
TOMORROW
starts here.
CISCO
Cisco live!

Design and Deployment of Outdoor Wireless Mesh

BRKEWN-2667

Matt Fowler

Consulting Systems Engineer

#clmel

Session Agenda

- Why Outdoor Wireless is important
- Products and Deployment Modes
- Important Features
- Design Recommendations / Best Practices

Why Use Cisco Wireless?

Cost effective

- Unlicensed spectrum
- Availability of client devices
- Zero on-going communication costs

Standardised

- IEEE 802.11
- Can deliver throughput where you want it
- It's global. Same Frequencies everywhere

Cisco Innovation

- 802.11a/b/g/n/ac
- Attention from the industry (ex. Security)
- Clientlink
- CleanAir
- HDX
- Cisco Manageability

Scalability & Ease of use

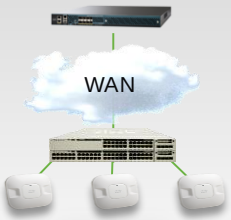
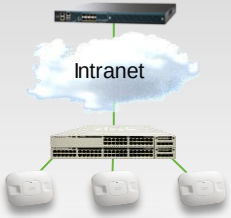
- Just keep on adding nodes
- Low impact for new sites
- Outdoor extension of the indoor Wireless LAN

It’s an 802.11ac Wi-Fi World!

- Extend indoor Enterprise coverage outdoor
- Upwards of 50% of enterprise traffic will originate on WiFi by 2017
- Half (50%) of all new Wi-Fi devices in 2014 will be 802.11ac capable (ABI Research)
- 802.11ac Wave 1 can fulfill smartphone and tablet bandwidth requirements for 5+ years
- 802.11ac improves battery efficiency by 2x for smartphones, tablets, and laptops

Cisco Outdoor Wireless Overview

Supported Outdoor Models

	Autonomous	FlexConnect/Flex +Bridge	Centralised
	 Standalone APs	 Traffic Distributed at AP	 Traffic Centralised at Controller
Best suited for	**P2P/WGB Bridges**	**Branch Outdoors**	**SP/Enterprise**
Benefits	• Simple and cost-effective for small networks	• Highly scalable for large number of remote branches • Simple wireless operations with DC hosted controller	• Simplified operations with centralised control for Wireless • Wireless Traffic visibility at the controller • Bridge/Local modes
Key Considerations	• Limited RRM, • L2 roaming only	• L2 roaming only • WAN BW and latency requirements	• System throughput

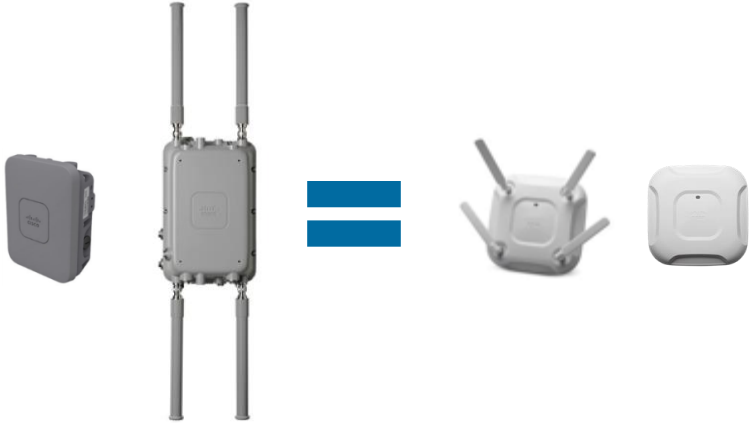
There are multiple ways to achieve the same solution

- Deploying an outdoor network is expensive and time consuming
- This session will help provide information so YOU:
  - Plan networks around your end users needs
  - Select the correct operating mode for your network
  - Meet your businesses needs

Cisco Outdoor Centralised/Flexconnect Overview

Access Point Modes Overview

- All Cisco Access Points Support:
  - Local mode
  - Monitor mode
  - Flexconnect Mode
  - Bridge Mode
  - Flex + Bridge Mode (new to 8.0 release)
  - Sniffer Mode
  - Rogue Detector Mode



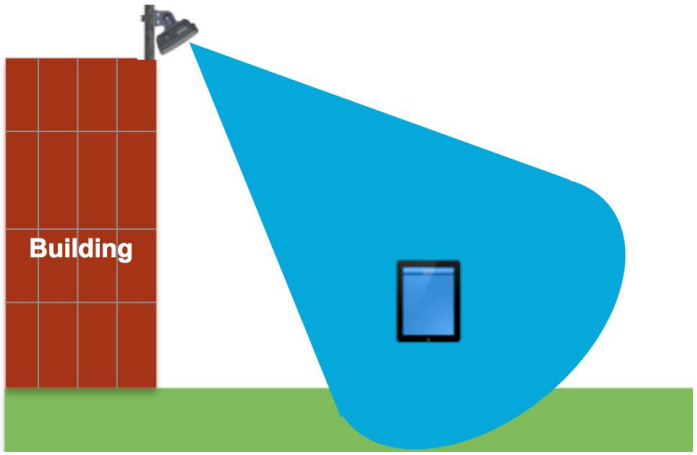
- Why use a AP15XX, not an indoor AP?
  - Ruggedised AP (IP67 rated)
  - Transmits at higher power levels (depending on Regulatory Domain)
  - Meets outdoor regulatory constrains
  - No expensive NEMA enclosure

AP Modes Supported (7.3 release and later)

Local Mode vs. Bridge Mode

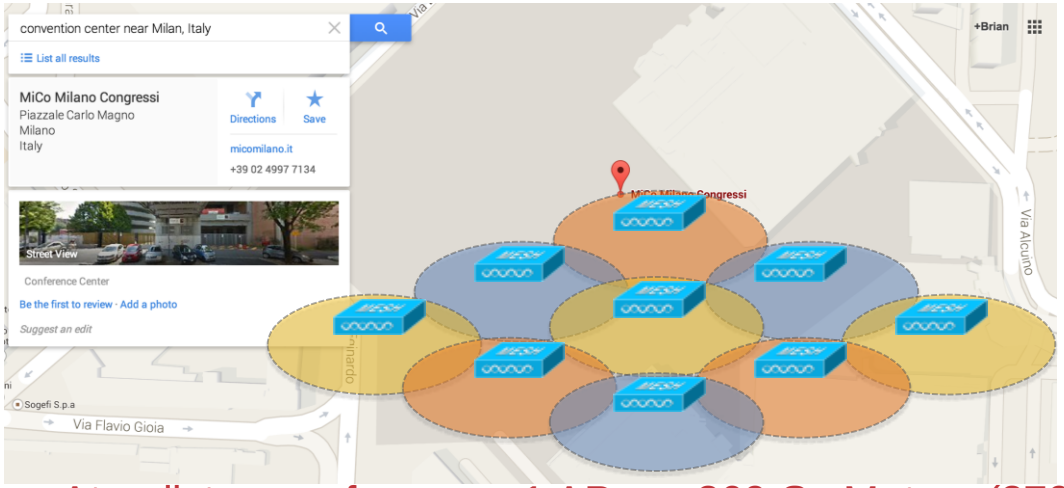
Life is full of Trade-offs

Local Mode	Bridge Mode
+100% Client Access on both 2.4 and 5GHz	-5GHz for Backhaul, can be shared for 5GHz client access
-Requires wired Ethernet drop per AP including cabling and installation costs	+Does not require wired Ethernet drop, only power
Should be used for High Density Deployments	Should be used cover large areas
Use Case: Large City deployment	Use Case: Open Mining Facility



Use Case 1: High Density City Deployment

WLC 8510 with HA

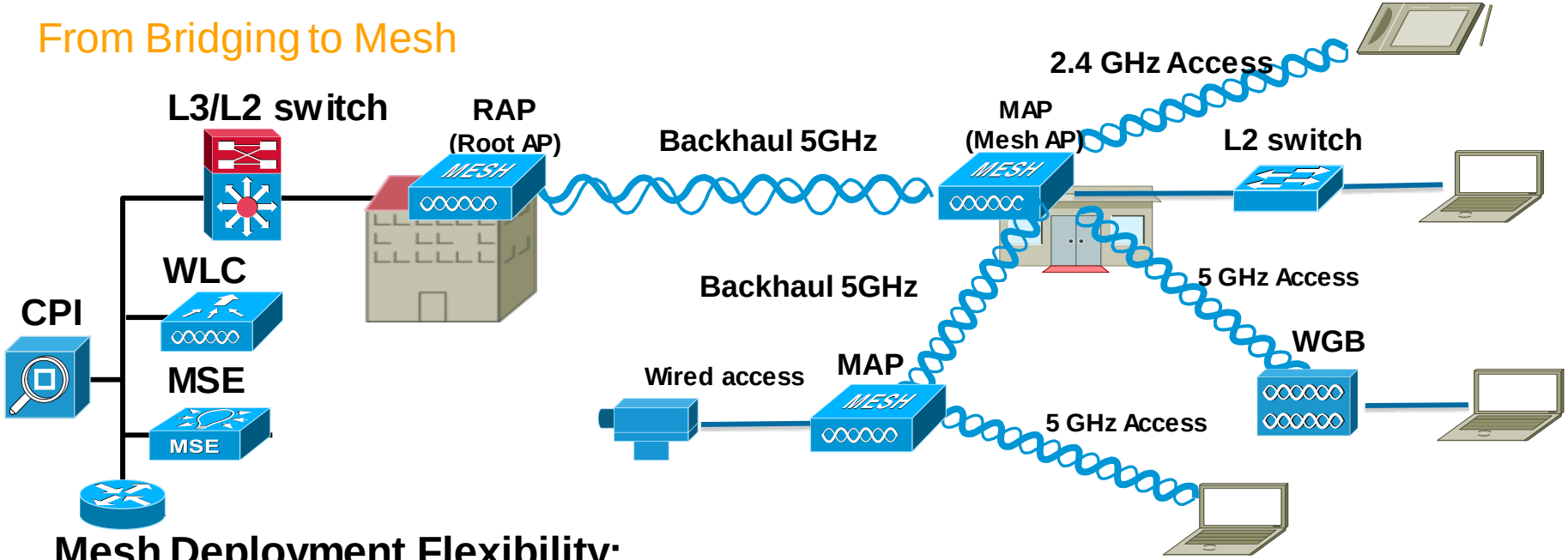


- At a distance of approx: 1 AP per 260 Sq Meters (2700 Sqft)
- Depending on client density APs can be spaced closer/farther
- Directional antennas / HDX features allow more additional APs
- APs should be in Local/Flexconnect mode
- RRM should be enabled with full HDX feature set

Bridge Mode

Cisco Outdoor Mesh Architecture Overview

From Bridging to Mesh



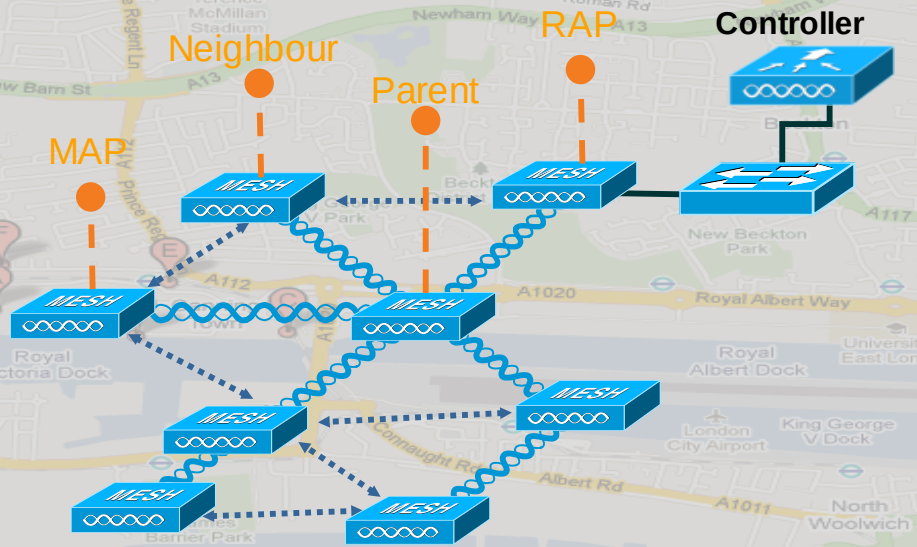
Mesh Deployment Flexibility:

- LAN-to-LAN connectivity
- Multiple hop backhaul
- 2.4 GHz and 5GHz wireless client access
- Ethernet Access to wired clients
- LAN-to-LAN in motion with Work Group Bridge (WGB)

What is Mesh?

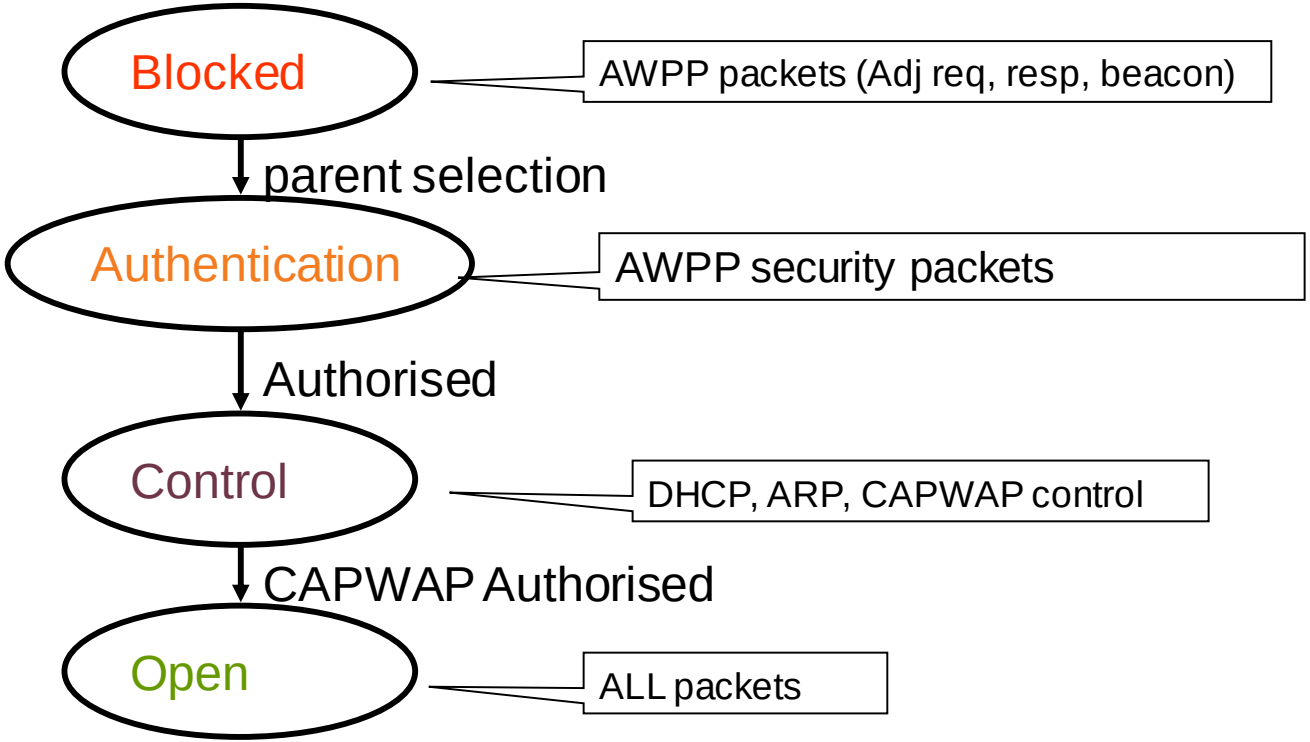
Self-configuring, Self-healing Mesh

- Optimal parent selection selects the path "ease" across each available backhaul
- Ease based on number of hops and link SNR (Signal Noise Ratio)
- AWPP uses a "Parent Stickiness" value to mitigate Route Flaps
- AWPP integrates 802.11h DFS (Dynamic Frequency Selection) for radar detection and avoidance
- From release 7.0.116 preferred parent can be configured



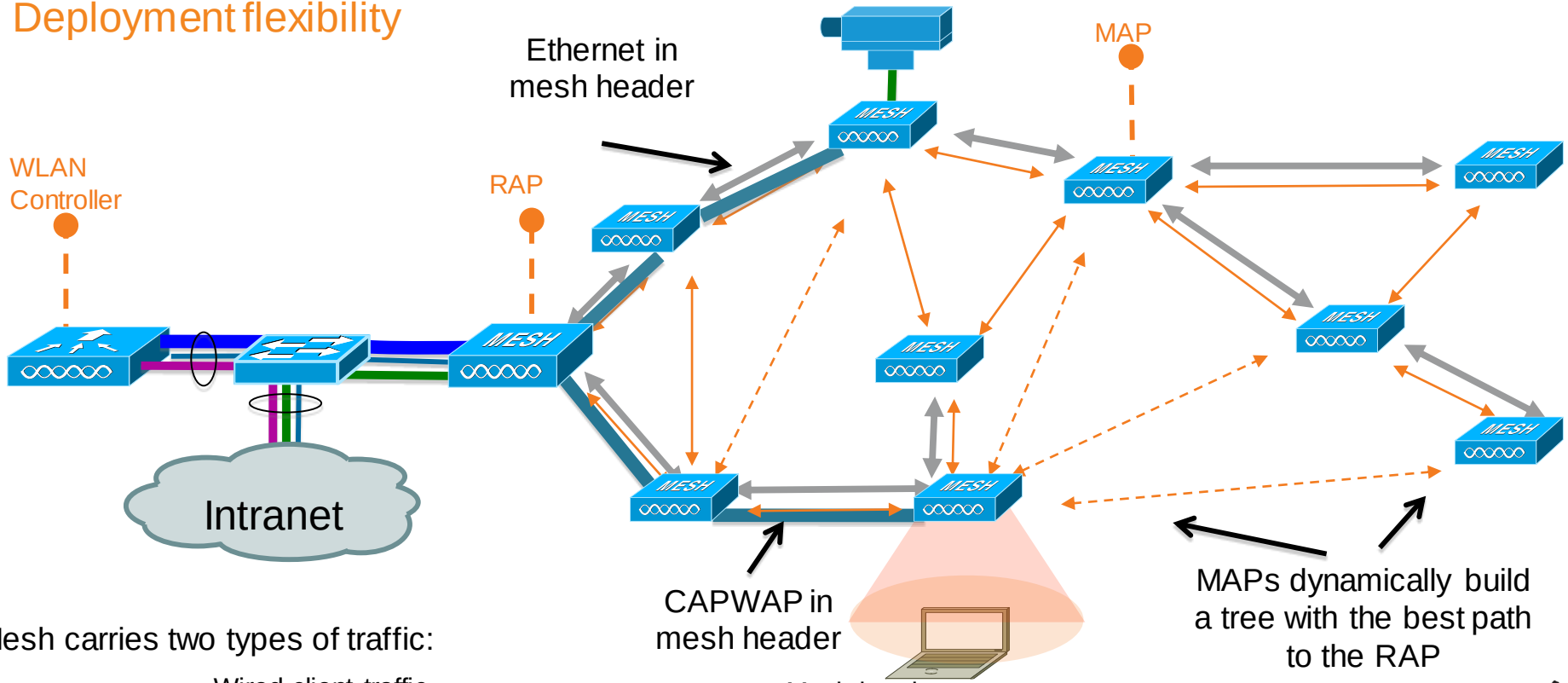
Adaptive Wireless Path Protocol (AWPP) establishes the best path to the Root

Port-control (port-filtering)



How Does Traffic Pass in a Bridge Mode Deployment?

