TOMORROW starts here.

Cisco live!

Converged Access Architecture, Design and Deployment

BRKARC-2665

Dave Zacks

Distinguished Systems Engineer

Cisco live!

Converged Access –
Architecture, Design, and Deployment

BRKARC-2665 – **Session Overview and Objectives**

Cisco is bringing together the best of wired and wireless networking into “One Network” with Converged Access.

This session introduces the Converged Access solution, including the next-generation Catalyst 3850 switch, and how you can employ this exciting new platform within your network – discussing various design considerations and placement within various network deployments.

You will learn how the Converged Access architecture is designed and operates, how roaming works seamlessly, as well as many of the Multicast, NetFlow, QoS, and Security features inherent within the solution.

This session is targeted to Network Managers, Architects and Administrators.

Converged Access –
Architecture, Design, and Deployment

Your Instructor Today … **Dave Zacks**

I am a **Distinguished Systems Engineer**, and have been with Cisco for 14+ years.

I work primarily with large, high-performance Enterprise network architectures, designs, and systems. I have over 20 years of experience with designing, implementing, and supporting highly available network systems and solutions that have included many diverse network technologies and capabilities, using multiple different topologies.

I have been involved with the Converged Access solution within Cisco for 3+ years.

Quick note – Throughout this presentation, the term "**3x50**" is used to refer to **both the Catalyst 3850 and 3650 platforms** together (saves space rather than spelling out 3850 / 3650 every time). **Only these two platforms are inferred when the term "3x50" is used in this presentation.**

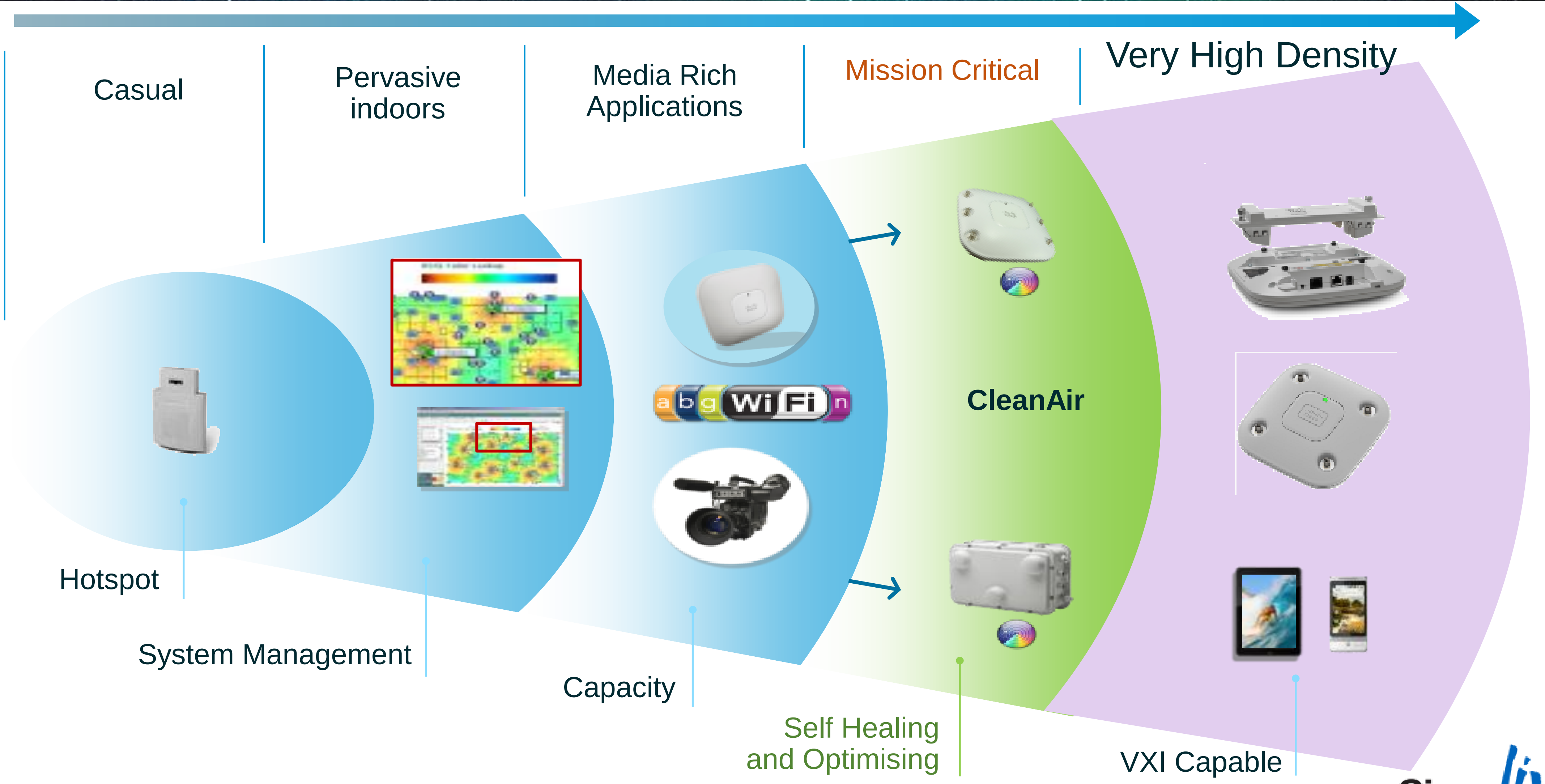
Dave Zacks
Distinguished Systems Engineer
dzacks@cisco.com

