Cisco live!

What You Make Possible

TOMORROW starts here.

CISCO

Design and Deployment of Outdoor Mesh Wireless Networks

BRKEWN-2027

TOMORROW starts here.

Video – Wifi History

Did You Know?

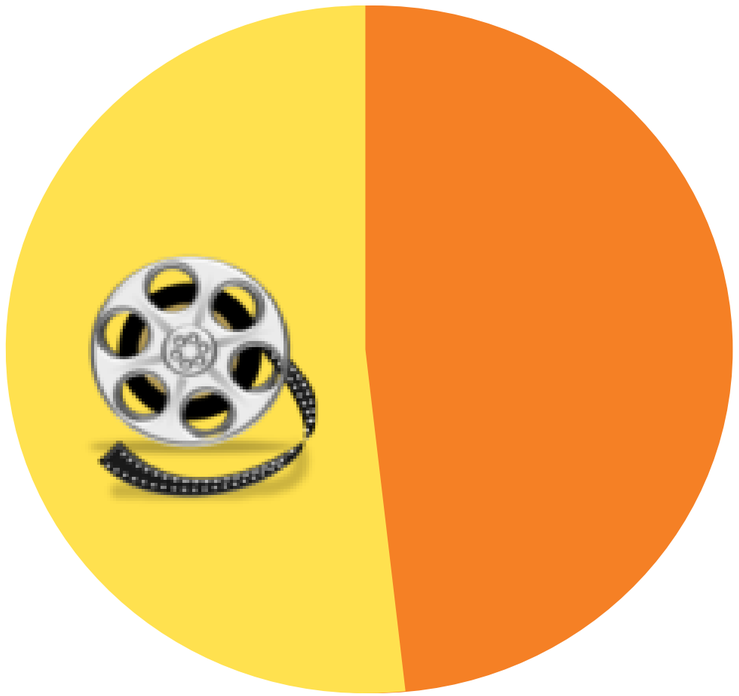
Mobile data traffic grew 133% (x2.3)

Did You Know?

Connections Speeds Doubled

Source: Cisco Visual Networking Index 2011

Did You Know?



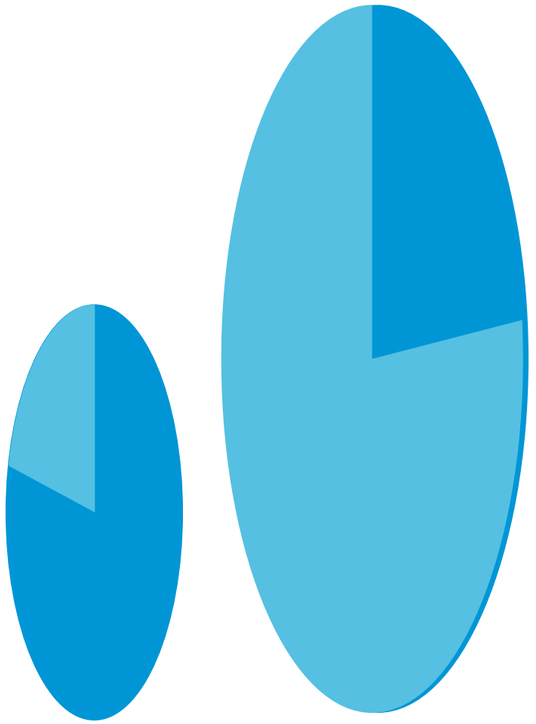
More than 50% is already Video

Source: Cisco Visual Networking Index 2011

Did You Know?

Smartphones

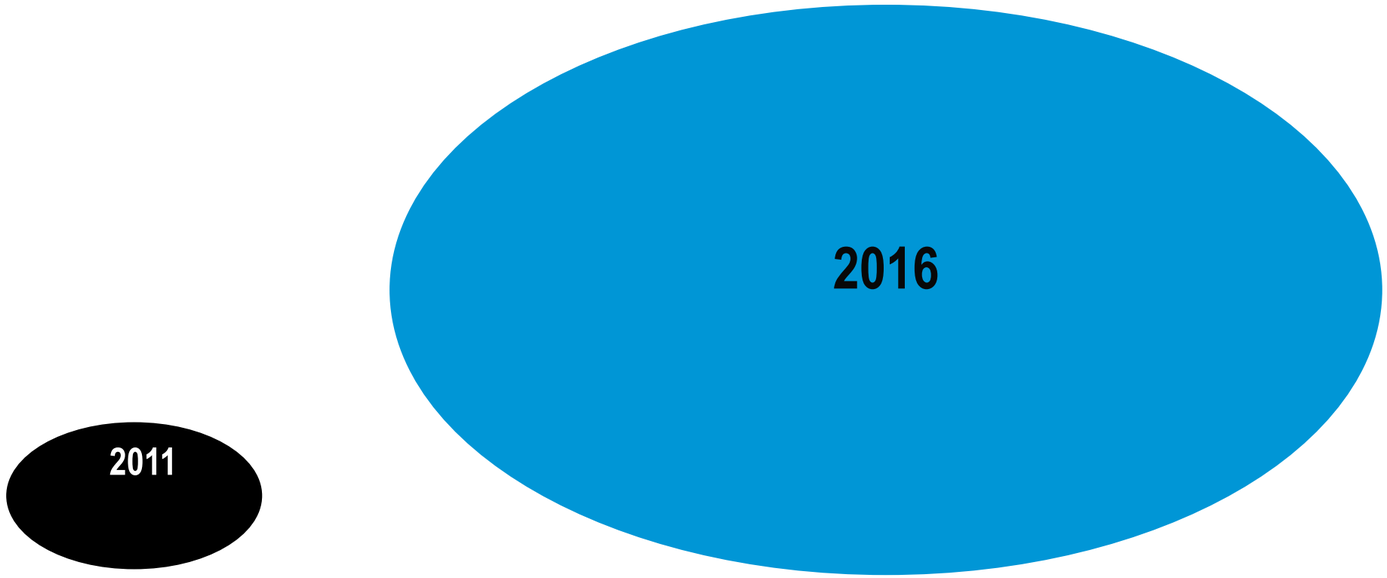
Only 12% of Handsets



But 82% of Traffic

Source: Cisco Visual Networking Index 2011

Are you ready for this 2015

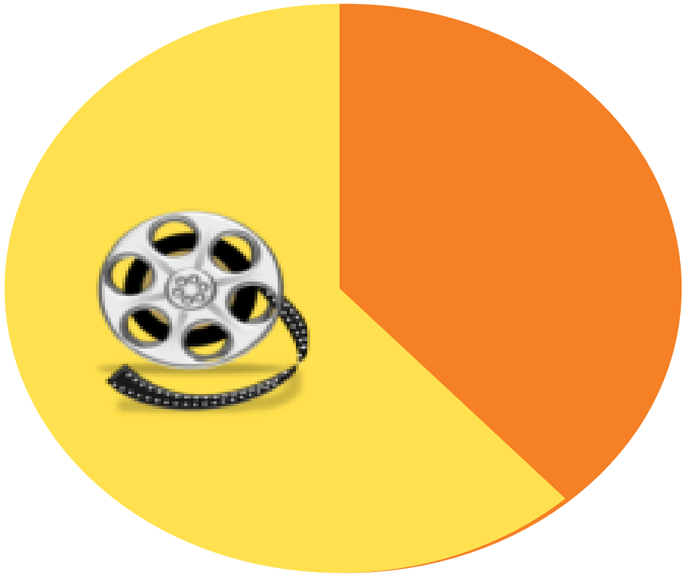


Mobile data to grow by x18

Source: Cisco Visual Networking Index 2011

Are you ready for this 

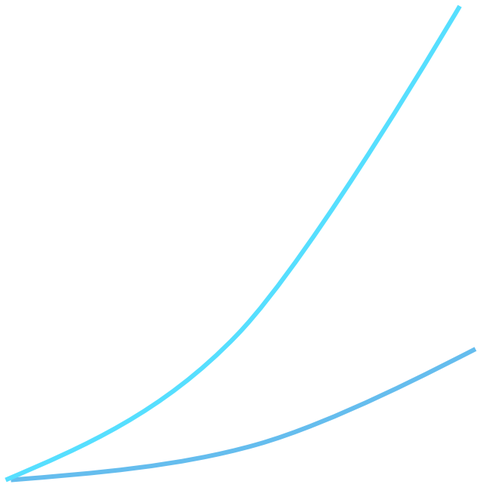
About 67% will be video



Source: Cisco Visual Networking Index 2011

Are you ready for this 

Mobile data grow rate will be



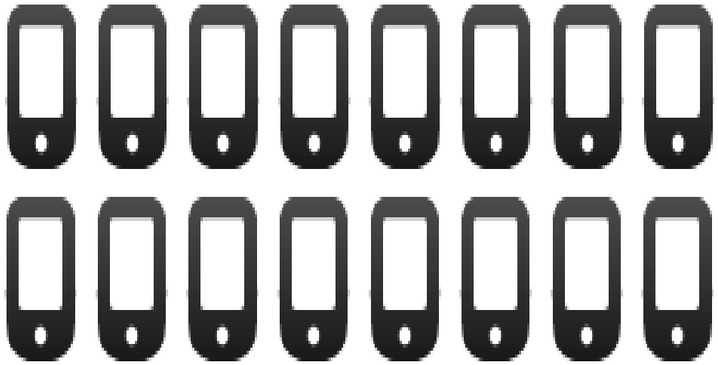
x3 faster
than fixed IP traffic growth

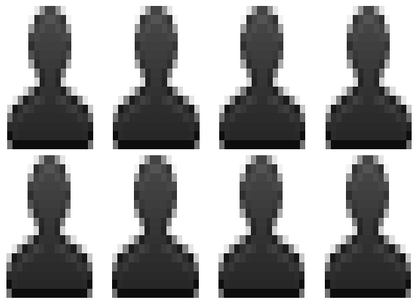
Source: Cisco Visual Networking Index 2011

Are you ready for this 2015

10 billion

Connected devices
(1.4 per capita)





Source: Cisco Visual Networking Index 2011

Are you ready for this 

Avg. smartphone user to generate about

2.6GB / month

Comparing to 150MB today

Source: Cisco Visual Networking Index 2011

Agenda

- Wireless connectivity Outdoors
- Cisco Outdoor Mesh architecture overview
- Bringing Wifi innovation outdoors
- Cisco Wireless Outdoor: product portfolio update
- How to deploy an outdoor wireless network

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Cisco Outdoor WiFi and WiFi Mesh Main Markets

Muni Authority

Digital Divide

Municipal Applications (CCTV, Parking, Sensors)

Connected Communities

Service Provider

Last Mile option

3G Offload

Value added services

Enterprise

Indoor to outdoor coverage extension

(Universities, Manufacturing and Logistics, etc)

Transportation

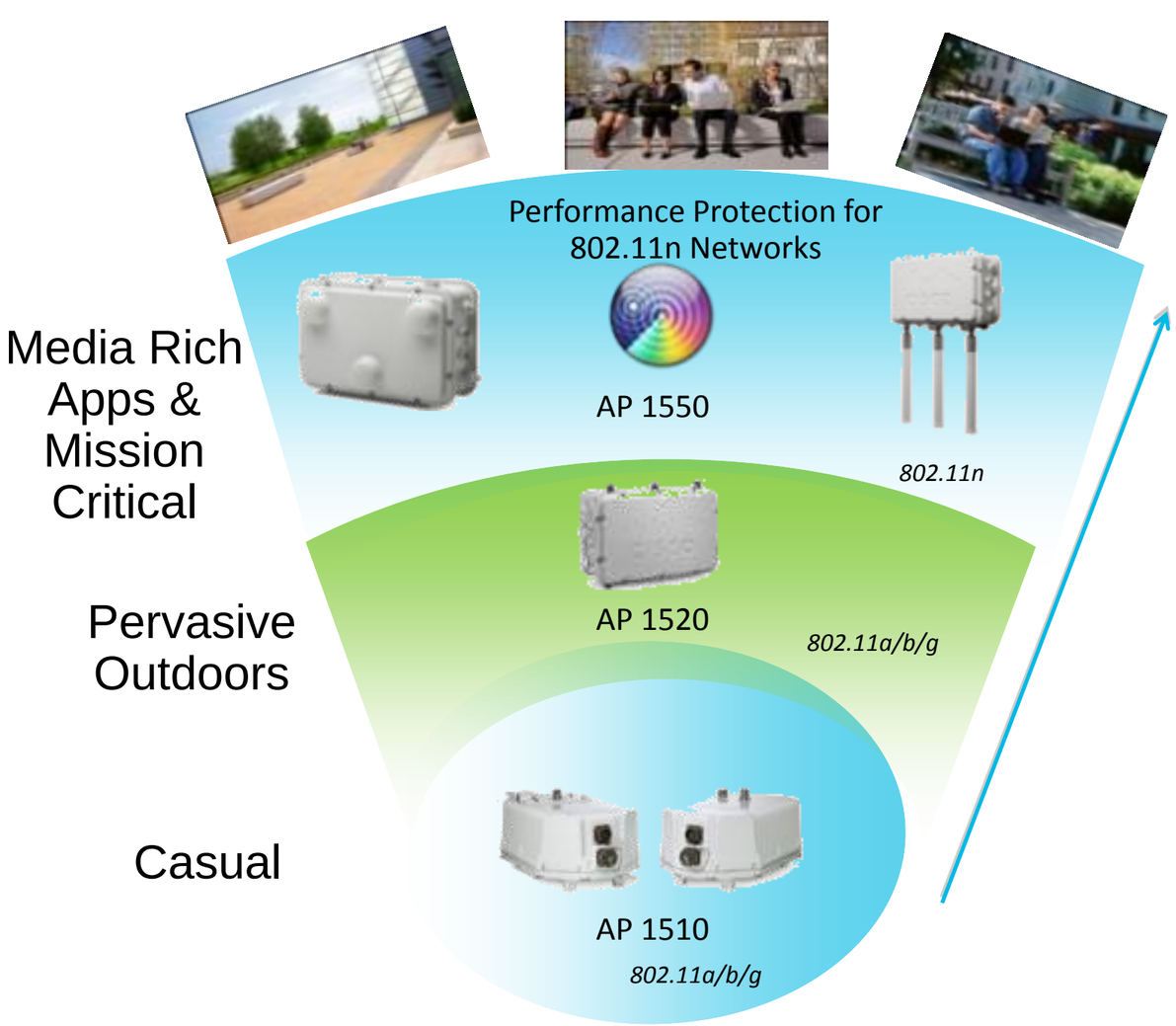
Train Operations

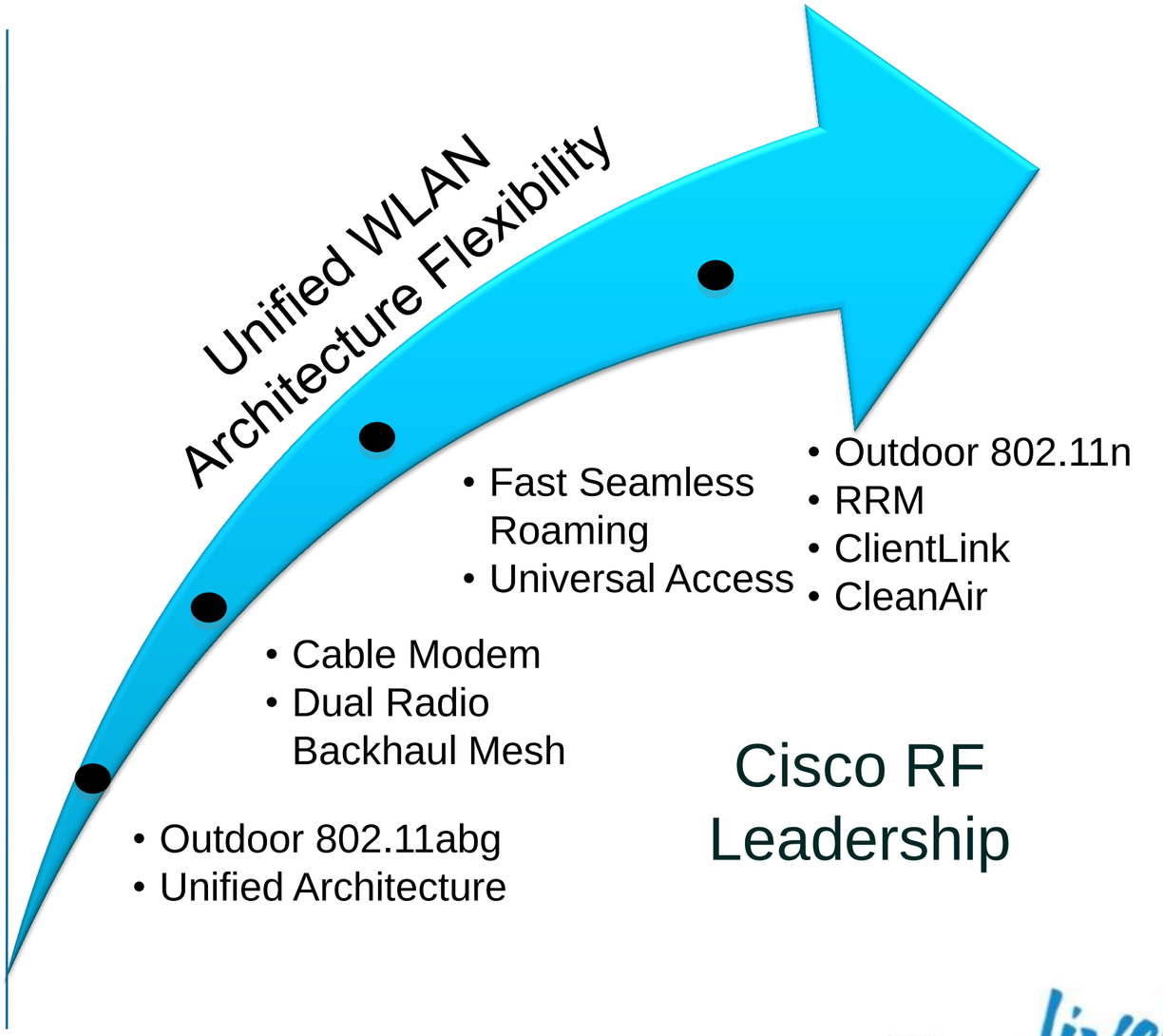
Safety

Customer Service

Outdoor WiFi network as the Platform

Enterprise/SP Outdoor Wireless Evolution

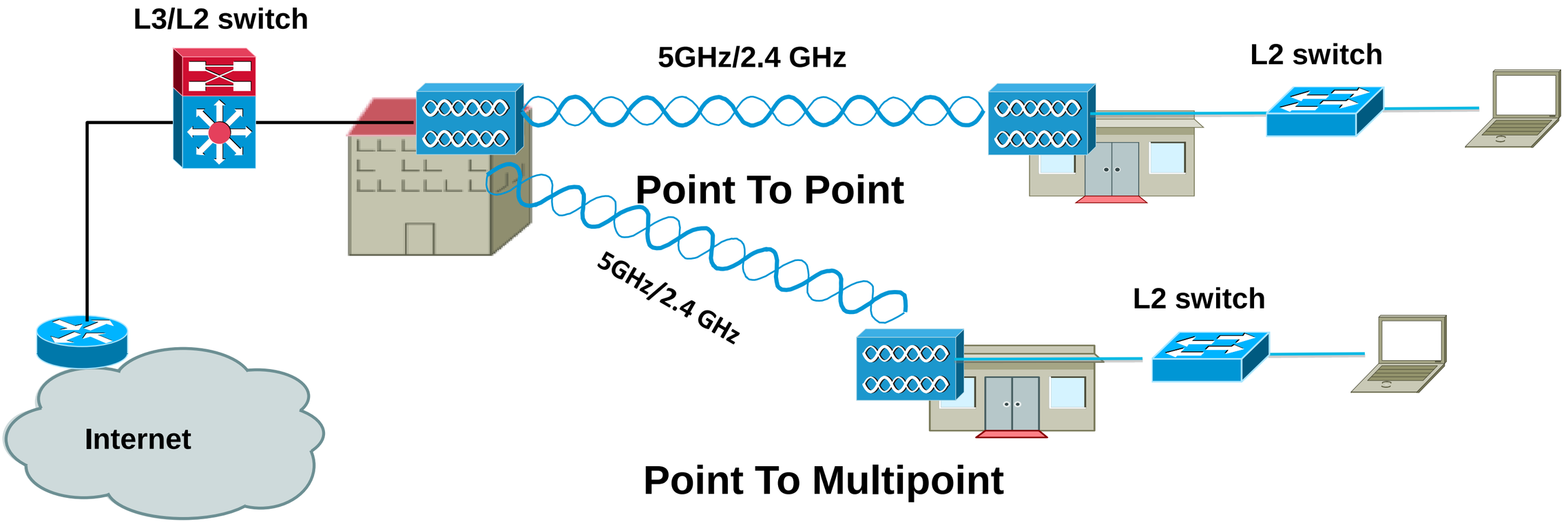




Cisco Outdoor Mesh Architecture Overview

Cisco Outdoor Mesh Architecture Overview

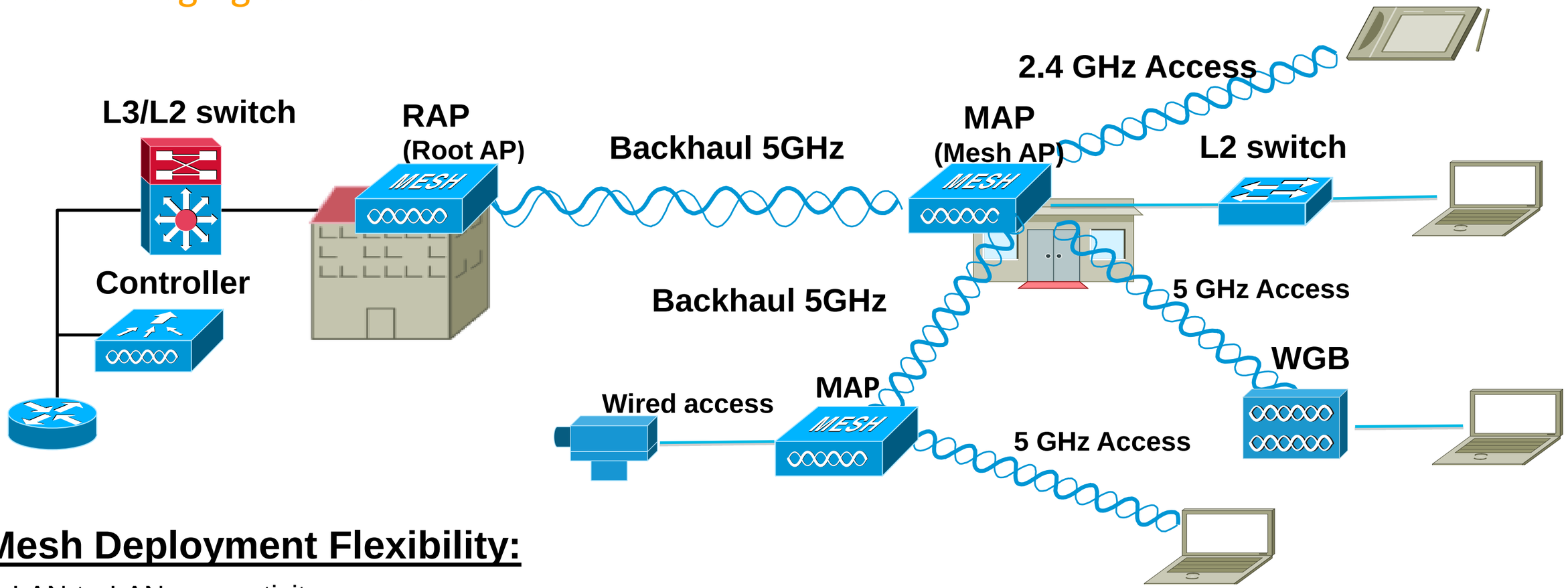
Bridging



Bridging: basic LAN to LAN wireless connectivity

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 a Mesh Network ?

What is a Root Access Point (RAP)?

The usual underground part of a seed plant body, which functions as an organ of absorption, aeration, and food storage or as a means of anchorage and support.

What is a Mesh Access Point (MAP)?