Deployment flexibility



Mesh carries two types of traffic:

- Wired client traffic
- Wireless client traffic
- Mesh header
- CAPWAP traffic

Mesh Fast Convergence

	Parent Loss Detection / Keep Alive Timers	Channel Scan/Seek	DHCP / CAPWAP Information	Time per hop (sec)**
Standard	21 / 3 sec	Scan/Seek all 5GHz channels	Renew / Restart CAPWAP	48.6*
Fast	7 / 3 sec	Scan/Seek only channels found in same bridge group	Maintain DHCP and CAPWAP	20.5*
Very Fast	4 / 1.5	Scan/Seek only channels found in same bridge group	Maintain DHCP and CAPWAP	15.9*

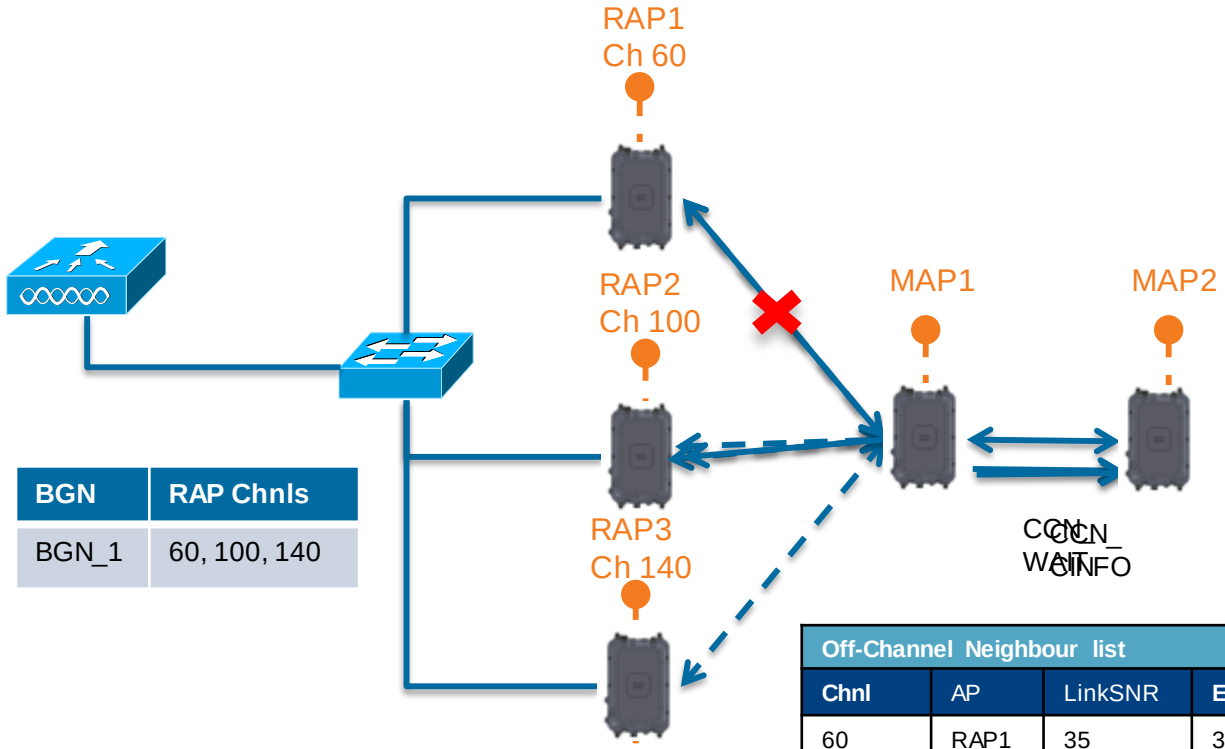
*Number are shown for same WLC, same Channel, and same Subnet. Times are longer if these variables are changed

**Number are part of early feature test, subject to change as of 8.0 CCO

WLC CLI Configuration only (Warning: Decreasing convergence time can lead to more parents changes)

```
config mesh convergence { standard | fast | very-fast } all
```

Mesh Convergence - Background Scanning Example



BGN	RAP Chnls
BGN_1	60, 100, 140

1. MAP1 Scan for parents
2. Finds Best Parent
3. Background Scans all parents
4. Parent Fails
5. Send CCN_WAIT to children
6. Join New Parent from list
7. Notifies child of channel change

Off-Channel Neighbour list			
Chnl	AP	LinkSNR	**Ease**
60	RAP1	35	3500
	MAP2	30	1200
100	RAP2	25	2500
140	RAP3	10	1000

Available in the 8.1 Release

Cisco Outdoor Mesh Architecture Overview

Scalability at different layers

Access Point

32 MAPs per RAP (>20 recommended)

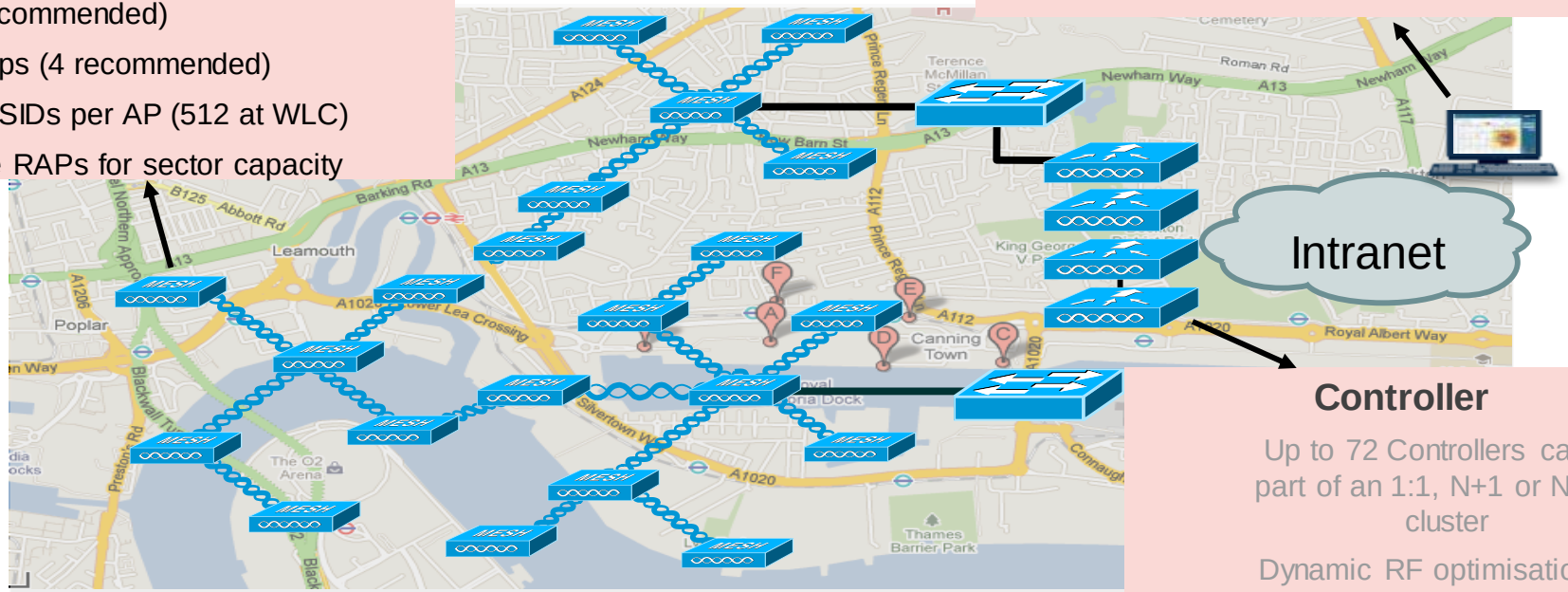
8 Hops (4 recommended)

16 SSIDs per AP (512 at WLC)

More RAPs for sector capacity

Management

Prime manages up to 20,000 APs, 200K wireless Clients



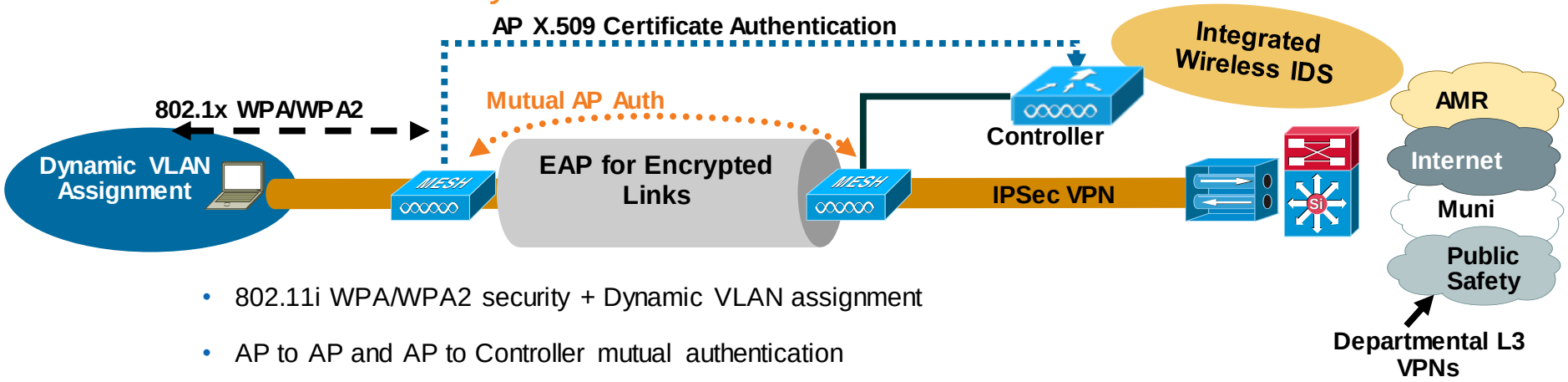
Controller

Up to 72 Controllers can be part of an 1:1, N+1 or N+N+1 cluster

Dynamic RF optimisation on access link for additional radios

Security using Cisco Mesh

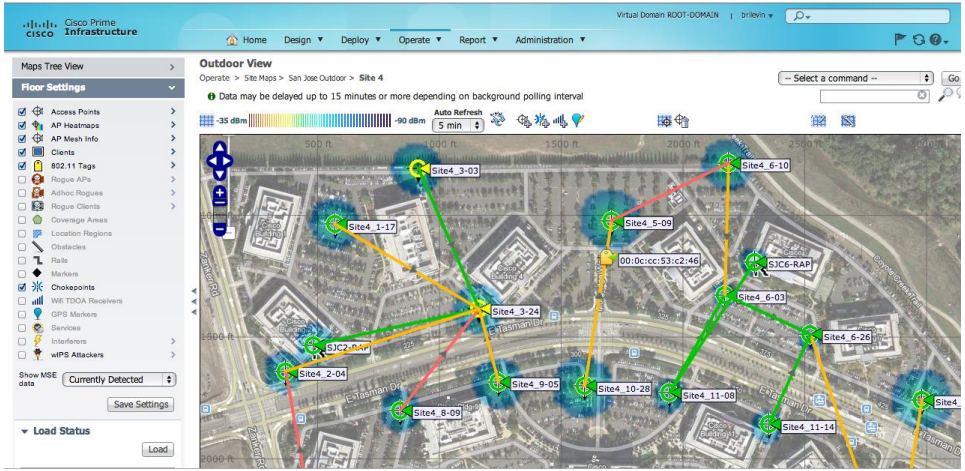
Robust embedded security



- 802.11i WPA/WPA2 security + Dynamic VLAN assignment
- AP to AP and AP to Controller mutual authentication
- EAP authenticated and AES-based encrypted backhaul mesh links
- Encrypted control traffic between AP and Controller
- Rogue AP detection and blacklisting
- Integrated Wireless IDS and Attack correlation software
- Mobile L3 VPNs for “confidential” client traffic
  - Cisco’s AnyConnectVPN Client uninterrupted L3 roaming between Wi-Fi, cellular, etc. networks

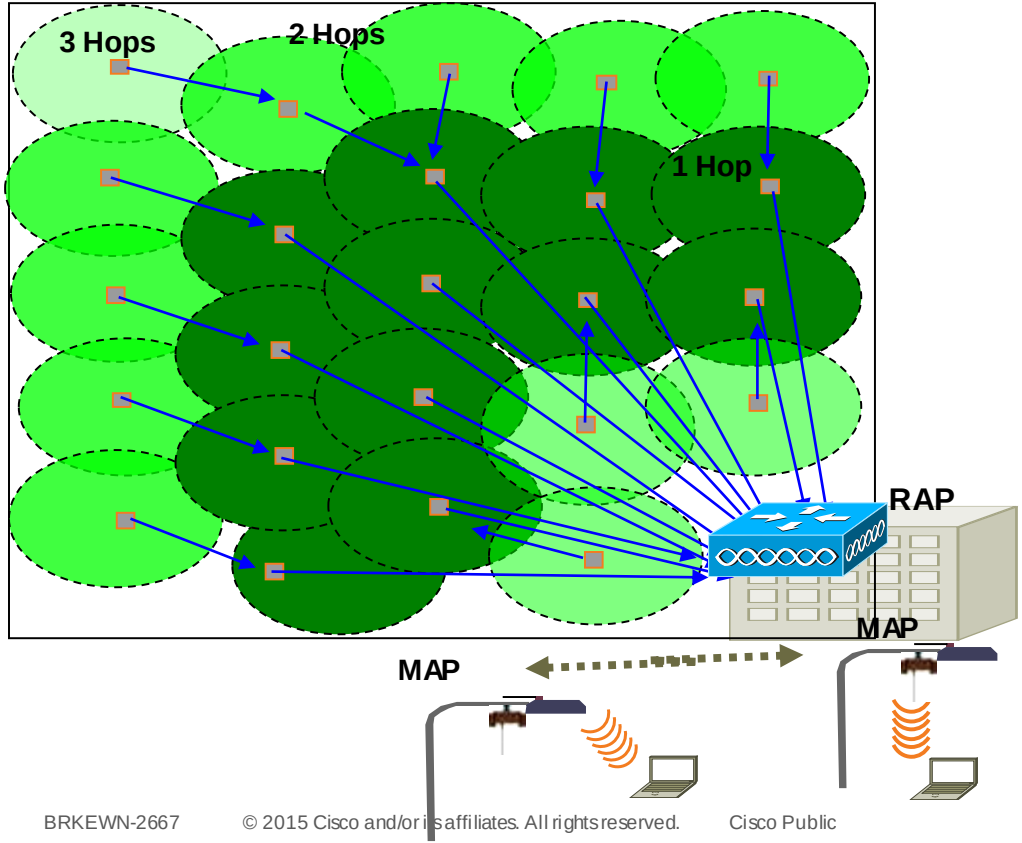
How do I determine how the mesh forms?