Agenda – BRKARC-2665

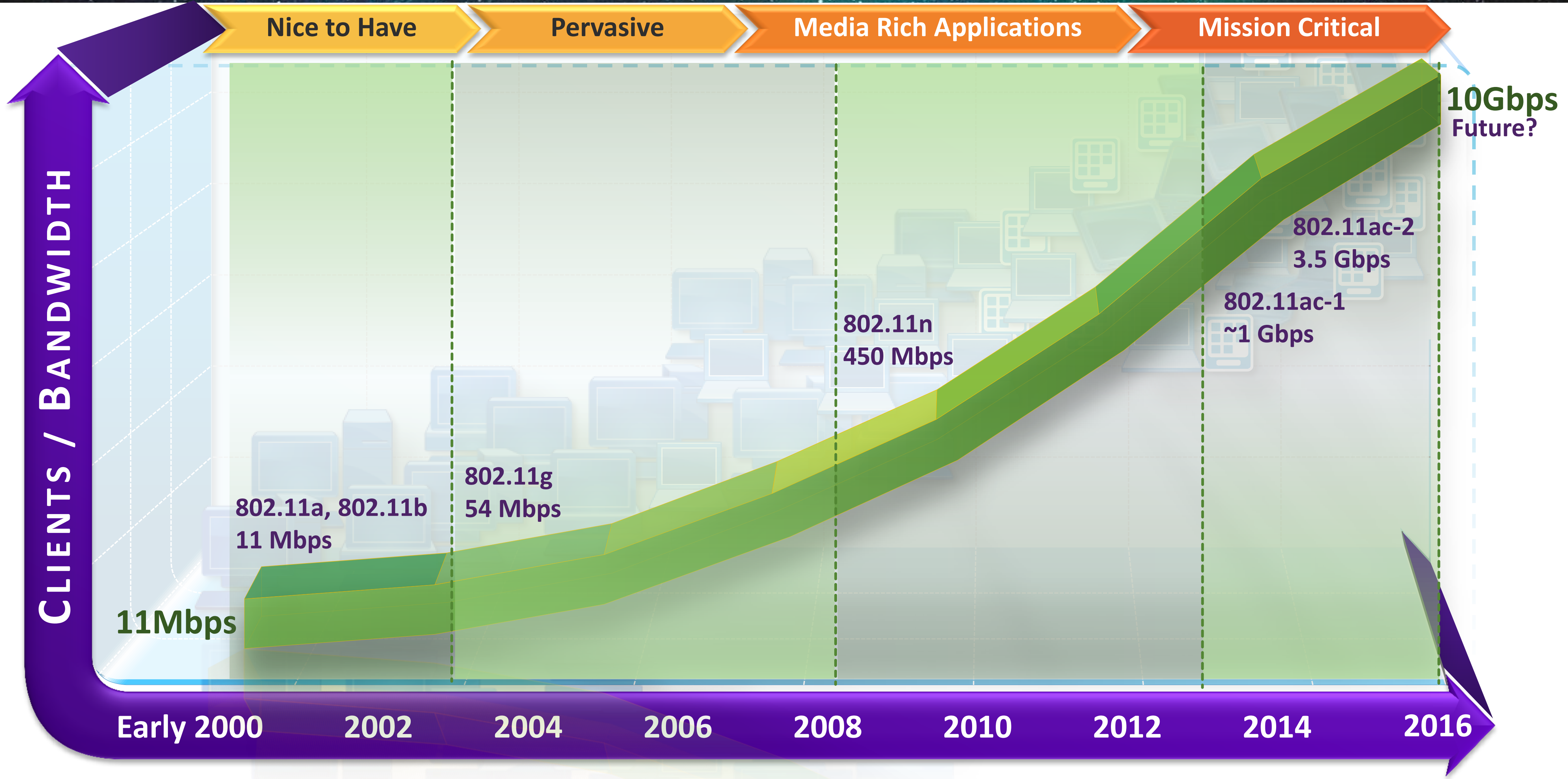
- ► Evolution … Towards One Policy, One Management, One Network
- Converged Access – Platform Overviews
- Existing Wireless Deployments – Architecture Refresher
- Converged Access Architecture –
  - Terminology and Building Blocks
  - Traffic Flows and Roaming
  - High Availability
  - Quality of Service
  - Security
  - Multicast
  - NetFlow
- Converged Access Design and Deployment –
  - IP Addressing
  - Design Options
  - Deployment Examples
- Summary

Enterprise Wireless Evolution

From Best-Effort to Mission-Critical and Very High Density



Wireless Standards –
Past, Present, and Future



How Many Mobile Data Devices
Do You Think You Will Carry Everywhere in 2016?