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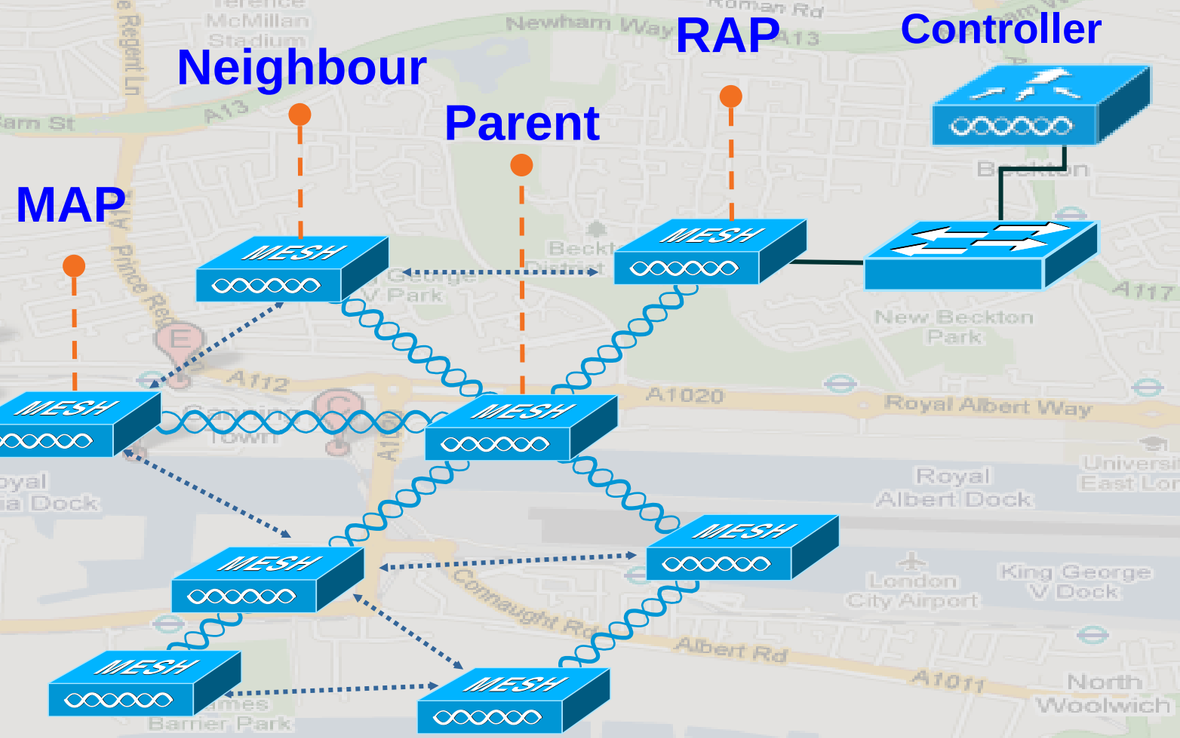
Cisco Outdoor Mesh Architecture Overview

Self-configuring, Self-healing Mesh

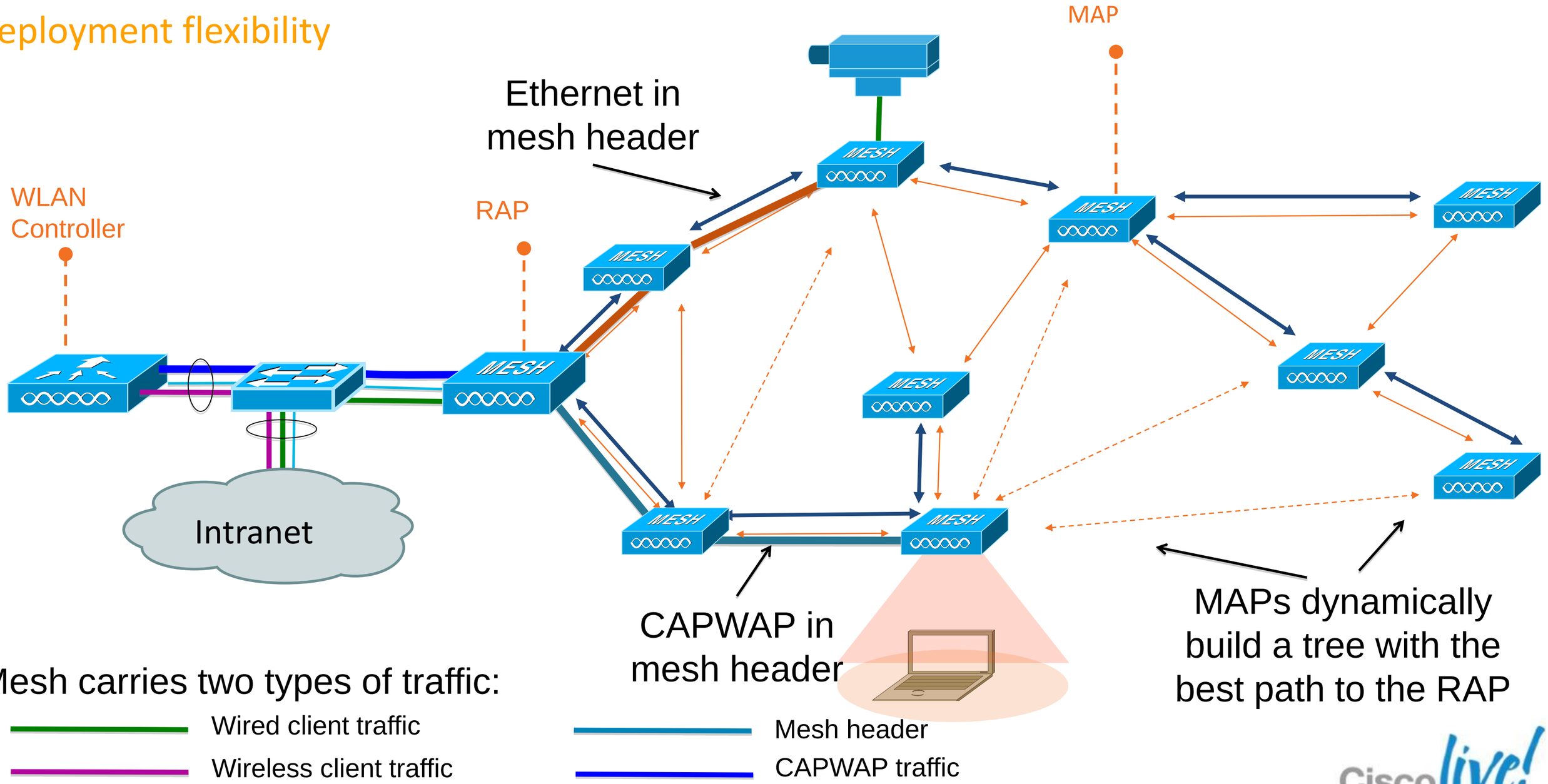
- Optimal parent selection selects the path "ease" across each available backhaul
- Ease based on number of hops and link SNR (Signal Noise Ratio)
- AWPP uses a "Parent Stickiness" value to mitigate Route Flaps
- AWPP integrates 802.11h DFS (Dynamic Frequency Selection) for radar detection and avoidance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



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

Cisco Outdoor Mesh Architecture Overview

Deployment flexibility



Mesh carries two types of traffic:

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

Cisco Outdoor Mesh Architecture Overview

Scalability at Different Layers

Access Point

32 MAPs per RAP (20 recommended)

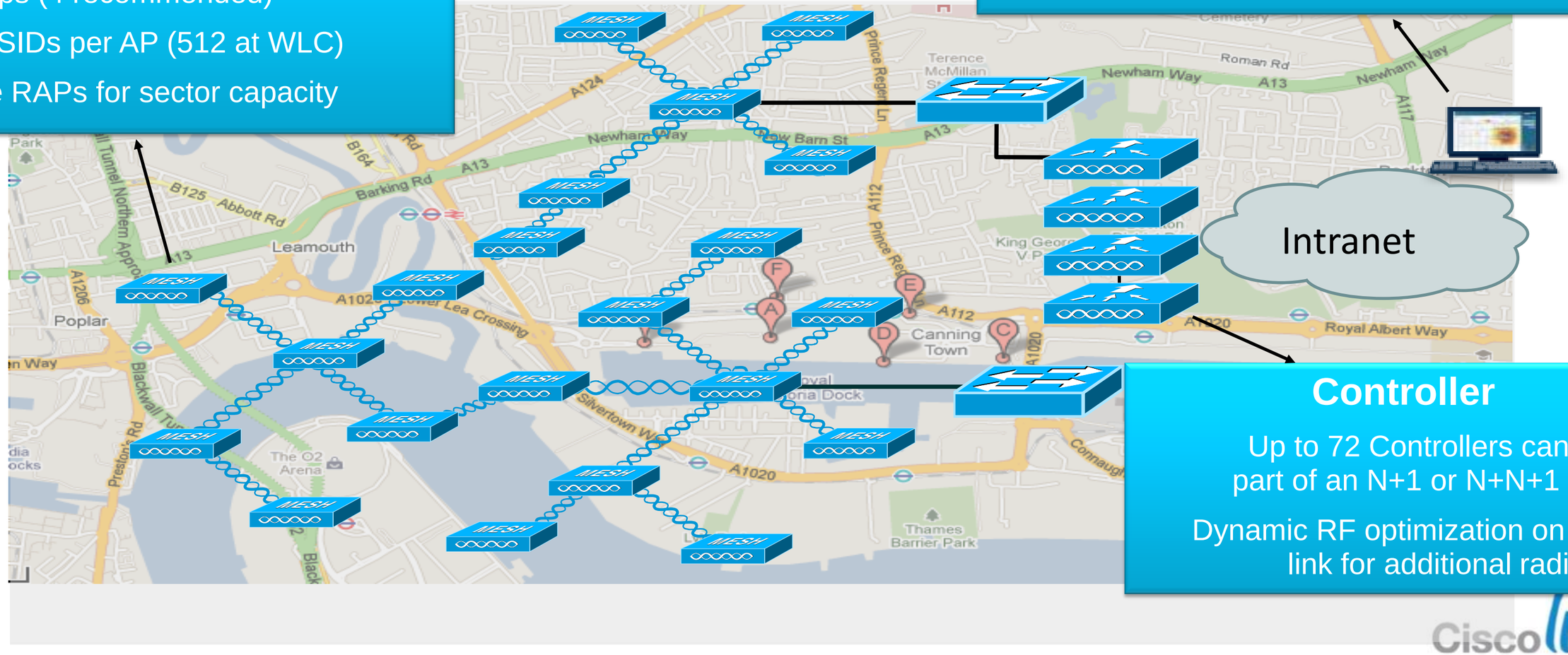
8 Hops (4 recommended)

16 SSIDs per AP (512 at WLC)

More RAPs for sector capacity

Management

PI manages up to 15000 Aps & 1250 WLCs



Controller

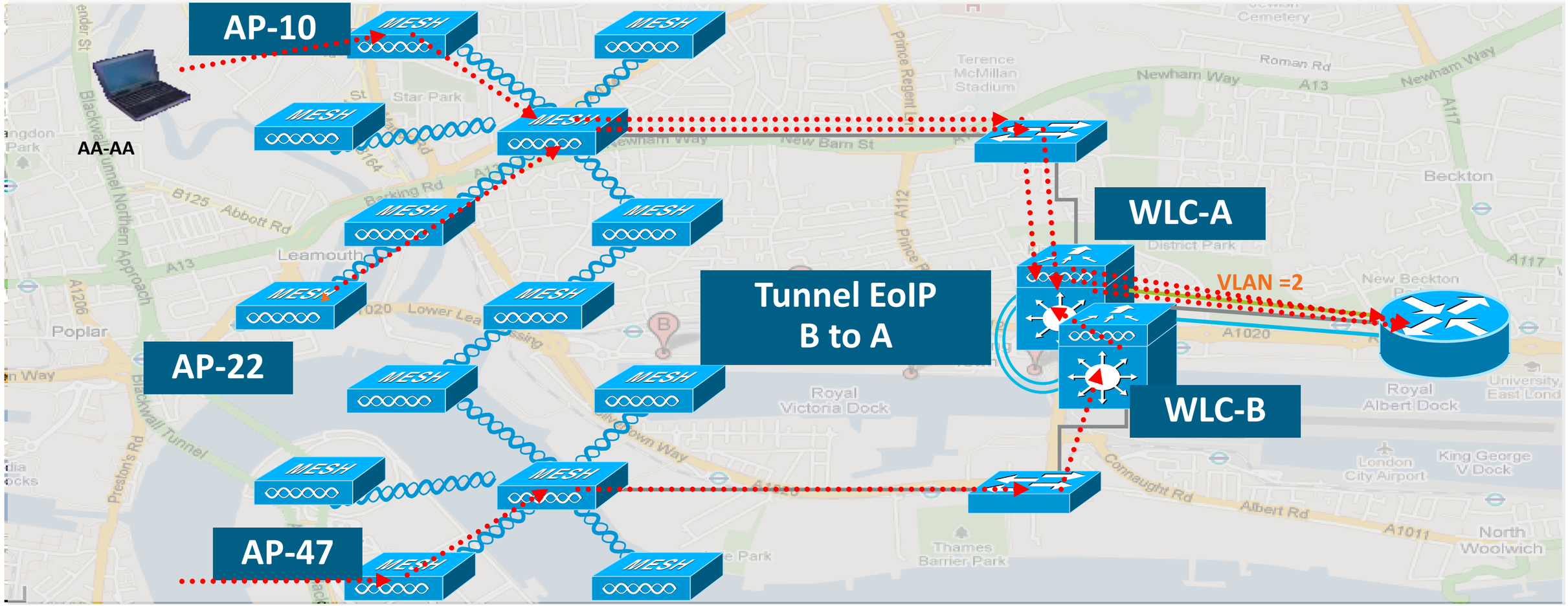
Up to 72 Controllers can be part of an N+1 or N+N+1 cluster

Dynamic RF optimization on access link for additional radios

Cisco Outdoor Mesh Architecture Overview

Seamless user mobility

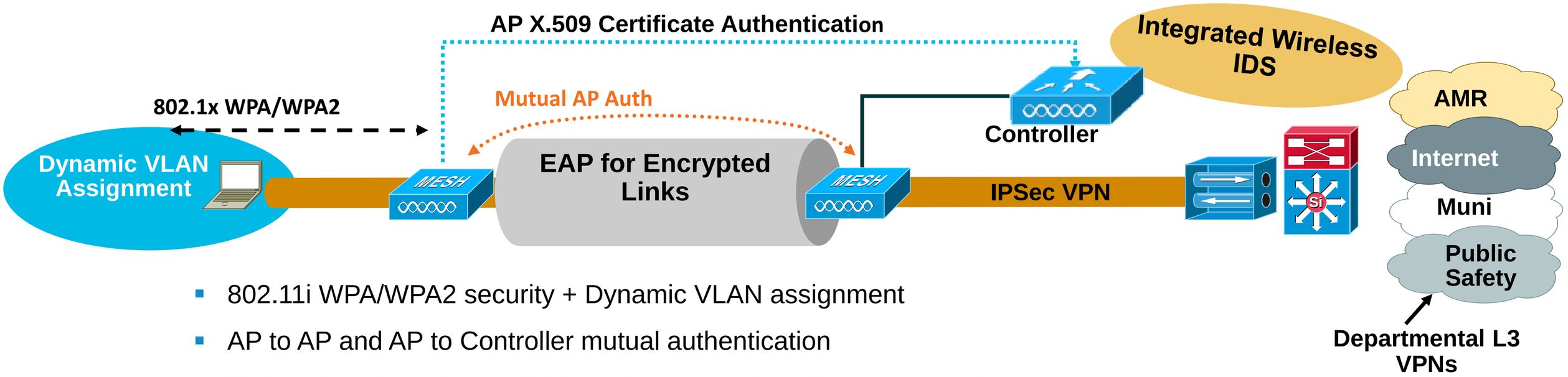
Inter-controller L3 Roaming



MAC	SSID	AP	WLAN	WLC	VLAN	IP
AA-AA	**OpenWiFi**	**47**	**2**	**B-A**	**2**	**10.10.10.2**

Cisco Outdoor Mesh architecture overview

Robust Embedded Security

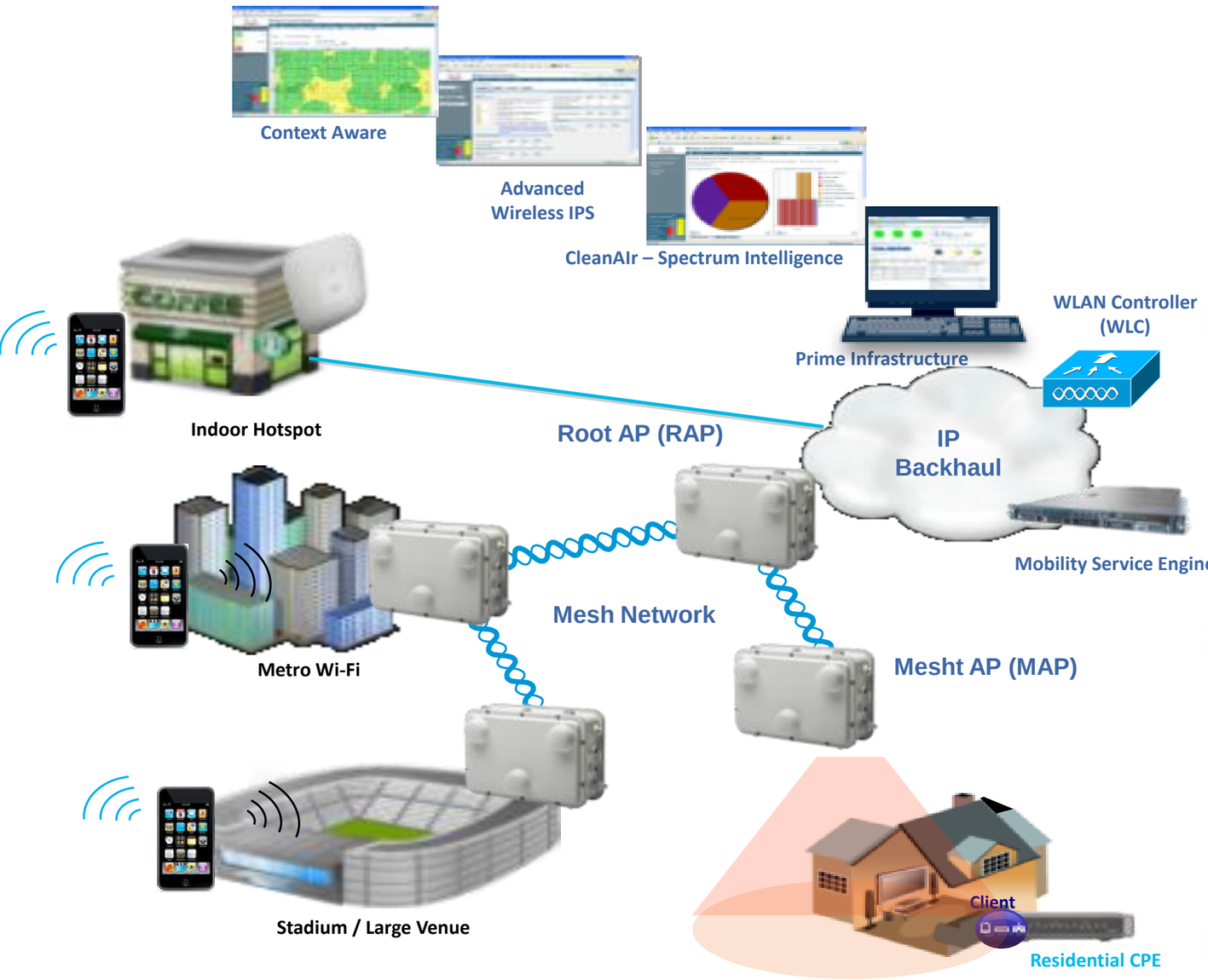


- 802.11i WPA/WPA2 security + Dynamic VLAN assignment
- AP to AP and AP to Controller mutual authentication
- EAP authenticated and AES-based encrypted backhaul mesh links
- Encrypted control traffic between AP and Controller
- Rogue AP detection and blacklisting
- Integrated Wireless IDS and Attack correlation software
- Mobile L3 VPNs for “confidential” client traffic

Cisco’s AnyConnectVPN Client uninterrupted L3 roaming between Wi-Fi, cellular, etc. networks

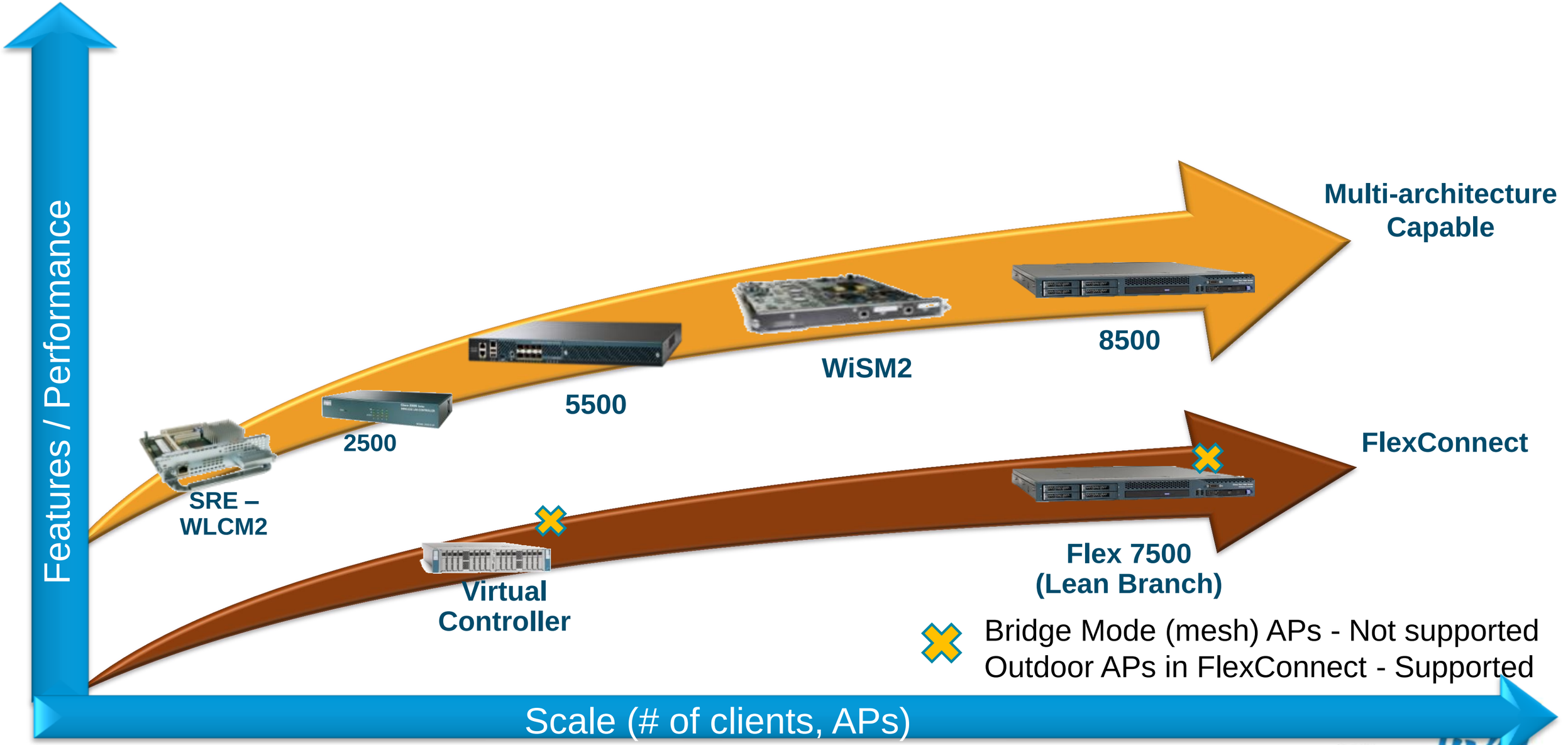
Cisco Outdoor Mesh Architecture Components

Cisco Wireless Outdoor Architecture Components



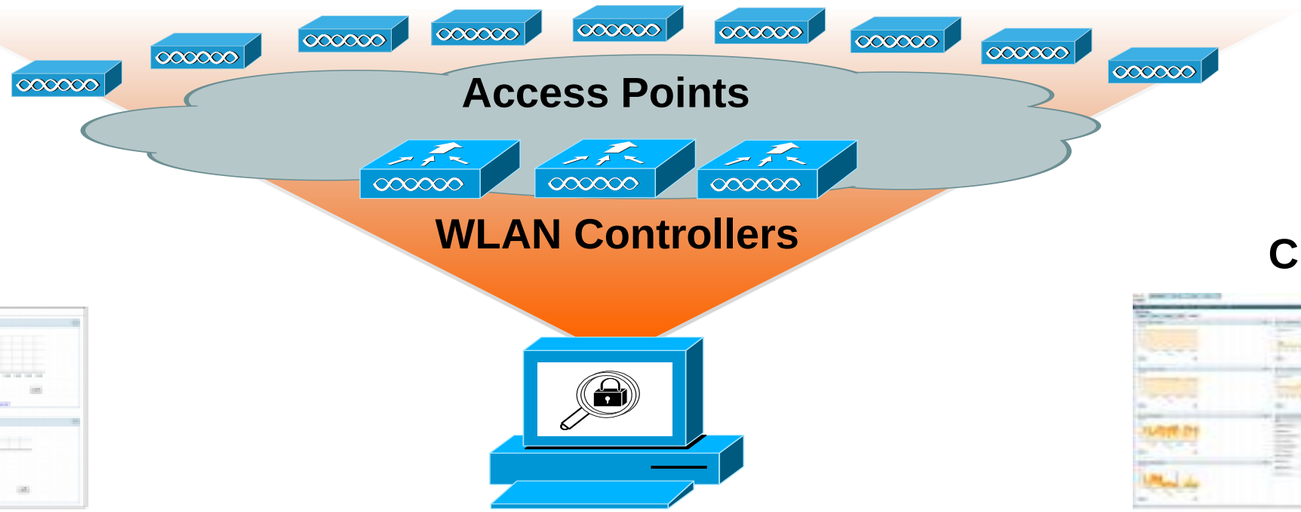
- Access Points:
  - 802.11abgn
  - CleanAir, ClientLink, etc.
  - Outdoor enclosure, AC/DC power; PoE capable. Battery backup
  - POE port for peripheral devices
- Wireless LAN Controller (WLC):
  - Handles RF algorithms and optimization
  - Seamless WiFi L3 mobility
  - Provides security at each Layer
  - Image and configuration Management
- Prime Infrastructure
  - Network-wide policy configuration and device management
  - Design and deployment tools
  - Monitoring and troubleshooting
- Mobility Service Engine (MSE)
  - Enables Mobility services (WIPS, Context aware)

Controller Product Portfolio

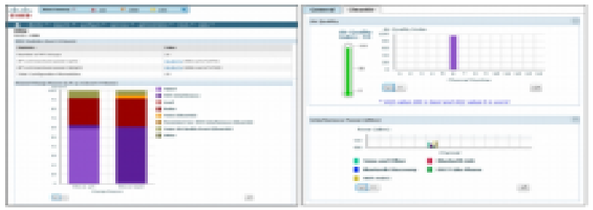


Prime Infrastructure (PI)

Cisco PI Management Platform for Lifecycle Management of Enterprise-Class Wireless Networks