- We deploying a mesh network we recommend:
  - Placing Access Points where the desired parent will have the highest linkSNR
  - Setting Bridge Group Names (BGN)
  - Configuring a Preferred Parent



Bridge Groups

Sectorisation (Bridge Group)

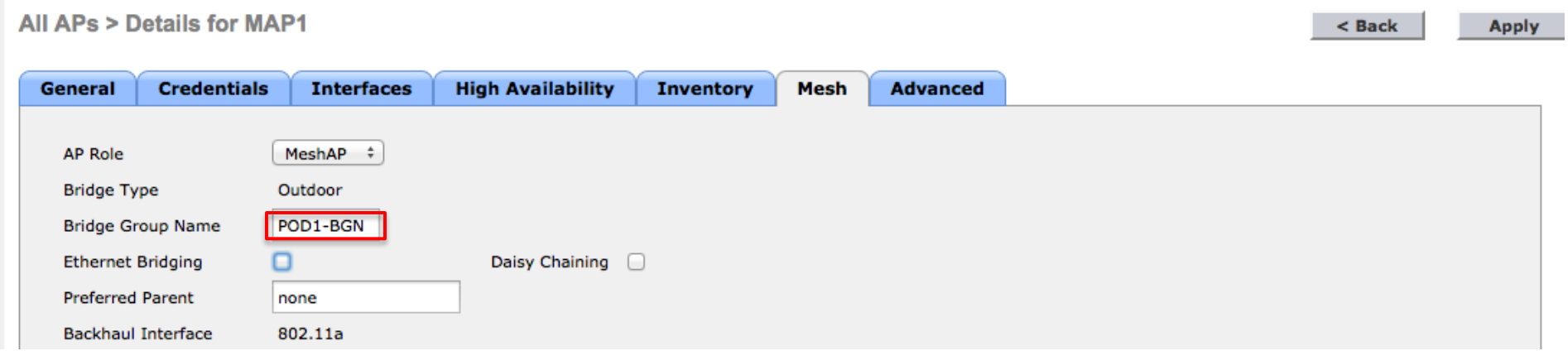


- Logically groups APs and controls the association of the radios
- For adding capacity we recommend that you have more than one RAP in the same sector, with the same BGN, but on different channels
- Having multiple RAPs with same BGN in an area is good for redundancy: when a RAP goes down its MAPs will join a different sector with same name
- A factory default BGN is empty (NULL VALUE). It allows the MAP to do the first association

How to Configure Bridge Groups

Setting Bridge Group Name (BGN)

- `config ap bridgegroupname set MESH-BGN AP_NAME`

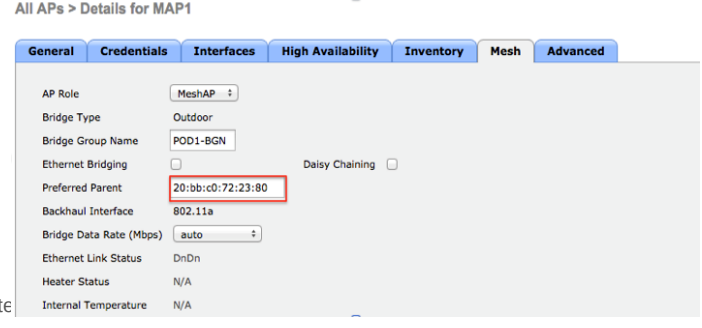


- Use bridge group names to logically group the mesh access points to avoid two networks on the same channel from communicating with each other
- An AP will join a mesh network of another BGN, but after 15 mins, the AP will drop AWPP and scan for its own BGN
- BGN misconfigurations will cause network instability

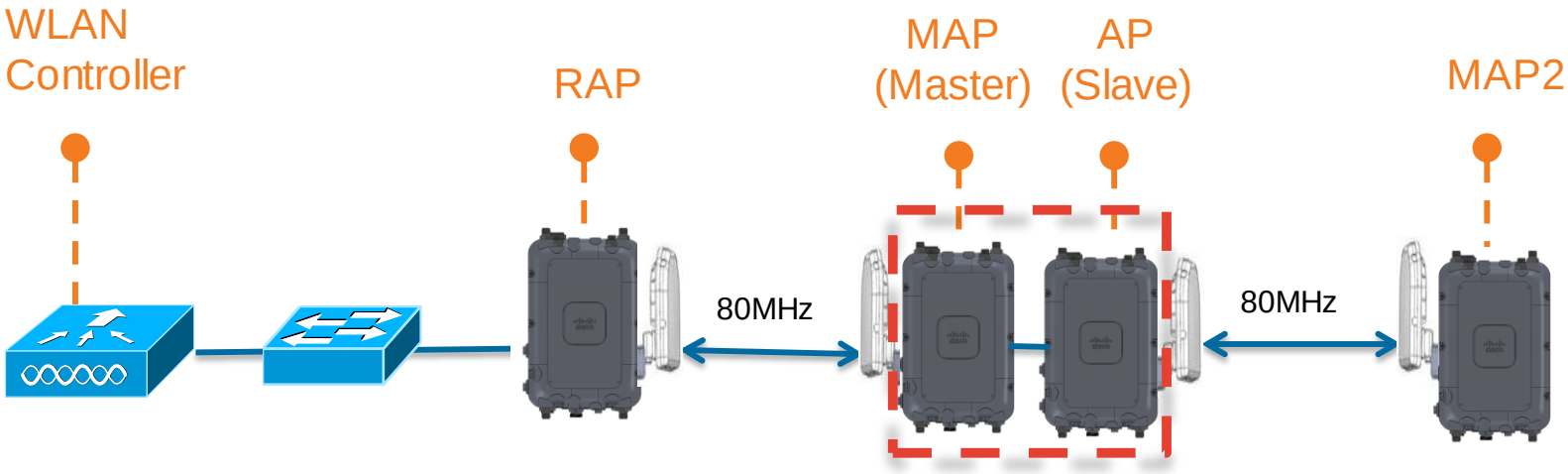
Preferred Parent

Preferred Parent will be selected for the following conditions:

- P.P parent is the best parent
- P.P link SNR is at least 20dB (In this case, other parents, however good, are ignored)
- P.P has link SNR between 12 and 20 dB, but no other parent is significantly better (SNR more than 20% better). For lower than 12dB SNR, P.P configuration is ignored
- P.P is not blacklisted
- P.P is not in silent mode due to DFS.
- P.P is in the same Bridge Group Name (BGN). If no other parent available in the same BGN, the child will join the P.P using the default BGN

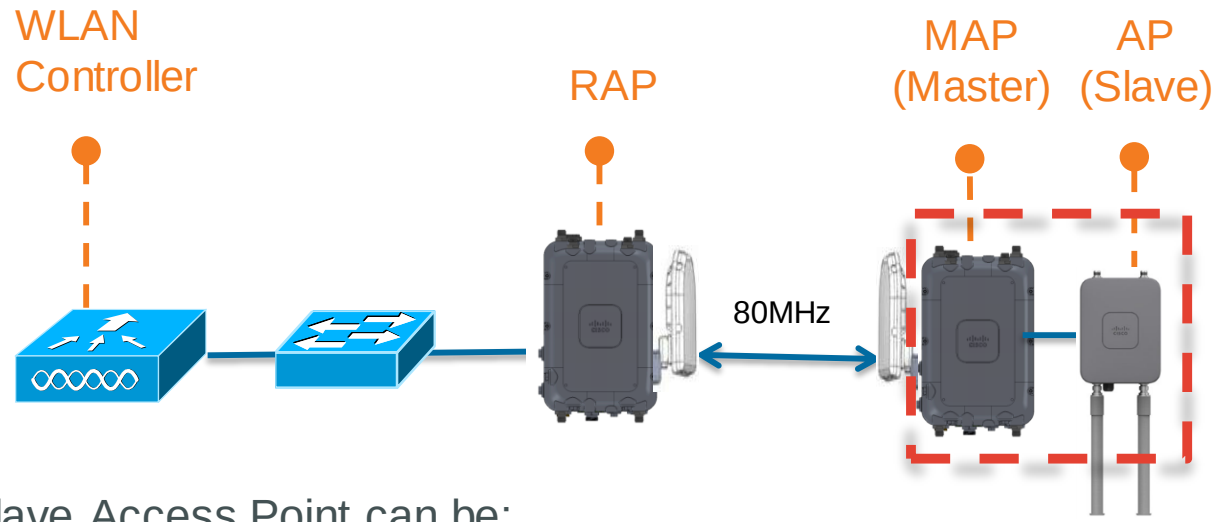


Daisy-chaining: Serial Backhaul Deployments



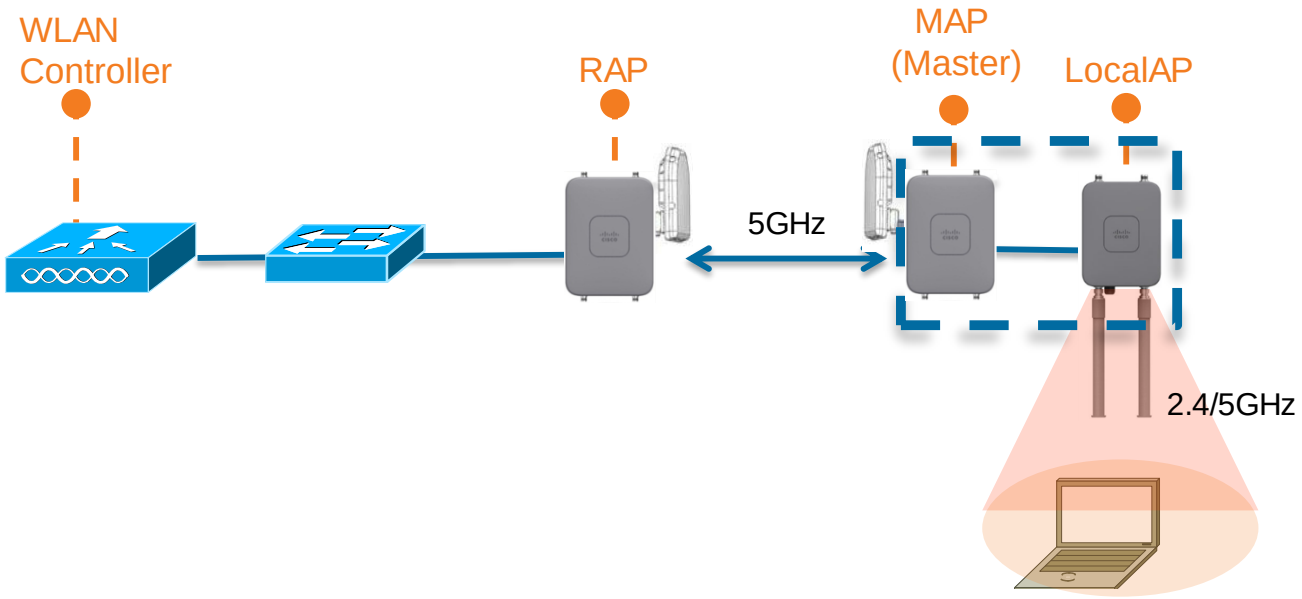
- Both 1532s and 1572s in Bridge Mode can utilise this configuration
- Master MAP & Slave MAP are operating on different 5GHz channels to maximise throughput across the mesh link
- BGN configuration and the Preferred Parent command are recommended to maintain the mesh tree
- Slave MAP must be configured in RAP Mode

Daisy-Chaining: Mixing Access Points



- Slave Access Point can be:
  - 1530 / 1550 / 3700P
- PoE-Out is 802.11at (25.5w), 1532E / 3702P can be powered directly!
- For PoE-Out, the 1572 power source must be AC / DC / or PoC

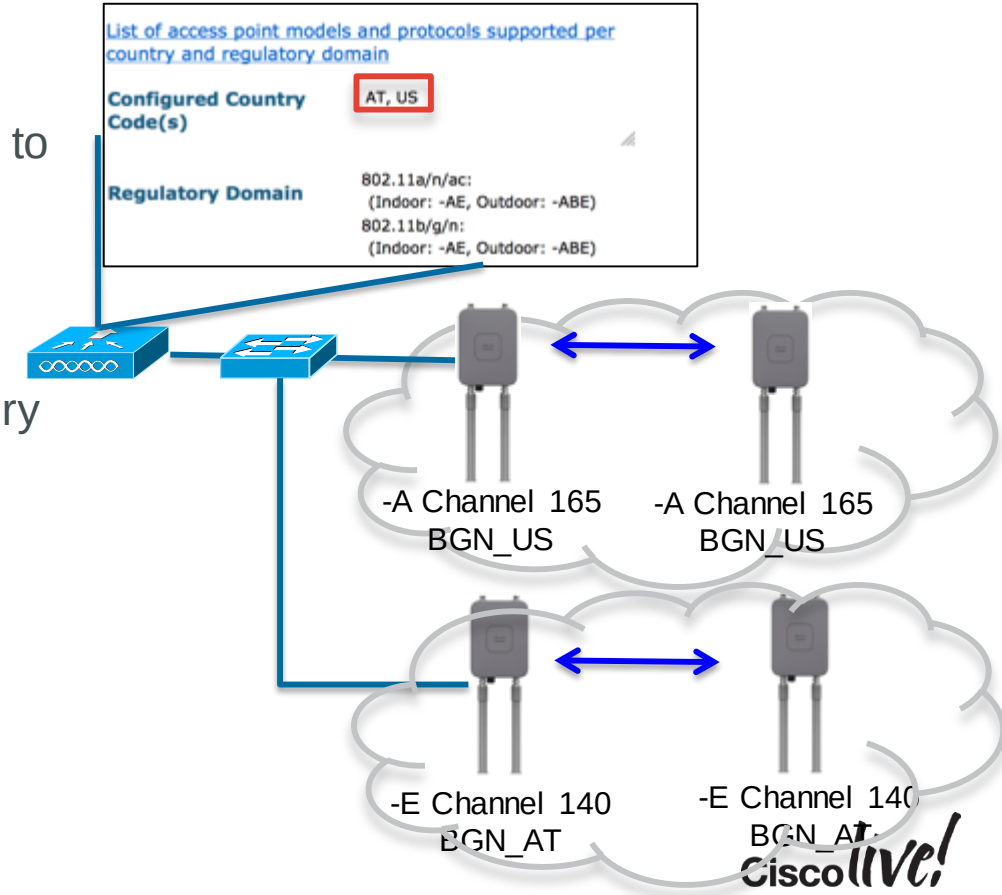
Daisy-chaining: Dedicated Client Access Device Deployments



- LocalAP is dedicated for Client Access, while Master MAP will provide the mesh backhaul link
- In this configuration, LocalAP should be in local mode or flex-connect mode
- The Master MAP must have Ethernet bridging enabled

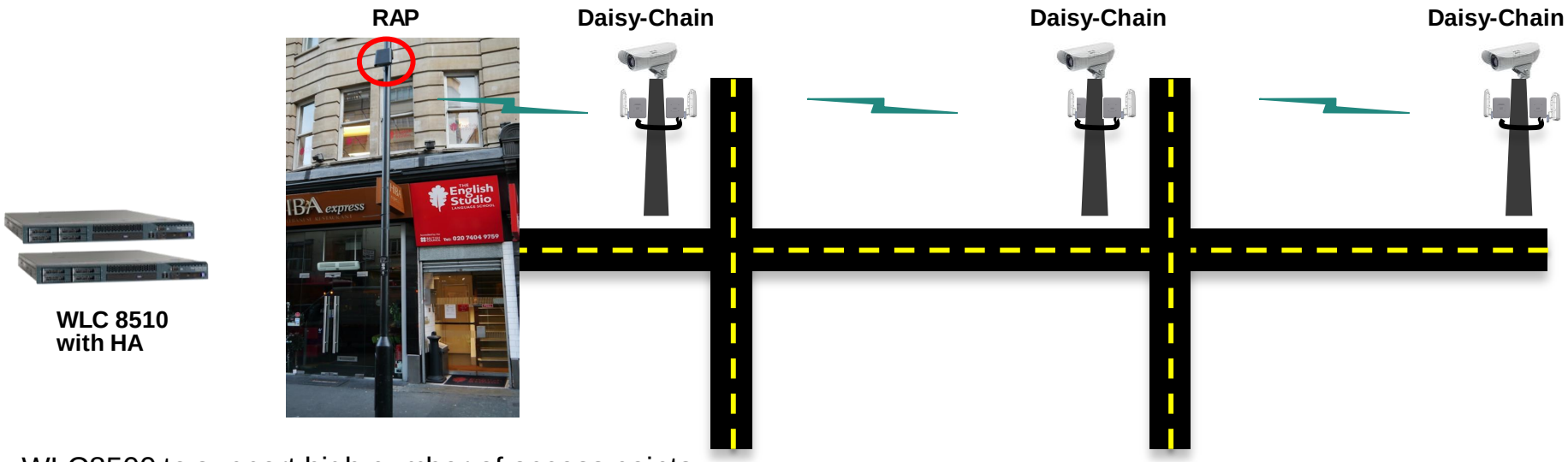
Multi-country Domain Support on a WLC

- 8.1 Code allows multiple Country Codes to be configured
- A Single WLC can now manage multiple regions
- Best Practices: APs of different regulatory domains should be deployed:
  - Different Physical locations
  - Different Bridge Group Names (BGNs)
  - This will avoid stranding MAPs



