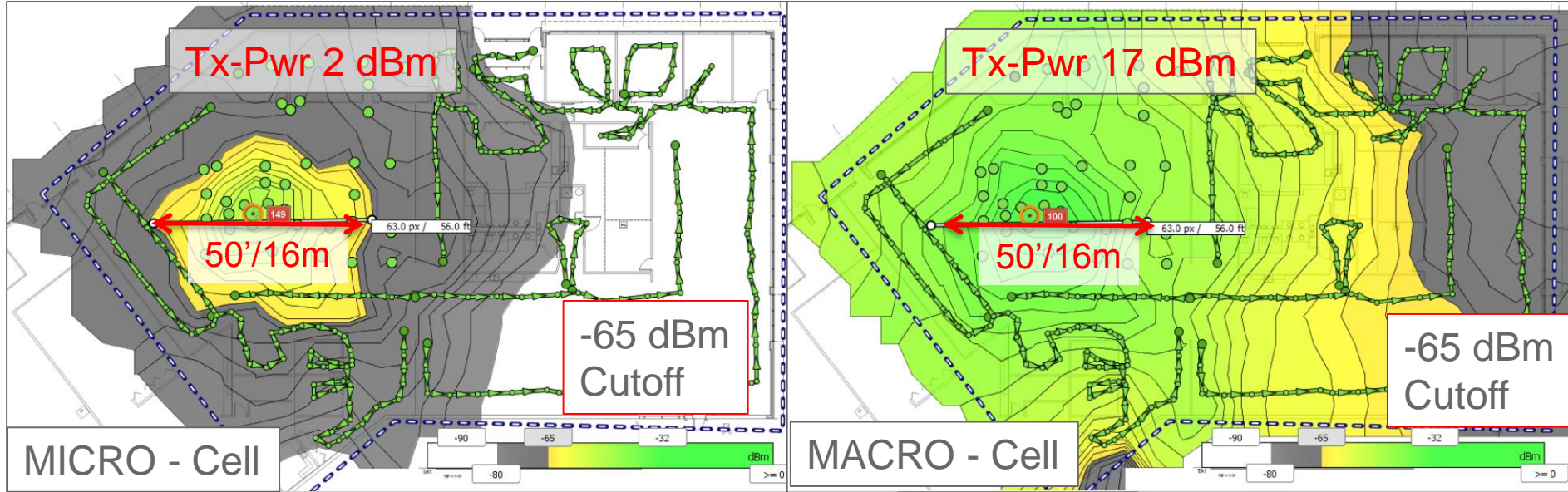
2800/3800i Dual Band
Single 5 GHz radio

- The further a client is from the AP, the lower the data rate will used
- Data Rate is a function of SNR
- The higher the SNR – The higher the data Rate will be
- 1 x 5 GHz cell has a finite amount of Air Time available
- Capacity is the sum of all clients within the cells Air Time

Single 5 GHz cell

Channel Utilization = 60%

-71 dBm
-75 dBm
-68 dBm
-51 dBm
-58 dBm
-63 dBm
-60 dBm
-73 dBm

1
36

-63 dBm = Client RSSI at AP
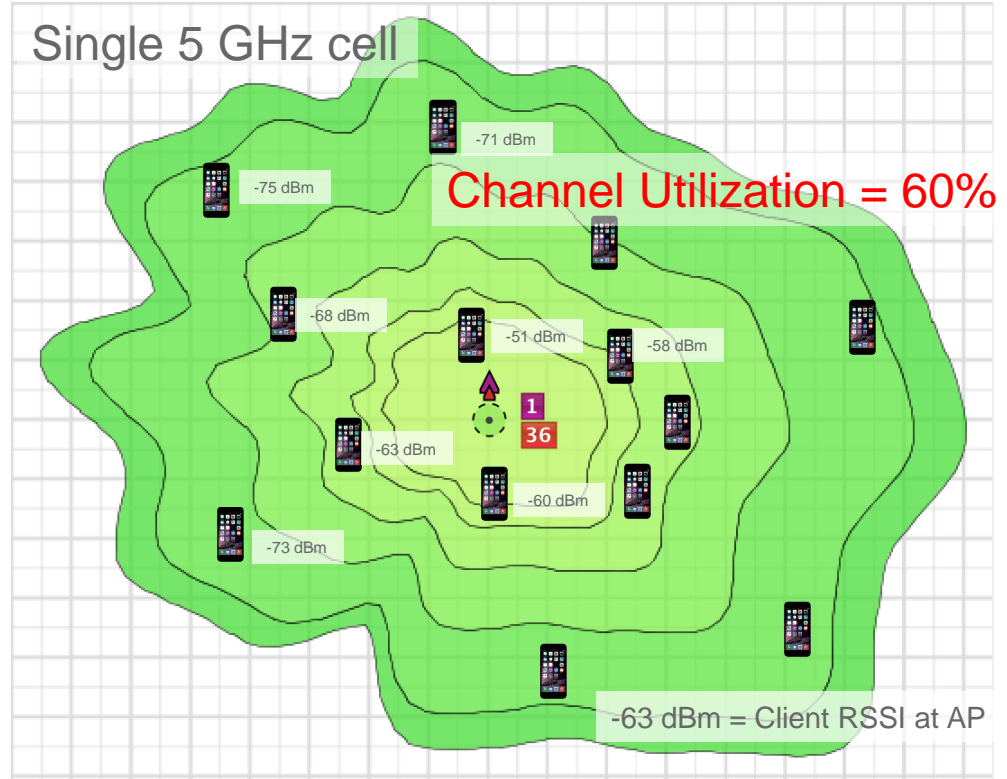
2800/3800i Macro/Micro
Dual 5 GHz radio

- **Creating 2 RF diverse 5 GHz cells**
  Doubles the Air Time available

- **Optimizing Connections**
  (Macro vs Micro) keeps like
  performing clients together, rather
  than have one drag down the other

- **Both radios share same SSIDs**
  Note: later releases we will likely
  allow for different SSIDs