Radio Resource Mgmt

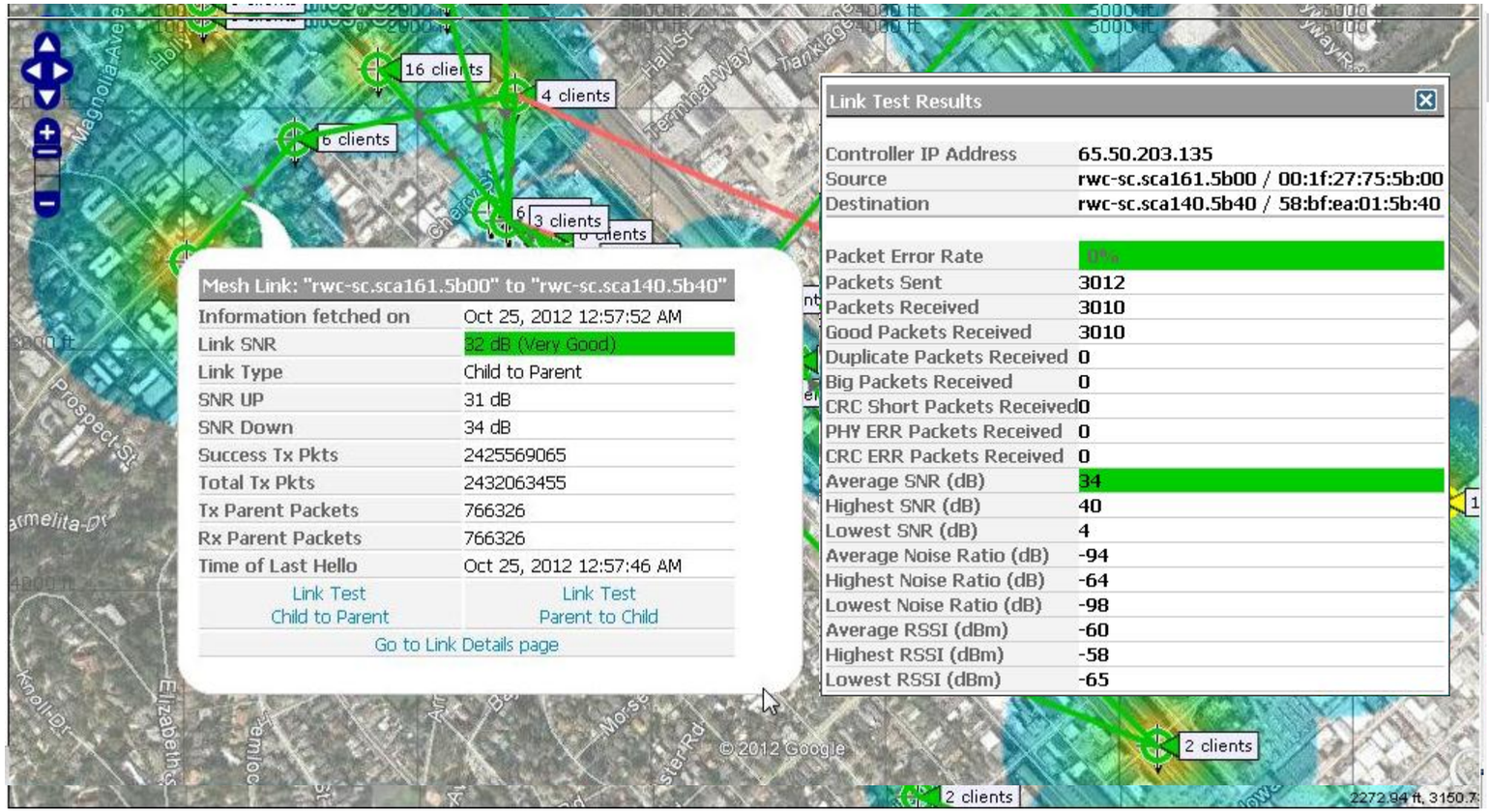


Cisco Clean Air

Troubleshooting

Alarm Monitoring

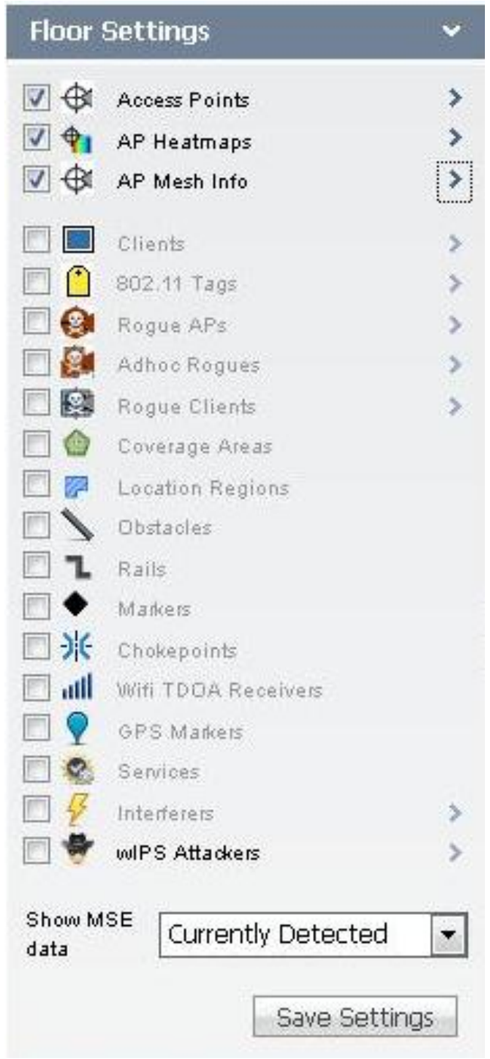
Fully Integrated Prime Infrastructure Mesh Management

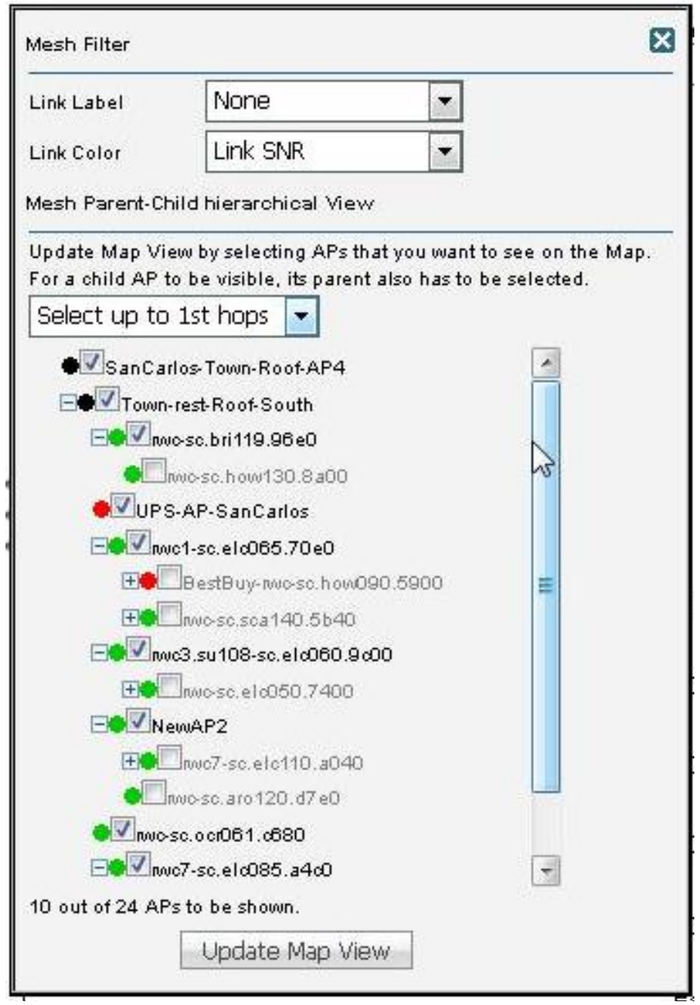


- Mesh Information on mouse roll over
- Neighbour AP Information
- Ping Test from Controller to AP
- Link Test from AP to AP
- Sensitive Mesh Reports & Stats

PI - AP Mesh Tree

AP Mesh Info Option to Display Mesh Tree on Map





Mesh AP 1552: Bringing WiFi Innovation to Outdoors

Cisco AP 1550 series

High Performance Outdoor Wireless

Features

- Outdoor 802.11n Access Point
- Dual-Radio APs (2.4 & 5 GHz)
- CleanAir & ClientLink (beamforming)
- Dual-band Antennas
  - Stick
  - Integrated; Low-Profile
- Backhaul
  - DOCSIS 3.0 / EuroDOCSIS 3.0
  - Fibre
  - Ethernet
  - Mesh

Benefits

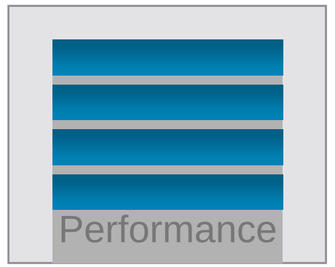
- RF Excellence:
  Integrated spectrum intelligence
- Unified Mode:
  Authentication, Security, Mobility,..
- Flexible Deployment:
  Access or mesh network, extension of an Ethernet network, Fibre, Wireless or Cable backhaul
- High Performance:
  Multipurpose network with low CAPEX & OPEX

Aspects of 802.11n

40MHz Channels | Packet Aggregation | Backward Compatibility

MIMO (Multiple Input, Multiple Output)

Information is Split and Transmitted on Multiple Streams



Transmitter and Receiver Participate	Concurrent Transmission on Same Channel	Increases Bandwidth	Requires MIMO Client

Beam Forming | Maximal Ratio Combining | **Spatial Multiplexing**

AP1550 has the capability of 2 X 3 MIMO

Aspects of 802.11n

40MHz Channels | Packet Aggregation | Backward Compatibility

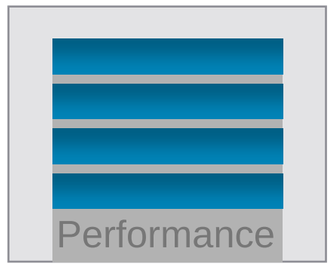
MIMO (Multiple Input, Multiple Output)

Without MRC

Multiple Signals Sent;
One Signal Chosen

With MRC

Multiple Signals Sent and Combined at the Receiver Increasing Fidelity



Performed by Receiver (Hear Better)	Combines Multiple Received Signals	Increases Receive Sensitivity	**Works with non-MIMO and MIMO Clients**

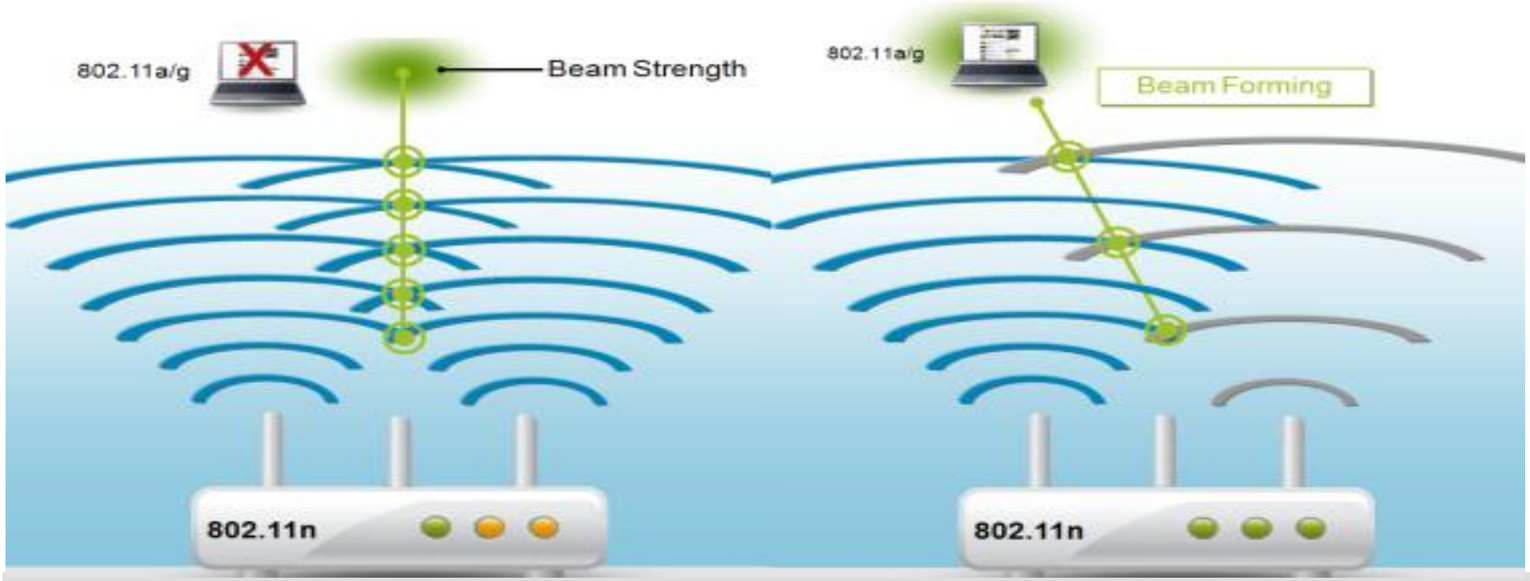
Beam Forming | **Maximal Ratio Combining** | Spatial Multiplexing

MRC gives a gain of 4.7 dB in UL for all Data Rates
MRC Gain is added in Rx Sensitivity number

Aspects of 802.11n

MIMO | 40MHz Channels | Packet Aggregation | Backward Compatibility

MIMO (Multiple Input, Multiple Output)



With Beam Forming
Transmissions Arrive in Phase, Increasing Signal Strength

Without Beam Forming
Transmissions Arrive out of Phase and signal is weaker

Performed by Transmitter (Talk Better)	Ensures Signal Received in Phase	Increases Receive Sensitivity	**Works with non-MIMO Clients**

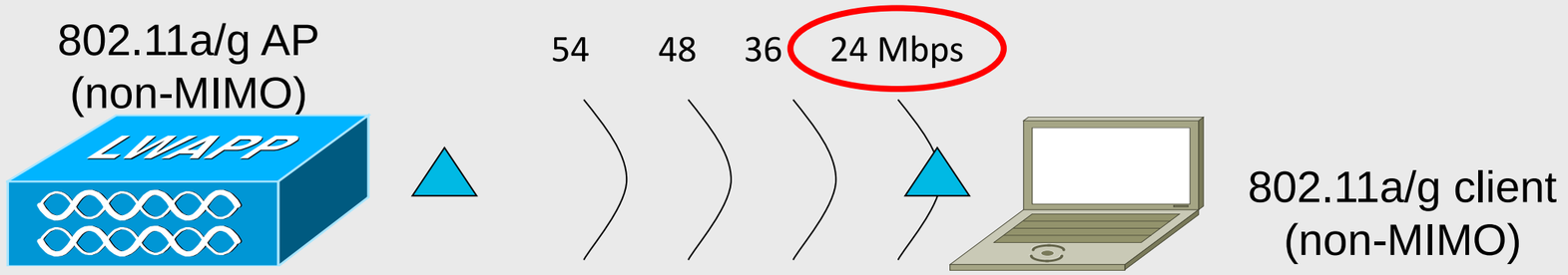
Beam Forming Maximal Ratio Combining Spatial Multiplexing

Beam Forming gives a gain of 4+ dB in DL

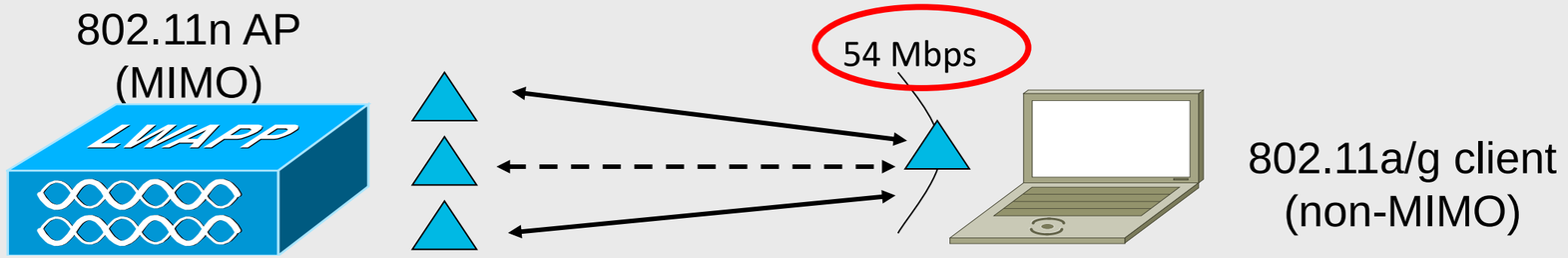
MIMO Benefits Summary

Throughput improves when all things come together

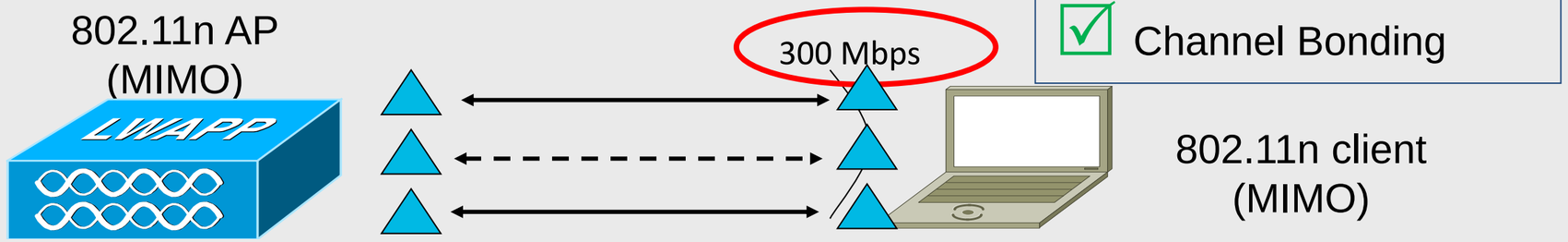
- ☒ MRC
- ☒ TxBF
- ☒ Spatial Multiplexing



- ☑ MRC
- ☑ TxBF
- ☒ Spatial Multiplexing



- ☑ MRC
- ☑ TxBF
- ☑ Spatial Multiplexing

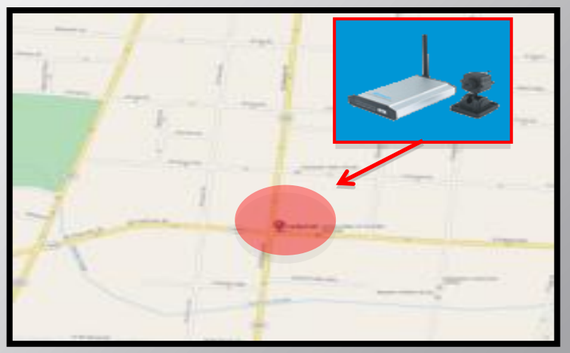


What is CleanAir Technology

- Classification processed on Access Point
- Interference impact and data sent to WLC for real-time action
- Prime Infrastructure and MSE store data for location, history, and troubleshooting