Use Case 2: Roadside Video Surveillance

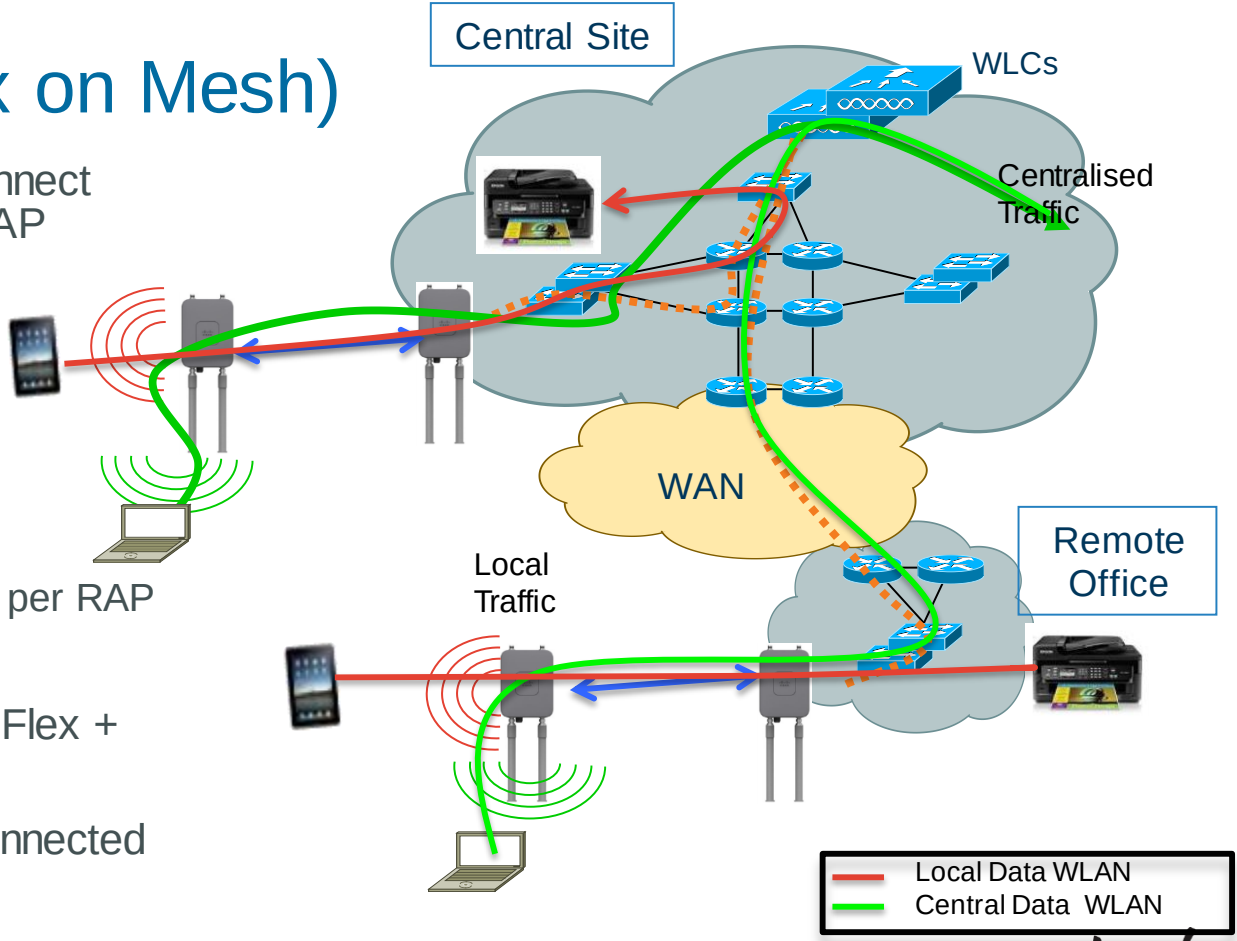
High Throughput over Multiple Mesh Hops



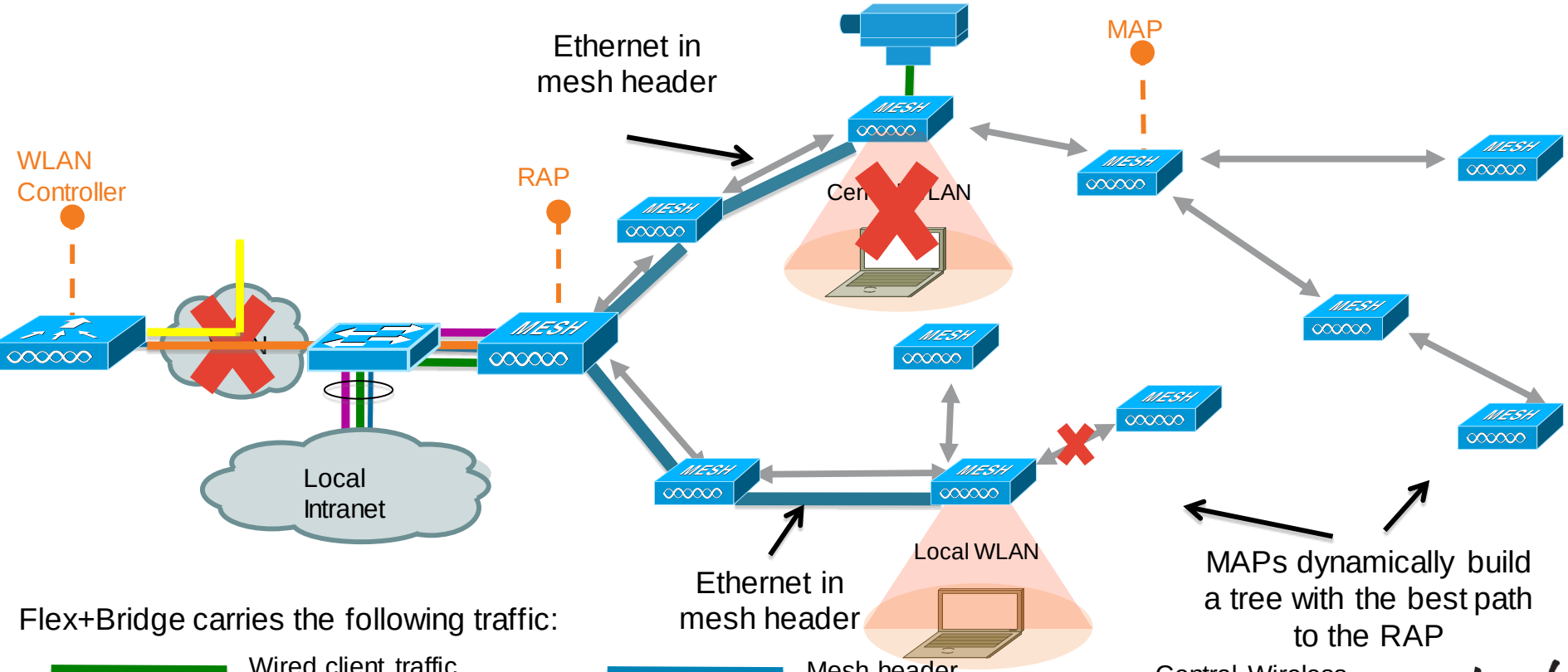
- WLC8500 to support high number of access points
- Daisy-Chaining allows 5GHz backhaul to operate on different channels maximising throughput over distance
- High throughput applications such as HD video can span up to 8 mesh hops
- 5GHz radios should use directional antennas to maximise distance
- 2.4GHz radios can serve clients

Flex + Bridge (Flex on Mesh)

- New AP mode that allows Flexconnect behaviour across mesh-enabled AP
  - Control plane supports:
    - Connected (WLC is reachable)
    - Standalone (WLC not reachable)
  - Data Plane supports:
    - Centralised (split MAC)
    - Local (local MAC)
  - Flexconnect Groups
  - Max 8 Mesh hops, Max 32 MAPs per RAP
  - Local AAA support
- A WLC have a mix of Bridge and Flex + Bridge
- RAPs inherent VLANs from its connected MAP



How Does Traffic Pass in a Flex + Bridge Mode Deployment?

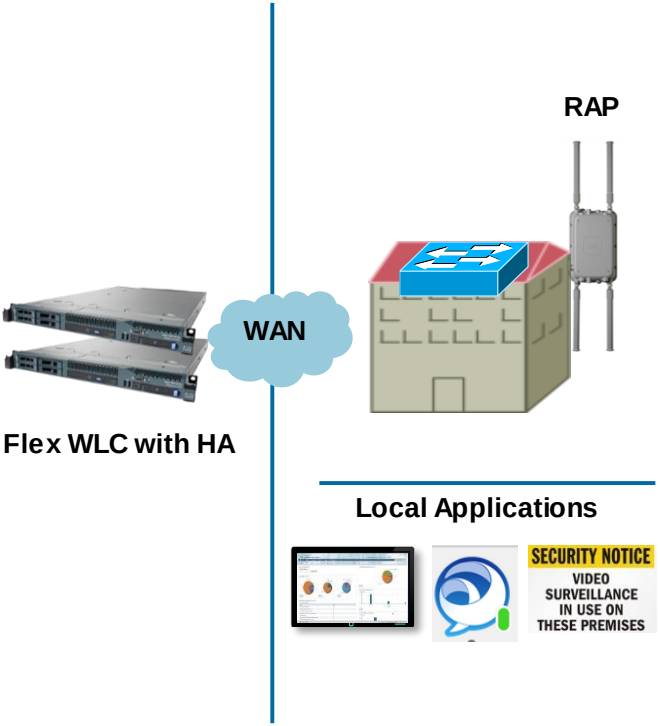


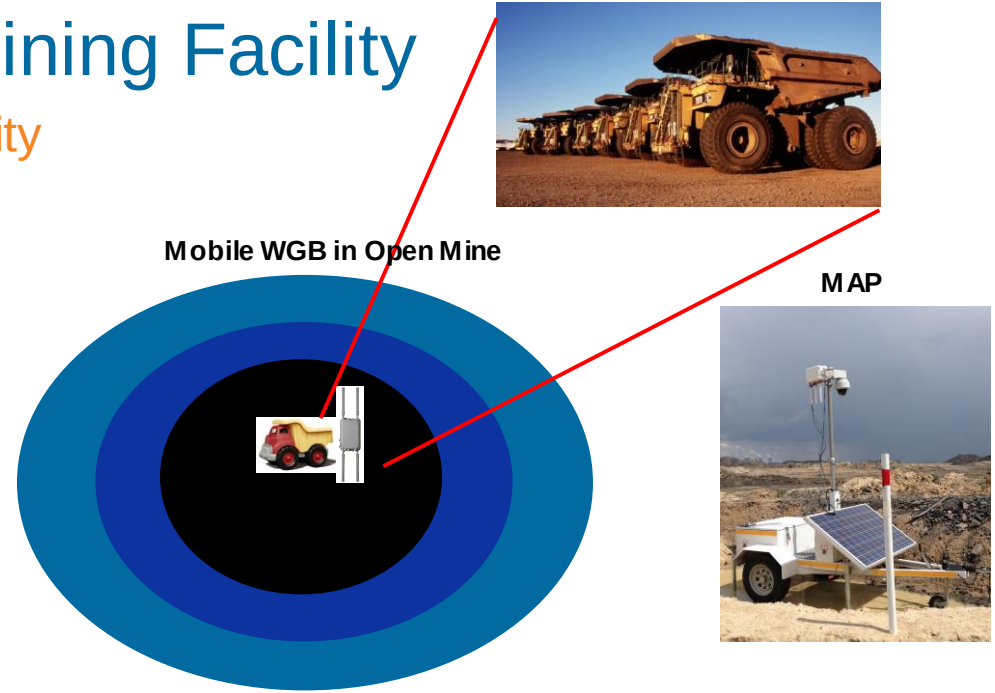
Flex+Bridge carries the following traffic:

- Wired client traffic
- Local Wireless client traffic
- Mesh header
- CAPWAP
- Central Wireless client traffic

Use Case 3: Open Mining Facility

Flex + Bridge to increase Reliability



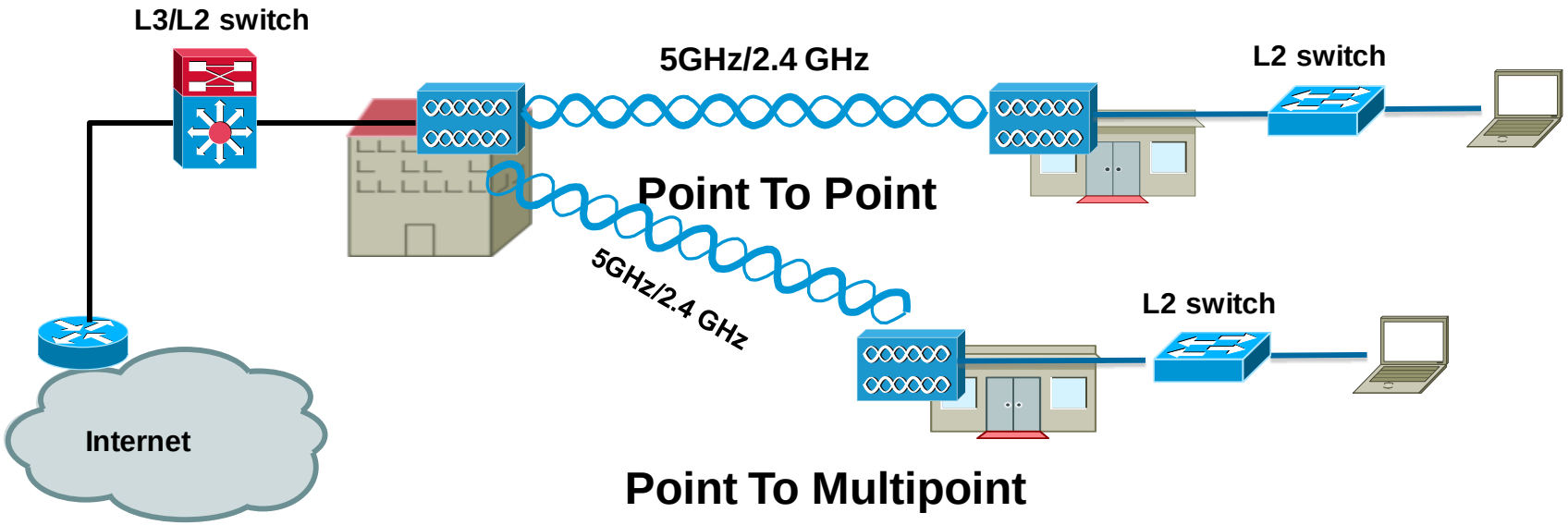


- Remote Mining Site:
  - Flex WLC at the Corporate Data Centre
  - RAP/MAPs operating in Flex+Bridge Mode around mine
  - WGB controlling vehicle connects via mesh network
  - Local Applications continue to operate, even if the WAN link is down

Cisco Outdoor Autonomous Overview

Cisco Autonomous Deployment Overview

Bridging



Bridging: basic LAN to LAN wireless connectivity

Outdoor Autonomous: Quick Overview

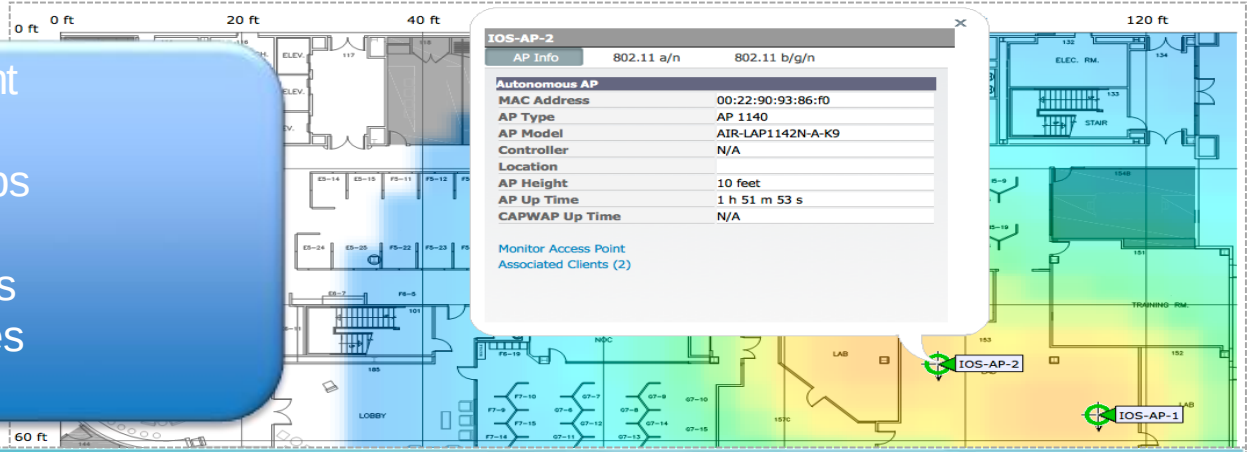
- **Root Bridge**—The root in a point to point (P2P) or point to multipoint (P2MP) deployment. Designed to take on non-root bridges, but can also accept associations from clients on non-backhaul radio
- **Non-Root Bridge**—Designed to connect to Root Bridge mode autonomous access points. Allows wired and wireless clients on non-backhaul radio
- **Workgroup Bridge**—Designed to connect as a client to the unified wireless architecture. Can bridge up to 20 wired clients. Recommended for mobile units.
- **Install Mode**—Uses a series of LED flashes to measure link RSSI between bridges. Allows installers to align access points

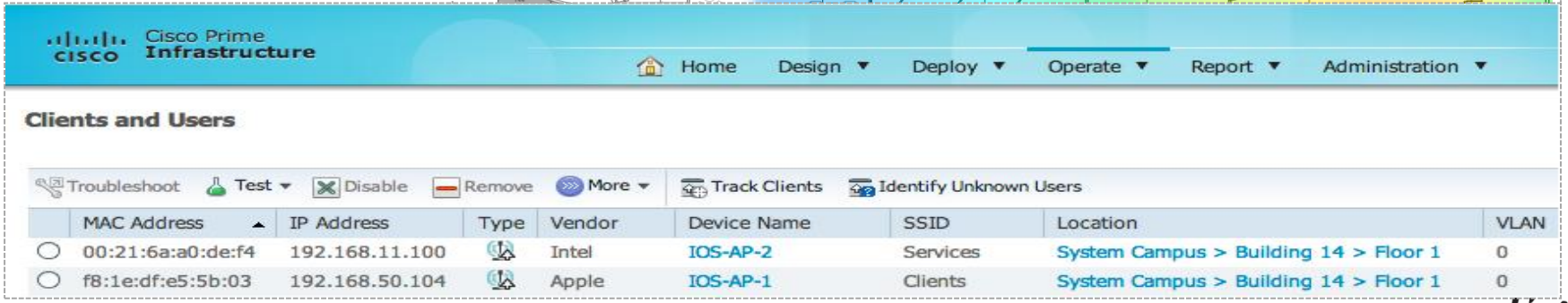
http://www.cisco.com/c/en/us/td/docs/wireless/access_point/15_2_4_JA/configuration/guide/scg15-2-4_book.html