5GHz Serving   5GHz Serving

**Macro/Micro
5 GHz cell**

-71 dBm

-75 dBm

**CU Chnl 36= 20% !
CU Chnl 108=24% !**

-68 dBm

-51 dBm   -58 dBm

36

108

-63 dBm

-60 dBm

-73 dBm

-63 dBm = Client RSSI at AP

Cisco*live!*
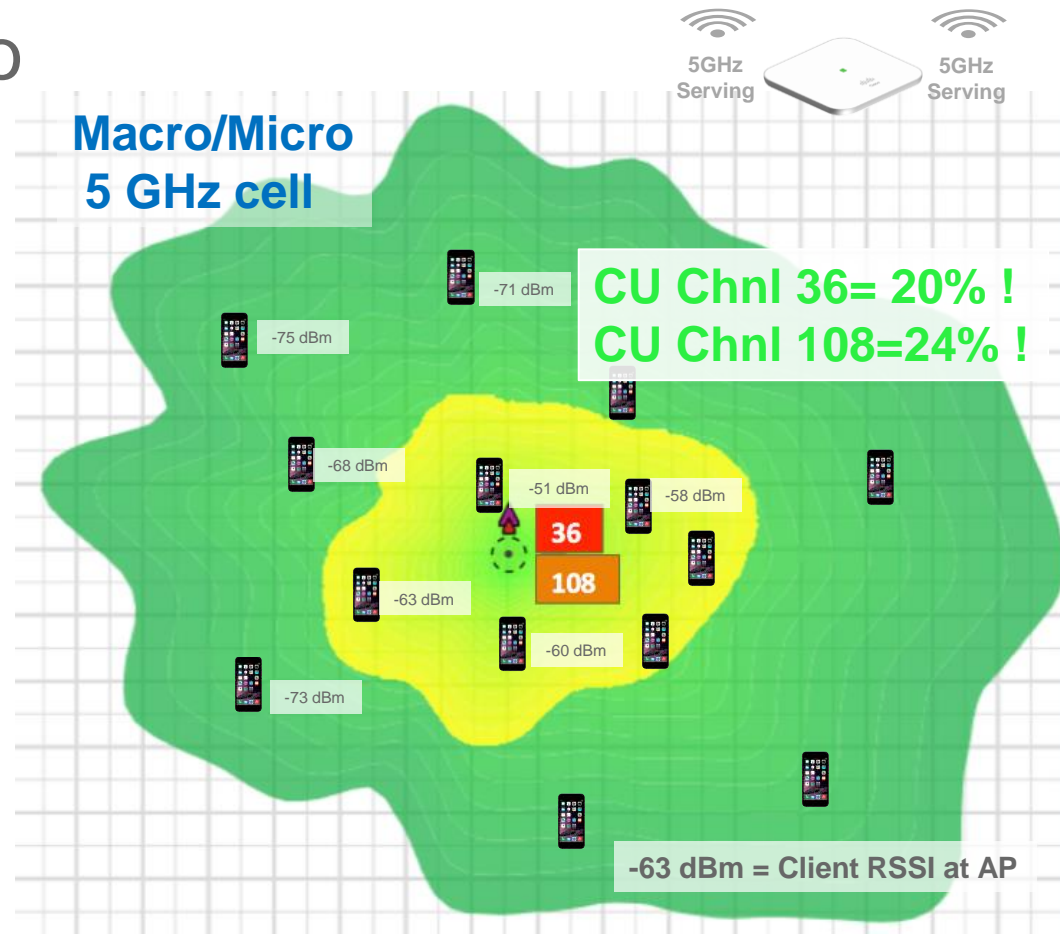
Intra-cell Roaming –
Macro to Micro

- The most likely scenario is a client will associate to the Macro cell first – since we have higher power and bigger footprint

- In this case, a client that has RSSI at the AP above the Micro cell threshold of -55 dBm will be moved into the Micro cell
  - -55 dBm default, configurable by user - CLI

- For an 802.11v client – on association we will send an 11v BSS Transition request with the Micro Cell BSSID as the only candidate

- For a non 11V client, we will send an 11K neighbor list and a disassociate

- Probe Suppression

Macro=Big

Micro=small

-51 dBm

-51 dBm
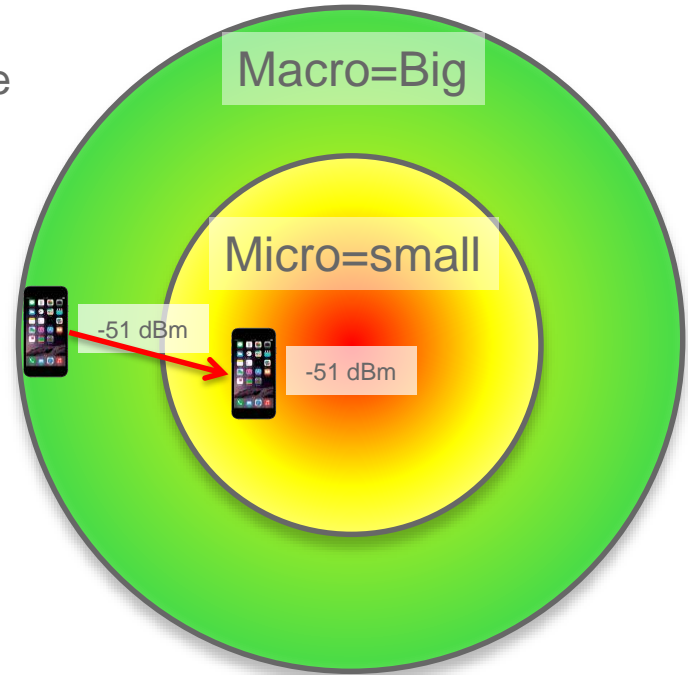
Intra-cell Roaming –
Macro to Micro

- If a client associates to the Micro cell first –less likely – but possible based on device scan and channels heard -

- In this case, a client that has RSSI at the AP below the Macro cell threshold of -65 dBm will be moved into the Micro cell
  - -65 dBm default, configurable by user - cli

- For an 802.11v client – on association, we will send an 11v BSS Transition request with the Macro Cell BSSID as the only candidate

- For a non 11V client, we will send an 11K neighbor list and a disassociate

- Probe Suppression

5GHz Serving   5GHz Serving

Macro=Big

Micro=small

-65 dBm   -65 dBm
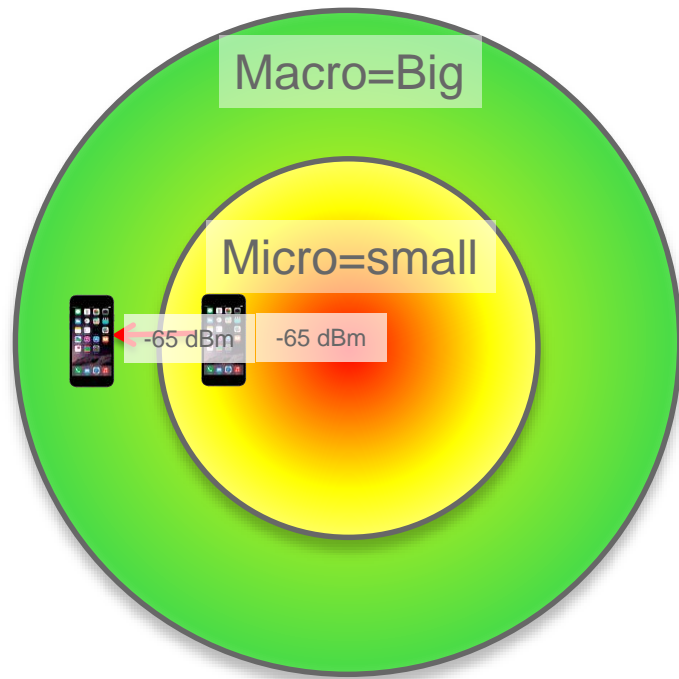
Intra-cell Roaming –
Probe Suppression

- Not every one supports 11v, 11k – yet

- A probing Client will most likely heard on both radios – within a reasonable time value

- Using the RSSI at the radio to determine the best cell we selectively respond from the Radio that matches best

5GHz Serving   5GHz Serving

Macro=Big

Micro=small

≥ 55 dBm?

-51 dBm   -51 dBm

Yes!

Probe - resp
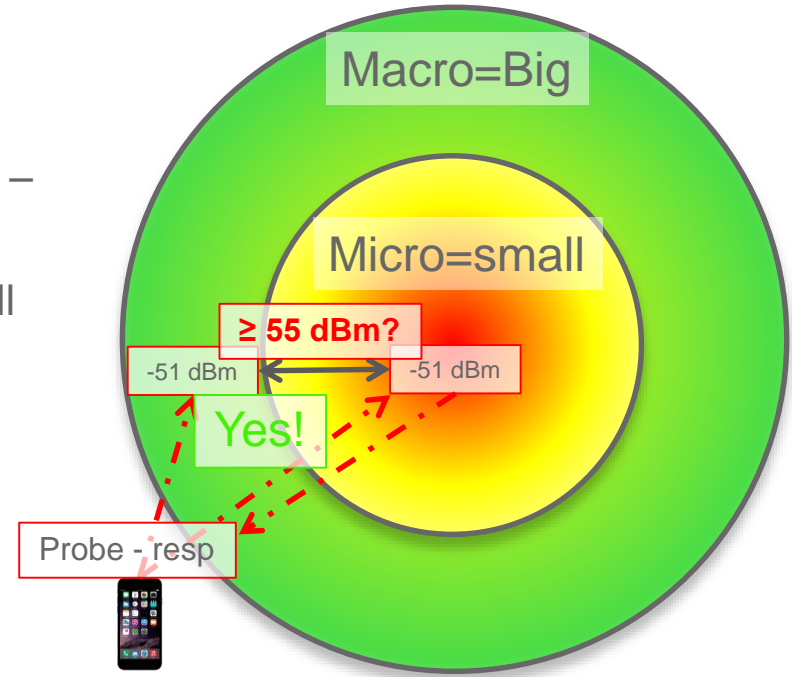
From Macro to Micro and Back again
show advanced client steering