Monitoring, Locate

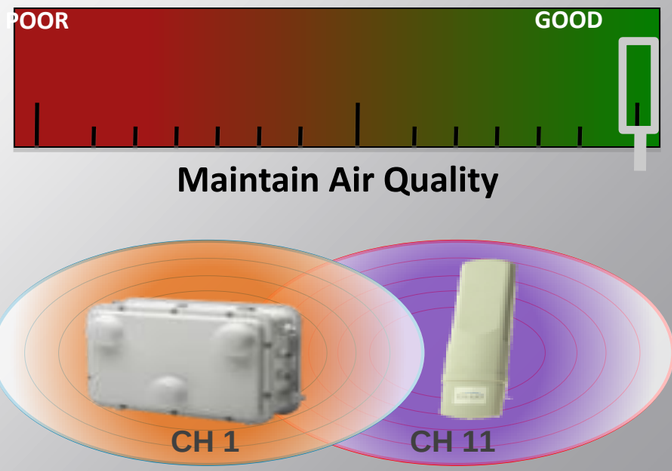
NCS, MSE



Visualise and Troubleshoot

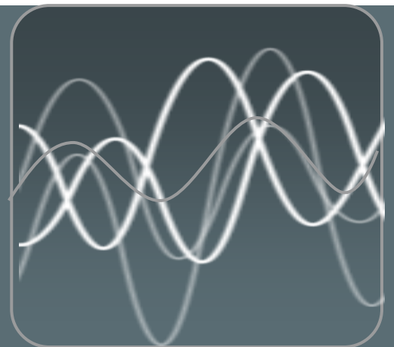
Mitigate

Wireless LAN Controller



Cisco CleanAir

Visibility of the RF Spectrum

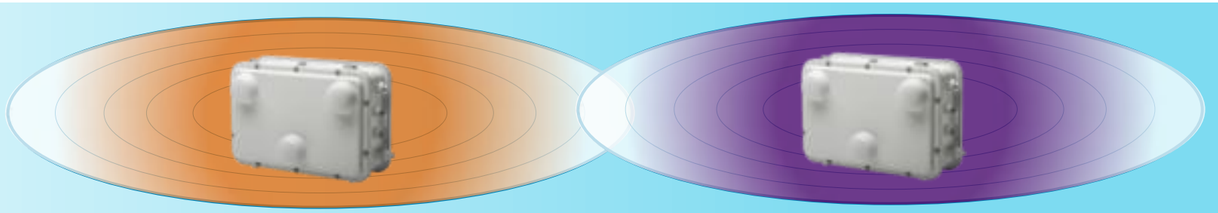


AIR QUALITY

PERFORMANCE

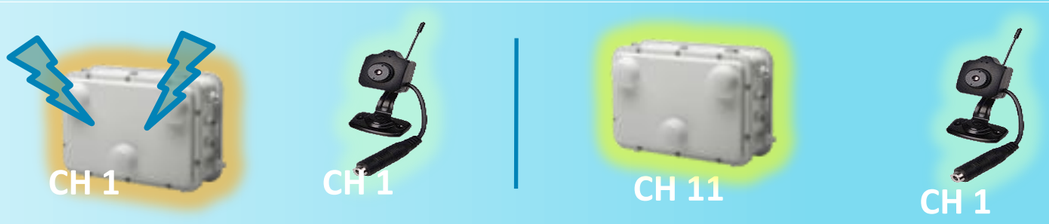
CleanAir: Self-healing and Optimisation

Interference Aware RRM



Maximises performance by avoiding interference

Event Driven RRM



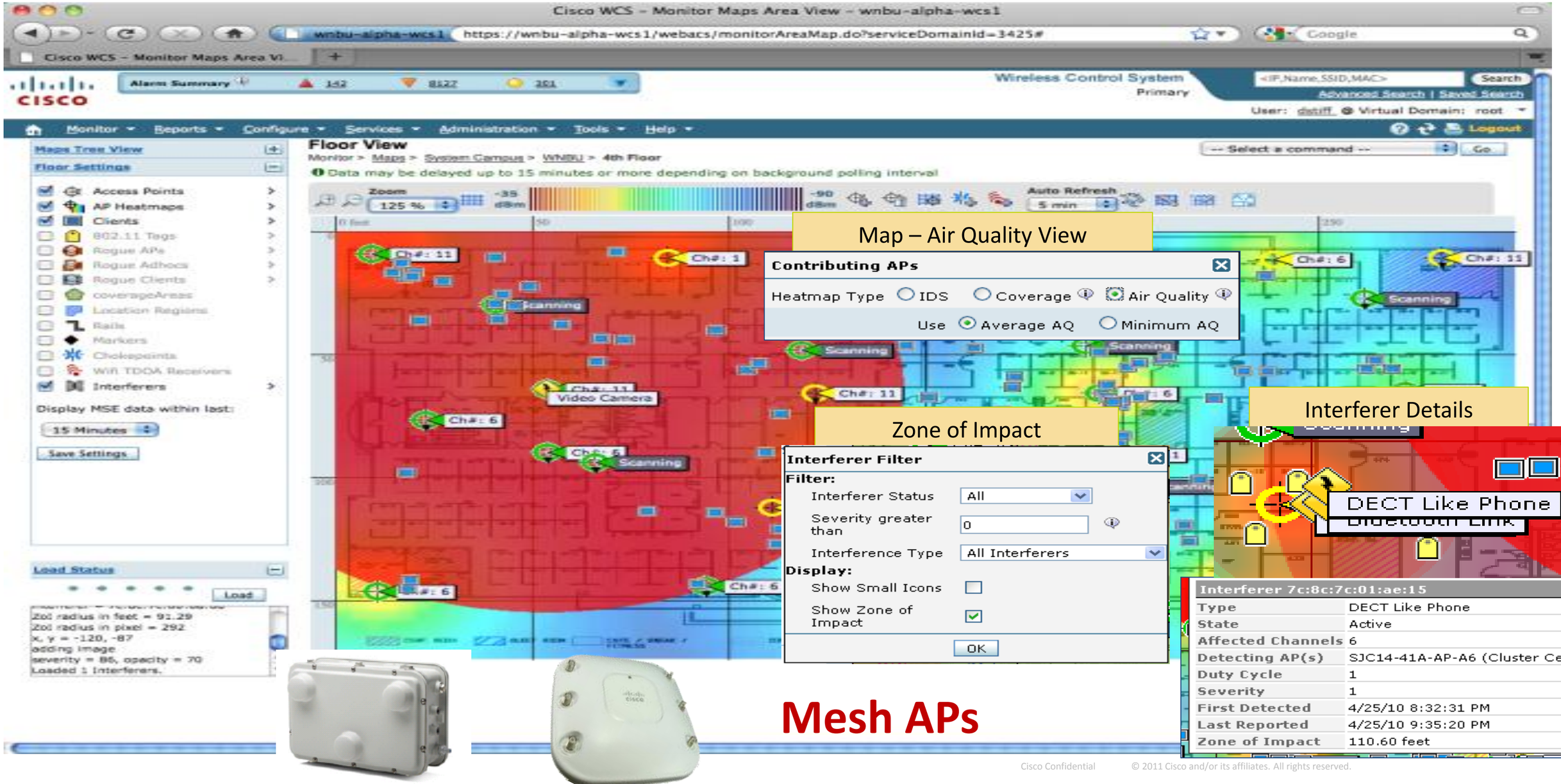
Self Healing to avoid Wi-Fi degradation

Persistent Device Avoidance

Self Learning to increase reliability

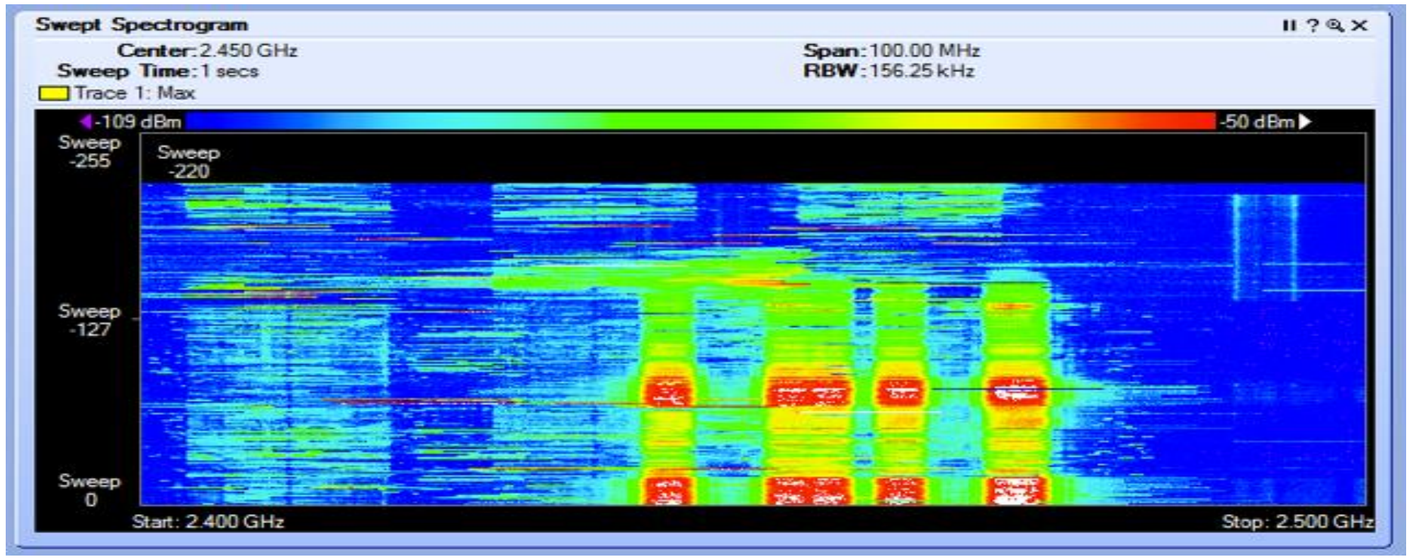
CleanAir:Network Visibility

Context Aware Services enable PI to show Interferer's location



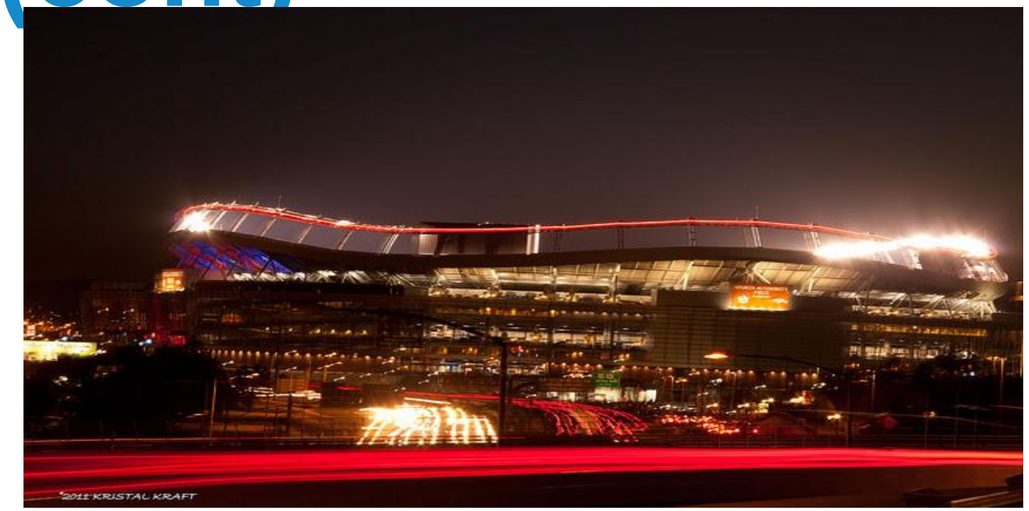
CleanAir in action in outdoor environments

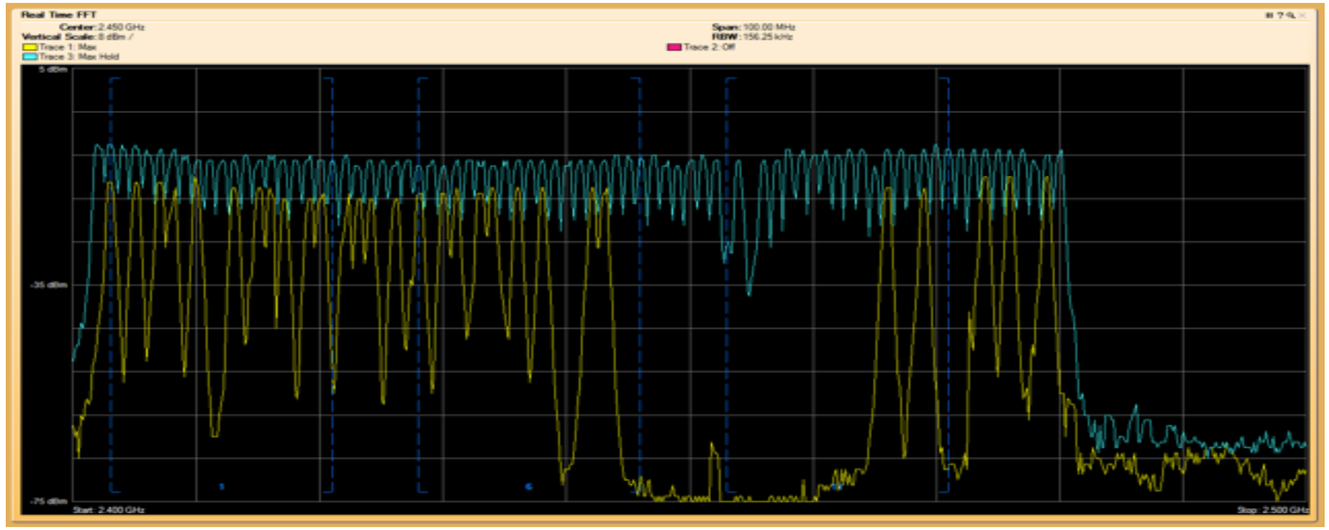
Parking Lot Cameras



CleanAir in action in outdoor environments (cont)

LED Lightning Control





CleanAir for Mesh Details

- CleanAir on 2.4 GHz for AP1552 in Bridge (Mesh) mode
- Interferers detected by Clean Air on 2.4 GHz include:

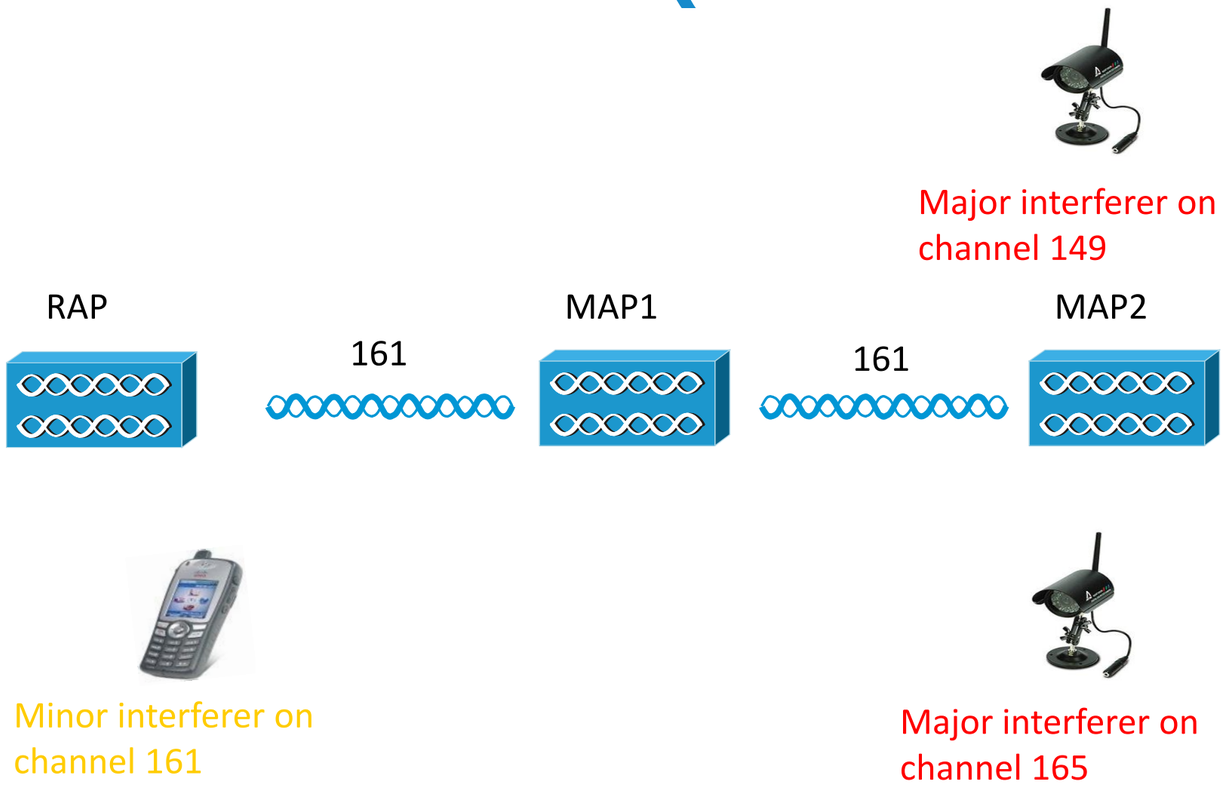
- ED-RRM supported
- CleanAir not supported in the 5GHz backhaul interface
- CleanAir Advisor introduced in 7.3 release for 5GHz

CleanAir Advisor (5GHz) vs. CleanAir (2.4GHz)

- CleanAir – Detects an interferer then through Event-Driven RRM, if required changes the serving channel

- Challenge – In a mesh network, nodes span a great distance. To avoid a minor interferer you can encounter a major interferer

- Solution = CleanAir Advisor detects the interferers and generates alarms but takes no automatic actions. The system administrator then decides what to do.



CleanAir Recommendations for Mesh

- AP Density recommendation for CleanAir remains the same as normal Mesh AP Deployment
- APs should be RF neighbours for any possibility of Merging (spatial proximity)
- Location Resolution in the Outdoors is to the nearest AP
- Outdoor Custom Calibration possible from 7.0.116.0 onwards
  - Location error may double without custom calibration model
- Installation with a low density of sensors has the possibility of having duplicate entries of interferers
- Mixing CleanAir (AP1552) and Legacy AP's (AP152X) operating in Local Mode (serving clients) is Not supported – nor is recommended

CleanAir With MSE

With MSE / Context Aware	**System wide Interferer Details & Event Correlation*** Lowers Problem Resolution Time/Cost	**Zone of Impact & Interferer Notification** Improved Visibility & Reduces Resolution Time / Cost	**History & Playback** investigate past problems	**Locates Non-Wi-Fi Interferers & Rogues** Improved Security
				
Without MSE	**Interferer details and event correlation not readily available**	**No visibility to Interferers and their impact**	**No historical data for trouble-shooting purposes**	**Cannot locate rogue devices and interferers / Non-Std Wi-Fi** Thus compromising network security

* Useful when customers have more than one WLC

New Outdoor AP Modes (7.3 release)

AP1552 now supports:

- Local mode
- Flexconnect Mode

  Local and FlexConnect Modes are supported for Outdoor **APs connected to the controller using the Ethernet interface**. Mesh is not supported.
- Monitor mode, Rogue Detector and Sniffer Mode
- Besides the previously supported Bridge Mode

New Modes provide flexibility

Why use a AP1552, not an indoor AP?

- Ruggedized AP
- Transmits at higher power levels
- Meets outdoor regulatory constrains

AP1552 in Local Mode vs. Bridge Mode

If Mesh is not needed local mode unlocks features

Features:

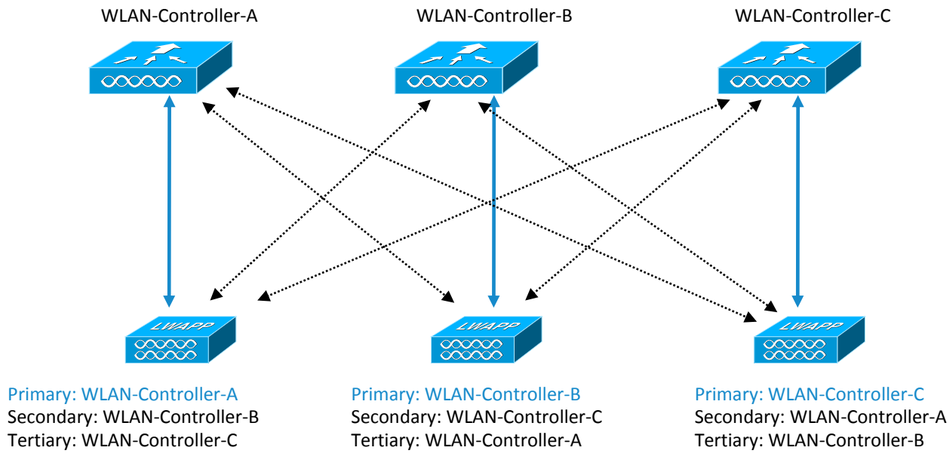
- Local mode feature parity
  - CleanAir on both bands
  - ED-RRM on both bands
  - BandSelect
  - VideoStreaming
  - Improved VoWLAN preformance
  - Avoids wasting airtime by sending mesh beacons

Use case: Citywide WIFI using the AP1552C

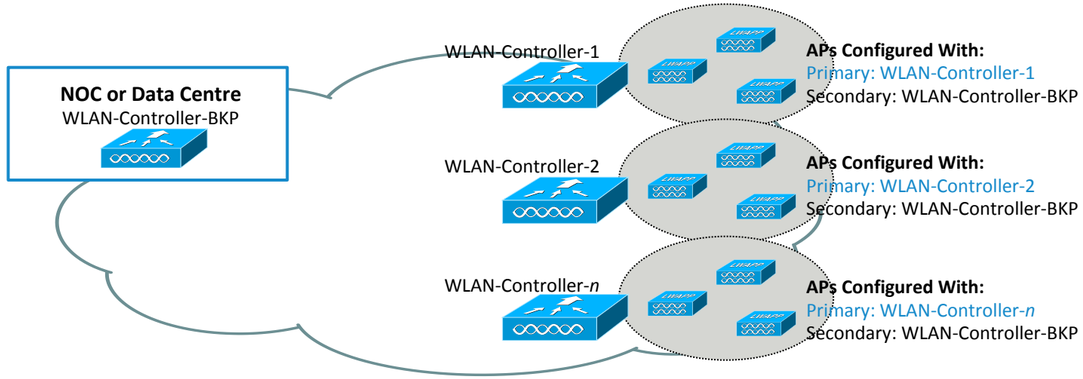
- Each AP has a dedicated backhaul, so there is no need to mesh. Local Mode provides a feature rich end-user experience

Controller Redundancy for Mesh

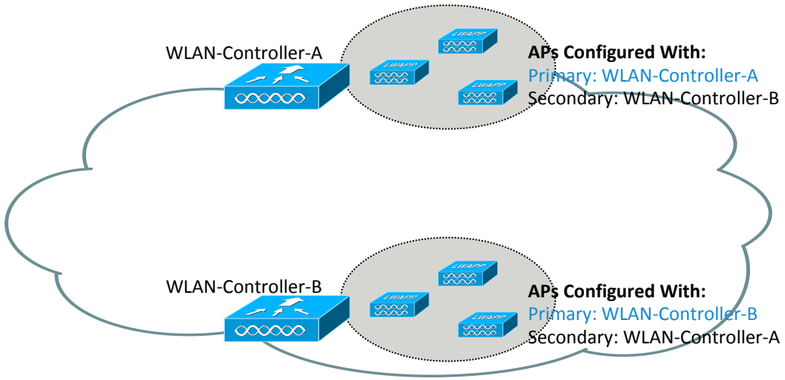
Resiliency



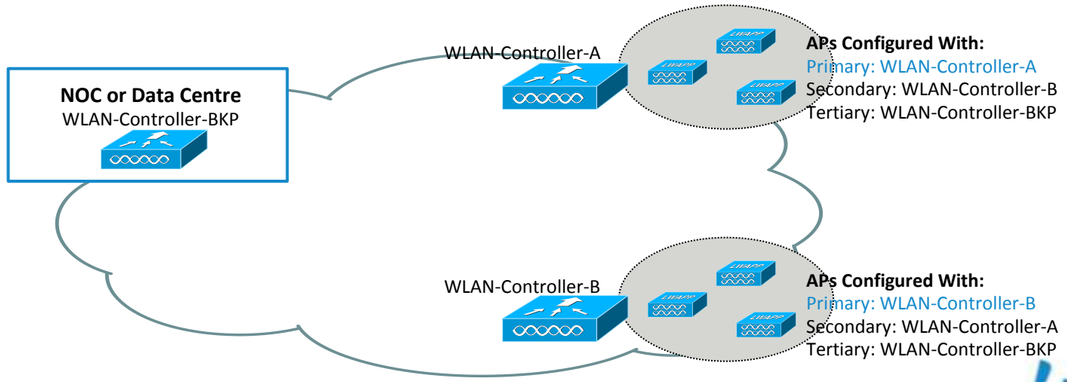
N:1 Redundancy



N:N Redundancy

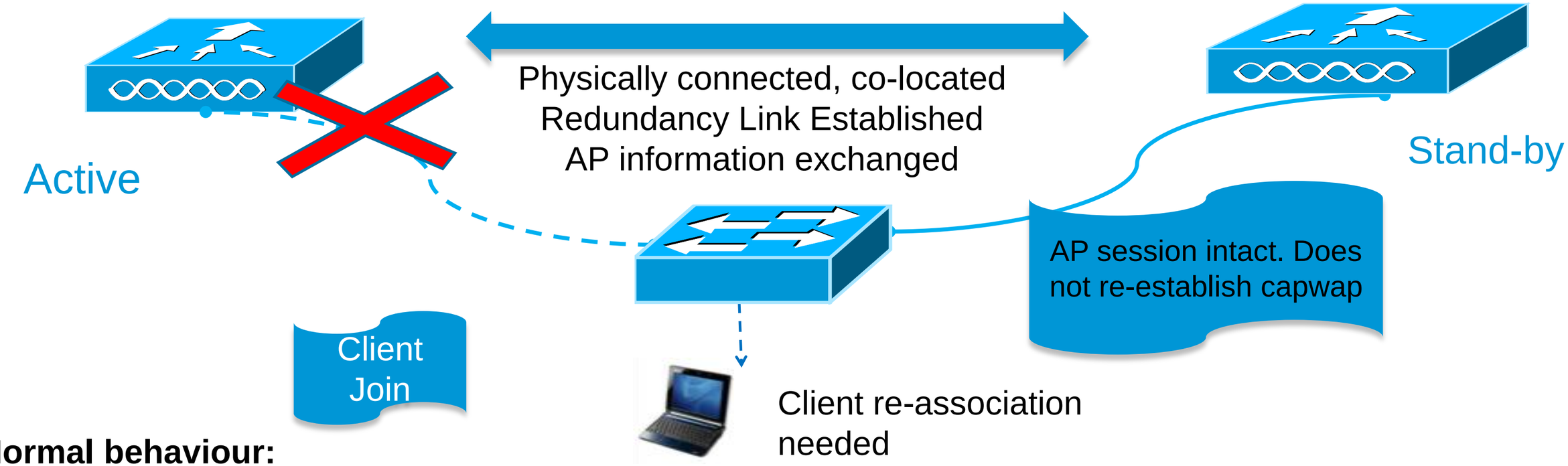


N:N:1 Redundancy



AP SSO - High Availability Solution for Mesh

AP Stateful fail-over



Normal behaviour:

Around of 12 seconds for AP to switch to the next WLC. 500 APs fail-over takes approximately 90 seconds. Clients re-associate time is in addition

New behaviour with AP SSO

1:1 AP stateful Switch over for 5508, WiSM2, Flex7500, 8510

Goal of **sub-second transition** of APs from one WLC to another

Clients re-associate after that and sessions need re-establishment

No duplicate licensing around HA: New HA SKU for 5508, WiSM2, Flex7500

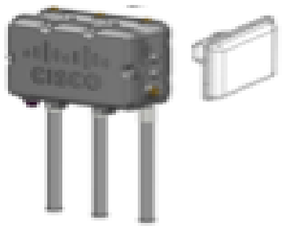
Cisco Wireless Outdoor Portfolio Update

Cisco Aironet Outdoor - 802.11n AP Series

Low Profile
1552I

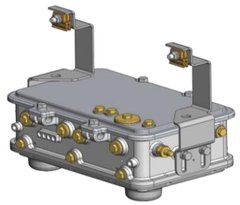
- Integrated Antennas
- Low Power Consumption
- Seamless Connectivity
- CleanAir, ClientLink

Versatile
1552E
1552EU



- External Antennas, Deployment Flexibility
- High Power Gain
- Fibre SPF Option
- PoE Out
- CleanAir, ClientLink

MSO / Cable
1552C
1552CU



- Integrated DOCSIS 3.0 Cable Modem
- Cable Plant Powered
- High Power Gain
- Deployment Flexibility
- CleanAir, ClientLink

Industrial
1552H
1552S

- ATEX Certified Class 1/Div 2/Zone 2
- Integrated Honeywell Sensor Gateway (S)
- Fibre SPF Option
- PoE Out
- CleanAir, ClientLink

Enterprise | Service Provider | Internet of Things

Cisco Aironet 802.11n 1550 Series: at a Glance

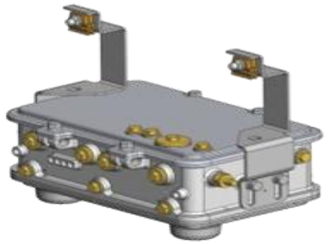
- RF Excellence:
  - Range coverage (40-100%) > Competitors. Area Coverage (200-400%) > Competitors
  - Lower CAPEX (fewer APs); Lower OPEX (less to deploy; maintain)
  - CleanAir 2.4 GHz Spectrum Intelligence
  - ClientLink Legacy Beam Forming
  - DFS capability to detect 0.5us radar pulses
- Cisco Designed Antennas
  - Gain 2.4 GHz: ▪ 2 dBi (integrated), 4 dBi (stick)
  - Gain 5GHz: ▪ 4 dBi (integrated), 7 dBi (stick)
  - External Antennas: One Side of AP (vs. Above/Below) => Lower Footprint
  - Integrated Antennas: Low-Profile AP
- Controller-Based
  - RRM, ClientLink, CleanAir, High-Speed Mobility, Mesh Self-Healing
- Uplink Options
  - Fibre: SFP (GLC-SX-MM-RGD=, GLC-LX-SM-RGD=), Ethernet, Mesh

1552E/H

1552I/C

Mixed Deployment Model

RAP
Cable BH



MAP Streetlight
powered

RAP
In Built antenna
Ethernet BH

MAP Streetlight
powered

MAP Streetlight
powered

RAP
Fibre BH

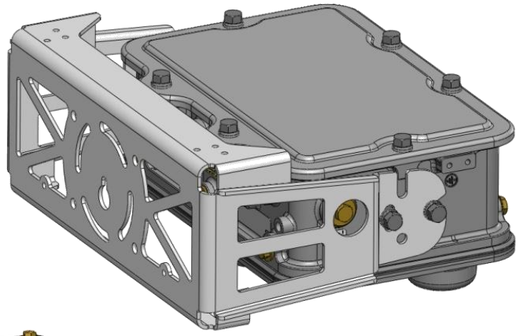
MAP
In Built Antenna

Pole/Wall/ Strand Mount

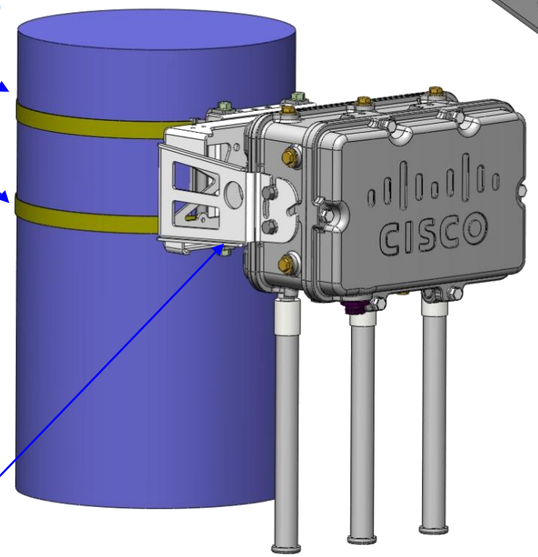
Standard Pole Mount Bracket Can Also be Wall Mounted