Cisco Prime Management of Autonomous APs

Autonomous Management Capabilities:

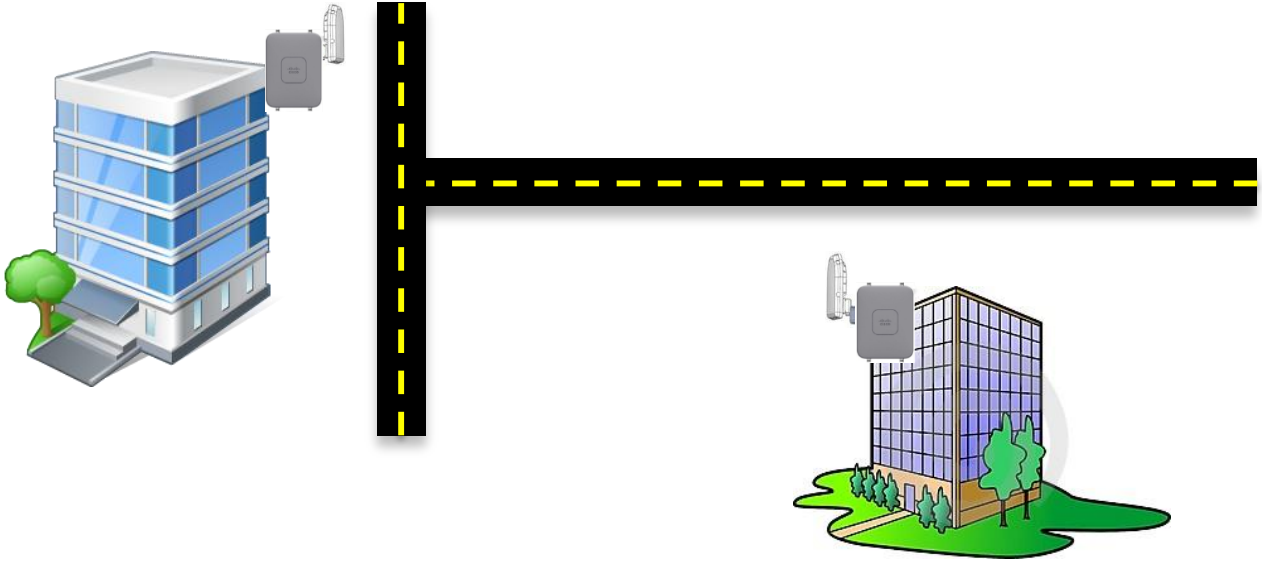
- Access Point Heat maps
- Monitoring AP Status
- Monitoring Client Status
- Configuration Templates
- Reporting





Use Case 4: Bridging Building

- 1532E Access Points
- Directional Antennas (AIR-ANT5114)
- Autonomous Mode
- No need for a WLC



Autonomous – Additional Information

- Quick Start Configuration Template:
  - https://supportforums.cisco.com/document/61936/autonomous-ap-and-bridge-basic-configuration-template
- Autonomous Configuration Guide
  - http://www.cisco.com/c/en/us/td/docs/wireless/access_point/15_2_4_JA/configuration/guide/scg15-2-4_book.html

Cisco Outdoor Product Line

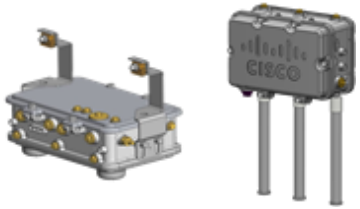
Cisco Aironet Outdoor Access Point Series Industry's Best

802.11ac / 802.11n Access Points

Base
1530

- 802.11n, 2G: 3x3:3; 5G: 2x3:2
- Low profile, competitive price
- 1x GigE port
- Power: PoE or VDC
- Int/External Antennas

High Functionality
1550



- 802.11n, 2x3 MIMO : 2 SS
- Multiple models and options
- Enterprise, Carriers, MSOs
- DOCSIS 3.0 8x4
- Int/External Antennas

Best in Class
1570

NEW

- 802.11ac, 4x4 MIMO : 3 SS
- HDX Technology
- CleanAir, ClientLink, Optimised Roaming for Outdoors
- Carrier and Enterprise-class
- NG Cable: DOCSIS 3.0 24x8
- Int/External Antennas
- Modular: Future Proof

Higher Throughput, Larger Area, More Pervasive Coverage

Bringing 802.11ac with HDX Outdoors

* Highest power allowed by FCC

Cisco Aironet 1570 Series

- 4x Transmit + 4x Receive
- 3 Spatial Streams
- Max. Allowable Transmit Power*
- Multi Mode Options: Flex, Mesh, Auto.
- NG DOCSIS (24x8), Fibre, Gig-E
- Future Proof: Plug-in Module via POE

HIGH DENSITY EXPERIENCE (HDX)

CLEAN AIR

RF Interference, Detection & Mitigation

CleanAir for 80MHz

CLIENT LINK

Increase Performance & Range

ClientLink 3.0

OPTIMISED ROAMING

Intelligent Handoff in High Density

Optimised Roaming

TURBO BOOST

More 802.11ac Clients per AP

Turbo Performance

Cisco Aironet 1530 Outdoor Access Point Series

Ultra Compact and Flexible for Enterprise and Service Provider

- Small and ruggedised IP67 design for outdoors
- Blends into the environment
- Innovative flexible port architecture: dual or single band external antenna configuration via software
- Flexible deployment modes: centralised, standalone, bridge, mesh, or daisy chain

1570 is Flagship Outdoor AP

1570 supports many options not available on the 1530

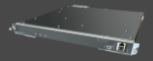
1570	Parameter	1530
✓	SFP backhaul	X
✓	Cable backhaul	X
✓	CleanAir	X
✓	ClientLink	X
✓	Direct AC power input	X
✓	PoE Out	X
✓	GPS	X
✓	802.11ac	X

Unified Access: Controllers

Campus

5500

WiSM2



8500

Branch

7500

2500

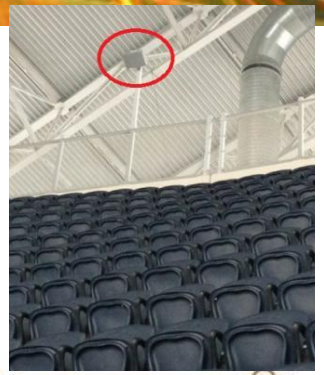
Virtual Controller

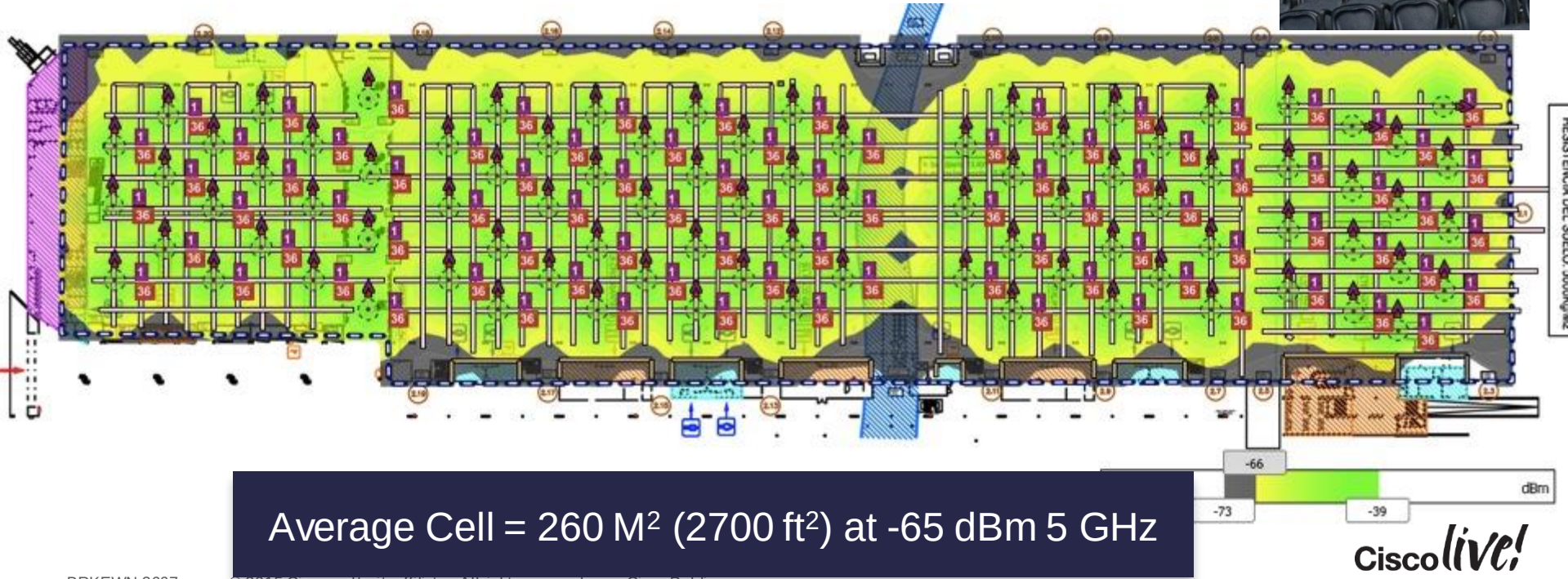
Cisco Outdoor High Density Products

AP Model Comparison

AP Model	1530 	1570 	3702P  
Radio Design	3x3:3(i) 2x2:2(e) 802.11n	4x4:3 802.11ac	4x4:3 802.11ac
Max Data Rate per Radio	300 Mbps	1300 Mbps	1300 Mbps
Antenna Configuration	Internal / External Single or dual band	External Single or dual band	External Dual band
Power Options	DC / PoE	AC, DC, PoE PoE out = 802.3at	PoE
Required SW	7.6	8.0MR1	7.6
Environment	-30 to 65 °C	-40 to 65 °C	-20 to 43 °C NEMA enclosure required

“The Grid” AP3700 + AIR-ANT2513P4M-N=

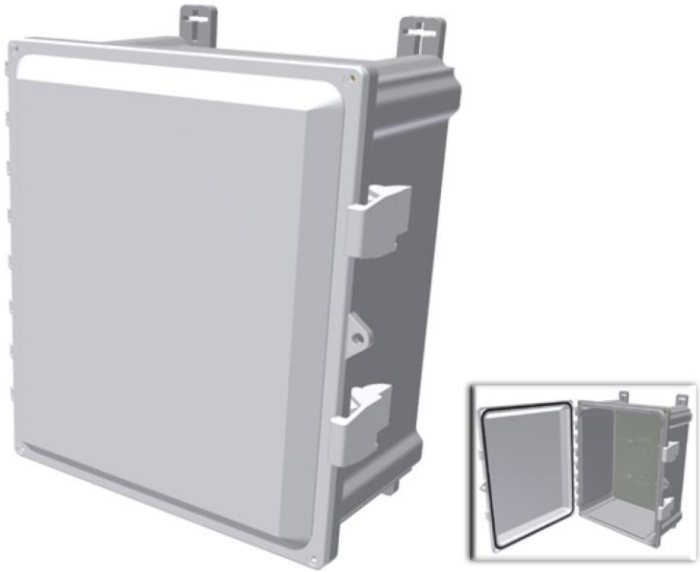




Average Cell = 260 M^2 (2700 ft^2) at -65 dBm 5 GHz

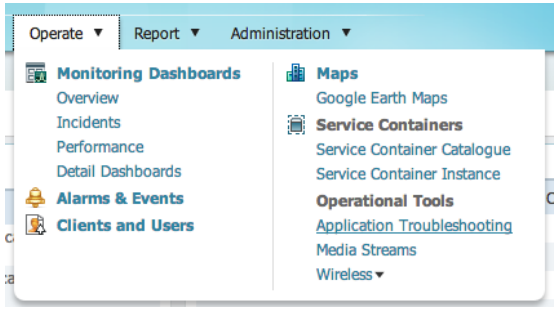
3700 in a NEMA Enclosure

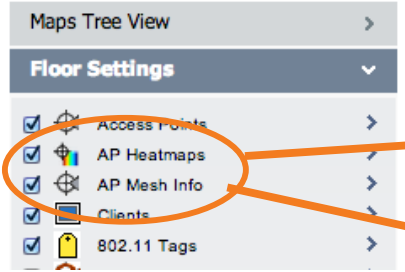
- National Electrical Manufacturing Association (NEMA)
- Indoor rated APs deployed outdoors, it must be enclosed
- Protects the AP against water, dust, extreme temperatures

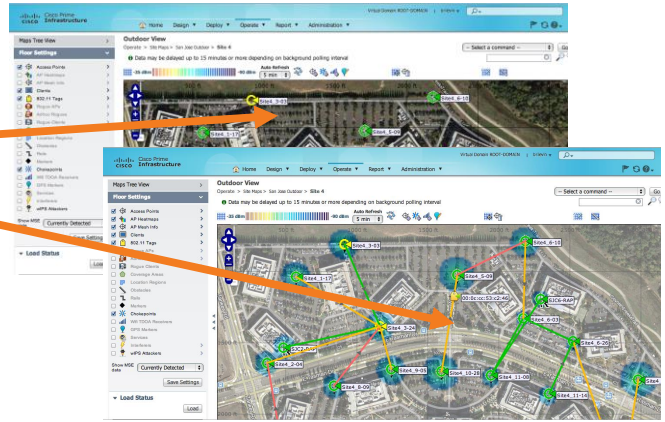


Cisco Network Management

Prime Infrastructure: Tracking Mesh APs / Clients



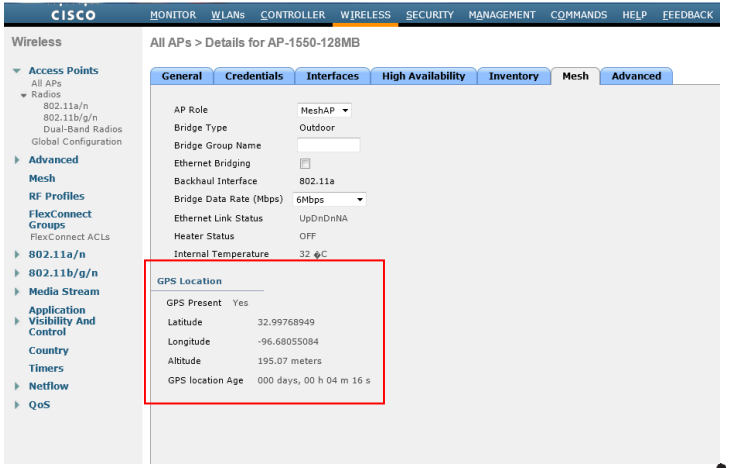




GPS status is visible on controller via following CLI commands.

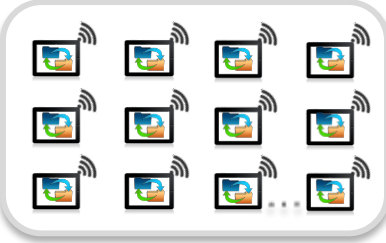
(Cisco Controller) >show mesh gps location summary

AP Name	GPS Present	Latitude	Longitude	Altitude	GPS location Age
AP-1520	NO	N/A	N/A	N/A	N/A
AP-1550	YES	32.99876807	-96.68068025	46.21 meters	000 days, 00 h 03 m 22 s



Design: What are your requirements and goals?

Aggregate and Per-User Throughput



- 802.11, like Ethernet 802.3, it is a shared medium – CSMA or talk and listen
- Aggregate throughput is the total bandwidth shared by all users in a cell
- The larger the cell, the more users in the cell
  - Greater per user throughput means smaller cells and more access points for a given area
- How many users per access point?
  - What's the aggregate throughput of the access point?
  - On average, what amount of per user throughput do you need to provide?
  - What is the Coverage Density

Key Statistics from Sporting Event at Large Stadium

- Total Attendance: ~80K
- Total unique associations:
  - ~18K (All SSIDs)
  - ~21% of attendees associated to the network at some point during the event
- Peak simultaneous associations:
  - 11.5K (All SSIDs)
  - Max of 14% of attendees associated to the network at the same point in time
- Peak Wi-Fi throughput
  - Downlink (Inbound to venue) ~400 Mbps
  - Uplink (Outbound from venue) ~850 Mbps
- Peak Wi-Fi Aggregate throughput
  - **1.108 Gbps** (Inbound + Outbound)
- MAX Per User Throughput = 0.0758 Mbps

How to Deploy Cisco Outdoors Mesh Network

Cisco live!