(Cisco Controller) >**show advanced client-steering**
Client Steering Configuration Information

Macro to micro transition threshold............ -55 dBm
micro to Macro transition threshold............ -65 dBm
micro-Macro transition minimum client count.... 3
micro-Macro transition client balancing win.... 3

Probe suppression mode......................... probe   Probe or Probe And AUTH
Probe suppression validity window.............. 100 s   Time we consider a probe on each radio as valid
Probe suppression aggregate window............. 200 ms   Time we consider multiple probes as one event
Probe suppression transition aggressiveness.... 3   How many Probes we will suspend before answering
Probe suppression hysteresis................... -6 dBm   Hysteresis on Microcell Client – ends Macro supression

Flexible Radio Assignment
3800/2800 e/p/e models and Macro/Macro

2800e/3800e Implementation Rules

- If Dual 5 GHz Role Selected

- No Dart connector – Standard AP

- With Dart connector -
  - Operation "IS" Macro/Macro
  - Macro Radio (Slot 0)
    - TX Pwr and Channel Custom – or RRM
    - *100 MHz channel separation Custom or RRM
  - Macro Radio (Slot 1)
    - TX Pwr and Channel Custom – or RRM
    - *100 MHz channel separation Custom or RRM
  - Same SSID's will be broadcast
  - Same AP Group and behavior applies to Both radios – still one AP
    - * Enforced by Software

Ciscolive!

Dual 5 GHz "E" model Macro-Macro cells or

Micro-Micro cells or any combination – have a ball – but follow the rules

6 dBi Patch back to back

Stadium antenna deployments for different coverage areas or higher density areas

ANT-2566D4M-R in different directions or even back-to-back tilted downward for Factory and warehouse deployments

Cable allows for secondary 5 GHz radio antenna to be physically spaced away from the primary radio allowing for Macro-Macro operation

Omni + directional deployments

Cisco live!

Dual 5 GHz – "E" Model – Macro/Macro cells
High Density at half the cable cost

- Using the Smart Antenna (DART) connector on the E Model enables Dual 5 GHz Macro-Macro cells with Discrete external antenna's

- 10ft (3m) dual AIR-ANT2566D4M-R back to back

- 14 dBm -TX

- mGig provides throughput investment

- Existing HDX Venues can double capacity - on existing cable plan

120' x 55'
6.6 K ft^2
600m^2
@-57 dBm

Cisco AP3802i 5GHz ⬍ 5GHz

-89   -57   -37   dBm
-63   >= 0
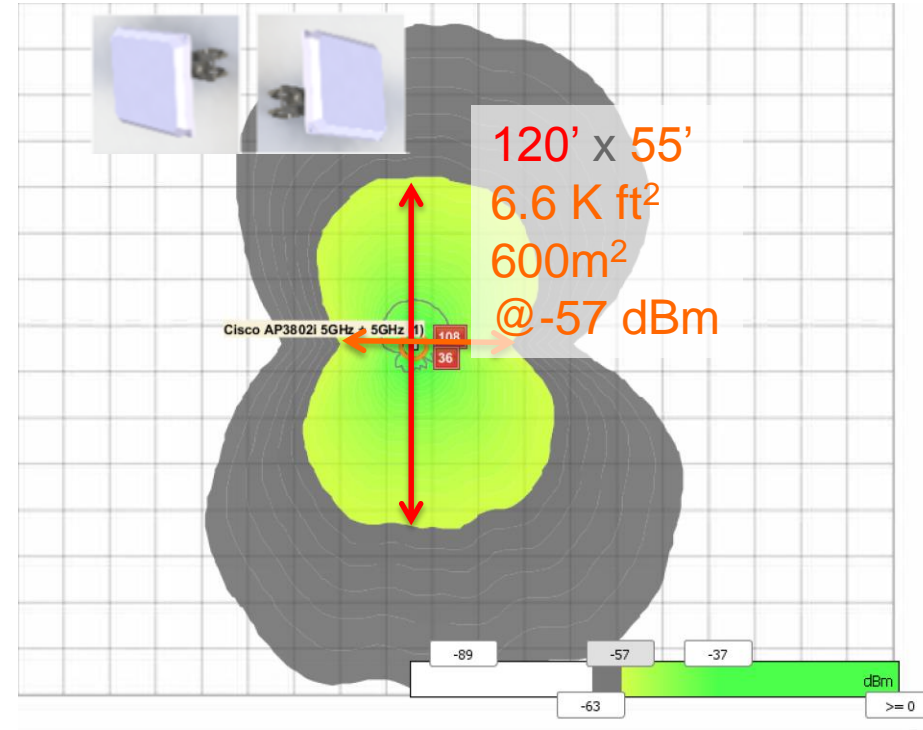
AP View Enhancements

- CDP / LLDP Enhancements

- Flexible Radio Support

- 160MHz Radio Support

- WSA Sensor Mode/Role Support

- Improved Performance Summary Thresholds

GENERAL

AP Name
C3700-AP1

Location
default location

MAC Address	fc:5b:39:00:04:d0
IP Address	192.168.21.216
CDP / LLDP	CORE, GigabitEthernet1/0/25
Model / Domain	AIR-CAP3702I-A-K9 / 802.11bg:-A 802.11a:-A
Power status	PoE/Full Power
Serial Number	FTX1835R16R
Groups	AP Group: default-group, Flex Group: default-flex-group
Mode / Sub-mode	Local / Not Configured
Max Capabilities	802.11n 2.4GHz,802.11ac 5GHz Spatial Streams : 3(2.4GHz), 3(5.0GHz) Max. Data Rate : 217Mbps(2.4GHz), 1300Mbps(5.0GHz)

AP View Enhancements

- Updated field formatting
  - \<SWITCH\>, \<PORT-TYPE\>\<PORT\>

- Enhancements for AP 3800
  - Port type will display as *GigabitEthernet* when a AP3800 is connected to a legacy Gigabit port
  - Port type will display as *TenGigabitEthernet* when a AP3800 is connected to a mGig port

GENERAL

	AP Name **AP58AC.78DC.A4A0**
	Location **default location**
MAC Address	58:ac:78:dc:a4:a0
IP Address	30.30.20.104
CDP / LLDP	cheetah-lab-sw1, GigabitEthernet1/0/7
Model / Domain	AIR-CAP3802E-B-K9 / 802.11bg:-A 802.11a:-B
Serial Number	FOC19448XMKE
Groups	AP Group: default-group, Flex Group: Not a member
Mode / Sub-mode	Local / Not Configured

1Gig Connected AP3800

GENERAL

	AP Name **barbados_vivek**
	Location **default location**
MAC Address	58:ac:78:dc:bb:60
IP Address	10.10.136.39
CDP / LLDP	c3850_Sree, TenGigabitEthernet1/0/38
Model / Domain	AIR-CAP3802E-B-K9 / 802.11bg:-A 802.11a:-B
Serial Number	FOC19454B40E
Groups	AP Group: default-group, Flex Group: Not a member
Mode / Sub-mode	Local / Not Configured

mGig Connected AP3800

AP View Enhancements

- Flexible Radio Support
  - Performance Summary & Radio Selector automatically update to reflect the radio operating role for Slot 0