AIR-BAND-INST-TL=

Pole Diameter Range supported from 2” to 16 “



2 Steel Straps



Band-it system

Pole Clamp

M8 stud and threaded holes

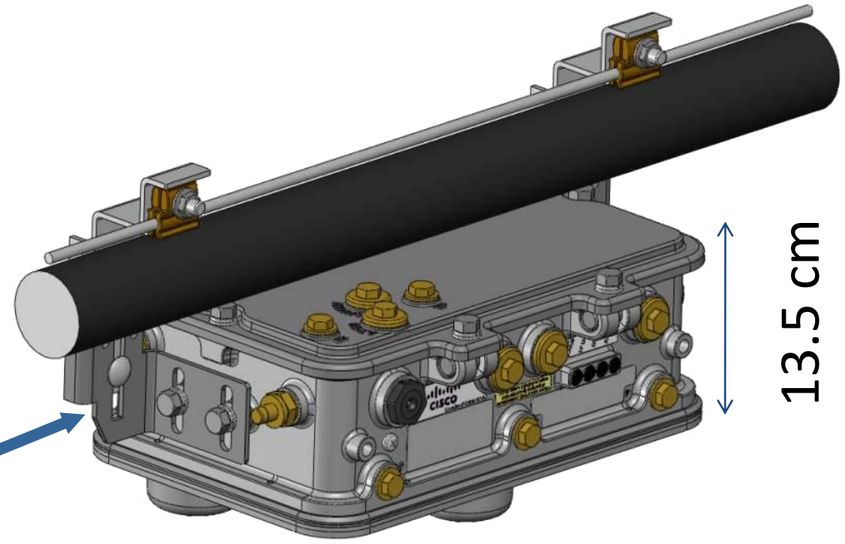
Pole/Wall Mount AP1552 E/H /1522

AIR-ACCPMK1550=

Strand Mount AP1552C

AIR-ACCSMK1550 $0

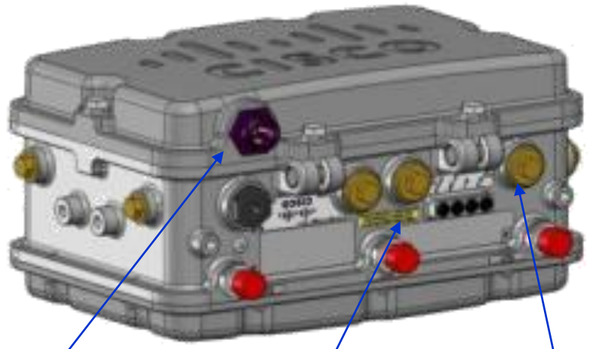
AIR-ACCSMK1550= (Spare Kit)

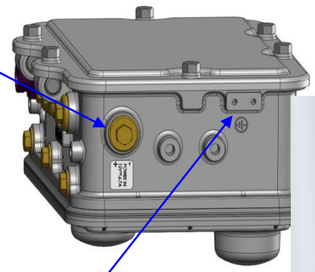


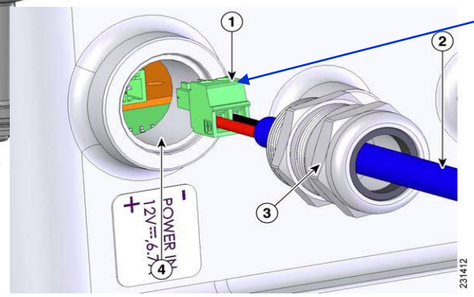
Strand slope adjustment

Power Options

- AC Power
  - 100 - 480 VAC (47-63 Hz) – Connecting AC or Streetlight Power (1552E)
  - 100 - 240 VAC – Connecting AC or Streetlight Power (1552H)
  - 100 - 277 VAC – Connecting AC or Streetlight Power (1552I)
- External Supply
  - 12 VDC – Connecting DC Power Cable (All Models)
- External Power Injector
- Internal Battery Backup
  - 2 hours of autonomy (1552E/H)
- Power over Cable (POC)
  - (40 - 90VAC) Connecting Cable POC (1552C)
- PoE OUT 802.3af compliant to connect IP Devices such as Video Cameras
  - Not available when using Power Injector (PoE in) as the power source
  - Auto-MDIX, which enables to connect crossover or straight through cables



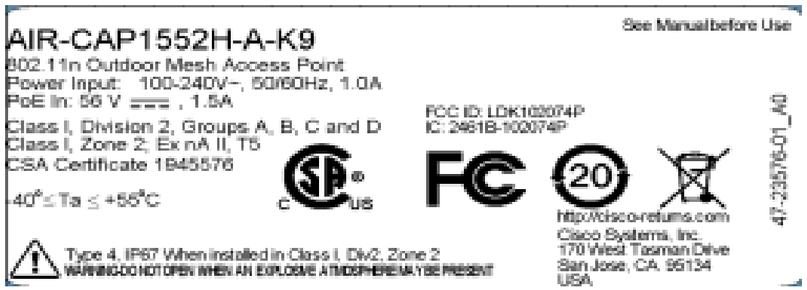


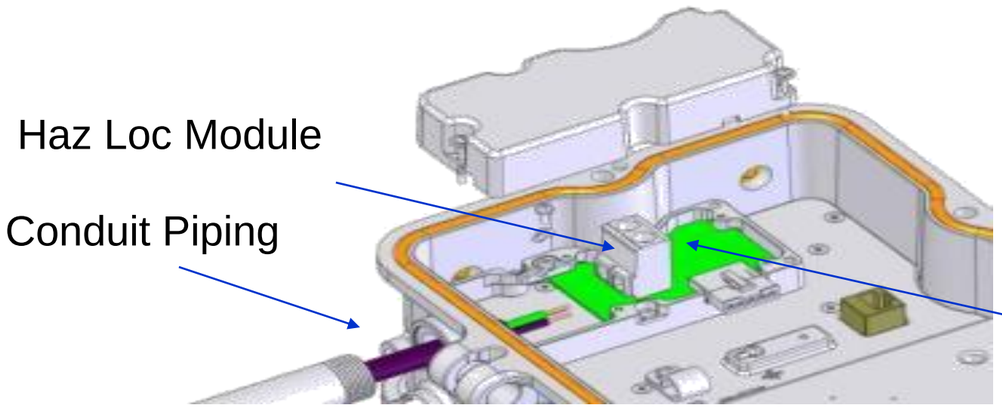


External Supply: ELPAC Power Systems Model# FW7212, 12VDC, 6A, 72 W

Cisco 1552H Hazardous Locations Certification

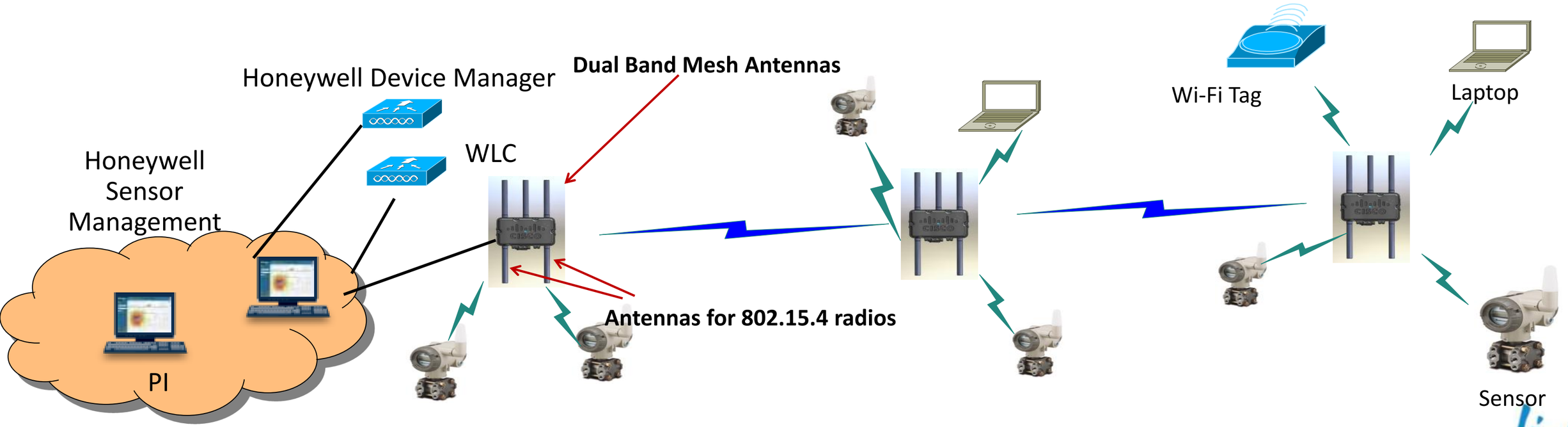
- Extreme harsh conditions
- Class 1, Division 2/Zone 2 is for Occasional Environments with flammable gases, vapors and oil, like oil sand open-pit mining.
- Class 1, Division 1/Zone 1 is for Environments with full time ignitable concentrations of flammable gases, vapors or liquids
- ATEX certification for worldwide deployment:
  Class I, Zone 2 (AIR-LAP1552-HZ-E-K9). Power Entry Module, Groups IIC, IIB, IIA with T5 (120 deg C) temp code
- For Class I, Zone 1/Division 1 requirements:
  use 3rd party explosive proof enclosures (ex. TerraWave)
- Certified with Antennas





AP 1552S – 802.11n + ISA100.11a

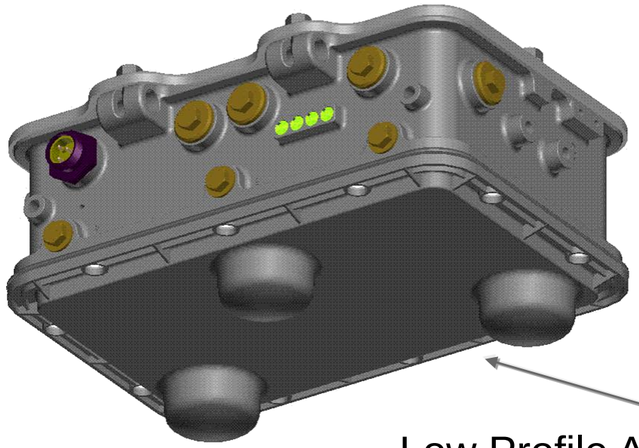
- Integrate Honeywell ISA-100.11a compliant gateway into AP1552
  - Field sensors communicate (IEEE 802.15.4 radio) to gateway & AP provides Wi-Fi access and backhaul connectivity
- Improves upon Honeywell current solution
  - 2-box solution integrated into one, easier installation
  - Upgrades from 802.11a/b/g to 802.11n Wi-Fi performance



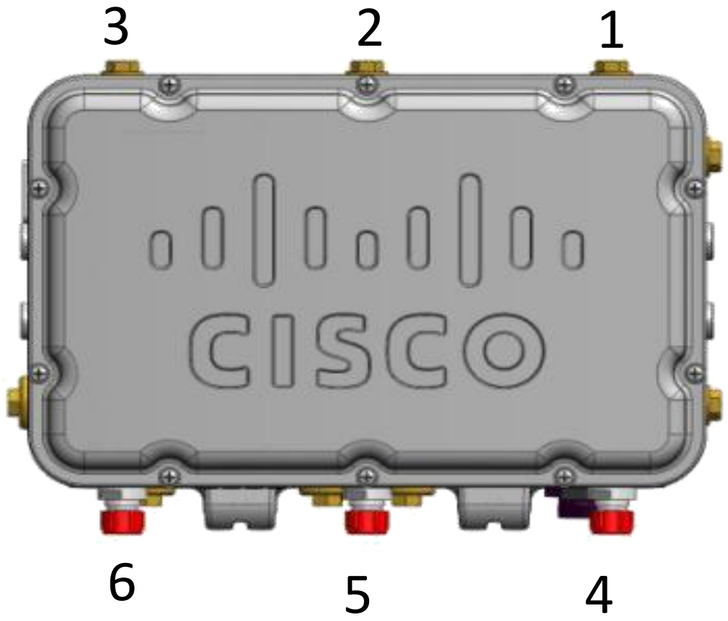
1552 E Hardware Details & Certifications

- Dimensions (WxLxH): 31.12cm x 21.84 cm x 16.26 cm
- Weight 17.3 lbs (7.85 Kg) - (no mounting brackets and antennas)
- Battery : 1.5 lbs (0.7 Kg)
- Pole mounting bracket: 6.1 lbs (2.8 kg)
- Wind Loads
  - Sustained Winds: 161 Km/hr, Wind Gusts: 265 Km/hr
- Fibre SFP connectors:
  - 1000LX single-mode (long Reach; 2000 m) (GLC-LX-SM-RGD=)
  - 1000SX multimode (500m) (GLC-SX-MM-RGD=)
- Environmental Ratings
  - IP67 & NEMA4X
  - Operating Temperature : -40 to + 55 C Plus Solar Loading
  - Storage Temperature: -50 to 85˚ C (-58 to 185˚ F)
  - Humidity 0 ~100%
- Compliance
  - Directive 1999/5/EC
  - Health and Safety (EN60950-1: 2006 +A11:2009; EN 60950-22:2006; EN 50385: 2002)
  - Radio Approvals (EN 300 328 v 1.7.1; EN 301.893 v 1.5.1)
  - EMI and Susceptibility (EN 301.489-1 v1.8.1; EN 301.489-17 v2.1.1)

Antenna Ports



Low Profile Antenna



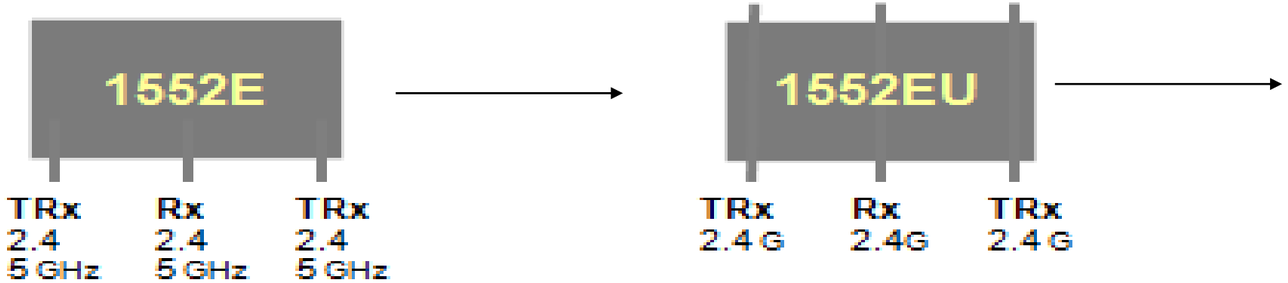
For Your Reference

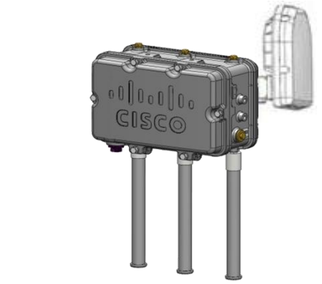
1	Not used	4	Antenna port 4 - Type N connector (with Cap)
2	Not used	5	Antenna port 5 - Type N connector (with Cap)
3	Not used	6	Antenna port 6 - Type N connector (with Cap)

Antennas & LEDs Facing Downwards to the Ground

New Platforms 1552CU & 1552EU

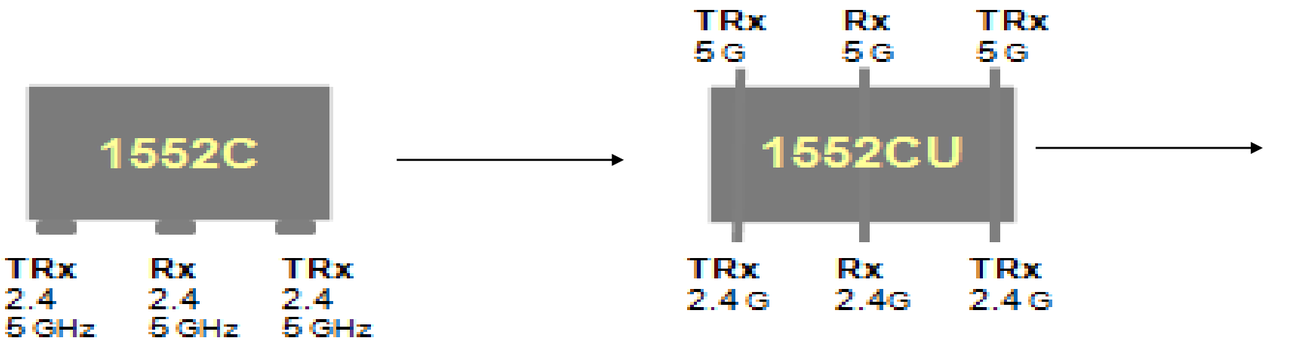
- **1552CU = 1552C – Integrated Antennas + Uniband** (2.4 & 5 GHz) **ports**
- **1552EU = 1552E + Uniband** (2.4 & 5 GHz) **ports**

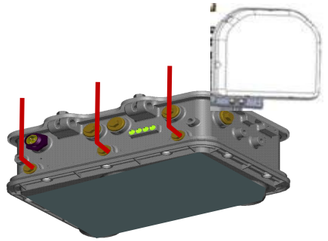




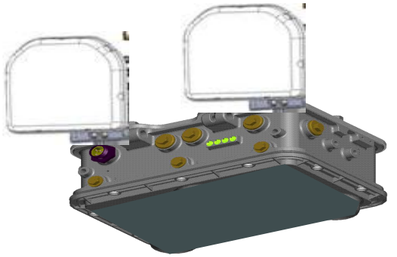
- **1x Single-band, Directional Antenna**
  - 5 GHz: ≈ 15 dBi, 2.4GHz: ≈ 13 dBi
- **3xSingle-band, Omni Antennas**
  - 5 GHz:8 dBi, 2.4GHz: 5, 8 dBi

- **2x Single-band, Directional Antennas**
  - 5 GHz: ≈ 15 dBi, 2.4GHz ≈ 13 dBi



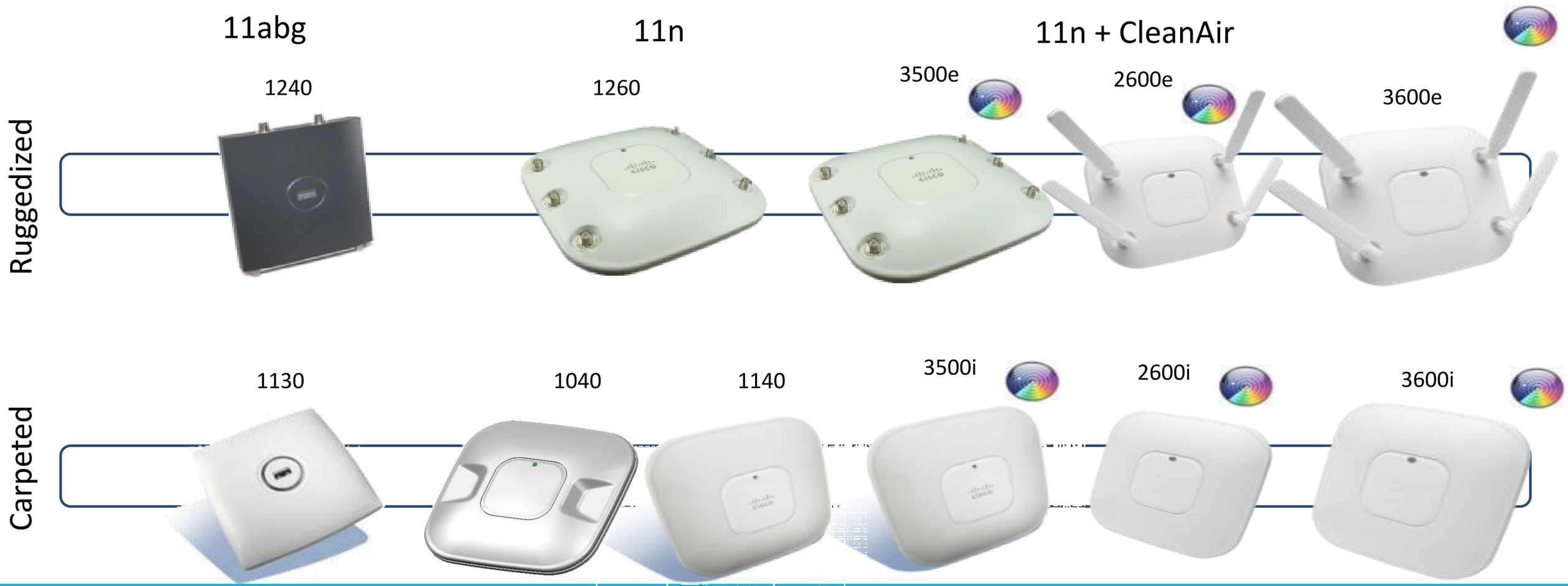


- **1x Single-band, Directional Antenna**
  - 5 GHz: ≈ 15 dBi, 2.4GHz: ≈ 13 dBi
- **3xSingle-band, Omni Antennas**
  - 5 GHz:4 dBi, - 2.4GHz:2 dBi



- **2x Single-band, Directional Antennas**
  - 5 GHz: ≈ 15 dBi , 2.4GHz: ≈ 13 dBi

Cisco Aironet Indoor Mesh Access Points



Complete interoperability with Outdoor Mesh

Can be placed outdoor in a proper ruggedized enclosure

APs orderable directly in Mesh Mode, No Extra License

Attention: Multi Country not supported when APs are in Bridge Mode

Initial Configurations

Mesh Process Overview

1. Root Mesh AP (RAP) joins to WLC with CAPWAP
2. MAP(MAP) selects a PMAP (Parent Mesh AP) with AWPP
3. MAP goes through authentication (Mesh Security)
4. MAP Joins to WLC with CAPWAP
5. MAP ready to accept clients

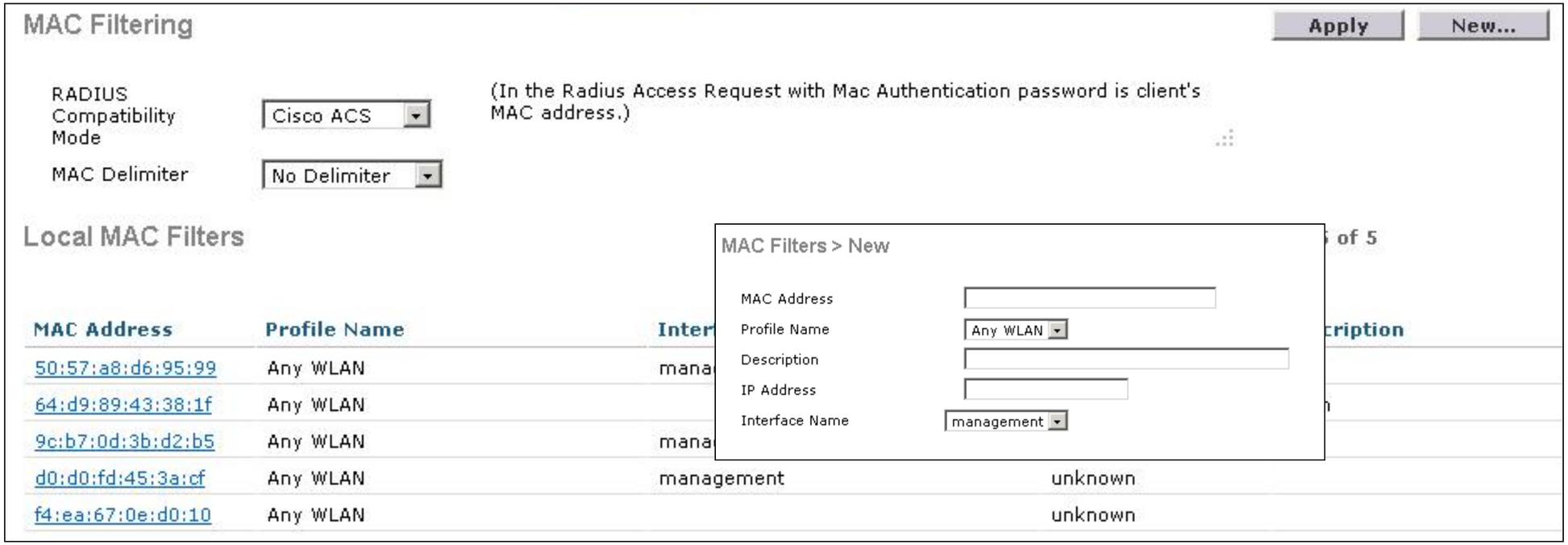
AWPP Parent Selection

- First, prefer any parents with same Bridge Group Name.
- Will connect to other parents with default Bridge Group Name, if no parent with configured BGN available. Every 15 minutes, disconnect, go back to Scan state, and try to find parent with same Bridge Group Name.
- The AWPP Parent Selection process is based on a metric (called Adjusted Ease) that is computed based on the RF Signal to Noise Ratio, and the number of hops to an AP connected to the wired network.
- At a high level, a composite SNR is computed based on how well we hear our neighbour, and how well our neighbour hears us.
- The composite SNR is converted to an Ease.
- The Ease is divided by the number of hops to the RAP with the connection to the wired network.
- The potential parent with the greatest Ease is selected to attempt connection with first.

Preferred Parent Selection

- Allows you to configure preferred parent for a MAP. This feature enabled you to enforce a linear topology in mesh environment.
- The child AP selects the preferred parent based on the following conditions:
  - Preferred parent is the best parent.
  - Preferred parent has a link SNR of at least 20 dB.
  - Preferred parent has a link SNR in the range 12 dB and 20 dB, but no other parent is significantly better (SNR more than 20% is better). For SNR lower than 12 dB, the configuration is ignored.
  - Preferred parent is not blacklisted.
  - Preferred parent is not in silent mode because of dynamic frequency selection (DFS).
  - Preferred parent is in the same bridge group name (BGN). If the configured preferred parent is not in the same BGN, and no other parent is available, the child will join the parent AP using the default BGN.