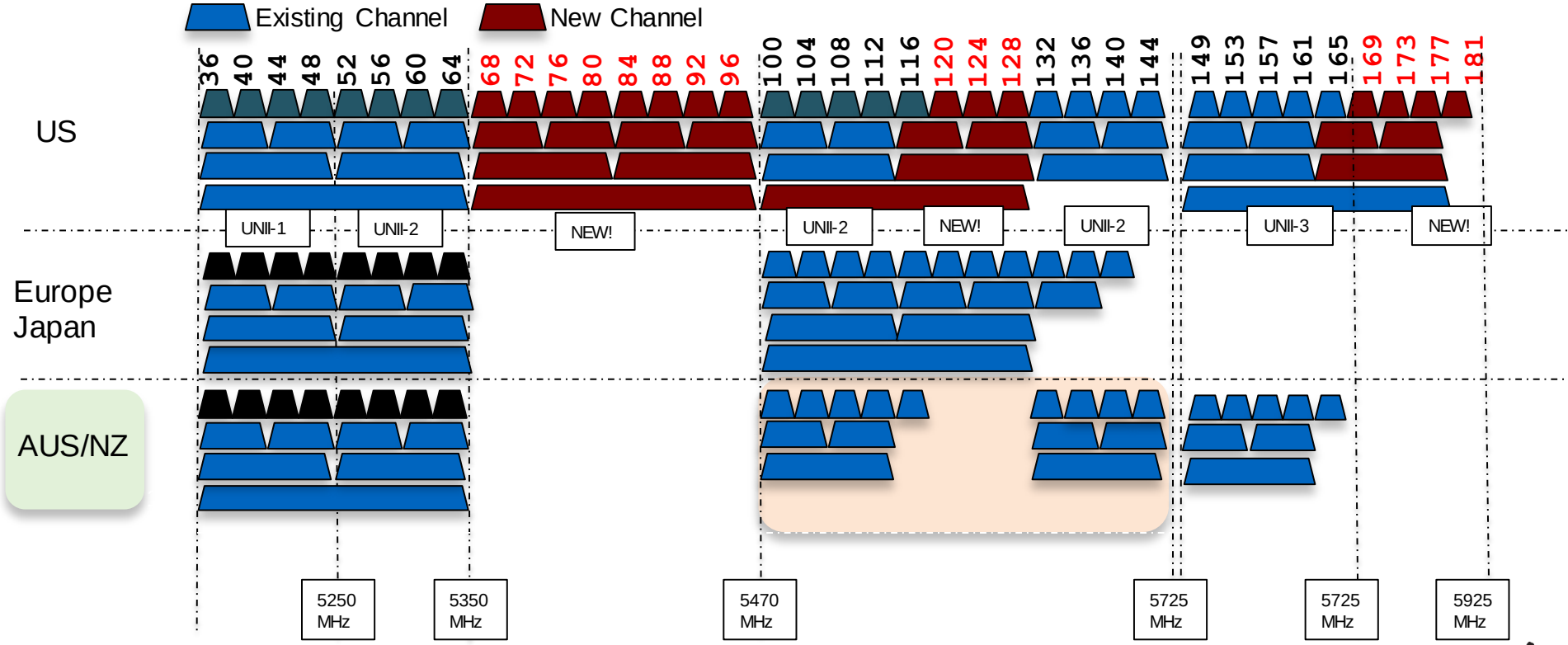
How to Deploy an Outdoor Wireless Network

Wi-Fi network planning and deployment involves….

- Regulatory considerations:
  - 802.11 Standard, Radio Emissions, Radar and Dynamic Frequency Selection (DFS). Certifications. All this varies per country.
- Design and Planning
  - Coverage considerations (RF is key)
  - User requirements (HDX, remote mining site, enterprise extension)
  - Client type (Smart Phones, Tablets, Laptops, …). Weakest Link typically would be the Uplink on a Smart Phone
  - CAPEX & OPEX available for project; match to type of Service, robustness of Coverage, etc.
- Site Survey
  - Location & Height, Line-of-Sight (LoS)/Partial LoS, Interference, Access to wired backhaul (i.e. Max # Hops)

Current Standards and Directives:

The 5 GHz Spectrum



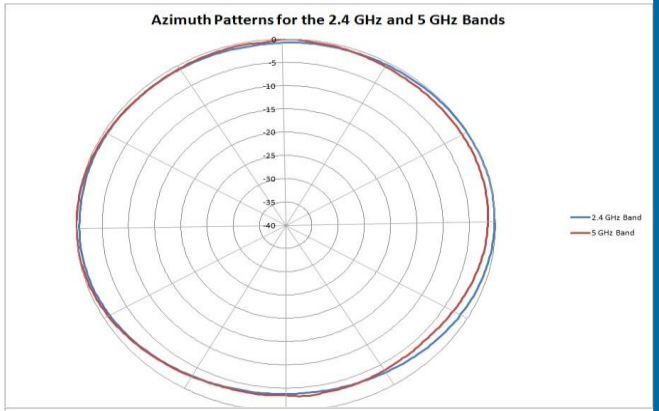
Understanding Radio Frequency

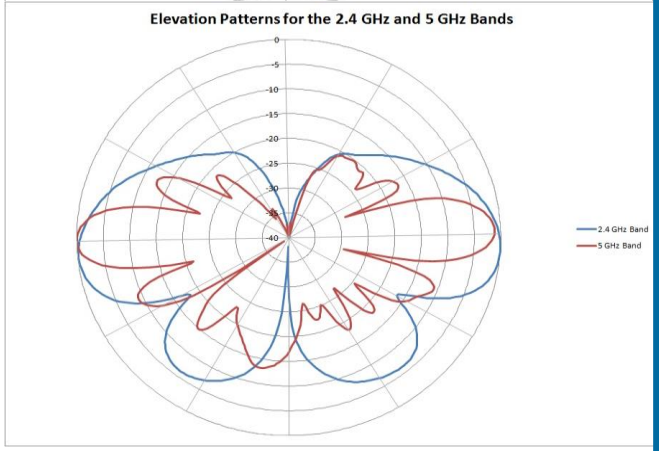
RF Basics: Channel Utilisation is KEY!

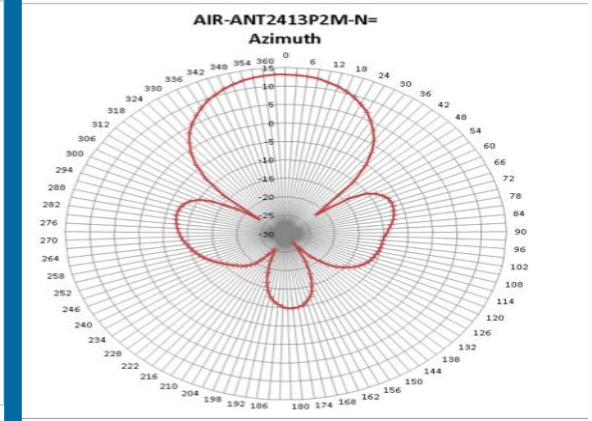
Antenna Overview

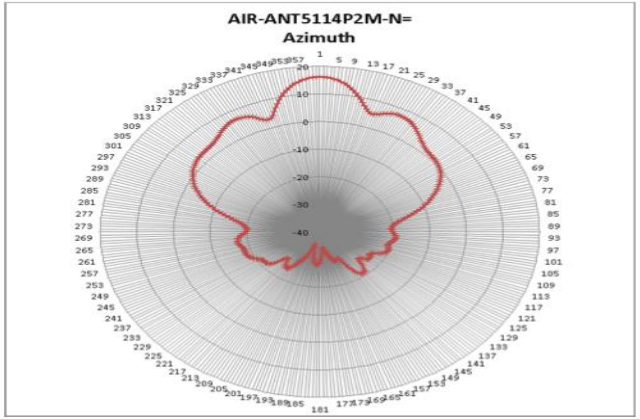
- Omni vs. Directional
- Dual band vs. Single band
- Distance vs. Density

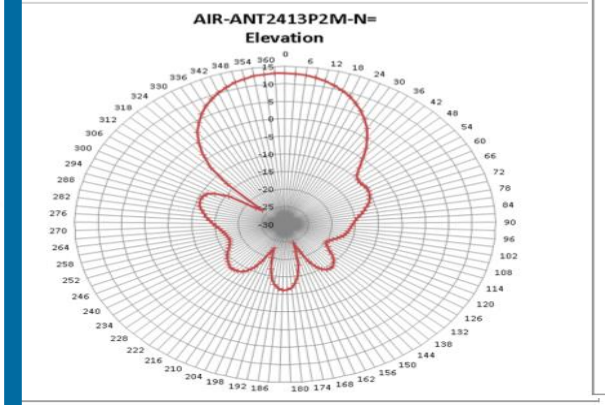
Omni vs. Directional Antennas

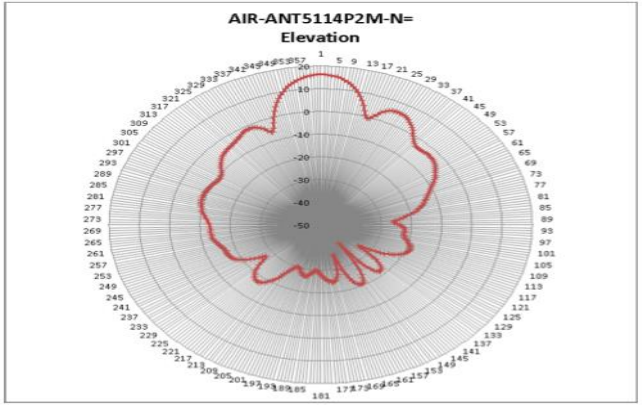












2.4GHz Comparison (AirMagnet)

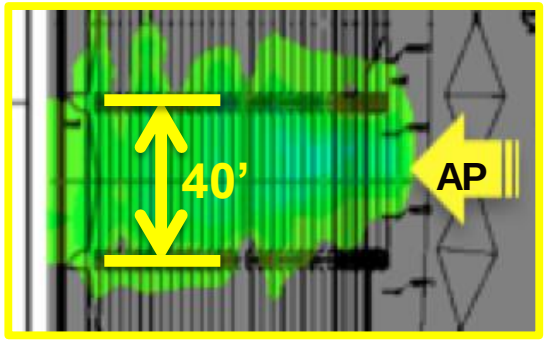
Diff View (top diagram)

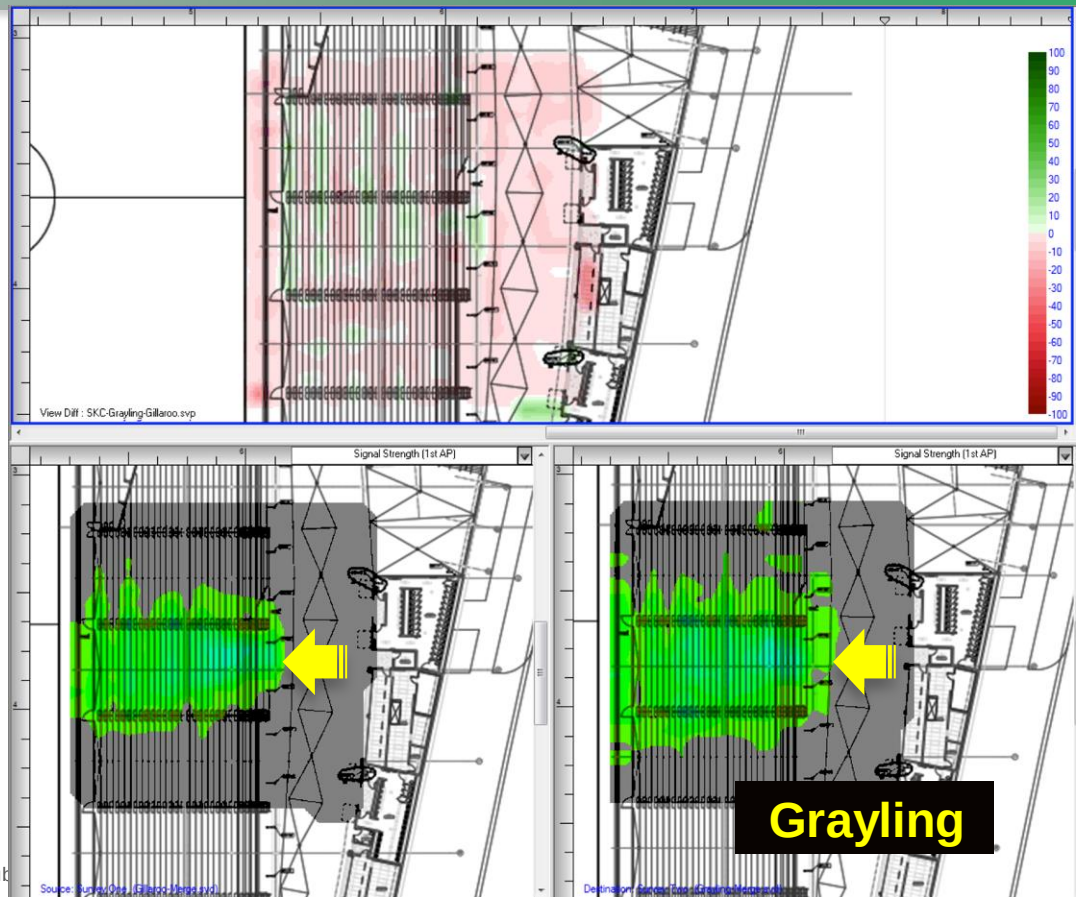
- Shows comparative power differences

Survey View (bottom diagrams)

- Slightly tighter 2.4 beamwidth
- -65 RSSI cutoff

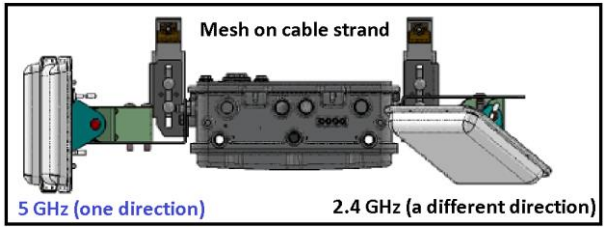
KEY:





Dual Band vs. Single Band

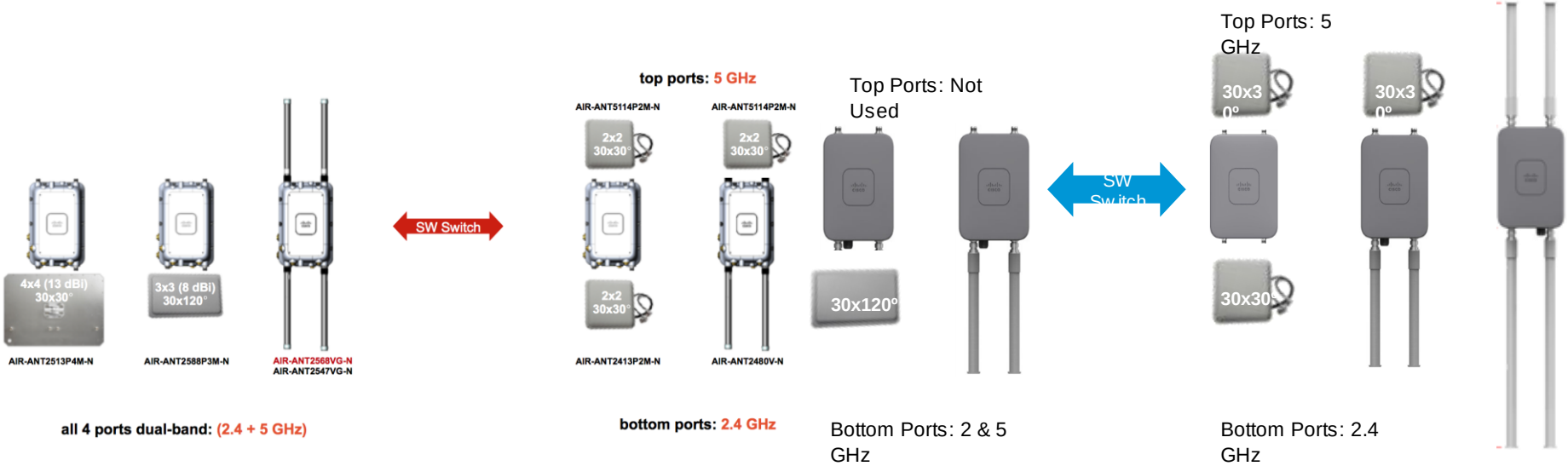
- Single Band/Uniband – Separate 2.4GHz and 5GHz antennas
- Dual Band – Allow the radio to share the same physical antennas



Uniband Access Points

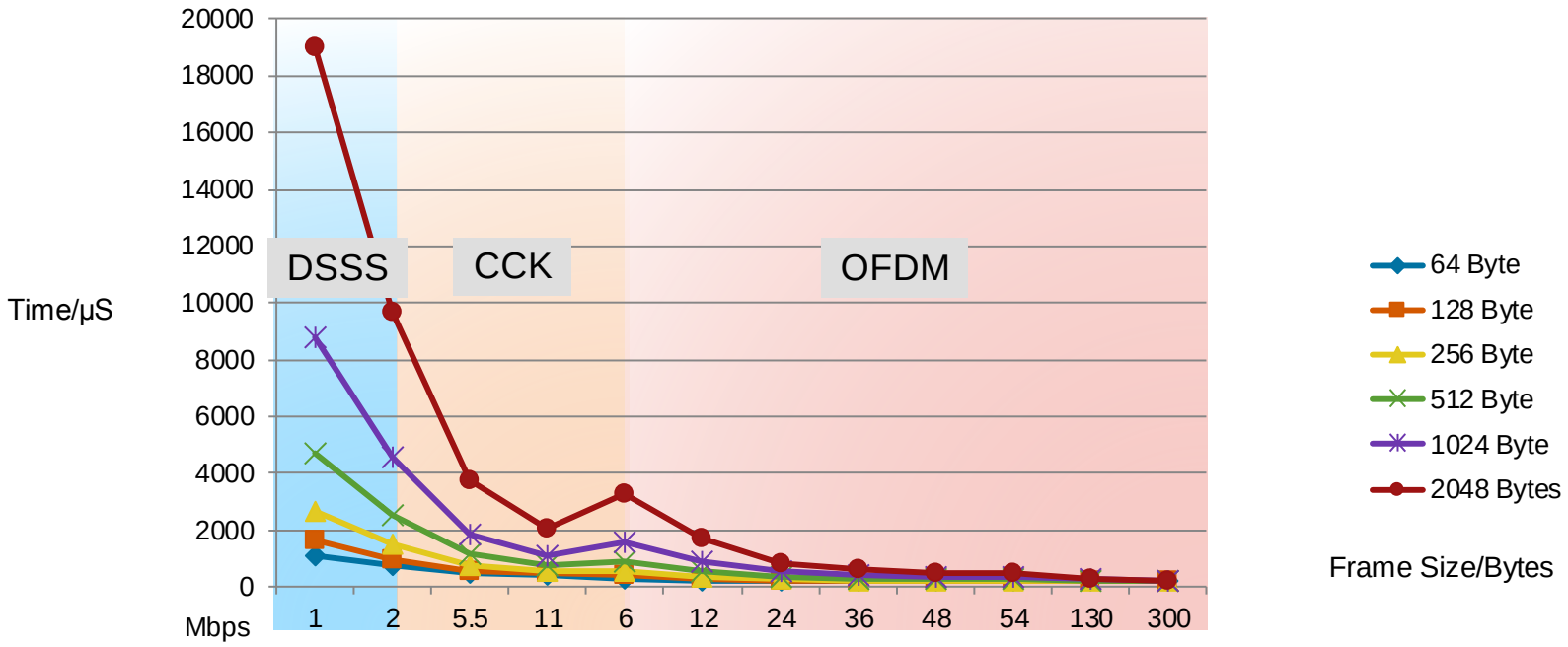
Dual Band Access Points

Flexible Antenna Ports: Support for Uniband or Dualband Antennas



- FlexPort can support either dual-band or single band antennas on the same platform
- Configurable via a software command
- Dual-band ports, use the bottom 2 antenna ports to connect to dual-band omni or directional antennas
- Single-band ports, use two separate 2.4 GHz and two 5 GHz antenna ports