PERFORMANCE SUMMARY		
	5GHz	5GHz
Number of clients	0	0
Channels	(36,40,44,48)	(100,104,108,112)
Configured Rate	Min: 6 Mbps, Max: 1300 Mbps	Min: 6 Mbps, Max: 1300 Mbps
Usage Traffic	182 MB	312 MB
Throughput	0	10 KB
Transmit Power	5 dBm	8 dBm
Noise	-128 -128 -128 -128	-93 -96 -98 -91
Channel Utilization	1%	2%
Interference	1%	1%
Traffic	0%	1%
Air Quality	-	(99,100,100,100)
Admin Status	Enable	Enable

AP_3800_I.D9A0 DETAILS

CLIENTS   RF TROUBLESHOOT   TOOLS

5GHz   5GHz

AP View Enhancements

- New Icons to distinguish APs running in dedicated sensor mode

- Reduced AP View for APs operating in dedicated sensor mode
  - General Information
  - Restart AP option

GENERAL	
	AP Name **AP3602** ⤤
	Location **default location**
MAC Address	7c:69:f6:1a:1f:7a
IP Address	172.20.224.208
CDP / LLDP	Rack-C-SW, GigabitEthernet1/0/11
Model / Domain	AIR-CAP3602E-A-K9 / 802.11bg:-A 802.11a:-A
Power status	PoE/Full Power
Serial Number	FTX1738GKFX
Groups	AP Group: default-group, Flex Group: default-flex-group
Mode / Sub-mode	Local / Not Configured
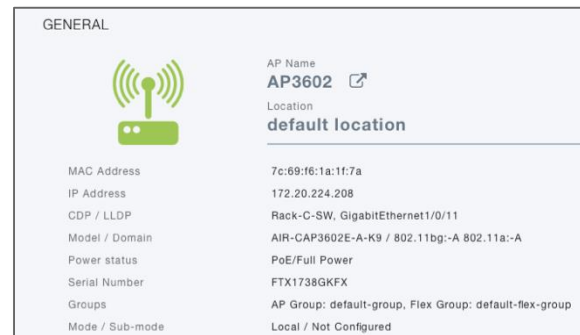
AP in Local / FlexConnect Mode – Client Serving Role

GENERAL	
	AP Name **APf07f.06a3.80e8** ⤤
	Location **default location**
MAC Address	f0:7f:06:a3:80:e8
IP Address	172.20.224.210
CDP / LLDP	Rack-C-SW, GigabitEthernet1/0/9
Model / Domain	AIR-CAP3702I-A-K9 / 802.11bg:-A 802.11a:-A
Power status	PoE/Full Power
Serial Number	FTX1839R1EN
Groups	AP Group: default-group, Flex Group: default-flex-group
Mode / Sub-mode	Sensor / Not Configured

AP in Monitor Mode/Role

Things to know about Todays RRM

- DCA restart – and rebooting a controller

- NDP Pruning interval – and what it means to you

- DBS

- Flex DFS

- The –B Domain – US Regulatory Changes

DCA – When and Why Re-Start?

DCA Sensitivity Threshold

- DCA evaluates the Cost Metric to determine optimal channels for the network

- The user defined threshold – DCA Sensitivity Threshold – allows customization of the algorithm

- The threshold is a Hysteresis to dampen DCA function

- If sensitivity is medium for 2.4 GHz then in order for a channel change to be made the new channel must be 10 dB better than the current channel or no change will occur.

2nd Hop RF Neighbor
1st Hop RF Neighbor
CPCI
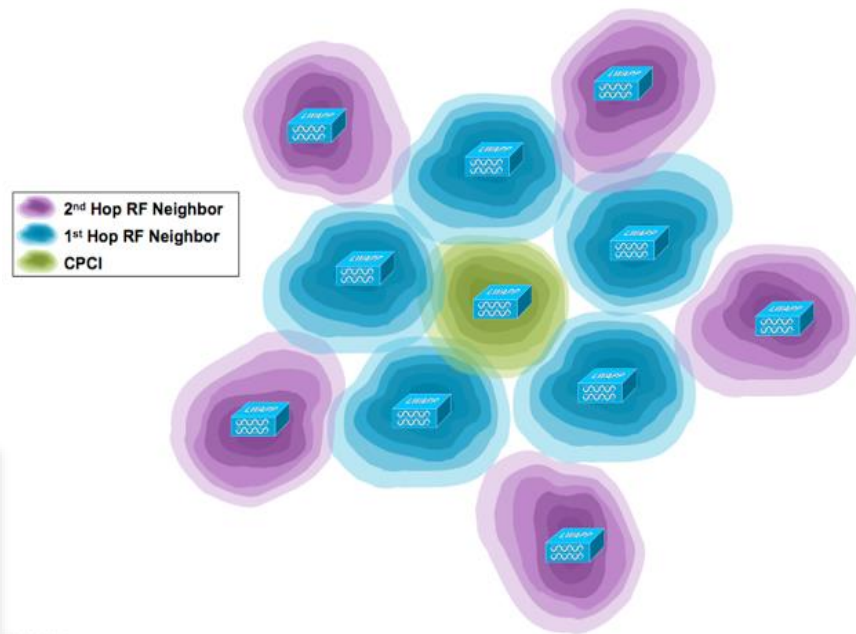
Version	Band	Low	Medium	High
6.0 +	2.4 GHz	20 dB	10 dB	5 dB
	5 GHz	20 dB	15 dB	5 dB

DCA's OBSS (802.11n/ac)
Coexistence Use Cases

- The level of constructive coexistence among OBSS's is based on these criteria:
  - Fair channel access
  - Fairness between 11ac and 11ac is neutral

- Fairness between 11ac and legacy (11n and 11a)

- Number of hidden nodes decreases

- Number of collision decreases

- Overall performance and efficiency increases

Avoid 11n P20 on 11ac S20

11AC	P20	S20	S40 L/H	S80 L/H
11N	S20	P20	-	-

Avoid 11n P20 on 11ac S20 (not allowed by 802.11)

11AC	P20	S20	S40 L/H	S80 L/H
11N	-	S20	P20	-

DCA 802.11ac Use Cases

Avoid 11n P20 on 11ac S20

11AC	P20	S20	S40 L/H	S80 L/H
11N	S20	P20	-	-

Avoid 11n P20 on 11ac S20 (not allowed by 802.11)

11AC	P20	S20	S40 L/H	S80 L/H
11N	-	S20	P20	-

- In simulations and analysis, the general level of constructive coexistence decreases between two OBSSs in the order for these possible scenarios:

- Primary and secondary20 channels mismatched

- Primary channel on secondary40 or secondary 80 channels

- Primary channels aligned

DCA Restart

No Longer Automatic with Reboot!

- DCA Startup Mode – enables aggressive channel search
  - Removes customer configured Hysteresis (sensitivity)
  - NO NCCF check
  - Lower internal dampening
  - Much more than simply changing sensitivity to High (5 dB)

- 7.6 and before – DCA entered Startup mode on reboot of RF Group Leader WLC

- 8.0 and forward – Only invoked on Reboot w/code upgrade
  - Config 802.11a/b channel global restart – any time

When Should You Restart DCA?

Ask a Good question– get a Good answer

- Add/Subtract Channels?

- Change Bandwidth?

- Add/Subtract AP's?

- Change AP models?

- Time in Steady State

Neighbor Discovery Protocol – NDP
Changes in Pruning Interval and configuration

About RF Groups, Neighbors, and Neighborhoods

WLC's having the same RF Group Name participate as the same RF Network. This ascii value is used by AP's attached to these controllers in Neighbor Messages Sent over the air, and allows AP's to identify one another As belonging to the same RF Network.