AP MAC Filtering

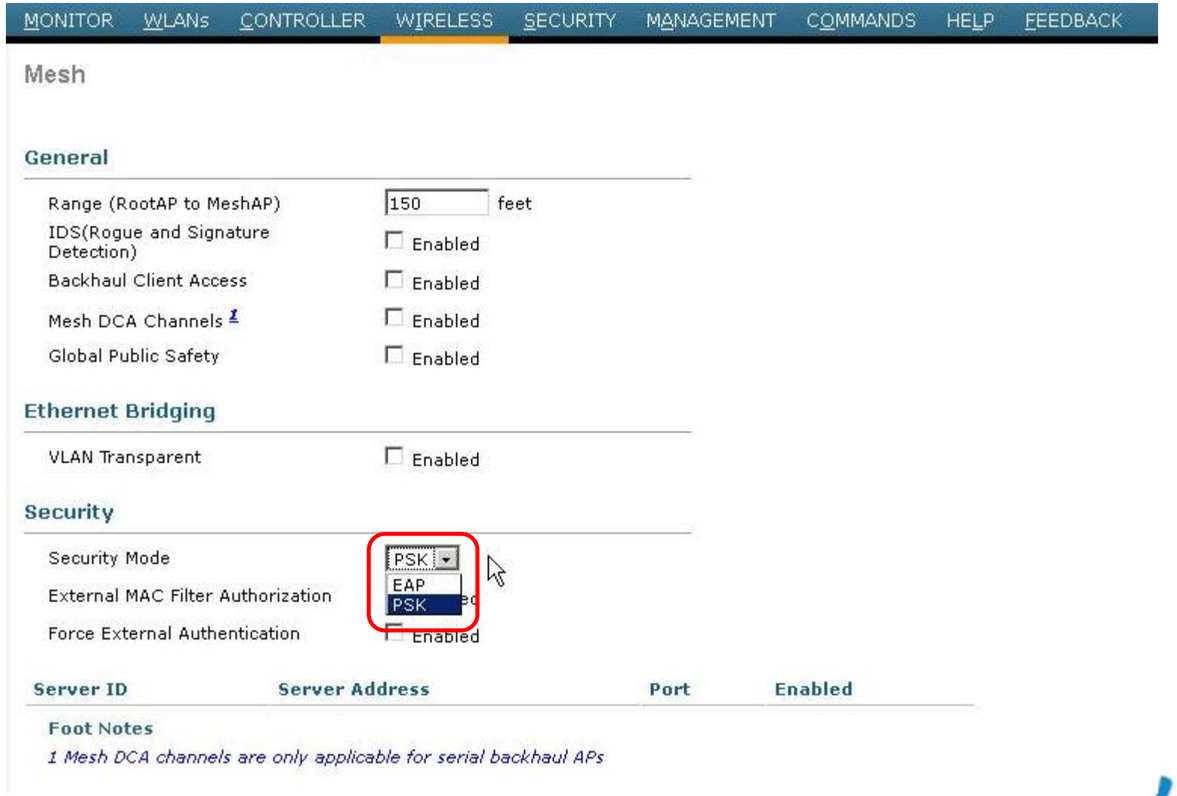


- - You must enter the MAC address for all mesh access points that you want to use in the mesh network into the appropriate controller. A controller only responds to discovery requests from outdoor radios that appear in its authorisation list. MAC filtering is enabled by default on the controller, so only the MAC addresses need to be configured.
- - For 1500 series the BVI MAC address is used. For the indoor APs the Ethernet MAC address is used.

Mesh Security Modes

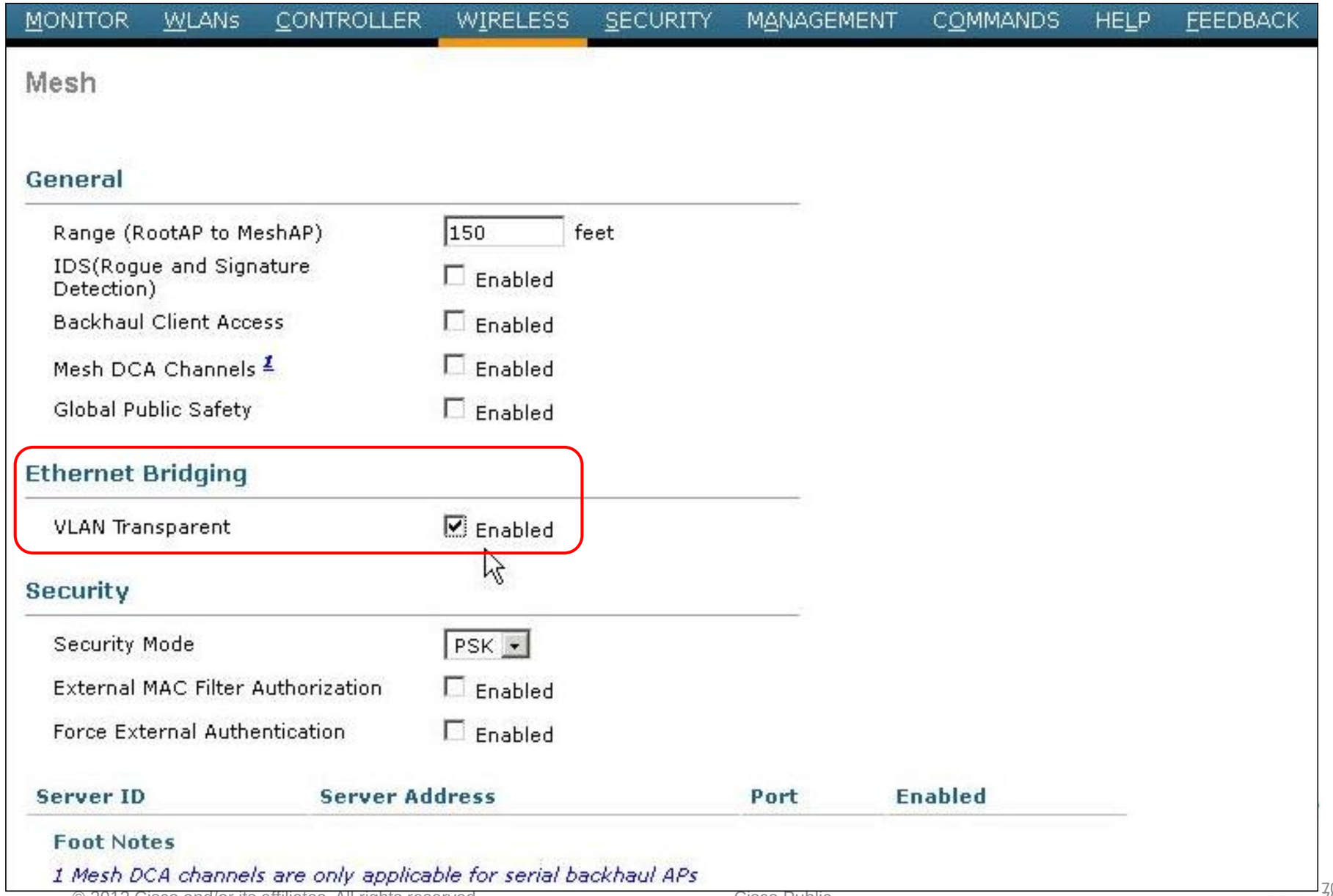
- PSK (Public Shared Key)
- EAP (Extensible Authentication Protocol)
  - ✓ EAP-FASTv2
  - ✓ Local-Auth
  - ✓ External AAA Server.

- Mesh wireless links between APs are always AES Encrypted. Key derived from PSK or EAP.



Ethernet Bridging

- Ethernet bridging is required to enable the Mesh AP ethernet port traffic transport.
- It´s disable by default



Design & Planning

Design & Planning

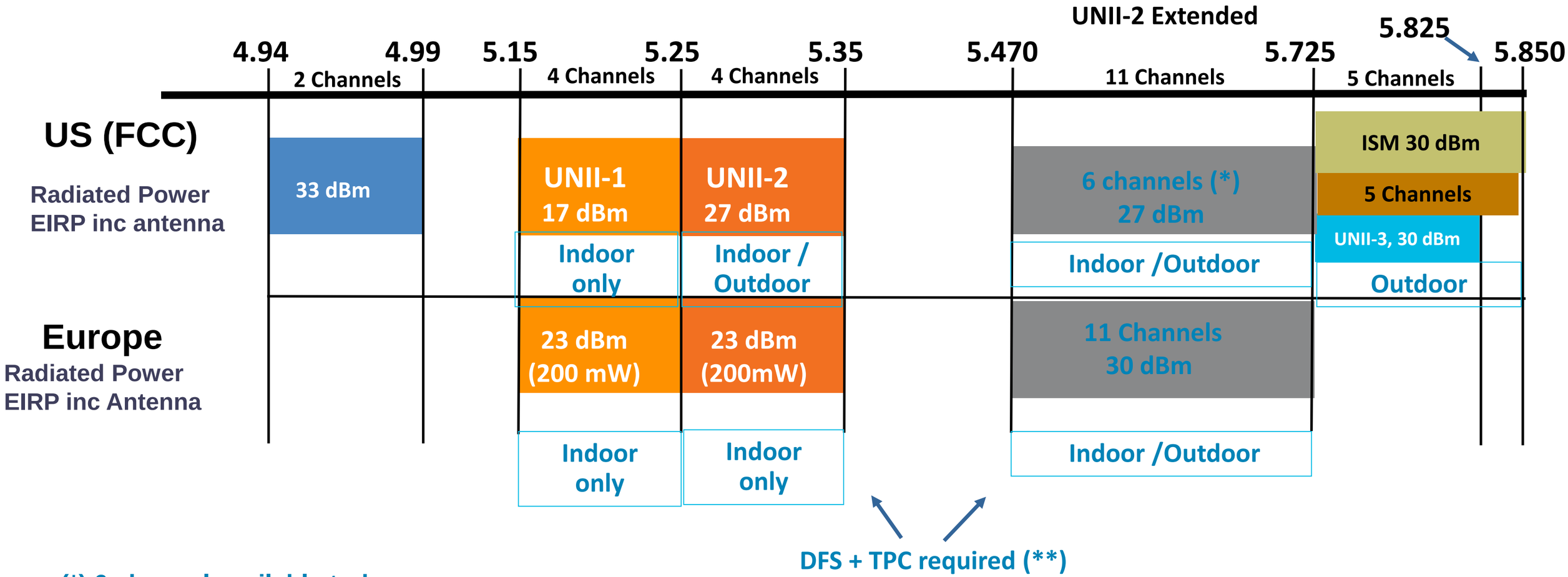
General Considerations

- RF Nature: Not an Exact Science,
- Mesh: AP-to-AP Backhaul Distance Capability should be ≈ 2x AP-to-Client
- WiFi Network Planning Involves:
  - Site Survey to Identify
  - Client type
  - User Experience:
  - CAPEX & OPEX
  - Regulatory Considerations;
  - Type of AP Used: AP1552E&H (External Ant.), AP1552C&I (Integrated Ant.)
    - AP1552E, AP1552H : Antenna Gain 2.4 GHz (4 dBi), 5 GHz (7 dBi)
    - AP1552C, AP1552I : Antenna Gain 2.4 GHz (2 dBi), 5 GHz (4 dBi)

Current Standards and Directives:

The 5 GHz Spectrum

For Your Reference



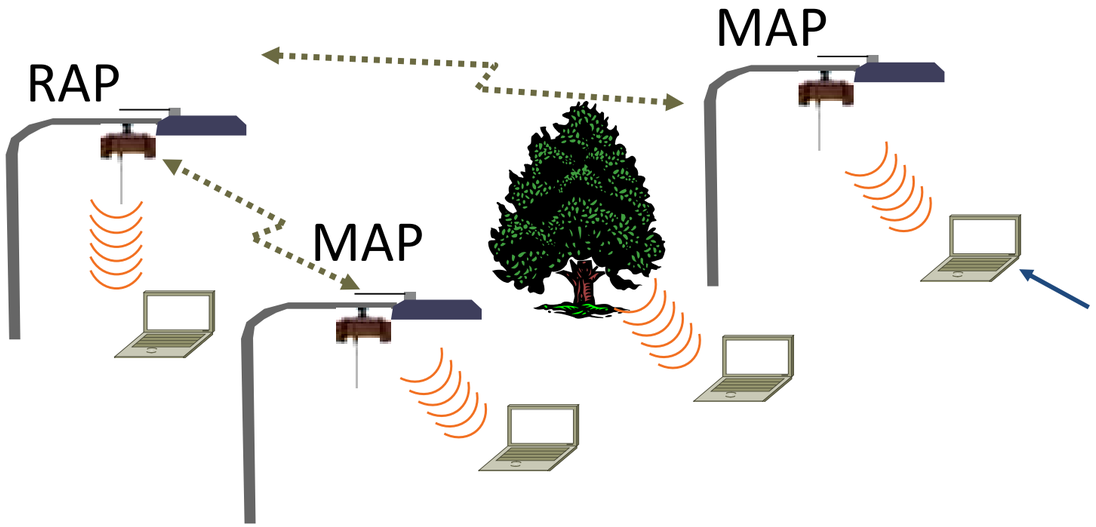
(*) 6 channel available today:
120, 124, 128 disabled to be compliant with DFS rules in Canada
116 &132 disabled to be compliant with new FCC Enforcement to protect TDWR

(**) Dynamic Frequency Selection (DFS) – Transmit Power Control (TPC)

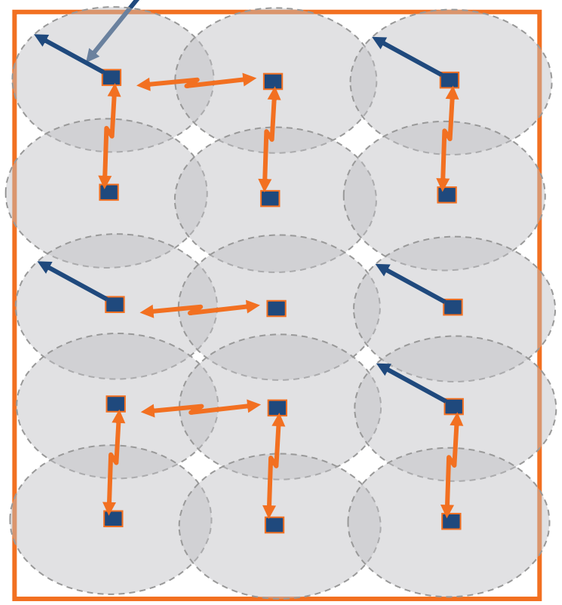
Design and Planning

Greenfield deployment in a flat environment

1 metre = 3.28 ft	1 sq-metre = 10.7 sq-ft
1 mile = 1.61 km	1 sq-mile = 2.6 sq-km



800 ft/ **250 meters** (cell radius) at 2.4 Ghz



1 square mile ~ 14 Cells

- Recommendations
  - Consider your weak link (client)
  - AP to AP distance = double AP to client

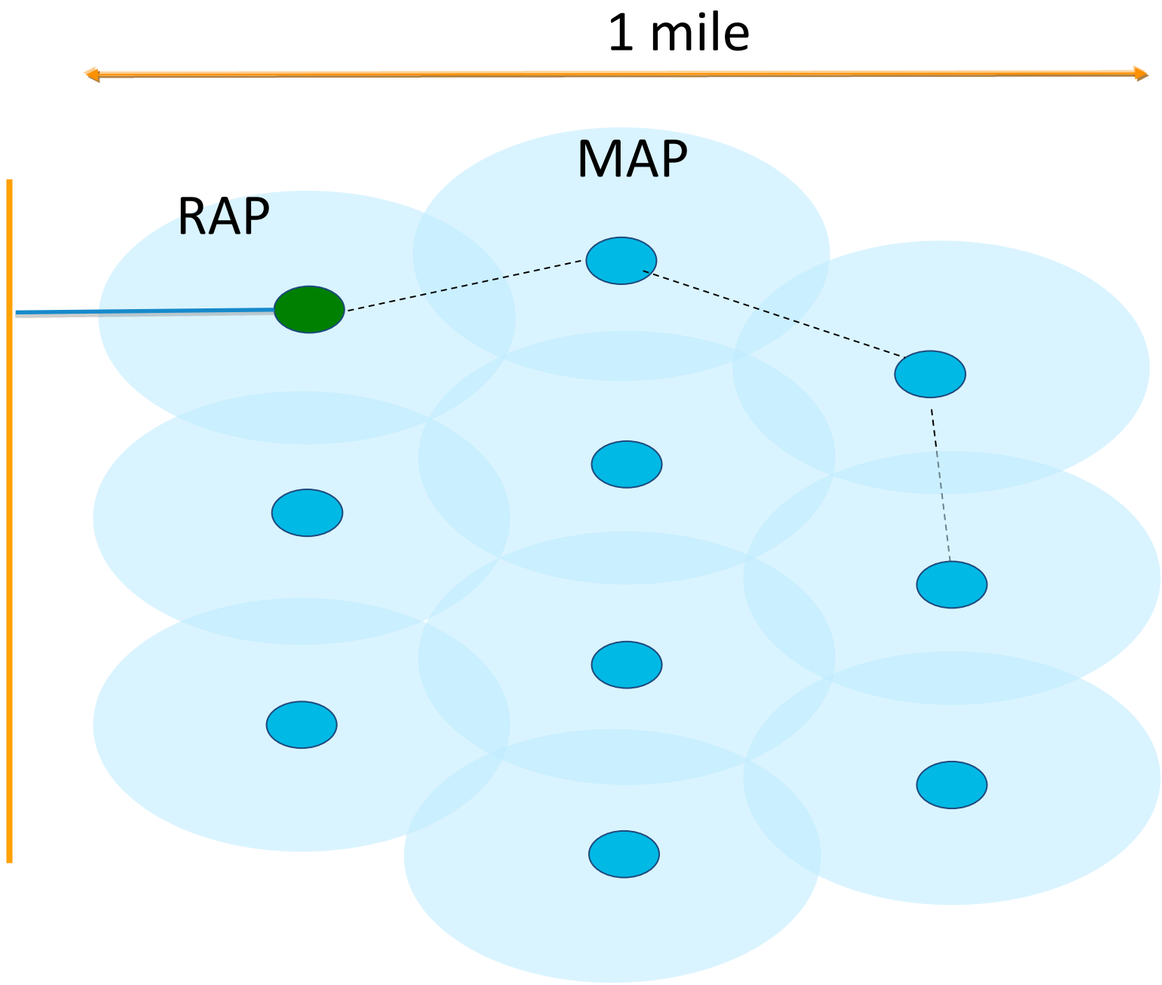
    AP1552C/I: 1600 ft/**500 m**

    AP1552E/H: 2000 ft/**600 m**
  - Decreasing AP to AP improves coverage

- Assumptions:
  - 100% coverage needed
  - APs are at 10 m; client at 1 m height
  - Data rate of 9 Mbps to estimate range
  - Throughput @ client >= 1 Mbps
  - LoS or Near LoS
  - Flat Terrain Environment

Design and Planning

General consideration

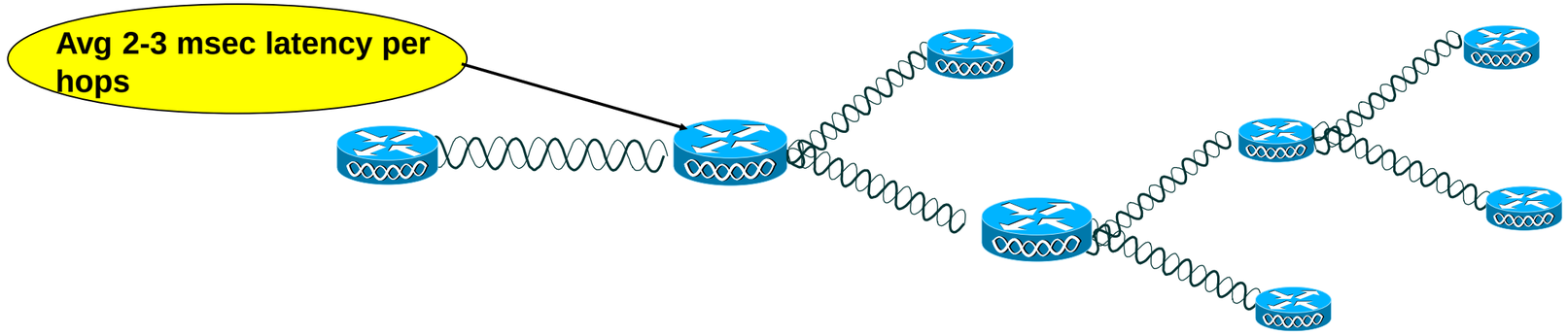


- In real world scenario you need to take in consideration obstacles; add more APs to have Line of Sight (LOS)
- At 2.4GHz MAPs' distance is given by the coverage you want for clients
- Client type (smart phones, tablets, etc): weakest link typically would be the Uplink on a smart phone
- For backhaul 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 link calculator: **Range Calculator**

http://www.cisco.com/en/US/docs/wireless/access_point/1550/range/calculator/1552_Link_Calculator_V1.xls

Design and Planning

Typical Backhaul Throughput and Latency



HOPS	RAP	One	Two	Three	Four
MAX Throughput (20MHz BH)	112 Mbps	83 Mbps	41 Mbps	25 Mbps	15 Mbps
MAX Throughput (40MHz BH)	206 Mbps	111 Mbps	94 Mbps	49 Mbps	35 Mbps

- Latency: 10 ms per Hop, 0.3-1 milliseconds typical
- Hops: Outdoor: code supports 8 Hops; 3–4 Hops are recommended
- Nodes: 20 MAPs per RAP are recommended

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*

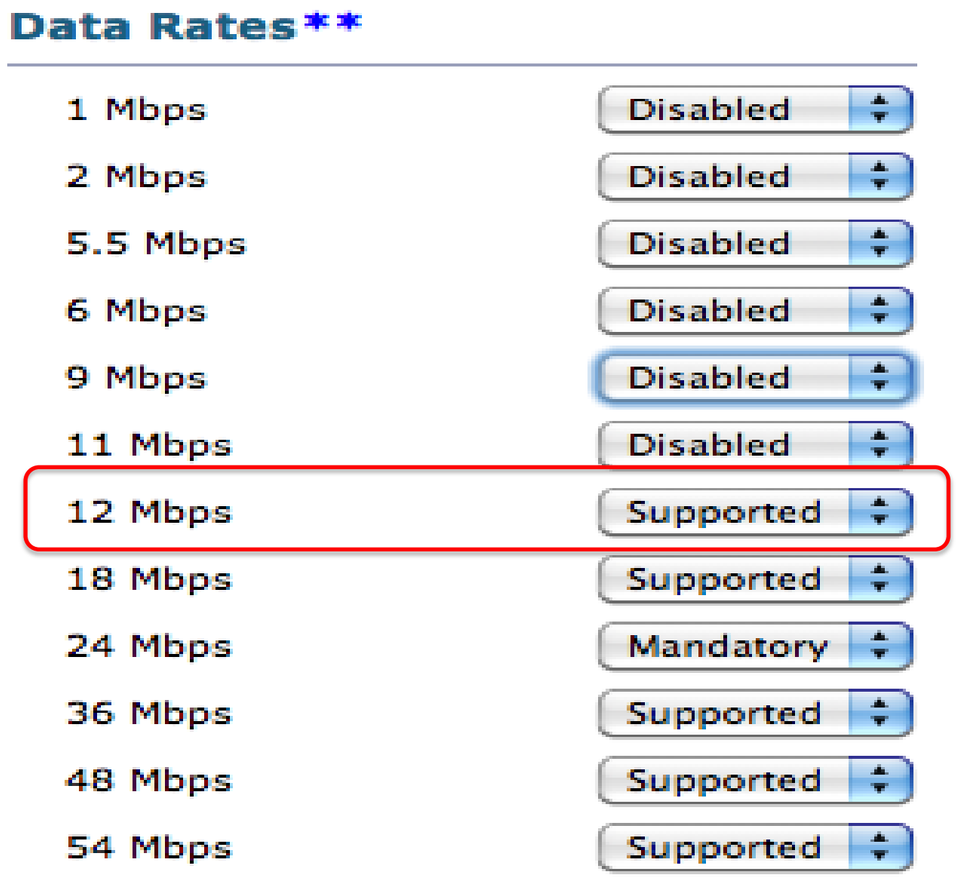
(**) Max data rate considering 5Ghz, 40 Mhz channel, 40ns GI

802.11n Client Matrix

Product Name	Standard	2.4 GHz Spatial Stream		5 GHz Spatial Stream		Authentication Supported
		Tx	Rx	Tx	Rx	
iPhone 4	b / g / n	1	1			EAP-TLS, TTLS, PEAP
iPhone 4S	b / g / n	1	1			EAP-TLS, TTLS, PEAP
iPhone 5	a/b/g/n	1	1	1	1	EAP-TLS, TTLS, PEAP
Sony Ericsson Xperia Mini	b / g / n	1	1			EAP-TLS/TTLS/PEAP/FAST
Samsung Note	a/b/g/n	1	1	1	1	EAP-TLS, TTLS, PEAP
Blackberry bold 9790	a/b/g/n	1	1	1	1	EAP-TLS/TTLS/PEAP/FAST/SIM/AKA
Nokia Lumina 800	b / g / n	1	1			EAP-PEAP
Nokia Lumina 710	b / g / n	1	1			EAP-PEAP
iPad 2	a/b/g/n/h	1	1	1	1	EAP-TLS, TTLS, PEAP
Cisco Cius	a/b/g/n	1	1	1	1	EAP-TLS
Dell Steak	b / g / n	1	1			EAP-TLS, TTLS, PEAP
Sony Ericsson Tablet	b / g / n	1	1			EAP-TLS/TTLS/PEAP/FAST
Motorola Xoom Tablet	b / g / n	1	1			EAP-TLS/TTLS/PEAP/FAST
Samsung Tablet 7 Inch	a/b/g/n	1	1	1	1	EAP-TLS, TTLS, PEAP
Samsung Tablet 10 Inch	a/b/g/n	1	1	1	1	EAP-TLS, TTLS, PEAP
Blackberry Playbook Tablet	a/b/g/n	1	1	1	1	EAP-TLS/TTLS/PEAP
Macbook Pro	a/b/g/n	3	3			EAP-TLS/TTLS/PEAP/FAST
Macbook Air	a/b/g/n	2	2	2	2	EAP-TLS/TTLS/PEAP/FAST
HP Pavilion G6	b / g / n	1	1			EAP-TLS/TTLS/PEAP/FAST/SIM/AKA
Broadcom WiFi Adapter 2012	b / g / n	1	1			EAP-TLS/TTLS/PEAP/FAST
Broadcom WiFi Adapter 2011	a/b/g/n	2	2	2	2	EAP-TLS/TTLS/PEAP/FAST