Distance vs. Density

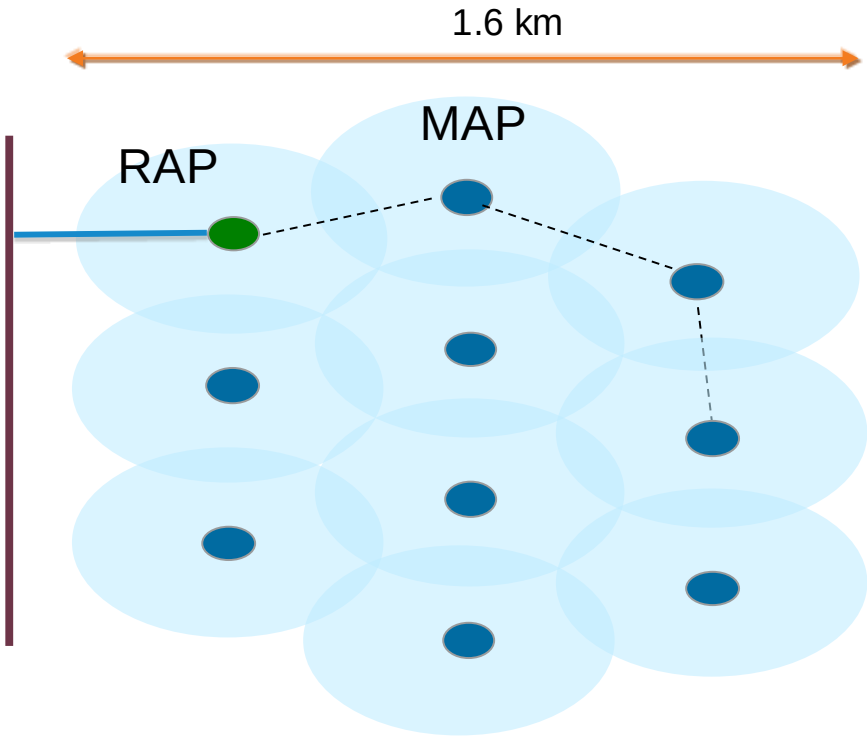


Spectrum is a Shared Finite Resource

Design and Planning

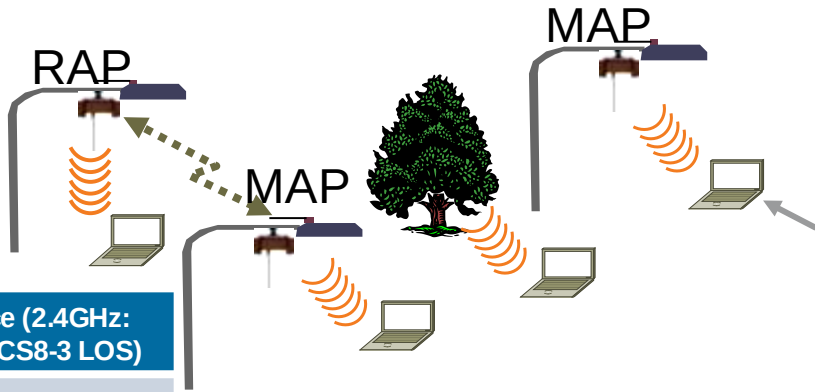
Design and Planning

General consideration

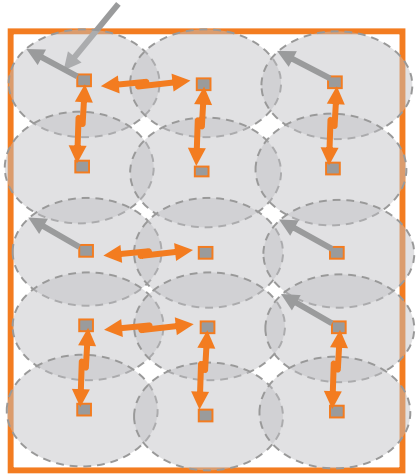


- In real world scenario you need to take in consideration obstacles; add more APs to have Line of Sight (LOS)
- Depending on network requirements you need 2.4GHz only or 2.4GHz and 5GHz client access
- Client type (smart phones, tablets, etc): weakest link typically would be the Uplink on a smart phone
- For backhaul set the data rate to “auto”
- The number of MAPs per RAP should be less than 32 but really depends on the application and bandwidth you want!
- Max hop count is 8. Four hops recommended..again throughput!
- Use the range and capacity calculator

Range Estimates, RAP to MAP

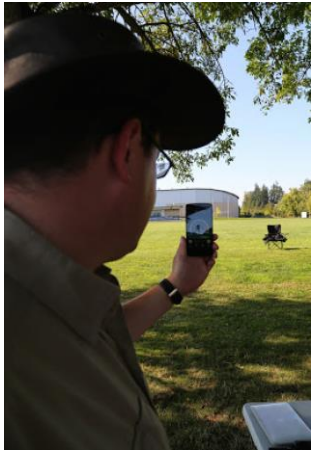


Reg Domain	Freq	Ant. Gain	Max Distance (MCS0 LOS)	High Throughput Distance (2.4GHz: MCS23, 5GHz: 80 MHz MCS8-3 LOS)
-A	2.4GHz	6	3.3km	200m
	5GHz	8	2.7km	30m
-E	2.4GHz	6	1km	30m
	5GHz	8	1km	20m
-A	2.4GHz	13	10km	335m
	5GHz	13	3km	60m
-E	2.4GHz	13	2.5km	70m
	5GHz	13	1.5km	30m



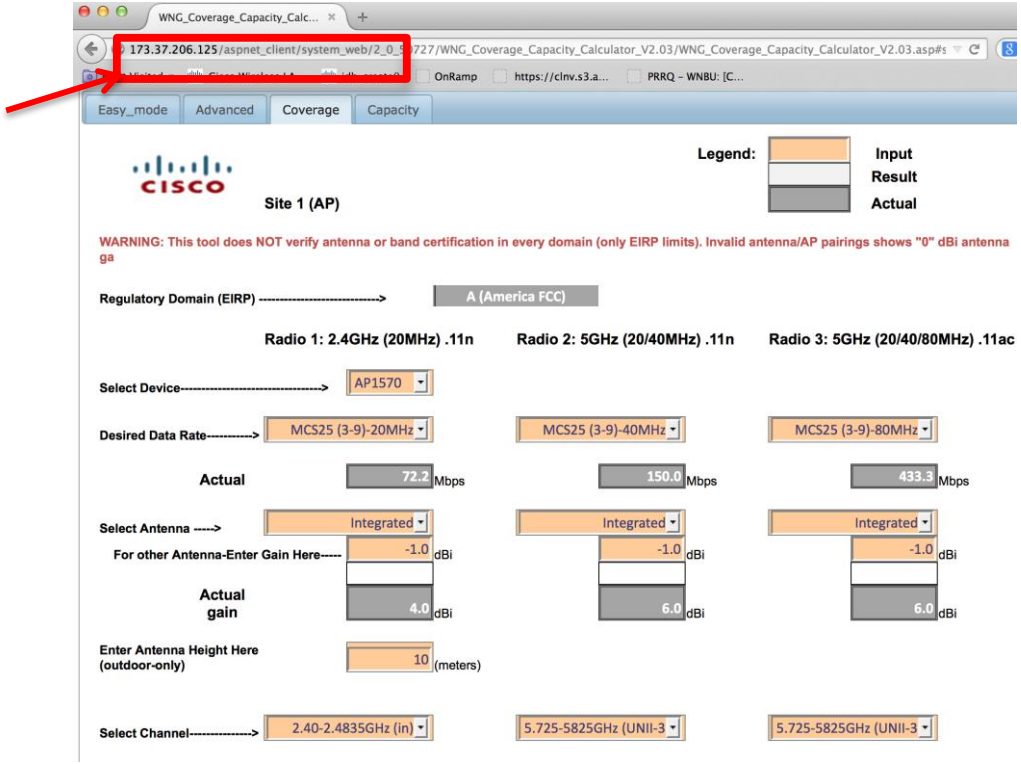
Range Estimates, AP to Client

Reg Domain	Freq	Ant Gain	Max Distance (MCS0 LOS)	High Throughput Distance (2.4GHz: MCS23, 5GHz: 80 MHz MCS9-3 LOS) to iPhone
-A	2.4GHz	6	800m	140m
	5GHz	8	160m	15m
-E	2.4GHz	6	280m	45m
	5GHz	8	160m	15m
-A	2.4GHz	13	1.5km	250m
	5GHz	13	275m	25m
-E	2.4GHz	13	320m	60m
	5GHz	13	180m	20m



WNG Coverage and Capacity Calculator

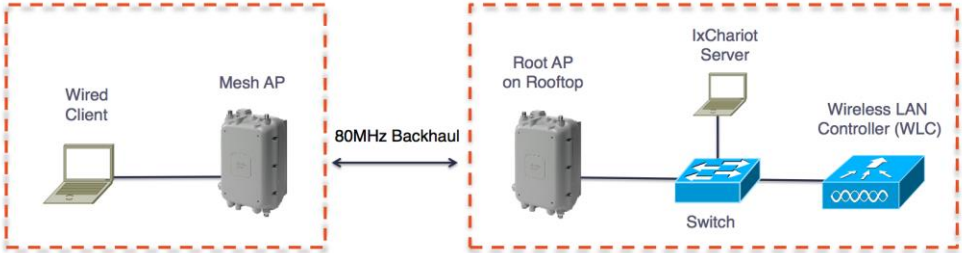
Online now!

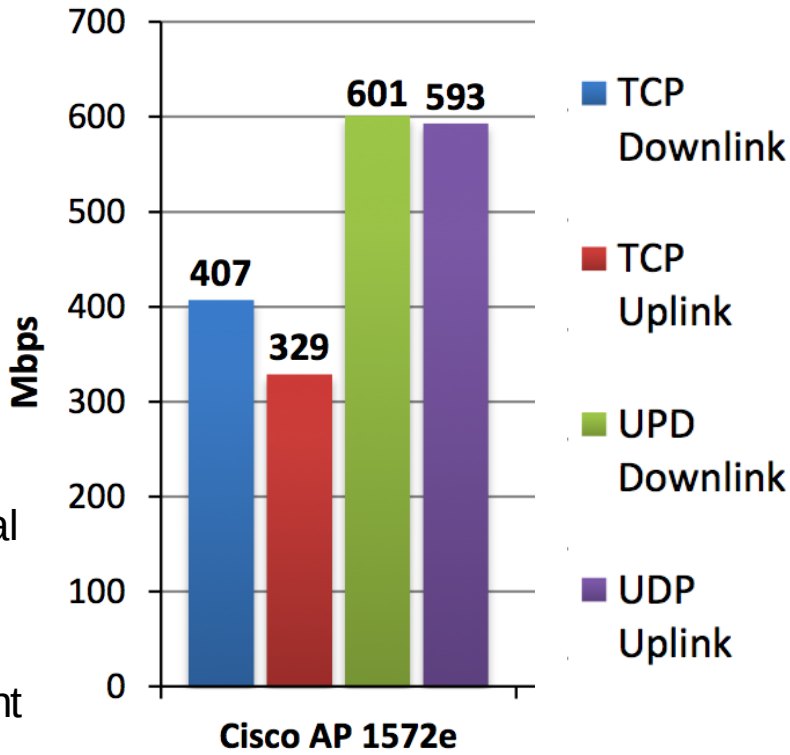


- http://173.37.206.125/aspnet_client/system_web/2_0_50727/WNG_Coverage_Capacity_Calculator_V2.0_HTML/WNG_Coverage_Capacity_Calculator_V2.0.htm

Design and Planning

Typical throughput



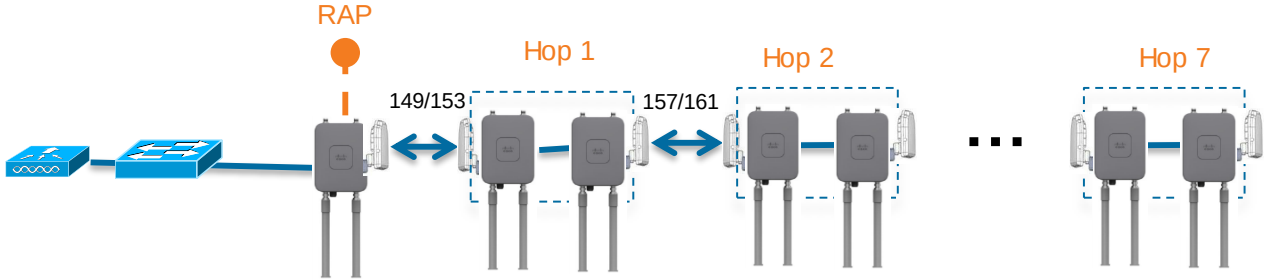


Source: http://miercom.com/pdf/reports/20141212.pdf

- Typical Throughput loss: 30%-40% per hop
- Latency: 10 ms per Hop, 0.3-1 milliseconds typical
- Hops: Outdoor: code supports 8 Hops; 3–4 Hops are recommended
- Daisy-Chaining increased the supported hop count

1532 Daisy-chaining Performance Numbers

Improvements using Daisy Chaining



Note:
- Wired lab environment
- Optimal LinkSNR
- MCS15
- 40MHz backhaul links
- Veriwave traffic generator
- Taken using 7.6MR2 code

	Hop 1	Hop 2	Hop 3	Hop 4	Hop 5	Hop 6	Hop 7
Data Rate (Mbps)	241.1	241.1	241.1	241.1	241.1	241.1	241.1
Average Latency (ms)	2.9	6.1	8.8	13.3	17.6	20	24.8
Max Latency (ms)	27.8	32.2	37.5	67	46.9	48.1	51.2
Rx Jitter	13.3	11.9	12	27.6	19.4	34.2	14.2

Design and Planning

At what distance shall I place the MAPs?

- It all depends on the bandwidth you need. Need to consider Data rate vs SNR
- Need to find a compromise between coverage and throughput

MCS index	Spatial Stream	Media capacity (Mbps) **	Minimum LinkSNR * (dB)
MCS 0	1	15	9.3
MCS 1	1	30	11.3
MCS 2	1	45	13.3
MCS 3	1	60	17.3
MCS 4	1	90	21.3
MCS 5	1	120	24.3
MCS 6	1	135	26.3
MCS 7	1	157.5	27.3
MCS 8	2	30	12.3
MCS 9	2	60	14.3
MCS 10	2	90	16.3
MCS 11	2	120	20.3
MCS 12	2	180	24.3
MCS 13	2	240	27.3
MCS 14	2	270	29.3
MCS 15	2	300	30.3

(*) LinkSNR = *Minimum SNR – MRC gain + fade margin*

(**) Max data rate considering 5Ghz, 40 Mhz channel, 40ns GI

Design and Planning

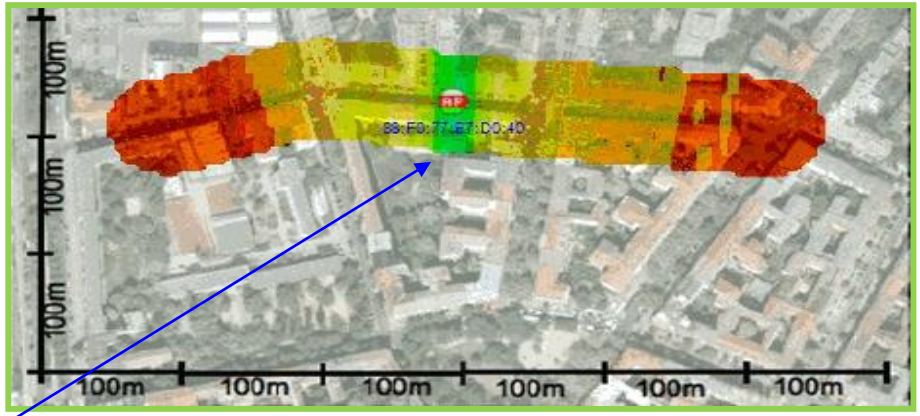
How to check backhaul connected data rate?

- How do you see the actual backhaul rate? Is it 802.11n rate?