WLC "A"
RF Group "BOB"

WLC "B"
RF Group "BOB"

> -80 dBm
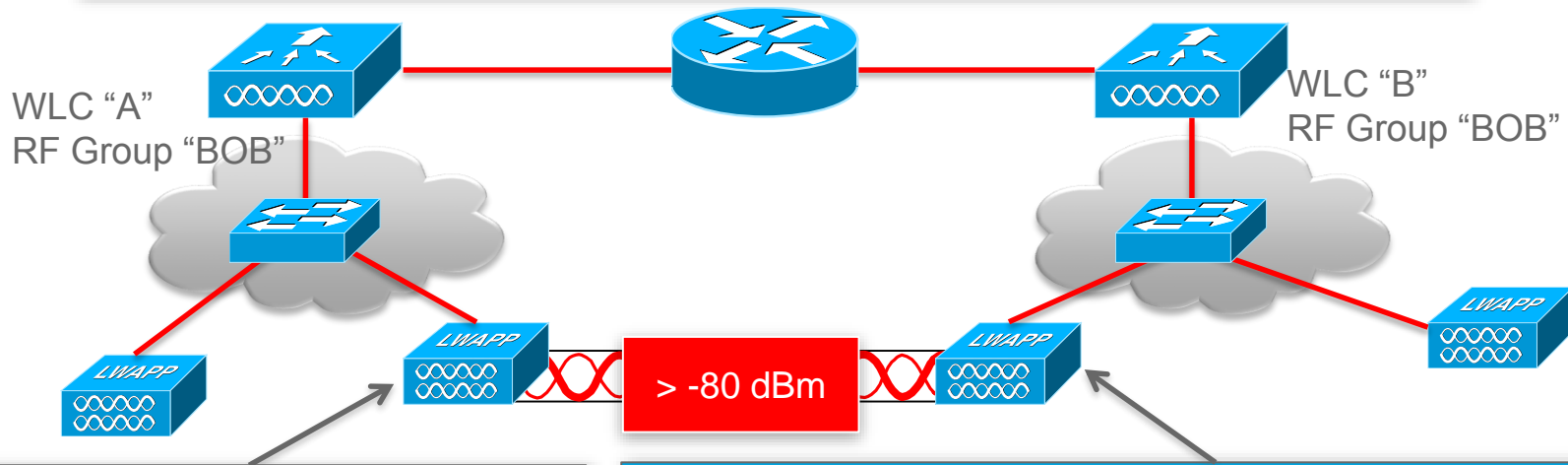
Neighbor Messages – are sent at full power and the Lowest possible data rate to probe the edges of Propagation.

RF Neighborhoods cross controller boundaries, AP's belonging to the same RF Group that can hear others Neighbor Messages will be organized into The same RF Neighborhood. The threshold for inclusion is -80 dBm. AP's will be dropped from a particular neighborhood if the signal falls Below -85 dBm.

Neighbor Messages = OTA – Over The Air - RF analysis

- Neighbor AP messages are sent every 60 seconds at highest power and lowest data rate (1 mbps on 2.4 GHz, 6 mbps on 5 GHz)

- Neighbor Messages are used by receiving APs and their WLCs to determine how to create inter and Intra-WLC RF Groups and Physical RF Neighborhoods

- Each AP listens for other AP's neighbor messages – and if it's RF Group name matches – the message is forwarded to it's controller and ultimately to the RF Group leader

- A list is maintained for each AP in the RF Group of who heard his neighbor messages and how loud

- 8.0 and newer code Neighbor Messages time at 5 x the neighbor interval (typically 15 minutes – 5 x 3 min. = 15) else 60 Minutes. 8.1 this is configurable – but more time is better
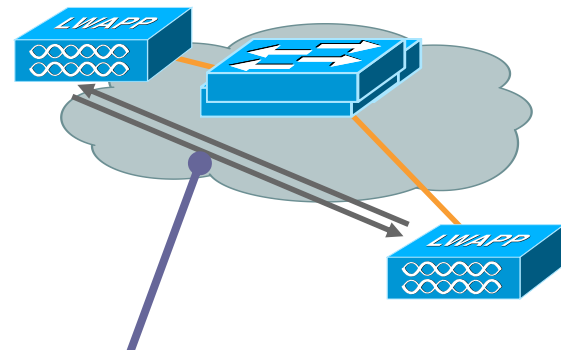
Neighbor messages are sent from each AP to multicast address - 01:0B:85:00:00:00

NDP - Retention

- Prior to 8.0 NDP Pruning interval was 60 Minutes

- 8.0 and later – default changed to 15 Minutes

- New command added in 8.1 – Neighbor Timeout Factor

- GUI = Wireless=>802.11a/b=>General

- Channel Scan Interval x Factor = pruning interval

180(s)x5 (factor) = 900 (s) or 15 Minutes

A Factor or 20 – restores Legacy Function

(Cisco Controller) >config advanced 802.11a monitor timeout-factor <5-60>

802.11a > RRM > General

Profile Threshold For Traps

Interference (0 to 100%)	10
Clients (1 to 200)	12
Noise (-127 to 0 dBm)	-70
Utilization (0 to 100%)	80

Noise/Interference/Rogue/CleanAir[1] Monitoring Channels

Channel List	Country Channels ▼

Monitor Intervals (60 to 3600 secs)

Channel Scan Interval	180
Neighbor Packet Frequency	180
Neighbor Timeout Factor (5 to 60)	5

Factory Default

Set all Auto RF 802.11a parameters to Factory Default.

Set to Factory Default

Why does NDP Pruning time matter?

- NDP is probability argument

- AP's listen for others while off channel

- NDP is sent on every channel – while Off Channel

- NDP can be Deferred for:
  - Voice Packets in Queue within the last 100 ms
  - No Tx Opportunity (it's just another packet – it has to clear CCA)
  - High Noise and Very Busy (high Channel Utilization) affect it

- DCA, TPC, and FRA Rely largely on NDP – and will be affected by changing Neighbor Relationships

- Increased Channel Changes or FRA Stability is the symptom of not retaining long enough

802.11a > RRM > General

Profile Threshold For Traps

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Noise/Interference/Rogue/CleanAir[1] Monitoring Channels

Channel List   Country Channels ⬍

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Factory Default

Set all Auto RF 802.11a parameters to Factory Default.

[Set to Factory Default]

Wait, More isn't Better?

- Disabling an AP, removes it from the Air

- The AP will be seen in Neighbor Relations - through NDP Pruning Time

- 7.6 and below – you will see the AP as a neighbor in Prime for 1 hour

- 8.0 and above – 15 Minutes

- However – if NDP is competing in a harsh environment – you will need longer retention in order to smooth the NDP results

- NDP – is NOT Client Traffic – so is a cost to throughput

- Adjusting this correctly for YOUR environment is the Key

RF Grouping Maximums 8.2/8.3 releases and Hierarchy

- Max AP's refers to Licensed count

- Max AP RF Group size means active AP's – not the aggregate license count of the controller from 7.0 forward.
  - Prior to 7.0 it was license count per controller. i.e. 5508-500 counted as 500 AP's regardless of how many where actually present.

- No worries if you exceed the RF group size – another will form – NOT a problem.

GroupLeader WLC	Max AP's	Max AP per RF Group
2500	75	500
WLCM2	50	500
3850	50	500
vWLC (small)	200	1000
5508	500	1000
WiSM2	1000	2000
5760	1000	2000
vWLC (large)	2000	2000
7500	6000	6000
8500	6000	6000

DBS – Dynamic Bandwidth Selection

Dynamic Bandwidth Selection - Problem

Selecting a channel width is challenging! We are not all RF GURUS!!