Coverage Limits for Capacity

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



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

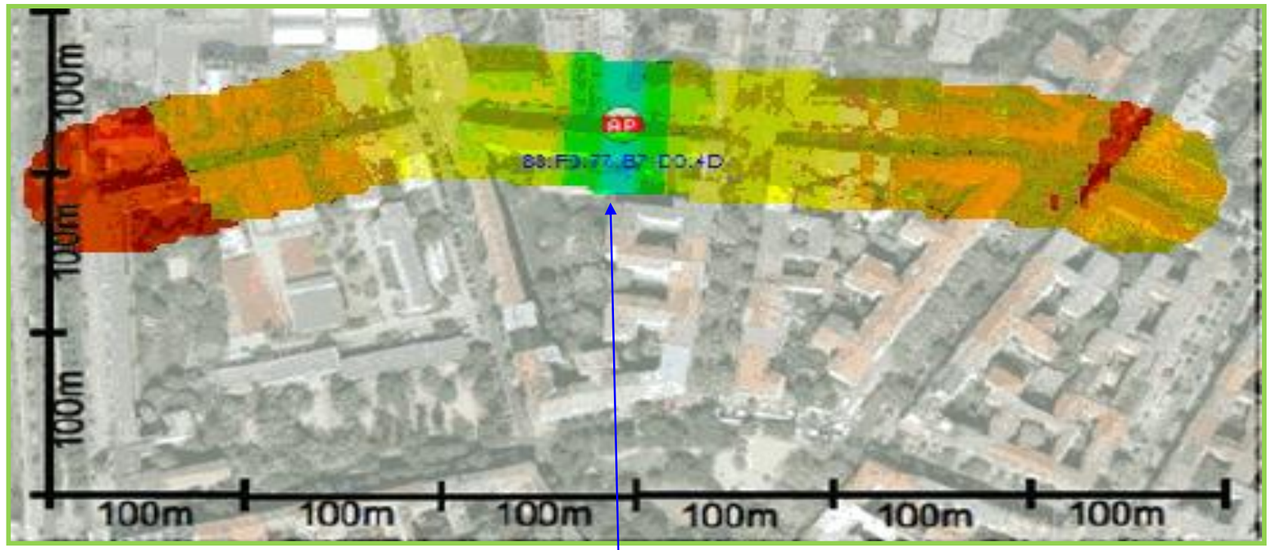
Numroutes 1, snr 0, snrUp 40, snrDown 43, linkSnr 39

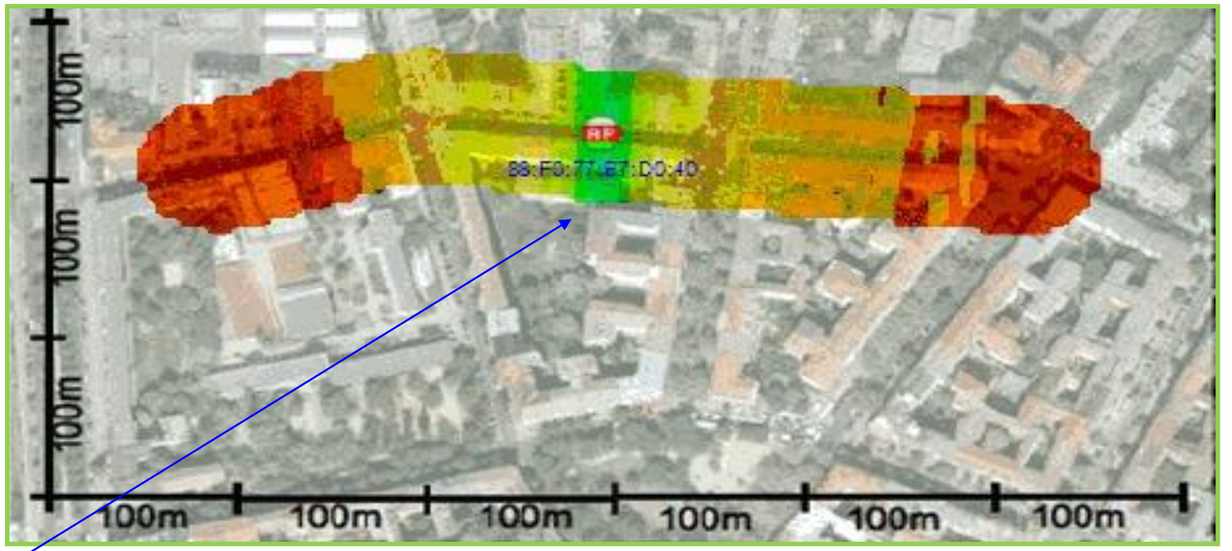
adjustedEase 8648576, unadjustedEase 8648576

[…snip]

Design and Planning

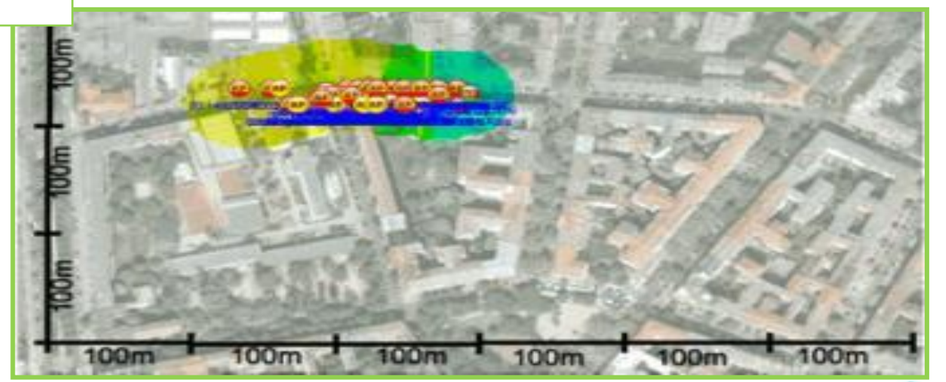
Real case example of urban coverage





Access Points

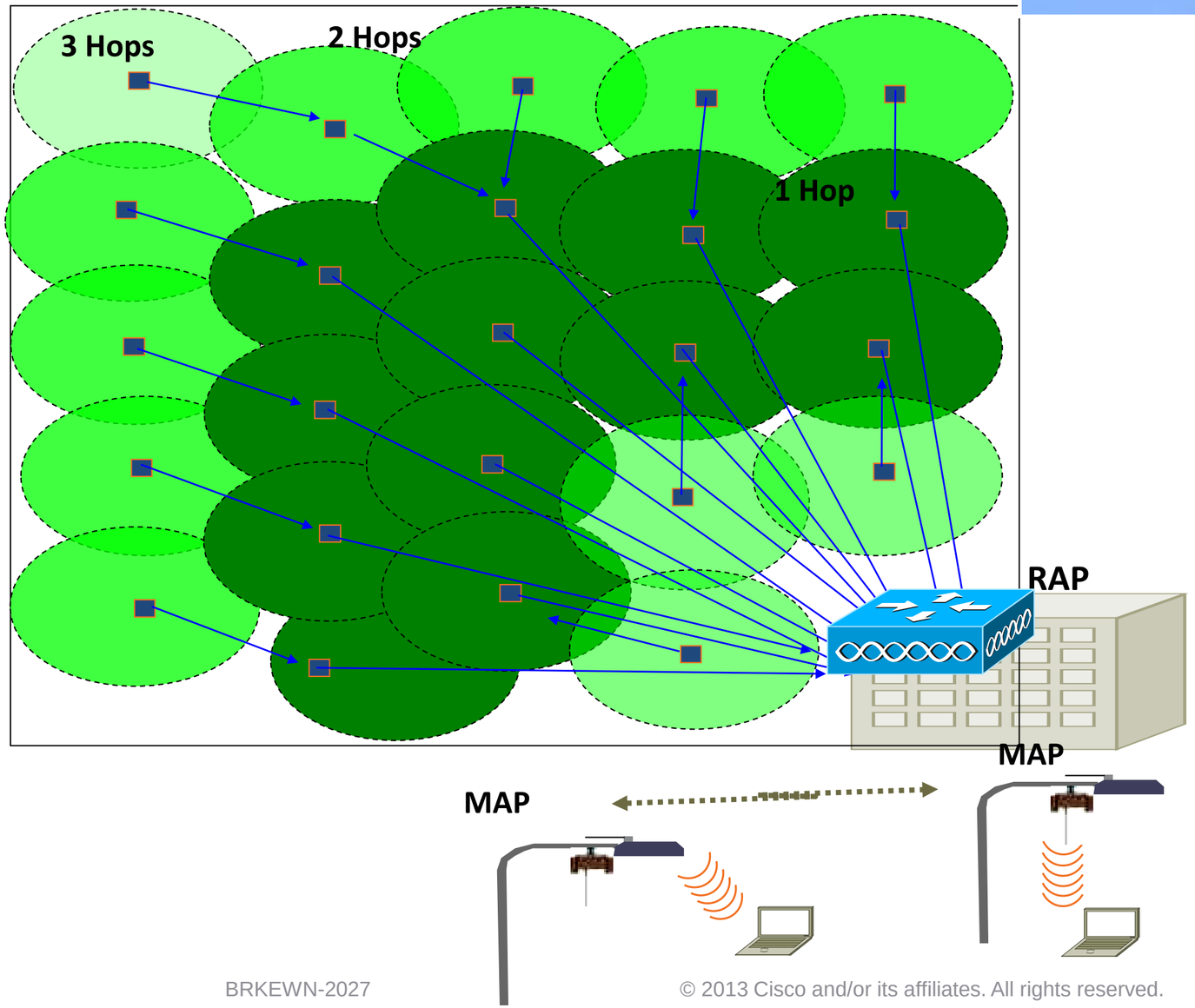
AP Name	Media Type	Mac Address	Channel	SSID
Non ACL, Neighborings, Rogues				
88:F0:77:B7:D0:4D	802.11n-5.0 GHz	88:F0:77:B7:D0:4D	108	
88:F0:77:B7:D0:40	802.11n-2.4 GHz	88:F0:77:B7:D0:40	11	
# of AP	2			



2.4 GHz Interferers

Design and Planning

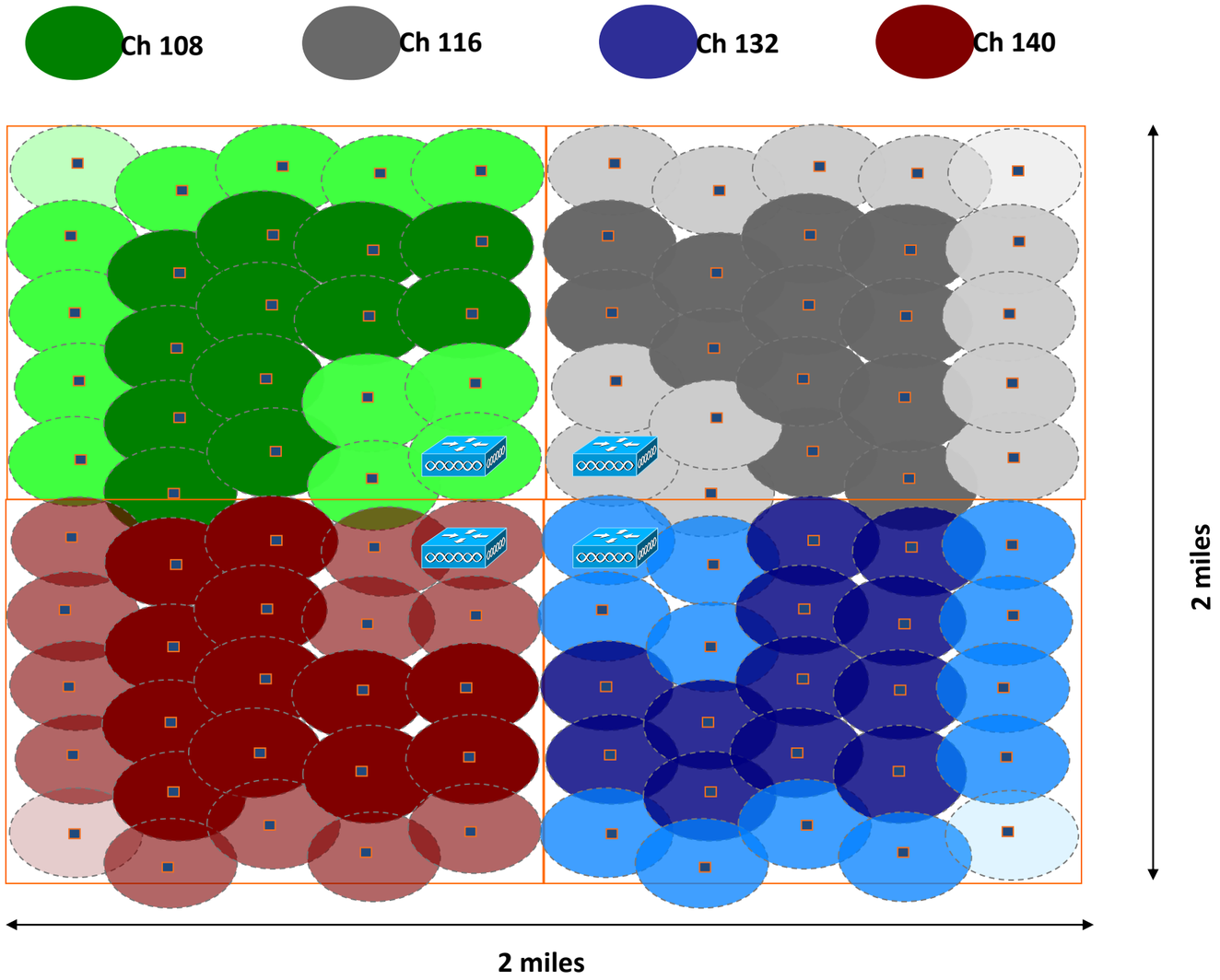
Sectorisation (Bridge Group)



- 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

Design and Planning

Mesh coverage model



- A Wired POP building might have 4 RAPs.
- Each RAP has 20-25 Mesh APs (MAPs)
- Each RAP on a different non adjacent channel, but same Bridge Group Name
- Most of MAPs within 3 hops of RAP
- If a RAP fails the MAPs belonging to the sector will go in SCAN mode and register to another MAP/RAP on a different channel/sector

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 fall back to DHCP and find a WLC. If even this fails, AP then attempts to discover a controller 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

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?

1550 Autonomous Code for Site Survey introduced in 7.3 release

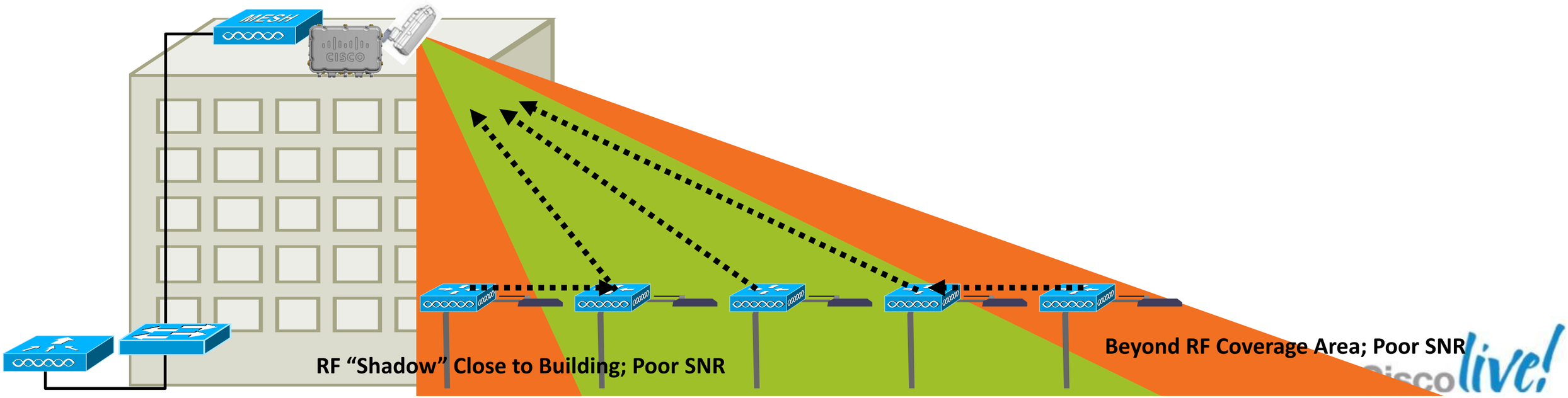
Site Survey and Deployment

Environmental Impact

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

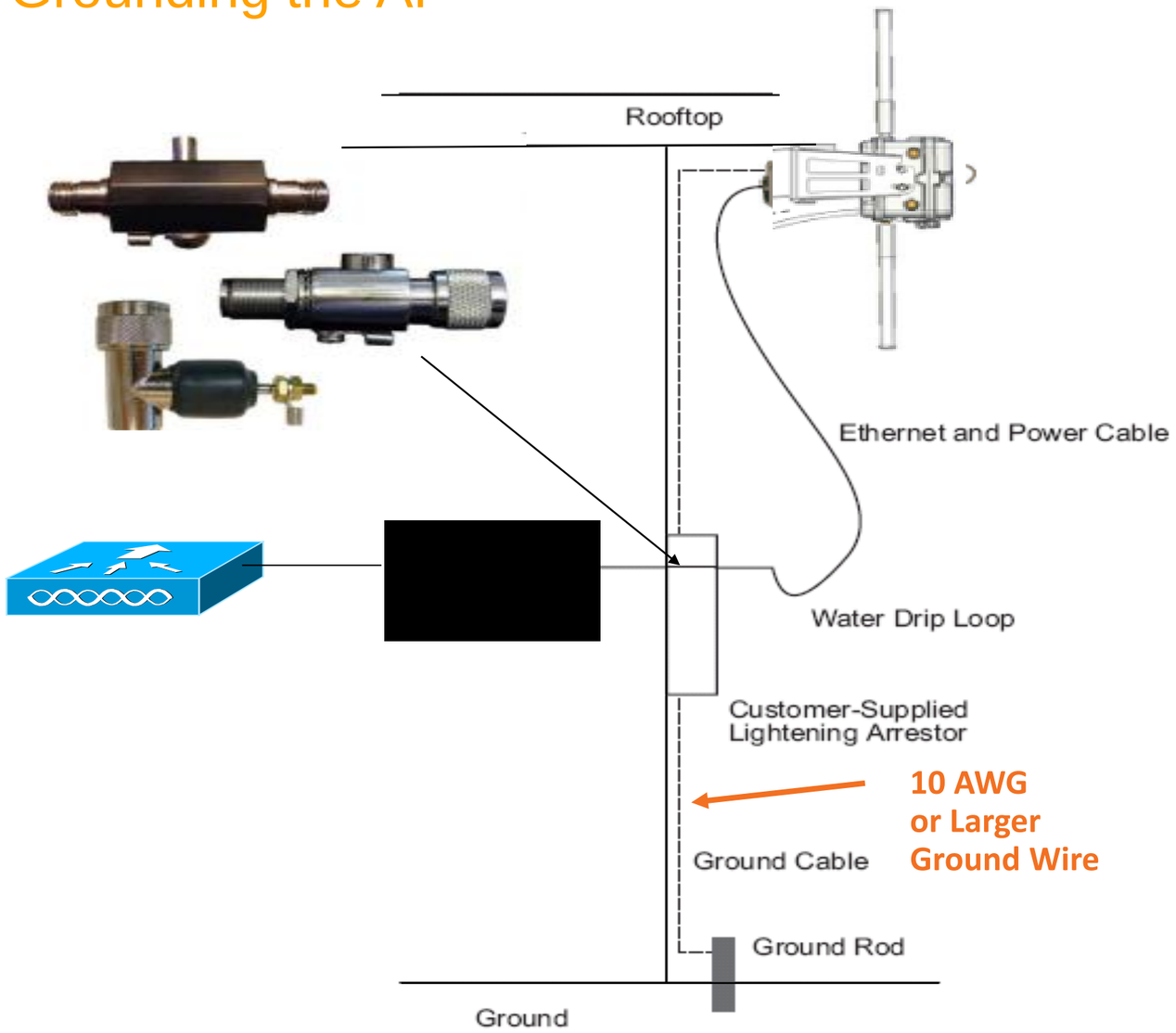
Collocating APs

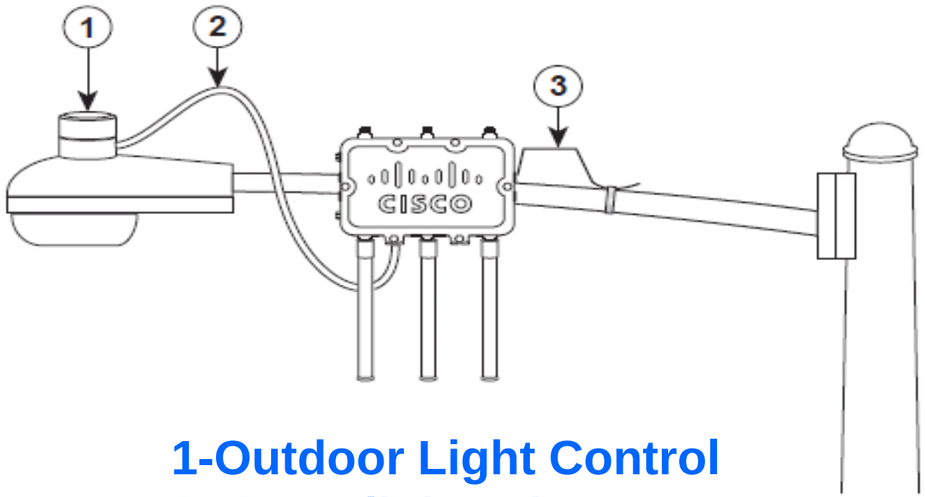
- Proper spacing = better performance and coverage
- Minimum Vertical Separation of 3 meters (10m if on adjacent channels)
- Recommended horizontal separation: 30 meters
- Antennas vertical alignment is another important factor
- Consider RF interferences: use Spectrum Expert

Now That's Better

Site Survey and Deployment

Grounding the AP



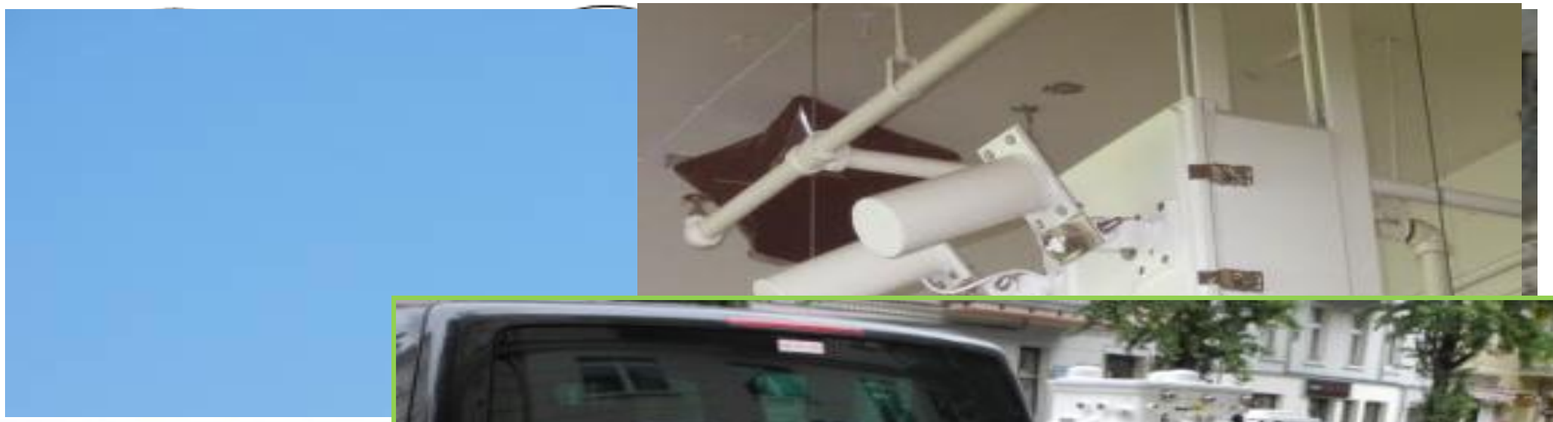


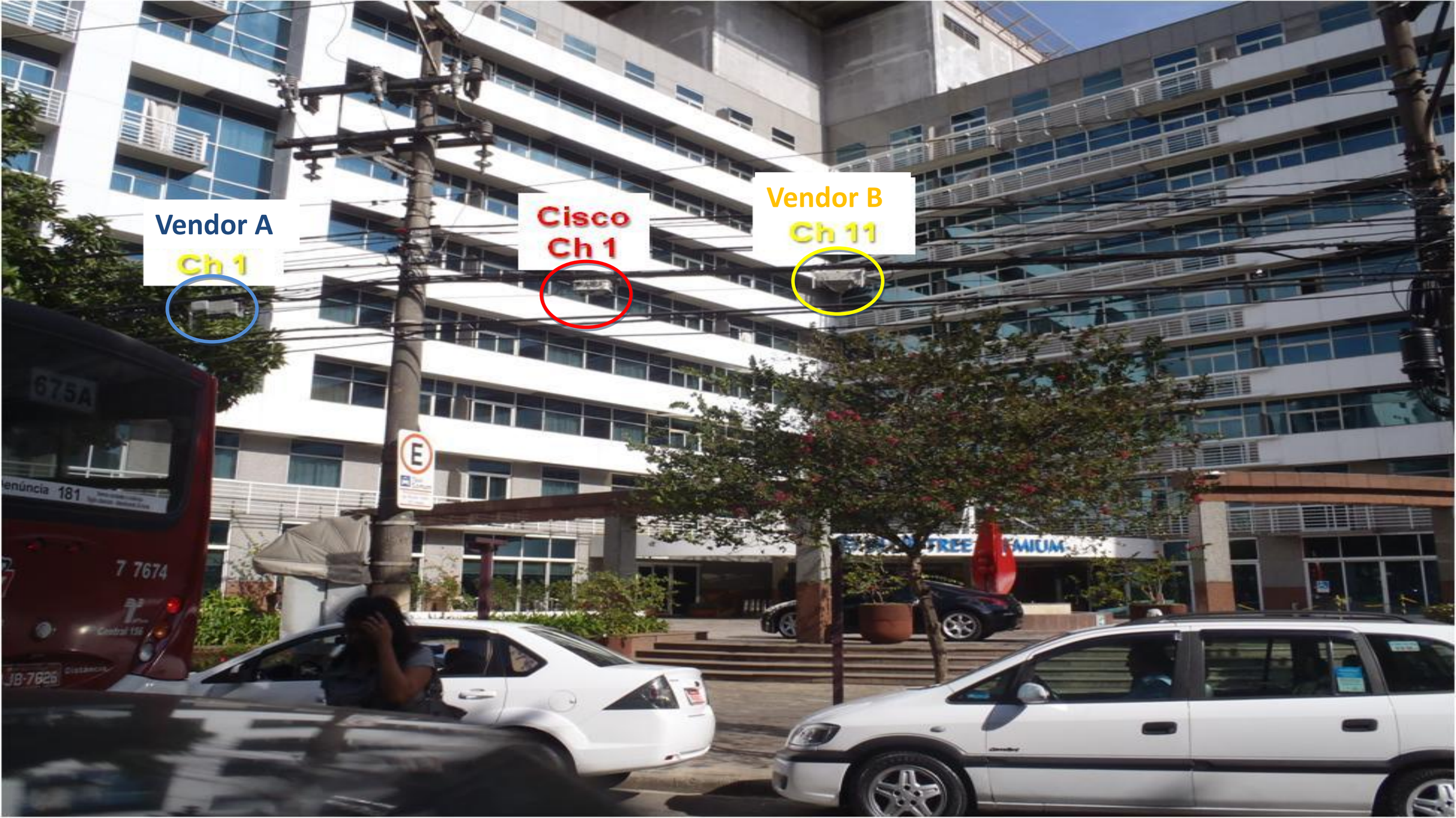
1-Outdoor Light Control
2- Streetlight Adapter
3-Copper Grounding Wire