  - (Cisco Controller) >show mesh neigh summary MAP_8c40
  - AP Name/Radio Channel Rate Link-Snr Flags State
  - ---------- ------- ---- -------- ------- -----
  - RAP_e380 136 m15 33 0x0 UPDATED NEIGH PARENT BEACON
  - Or:
  - Cisco Controller) >show mesh neigh detail MAP_8c40
  - AP MAC : 1C:AA:07:5F:E3:80 AP Name: RAP_e380
  - backhaul rate m15
  - FLAGS : 86F UPDATED NEIGH PARENT BEACON
  - Neighbor reported by slot: 1
  - worstDv 0, Ant 0, channel 136, biters 0, ppiters 10
  - Numroutes 1, snr 0, snrUp 40, snrDown 43, linkSnr 39
  - adjustedEase 8648576, unadjustedEase 8648576
  - […snip]

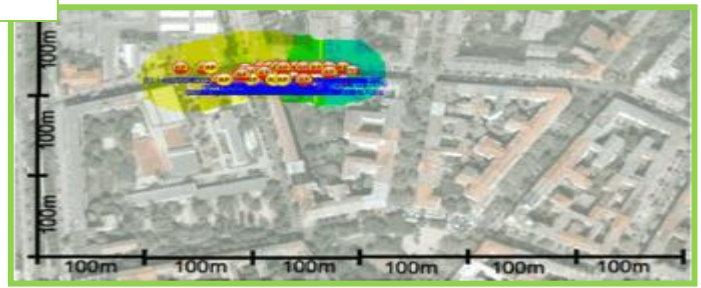
Design and Planning

Real case example of urban coverage



Access Points

AP Name	Media Type	Mac Address	Channel	SSID
Non ACL, Neighborings, Rogues				
88:F0:77:B7:D0:4D	802.11n-5.0 GHz	88:F0:77:B7:D0:4D	108	
88:F0:77:B7:D0:40	802.11n-2.4 GHz	88:F0:77:B7:D0:40	11	
# of AP	2			



2.4 GHz Interferers

Design and Planning

High Availability anti-stranded features

- Stranded: a MAP that is not able to associate and find a path to WLC
- DEFAULT BGN (Bridge Group Name): Mesh APs with incorrect BGN, can still join a running network using BGN named “DEFAULT”. With “DEFAULT” BGN:
  - MAP associates clients, and forms mesh relationships
  - After 15 minutes APs will go to SCAN state rather than rebooting
  - Do not confuse an unassigned BGN (null value) with DEFAULT, which is a mode that the access point uses to connect when it cannot find its own BGN
- DHCP fall back: this features allow a MAP configured with a wrong static IP address to fa back to DHCP and find a WLC. If even this fails, AP then attempts to discover a controlle in Layer 2 mode
- FULL SECTOR DFS: DFS functionality allows a MAP that detects a radar signal to transmit that up to the RAP, which then acts as if it has experienced radar and moves the sector

Site Survey and Deployment

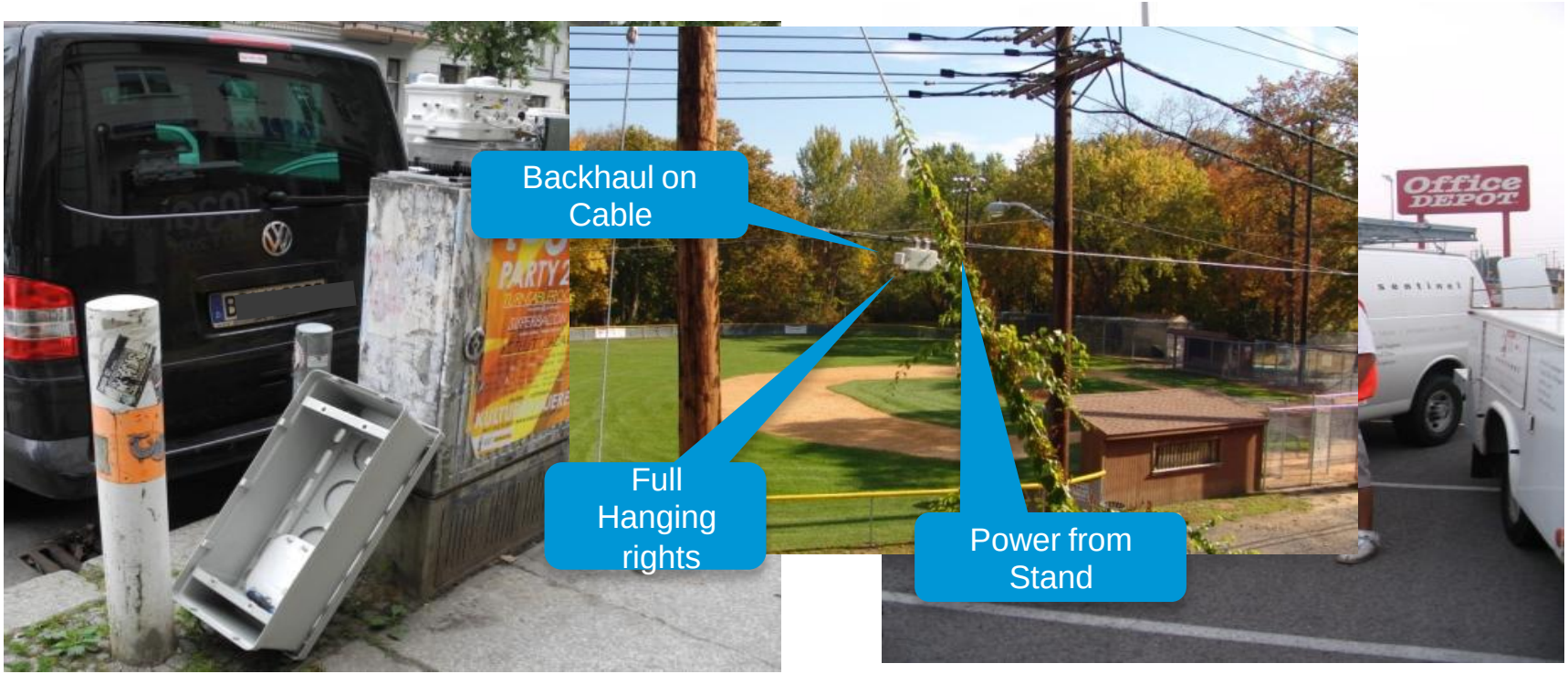
Site Survey and Deployment

The importance of site surveys

- Given the nature of the outdoor environment and the lightly licensed spectrum being used for WiFi based outdoor MESH
  - Site Survey's are important
  - Spectrum scans are equally important
  - You may not be able to remove the interference source
  - But you can design around it
- Remember to also survey at street level where clients will be operating
- If possible survey with either the client or "worst" client you expect to support
- Time based surveys may also be required n months after deployment
- Check for power availability
- Do you have the permits?
- Use the AP1532/1550/1570 for a site survey

Site Survey and Deployment

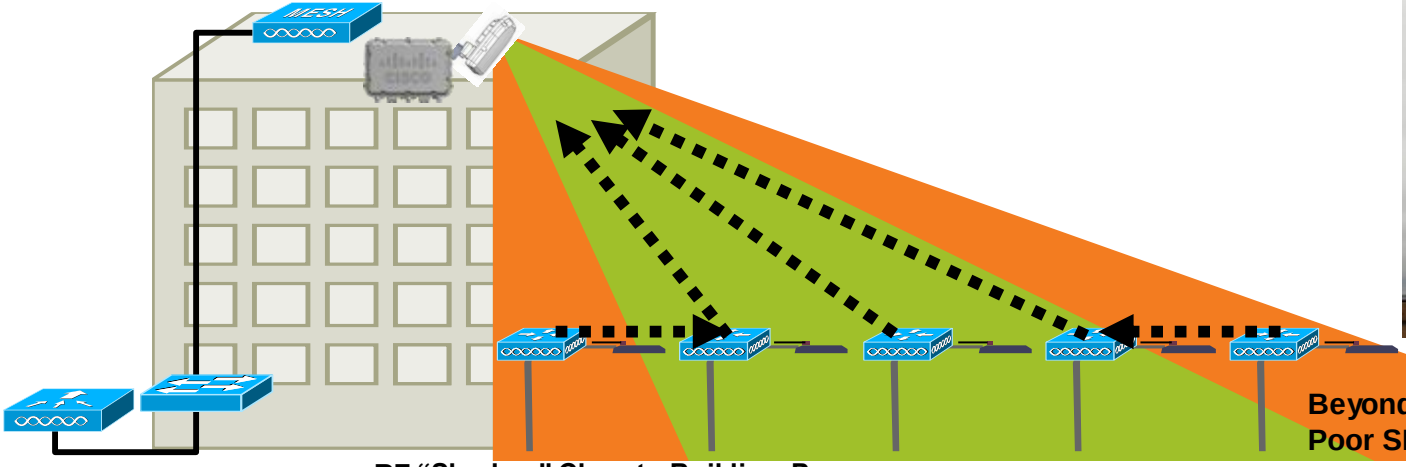
Get creative use different tools



Site Survey and Deployment

Mounting the APs

- Mount the Root AP to have a good view of the area to be covered
- Understand RAP coverage. Use Directional Antennas for the RAPs on the Roof Tops.
- Max recommended height for MAPs is 30 feet/10 meters
- Recommend placing the APs at the same height
- Minimum recommendation is 20~25 dB of SNR, RSSI of -67 dBm for all data rates, 15% cell overlap
- Do not install the MAPs in an area where structures, trees, or hills obstruct radio signals to and from the access point



Site Survey and Deployment

Access Point Pre-Provisioning

- By default the following parameters are set
  - AP Role: MAP
  - Default 2.4GHz and 5GHz channels are selected
  - Default Transmit Power is set: Power Level 1
  - Default Mesh Distances estimation is set to 12000ft
  - Default BGN
  - Backhaul Client Access is enabled
  - Default Mesh Encryption type is EAP
- Primary, Secondary, Tertiary Wireless LAN Controller should be set
- DCHP Sever
  - Option 43 – IP addresses of Wireless LAN Controllers
  - Option 60 – AP Type
  - Option 82 – DHCP Relay Information
- MAC-Authentication must be performed
  - At each Wireless LAN Controller
  - Use an External AAA

Site Survey and Deployment

Environmental Impact

Make it Easy → Make it Work → Make it Perform

For Your Reference

BEST PRACTICES (AirOS)

INFRASTRUCTURE

- Enable High Availability (AP and Client SSO)
- Enable AP Failover Priority
- Enable AP Multicast Mode
- Enable Multicast VLAN
- Enable Pre-image download
- Enable AVC
- Enable NetFlow
- Enable Local Profiling (DHCP and HTTP)
- Enable NTP
- Modify the AP Re-transmit Parameters
- Enable FastSSID change
- Enable Per-user BW contracts
- Enable Multicast Mobility
- Enable Client Load balancing
- Disable Aironet IE
- FlexConnect Groups and Smart AP Upgrade

MESH

- Set Bridge Group Name
- Set Preferred Parent
- Multiple Root APs in each BGN
- Set Backhaul rate to "Auto"
- Set Backhaul Channel Width to 40/80 MHz
- Backhaul Link SNR > 25 dBm
- Avoid DFS channels for Backhaul
- External RADIUS server for Mesh MAC Authentication
- Enable IDS
- Enable EAP Mesh Security Mode

SECURITY

- Enable 802.1x and WPA/WPA2 on WLAN
- Enable 802.1x authentication for AP
- Change advance EAP timers
- Enable SSH and disable telnet
- Disable Management Over Wireless
- Disable WiFi Direct
- Secure Web Access (HTTPS)
- Enable User Policies
- Enable Client exclusion policies
- Enable rogue policies and Rogue Detection RSSI
- Strong password Policies
- Enable IDS
- BYOD Timers

WIRELESS / RF

- Disable 802.11b data rates
- Restrict number of WLAN below 4
- Enable channel bonding – 40 or 80 MHz
- Enable BandSelect
- Use RF Profiles and AP Groups
- Enable RRM (DCA & TPC) to be auto
- Enable Auto-RF group leader selection
- Enable Cisco CleanAir and EDRRM
- Enable Noise &Rogue Monitoring on all channels
- Enable DFS channels
- Avoid Cisco AP Load

http://www.cisco.com/c/en/us/td/docs/wireless/technology/wlc/82463-wlc-config-best-practice.html

Summary

- Reviewed Products and Deployment Modes
- Discussed new and Important Features
- Reviewed Design Recommendations / Best Practices

Links

- 7.6 Mesh Deployment Guide: http://www.cisco.com/en/US/docs/wireless/technology/mesh/7.6/design/guide/mesh76.html
- AP1532 Deployment Guide: http://www.cisco.com/en/US/docs/wireless/controller/technotes/7.6/b_1532_dg.html
- Range and Capacity Calculator: http://www.cisco.com/en/US/docs/wireless/access_point/1550/range/calculator/WNG_Coverage_Capacity_QOS_Calculator_V1.37_external.xlsm
- AP1530 Hardware Installation Guidehttp://www.cisco.com/c/en/us/td/docs/wireless/access_point/1530/installation/guide/1530hig.html
- AP1550 Hardware Installation Guidehttp://www.cisco.com/c/en/us/td/docs/wireless/access_point/1550/installation/guide/1550hig.html
- AP1530 Ordering Guidehttp://www.cisco.com/c/en/us/products/collateral/wireless/aironet-1530-series/guide-c07-729725.html
- AP1550 Ordering Guidehttp://www.cisco.com/c/en/us/products/collateral/wireless/aironet-1550-series/data_sheet_c78-719520.html

Q & A

Complete Your Online Session Evaluation

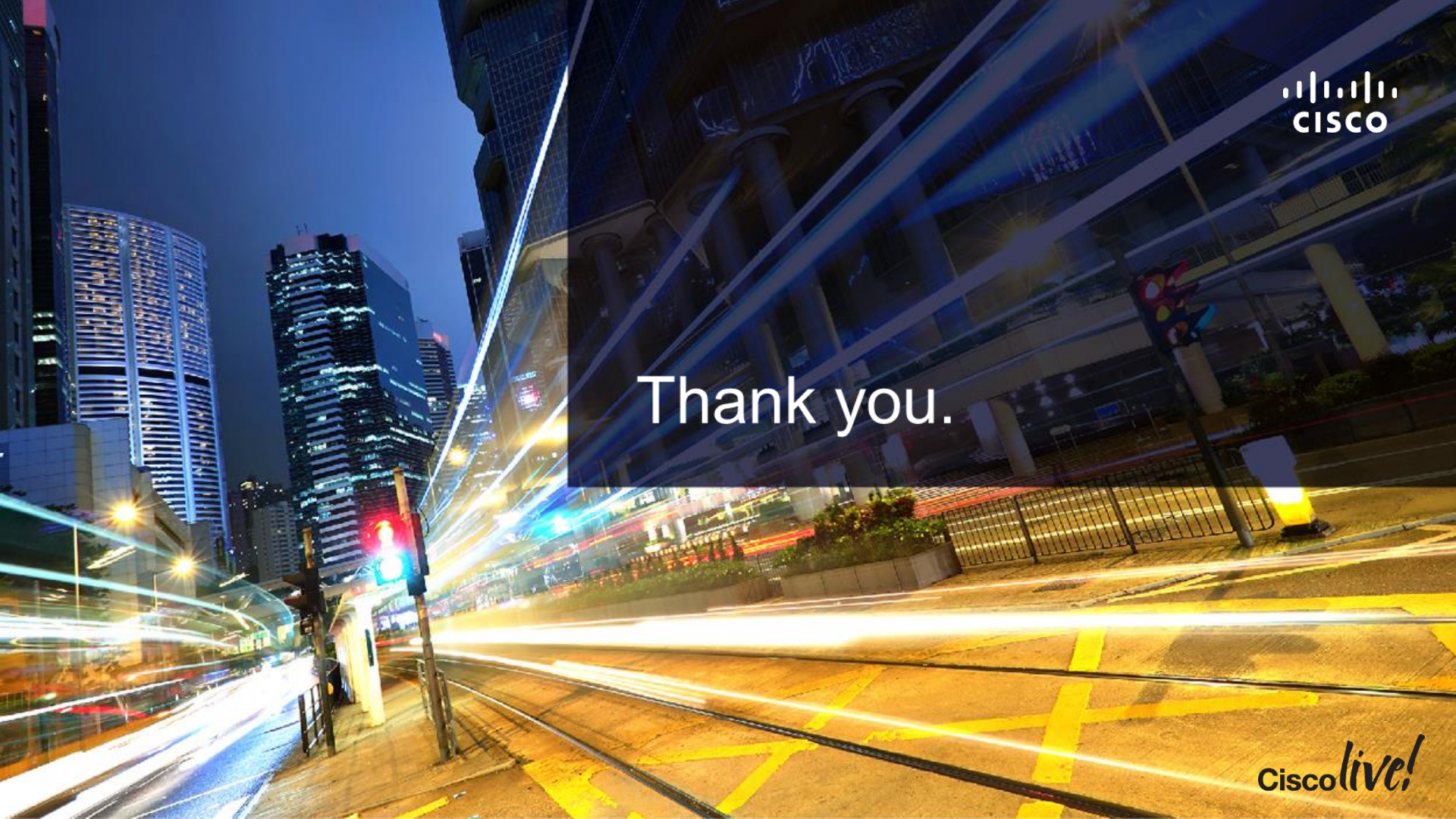
Give us your feedback and receive a Cisco Live 2015 T-Shirt!

Complete your Overall Event Survey and 5 Session Evaluations.

- Directly from your mobile device on the Cisco Live Mobile App
- By visiting the Cisco Live Mobile Site http://showcase.genie-connect.com/clmelbourne2015
- Visit any Cisco Live Internet Station located throughout the venue

T-Shirts can be collected in the World of Solutions on Friday 20 March 12:00pm - 2:00pm

Learn online with Cisco Live!
Visit us online after the conference for full access to session videos and presentations. www.CiscoLiveAPAC.com


Thank you.
cisco
Cisco live!

CISCO