Guidelines when to use Channel Bonding

- **Use 20 MHz channels**
  - If using voice only – or the spectrum has lots of radar activity forcing channel changes
  - If you have lots of non 11n/ac capable 5 GHz clients (early .11a clients)
  - If you have light/medium data requirements
  - You have lots of non 11ac APs already @ 20 MHz & no plans to upgrade
- **Use 40 MHz channels**
  - If using interactive or streaming video
  - If requirements are for moderate or heavy data usage
- **Use 80 MHz channels**
  - If using a significant amount of .11ac capable clients
  - If you have lots of .11ac smart phones (1-SS) and need faster throughput
  - High Definition Video streaming or other multimedia rich content applications
  - Heavy data usage for high throughput - Example (CAD or medical documents)
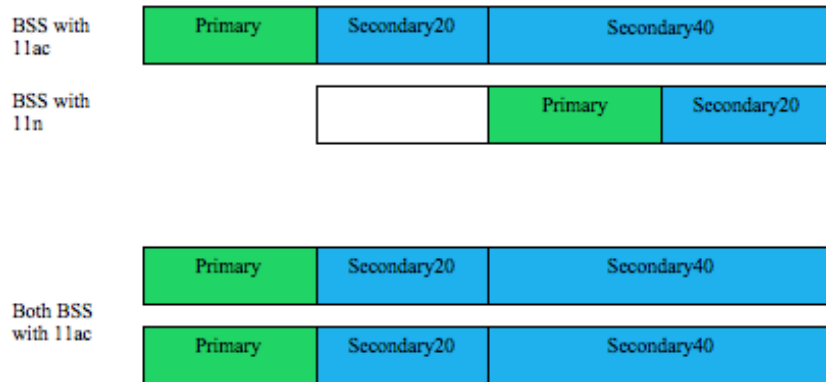
One of the real benefits of bonding is spectrum efficiency and overall system capacity. By allowing the clients to send and receive more data in a shorter period of time, the airwaves clear faster for other users and in some cases even battery life on the client device increases as it spends less time in power draining transmit mode.

Dynamic Channel Assignment Algorithm

Channel Assignment Method	⦿ Automatic	Interval: 10 minutes ⇕ AnchorTime: 0 ⇕
	○ Freeze	Invoke Channel Update Once
	○ OFF	
Avoid Foreign AP interference	☑ Enabled	
Avoid Cisco AP load	☐ Enabled	
Avoid non-802.11a noise	☑ Enabled	
Avoid Persistent Non-WiFi Interference	☐ Enabled	
Channel Assignment Leader	SmartRoam-TME-Lab (172.20.227.100)	
Last Auto Channel Assignment	371 secs ago	
DCA Channel Sensitivity	Medium ⇕ (15 dB)	
Channel Width	○ 20 MHz ○ 40 MHz ⦿ 80 MHz	
Avoid check for non-DFS channel	☐ Enabled	

Dynamic Bandwidth Selection - Solution

- Dynamic Bandwidth Selection (DBS) makes Dynamic Channel Assignment (DCA) easy
  - Uses DCA metrics to select the best channel, regardless of width
  - Calculates best channel/width using the following metrics:
    - Associated Client types
    - RF Neighbor Channel Widths
    - OBSS Channel Overlap ratio
    - Channel Utilization
    - Non-Wi-Fi Noise
    - Wi-Fi interference

BSS with 11ac	Primary	Secondary20	Secondary40
BSS with 11n		Primary	Secondary20
Both BSS with 11ac	Primary	Secondary20	Secondary40
	Primary	Secondary20	Secondary40

DCA and DBS calculation

"debug airewave-director channel enable"

- **DBS calculates Client Capabilities**

  DBS bs 0 #ac/n/a/vo/vi

  2/0/0/ 0/ 0

- Then assigns penalties

  P 80/40/20/vo/vi

  0.00/6.00/6.00/0.00/0.00

- And recommends 80 MHz

  80 Mhz recommended Channel Set:


```
>>>>>>>>>>>>>>>>>>>>>> groupDCACheck
08:cc:68:b4:20:60 : Computing channel assignment for AP 08:CC:68:B4:20:60(1)
: LRAD is profile member. Fetching profile data...

08:cc:68:b4:20:60   RRM Chan Assignment Mode: 2 Lrad Capability: 2 DCA Channel Width: 2

08:cc:68:b4:20:60 : Not using chan = 40 on AP 08:CC:68:B4:20:60(1) because of secondary20
08:cc:68:b4:20:60 : Not using chan = 52 on AP 08:CC:68:B4:20:60(1) because of secondary20
08:cc:68:b4:20:60 : Not using chan = 136 on AP 08:CC:68:B4:20:60(1) because of secondary20
08:cc:68:b4:20:60 : Not using chan = 157 on AP 08:CC:68:B4:20:60(1) because of secondary20
08:cc:68:b4:20:60 DBS bs 0 #ac/n/a/vo/vi  2/0/0/0/0 p 80/40/20/vo/vi  0.00/6.00/6.00/0.00/0.00 0/1536/1536/0/0
08:cc:68:b4:20:60   80Mhz Recommended Channel Set: 112 108 100 104 with Best Metric:-71.04
08:cc:68:b4:20:60   Alternative 80Mhz channel set: 0 0 0 0 with Best Metric: -71.04
08:cc:68:b4:20:00
```

CLIENTS				
Name	AP Name	Protocol	Connection ...	Status
unknown	upac	802.11ac	867 Mbps	Online
unknown	upac	802.11ac	433 Mbps	Online
unknown	downac	802.11ac	325 Mbps	Online
unknown	upstairs_3602e	802.11n	150 Mbps	Online
unknown	downac	802.11n	0 Mbps	Online
unknown	downac	802.11n	0 Mbps	Online

More Debug – DBS calculations

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.424: 64:d9:89:46:7f:b0 DBS bs 0 #**ac/n/a/vo/vi 0/0/0/0/0** p 80/40/20/vo/vi 0.00/0.00/6.00/0.00/0.00 0/0/1536/0/0

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.424: 64:d9:89:46:7f:b0 **Mix Mode Recommended** Channel Set: 132 0 0 0 with Best Metric:-80.91

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.426: 64:d9:89:43:4d:50 DBS bs 1 #**ac/n/a/vo/vi 0/1/0/0/0** p 80/40/20/vo/vi 0.00/0.00/6.00/0.00/0.00 0/0/1536/0/0

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.426: 64:d9:89:43:4d:50 **Mix Mode Recommended** Channel Set: 56 0 0 0 with Best Metric:-80.85

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.430: f4:0f:1b:b2:8d:80 DBS bs 0 #ac/n/a/vo/vi 0/0/0/0/0 p 80/40/20/vo/vi 0.00/6.00/6.00/0.00/0.00 0/1536/1536/0/0

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.430: f4:0f:1b:b2:8d:80 **80Mhz Recommended** Channel Set: 149 153 157 161 with Best Metric:-71.02

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.434: 08:cc:68:b4:20:60 DBS bs 0 #ac/n/a/vo/vi 2/0/0/0/0 p 80/40/20/vo/vi 0.00/6.00/6.00/0.00/0.00 0/1536/1536/0/0

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.434: 08:cc:68:b4:20:60 **80Mhz Recommended** Channel Set: 112 108 100 104 with Best Metric:-71.04

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.437: 08:cc:68:b4:20:00 DBS bs 0 #ac/n/a/vo/vi 1/1/0/0/0 p 80/40/20/vo/vi 0.00/6.00/6.00/0.00/0.00 0/1536/1536/0/0

- *RRM-MGR-5_0-GRP: Oct 06 17:53:12.437: 08:cc:68:b4:20:00 **80Mhz Recommended** Channel Set: 36 40 44 48 with Best Metric:-70.30

Dynamic Bandwidth Selection Configuration

- Wireless->802.11a/b->RRM->DCA

Dynamic Channel Assignment Algorithm

Channel Assignment Method	⦿Automatic Interval: 10 minutes ⇕ AnchorTime: 0 ⇕
	○Freeze **Invoke Channel Update Once**
	○OFF
Avoid Foreign AP interference	☑ Enabled
Avoid Cisco AP load	☐ Enabled
Avoid non-802.11a noise	☑ Enabled
Avoid Persistent Non-WiFi Interference	☐ Enabled
Channel Assignment Leader	Cisco_da:78:24 (172.20.227.99)
Last Auto Channel Assignment	300 secs ago
DCA Channel Sensitivity	Medium ⇕ (15 dB)
Channel Width	○20 MHz ○ 40 MHz ○80 MHz ⦿Best
Avoid check for non-DFS channel	☐ Enabled