Street Light Power Tap supports 100 to 480 VAC

Site Survey and Deployment

Environmental Impact



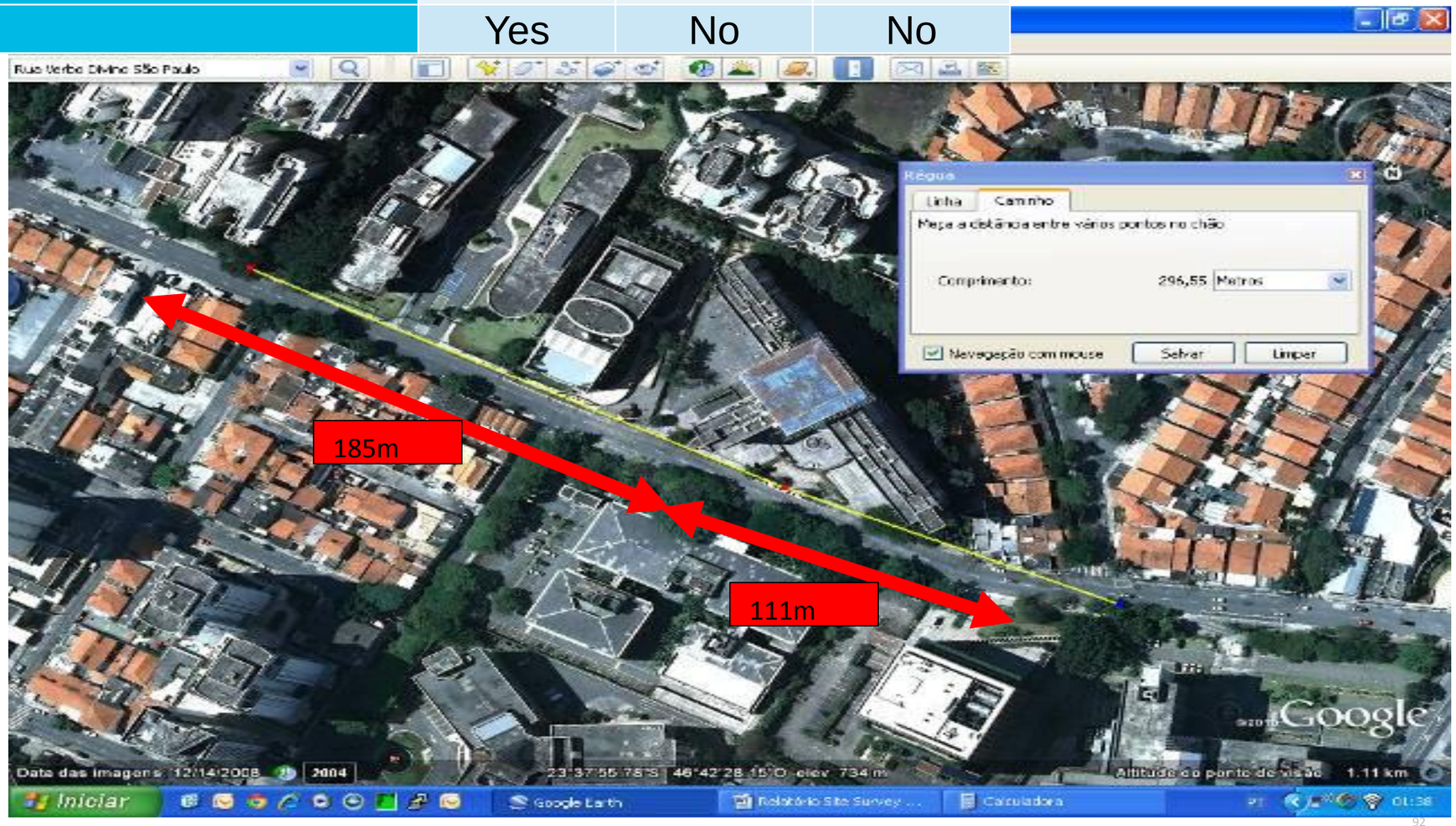

Vendor A
Ch 1
Cisco
Ch 1
Vendor B
Ch 11

Test Results

Test Results	Cisco	Compet X	Compet Y
Coverage Range (meters)	185m	142m	85m
Packet Loss%	4%	55%	N/D
Spectrum Management	Yes	No	No

Why that difference?

- CleanAir
- ClientLink
- MRC
- AP construction



Mesh for Air Craft Maintenance

Super Hornets

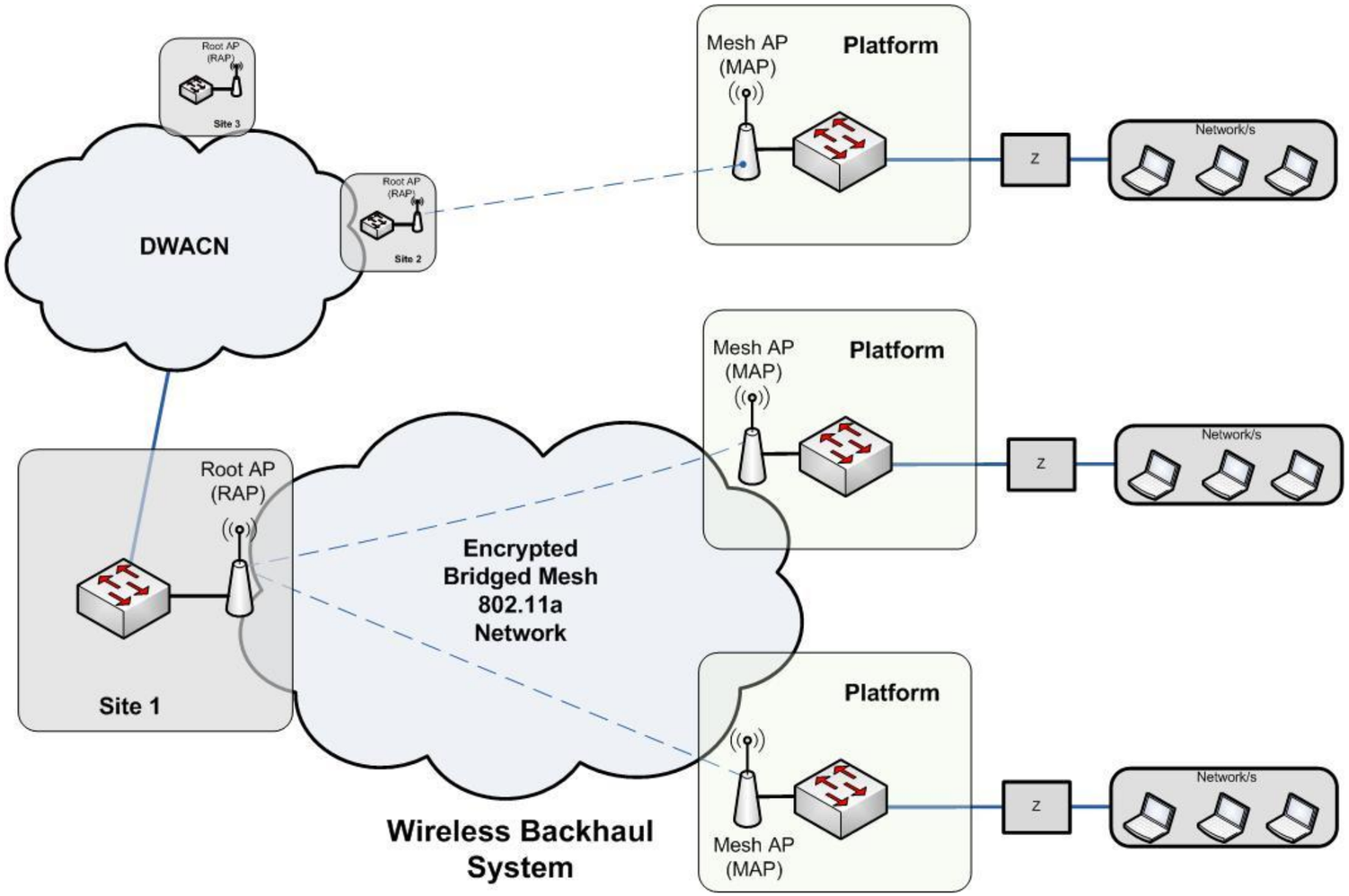
- Allow real-time electronic recording and monitoring of aircraft maintenance activity (replacing current manual methods).

- 802.11 network connectivity to aircraft hangers and runway apron required

- MUST not interfere with any live munitions (i.e. we don't want RF to trigger a bomb!)

Mesh to Fix a Breaking Fibre Cable

Ship Maintenance



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Q & A

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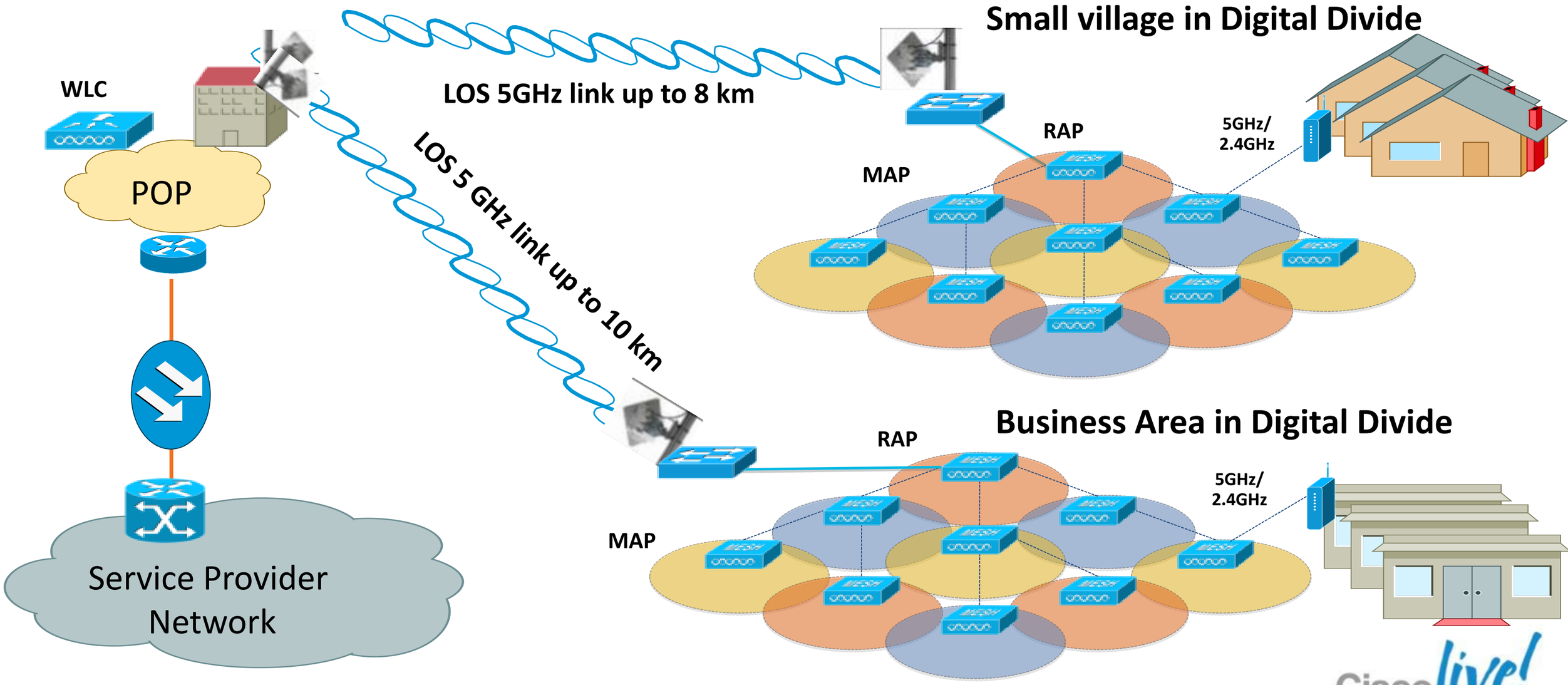
Design and Planning

Network Architecture (an example)



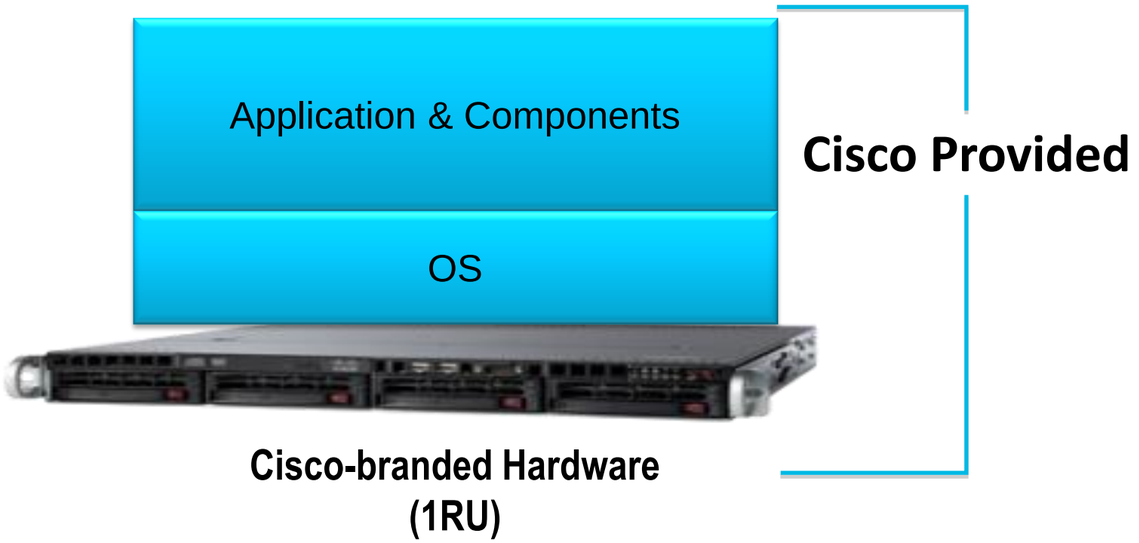
High Scale Controllers

	8500	7500	5500	WiSM2
Deployment type	Enterprise Large campus and SP Wi-Fi	Cloud controller for large number of distributed, lean/controller-less branches	Enterprise Campus and full service branch	Enterprise Campus with Catalyst 6k
Operational Modes	Local mode, FlexConnect, Mesh	FlexConnect only (Mesh not supported)	Local mode, FlexConnect, Mesh	Local mode, FlexConnect, Mesh
Maximum Scale	6,000 Aps 64,000 clients	6,000 Aps 64,000 clients	500APs 7000 clients	1,000APs 15000 clients
AP count range	300 – 6K AP	300 – 6K AP	12 – 500 AP	100 – 1000 AP
Connectivity	Dual redundant 10G ports	Dual redundant 10G ports	8x1G ports	Catalyst 6500 switch ports
Throughput (DTLS)	10Gbps (5Gbps)	1Gbps – FlexConnect Central switched	7Gbps (5Gbps)	16Gbps (9Gbps)
Power	AC and DC – dual redundant	AC dual redundant	AC (redundant PSU option)	AC (redundant PSU option)

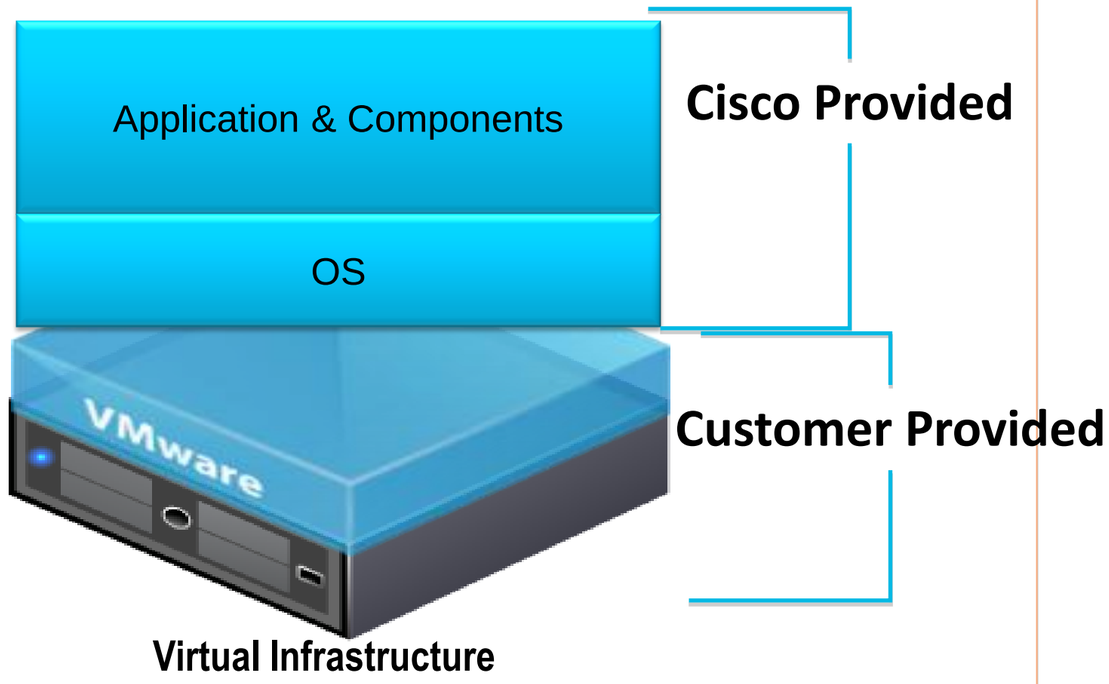
PI: Appliance Delivery Models

Physical and Virtual

Physical Appliance



Virtual Appliance



Increased scalability: 15000 lightweight APs, 5000 autonomous AP, 5000 switches

Useful Documents

Cisco External Web Page:

1. **AP1552 Data Sheet** http://www.cisco.com/en/US/prod/collateral/wireless/ps5679/ps11451/data_sheet_c78-641373.html
2. **AP1552 Country Compliance** http://www.cisco.com/en/US/prod/collateral/wireless/ps5679/ps5861/product_data_sheet0900aecd80537b6a.html#wp9005628
3. **AP1552 RF Tx Power Tables** http://www.cisco.com/en/US/docs/wireless/access_point/channels/lwapp/reference/guide/1550pwr_chn.pdf
4. **AP1552 Design Guide** http://www.cisco.com/en/US/partner/products/ps11451/products_implementation_design_guides_list.html
5. **AP1552 Range Calculator** http://www.cisco.com/en/US/partner/products/ps11451/products_implementation_design_guides_list.html
6. **Mesh Configuration Guide** http://www.cisco.com/en/US/partner/docs/wireless/controller/7.0/configuration/guide/c70mesh.html
7. **AP1552 Quick Start Guide** http://www.cisco.com/en/US/docs/wireless/access_point/1550/quick/guide/ap1550qsg.html
8. **AP1552 Hardware Installation Guide** http://www.cisco.com/en/US/products/ps11451/prod_installation_guides_list.html
9. **AP1552 Pole-Mounting Guide** http://www.cisco.com/en/US/docs/wireless/access_point/mounting/guide/1550polemount.html
10. **AP1552 Cable Strand-Mounting Guide** http://www.cisco.com/en/US/docs/wireless/access_point/mounting/guide/1550strandmount.html
11. **FCC Outdoor Installation Guidelines** http://www.cisco.com/en/US/prod/collateral/routers/ps272/data_sheet_c78-647116_ps11451_Products_Data_Sheet.html
12. **Power Injector Installation Guide** http://www.cisco.com/en/US/docs/wireless/access_point/1550/power/guide/1550pwrinj.html
13. **Product Safety Info.** http://www.cisco.com/en/US/prod/collateral/wireless/ps5678/ps6973/ps8382/product_bulletin_c78-570063_ps6521_Products_Bulletin.html
14. **Techwise TV** http://cisco.6connex.com/vep/index.html?eventname=cvc&langR=en_US&mcc=&share=#nid=node18976;cid=

Note: Some of these documents may not yet be posted. Many new documents will be posted in the next couple of weeks.

Associated Sessions and Recommended Readings

- Associated Sessions
  - **BRKEWN-2011** Managing an Enterprise WLAN with Network Control System (NCS)
  - **BRKEWN-3010** Understanding & Deploying the CleanAir Technology to improve enterprise WLAN spectrum management
- Prerequisites
  - **BRKEWN-2010** Design and Deployment of Enterprise WLANs
  - **BRKEWM-2017** Understanding RF Fundamentals and the Radio Design of Wireless Networks

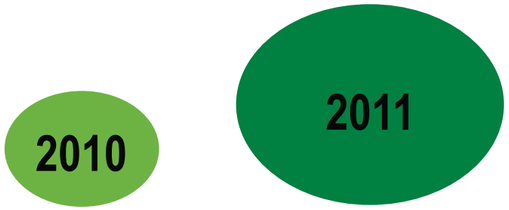
Abstract

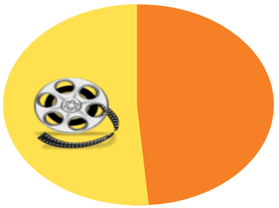
- This intermediate session will describe the Outdoor wireless products involved in delivering outdoor broadband wireless services for Service Providers, Municipalities, Transportation and other end user customers. The Cisco Outdoor Wireless Bridging and MESH Technologies will be discussed in detail.

- *The session is intended for wireless network architects, network designers, network planners working in Public Sector, Service Providers, Systems Integrators, small providers and enterprise customers. Attendees should have some basic knowledge in configuration of IP routers, Wi-Fi access points, and Radio Frequency planning. Basic understanding of the Controller Architecture is required.*

Did You Know ? 2011

Mobile data traffic grew 133% (x2.3)



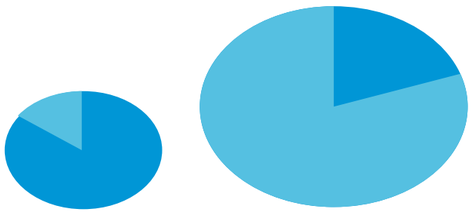


More than 50% is already video

Connection speeds Doubled

Smartphones

Only 12% of handsets



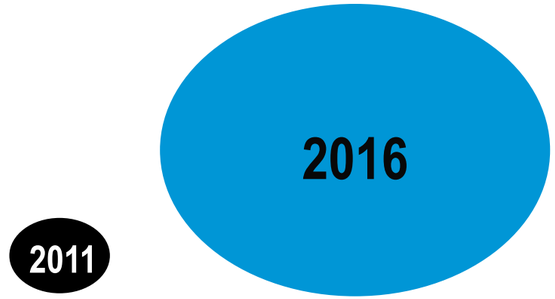
But 82% of Traffic

Tablets & Smartphones represent highest growth category

=  x 5

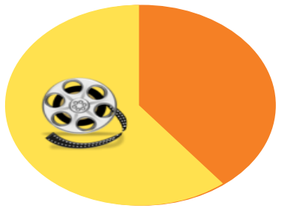
Source: Cisco Visual Networking Index 2011

Are you ready for this 2015

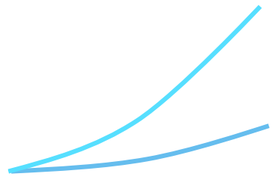


Mobile data to grow x 18

About 67% Will be video

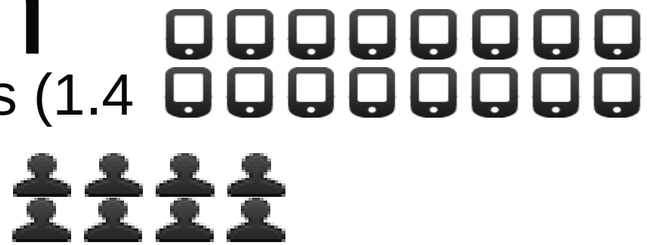


Mobile data grow rate will be



x3 faster than fixed IP traffic growth

10 billion Connected devices (1.4 per capita)



Avg. smartphone user to generate about 2.6GB /month

Comparing to 150MB today

Source: Cisco Visual Networking Index 2011