- WLC CLI Globally `config advanced 802.11a channel dca chan-width <20/40/80/160/best>`

- WLC CLI Per RF Group `config advanced 802.11a channel dca chan-width <20/40/80/160/best>`

Flex DFS – WLC 8.1

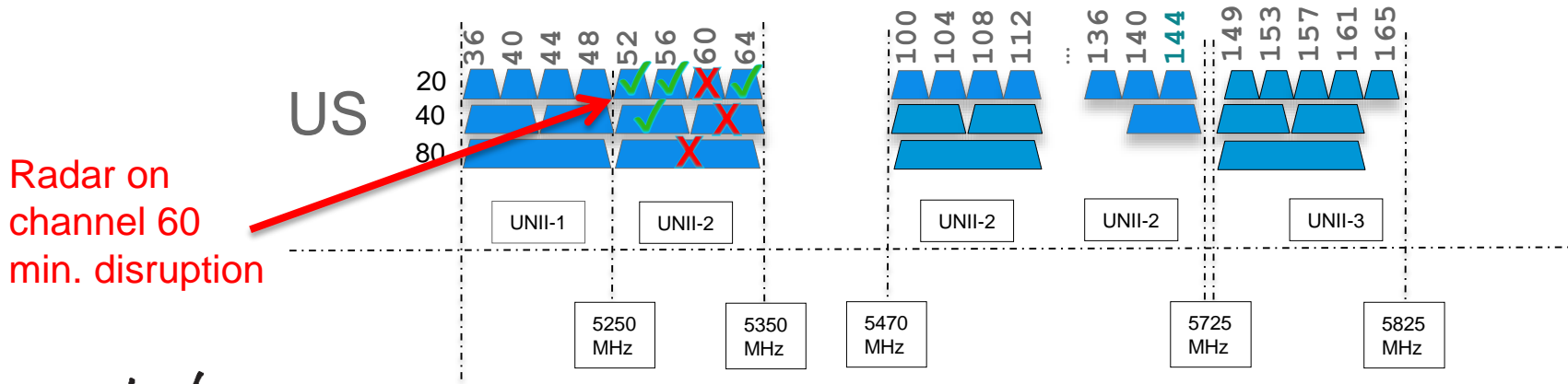# Dynamic Frequency Selection (DFS) - Problem

- **If a Radar Pulse is detected on a DFS channel, then that DFS channel is blocked for 30 mins (the AP cannot operate on that channel)**

- Majority of 5GHz channels require DFS

- There are "radar like" events that may cause false DFS detections due to:
  - Client interference
  - Misbehaving Rogue APs
  - Random Pulses
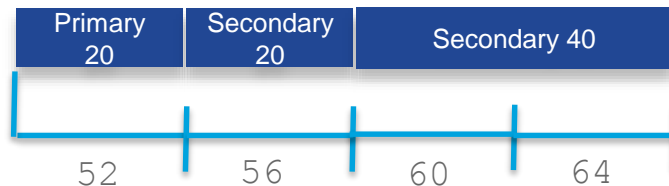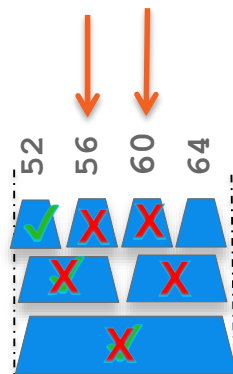
Reg Domain	Total 20MHz Channels	DFS Channels
-A	22	11
-E	15	11
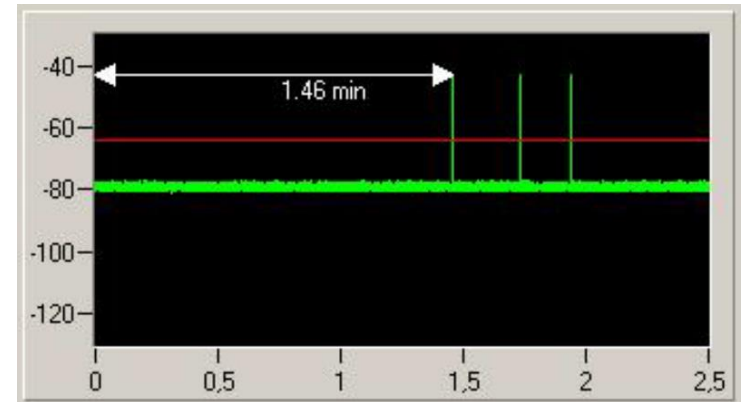
Flex-DFS Solution

- **Uses the CleanAir sAgE Chipset to Detect DFS Events**
  - Identify Radar frequency narrowed down to 1Mhz.
  - Prevent False or Off-Channels Radar alarms

- Integrated with DBS to select correct channel widths
  - Radar only affects a 20MHz Channel
  - Prevents additional 20/40MHz channels from going unused

Radar on channel 60 min. disruption
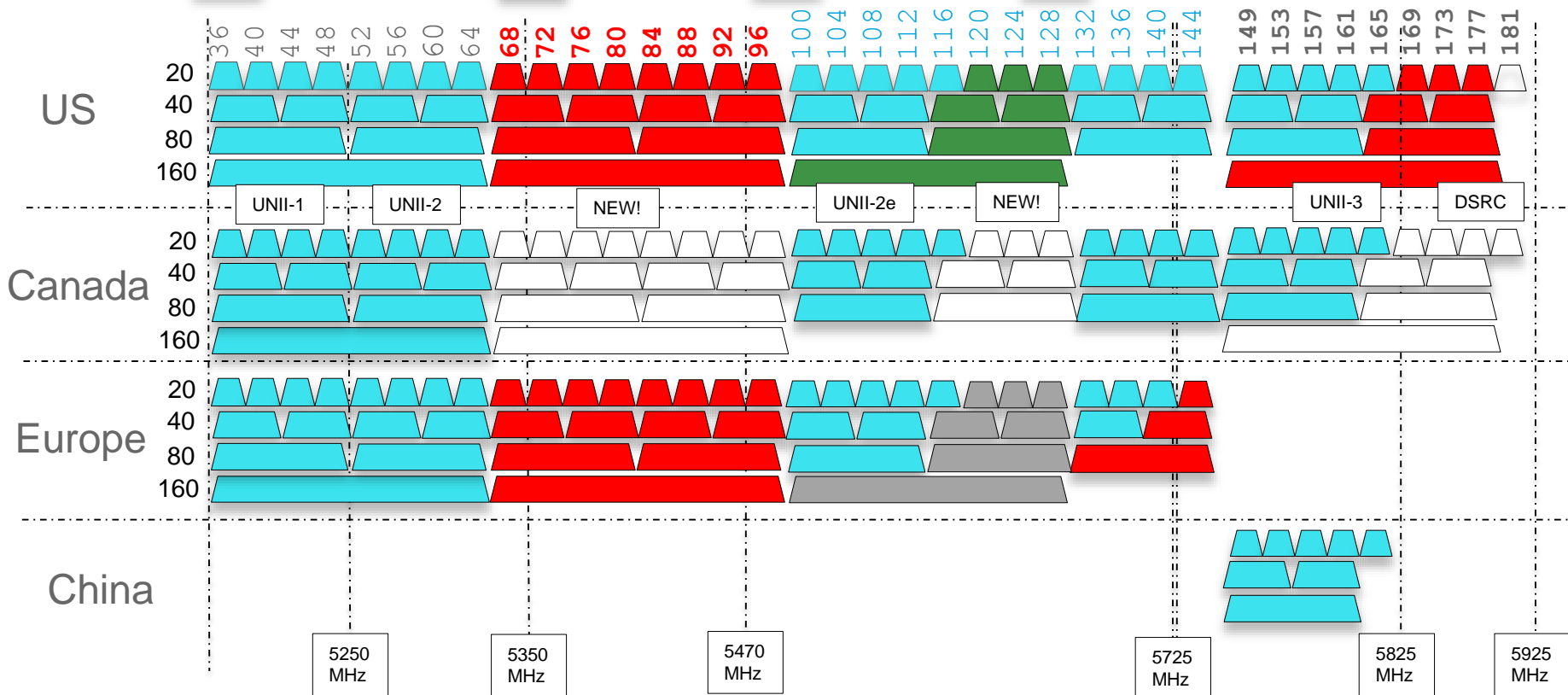
US

UNII-1 UNII-2 UNII-2 UNII-2 UNII-3

5250 MHz   5350 MHz   5470 MHz   5725 MHz   5825 MHz

Flex DFS and DBS Example

52 56 60 64

40 MHz Channel
80 MHz Channel 52/56/60/64
52/56

Radar Event on channel 56

Primary 20	Secondary 20	Secondary 40

52   56   60   64

US Regulatory Changes
The -B Domain

5 GHz 20/40/80/160 MHz Channel Plans

* DFS for channels 120-128 ETSi requires 10 Minute CAC

Cisco's Industry Standards and Spectrum Leadership
Opening up more 5 GHz for 802.11ac applications (FCC)

- Cisco's dedicated Regulatory Team (lead by Mary Brown) continue to lobby for more wide, non-overlapping channels enabling for better 802.11ac experience

- Current UNII spectrum allows
  - **6x** 80 MHz channels (**Five** in Canada and Europe)
  - **2x** 160 MHz channels (**One** in Canada)

- Additional unlicensed use of 5.35-5.47 GHz and 5.85-5.925 GHz would allow
  - **Thirty six** 20 MHz channels,
  - **Eighteen** 40 MHz channels
  - **Nine** 80 MHz channels
  - **Four** 160 MHz channels

Cisco team goal is all 5 GHz bands in FCC in mid-2016, followed shortly in Europe, and then discuss our findings with ITU-R at WRC-18

Wi-Fi coex with ITS/DSRC gets us
i) two extra 40's
ii) another 80 (outside of DFS)
iii) an additional 160 (the only 160 that is outside DFS !)
iv) more channels for indoor mesh/IoT
v) three extra 20's (the same amount of spectrum available at 2400 – 2474 MHz)
vi) helps recover spectrum potentially made unusable by LTE-U

New 5 GHz Channels totaling 60 MHz = ALL of available 2.4 GHz channels today
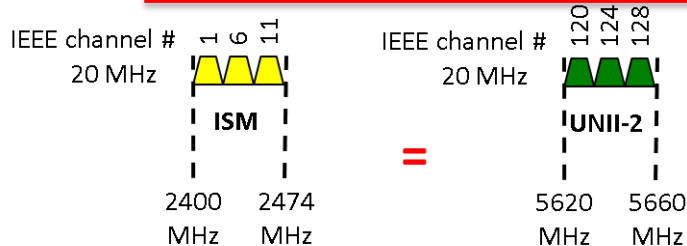
This is an FCC Regulatory Update

- 3600/2600 3700/3800 Gen 2 AP's may be upgraded

- Upgrade process involves new controller Image (currently 8.0 based)

- Cisco Employee – MUST do the update

- Files can NOT be left with Customer or On their controller (Primary/Backup)

- Once AP's are Updated – THERE IS NO GOING Back

- AP's will only be supported on Controller Images containing –B AP Builds 8.0 and forward – no older images
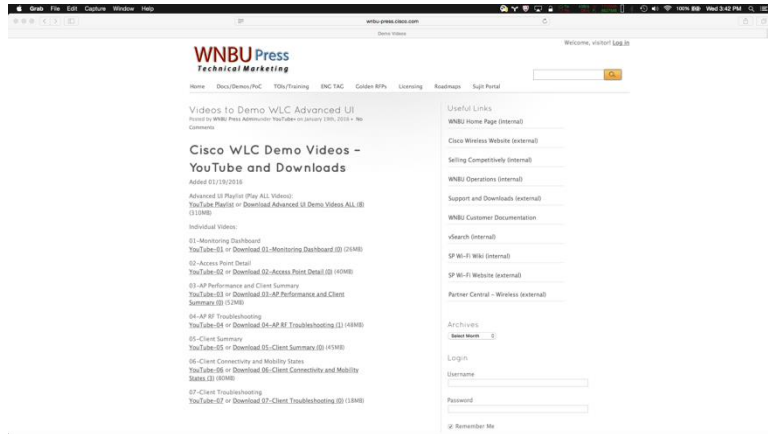
- Detailed deployment guide to come

Learning Resources

Additional Recent Documents

- [Cisco 8.2 RRM White Paper](#)

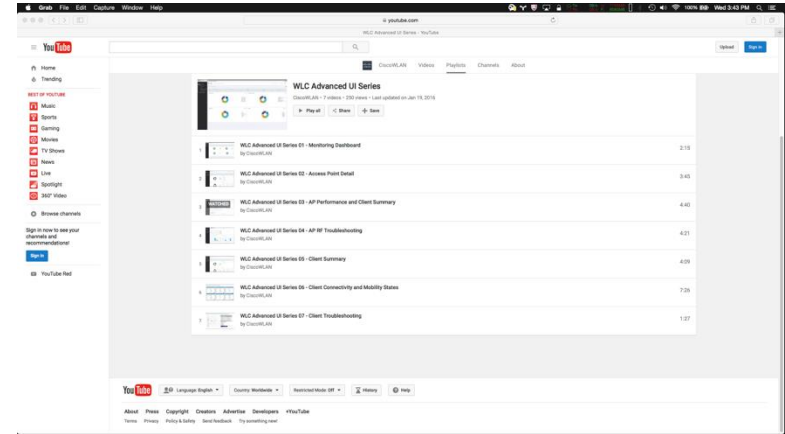- [Wireless Lan Controller - Technical Reference Page](#)

Where can I learn more?

WNBU Press

YouTube Channel

http://wnbu-press.cisco.com/

https://www.youtube.com/user/CiscoWLAN

Summary

Summary

- Evaluating what the goal of your network is on a regular basis will enable you to make better design decisions

- Good tools make and defend good decisions

- Eliminating spectrum hogs should be first priority – strongly consider eliminating anything not OFDM all together (Legacy 802.11b)

- Understand how RRM is evolving

- Let RRM, DCA and HDX help you – to help you.

Links/References

- [Cisco 802.11n Design and Deployment Guidelines](#)

- [Cisco High Density Wireless Lan Design Guide](#)

- [Cisco Client Link White Paper](#)

- [Client Link testing – Miercom](#)

- [Client Link 2 Testing - Miercom Report Cisco 3600e/i](#)

Recommended Reading
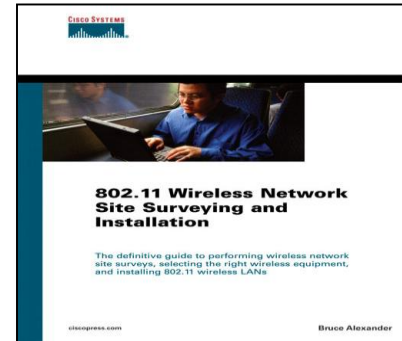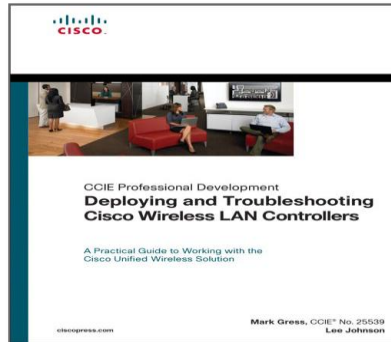
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Thank you