Think about it, and choose the best answer

1	3	5	7
			

One Network, with Converged Access –

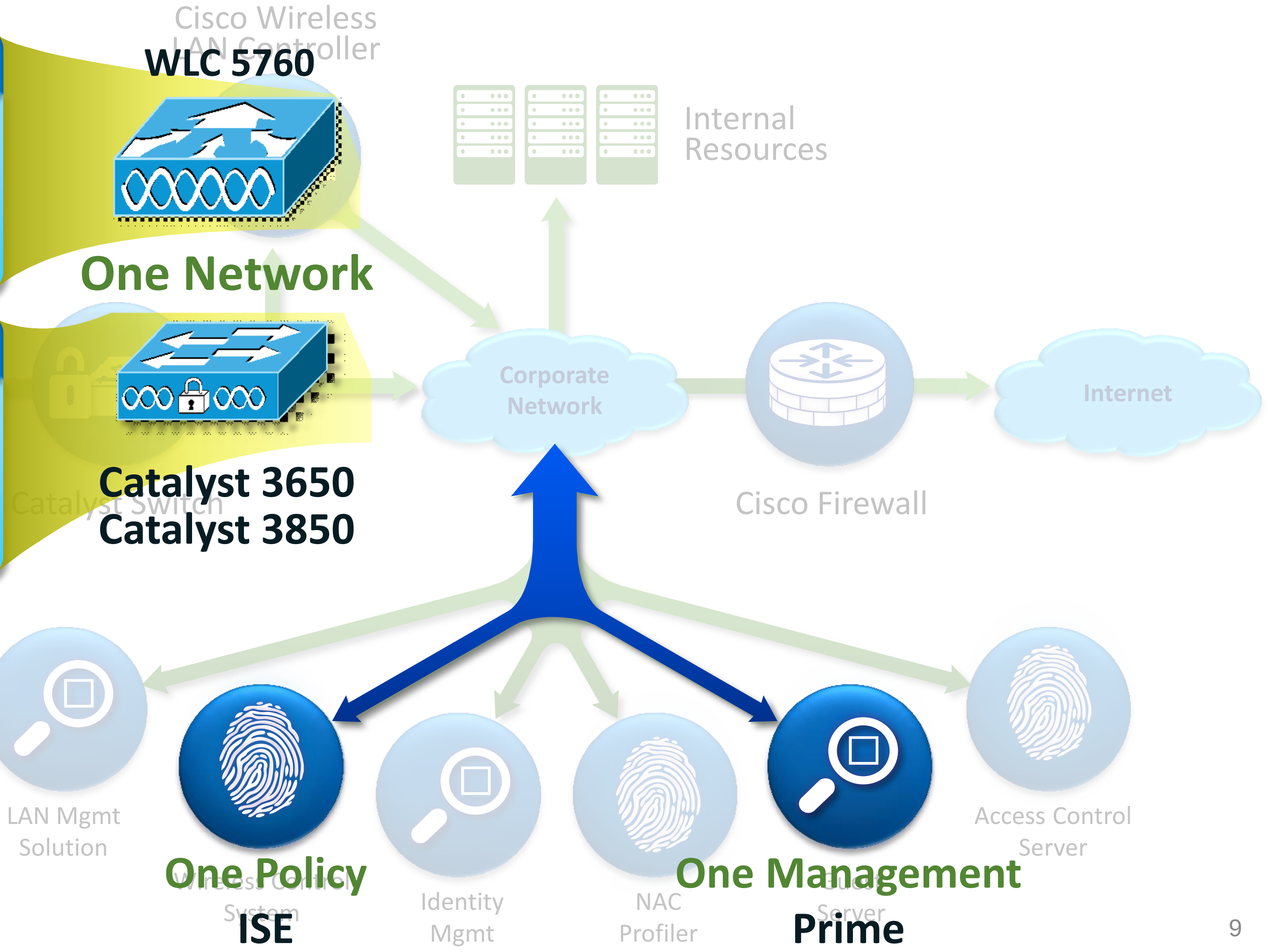
A New Deployment Mode for Wired / Wireless

IOS Based WLAN Controller

- Consistent IOS and ASIC w/ Catalyst 3x50
- Required to scale beyond 200/250 AP or 8,000 / 16,000 client domains

Converged Access Mode

- Integrated wireless controller
- Distributed wired/wireless data plane (CAPWAP termination on switch)



Converged Wired / Wireless Access – Benefits – Overview

Single platform for wired and wireless

Common IOS, same administration point, one release

Network wide **visibility** for faster troubleshooting

Wired and wireless traffic visible at every hop

Consistent security and Quality of Service **control**

Hierarchical bandwidth management and distributed policy enforcement

Maximum **resiliency** with fast stateful recovery

Layered network high availability design with stateful switchover

Scale with distributed wired and wireless data plane

Large stack bandwidth; 40G wireless / switch; efficient multicast; 802.11ac optimised

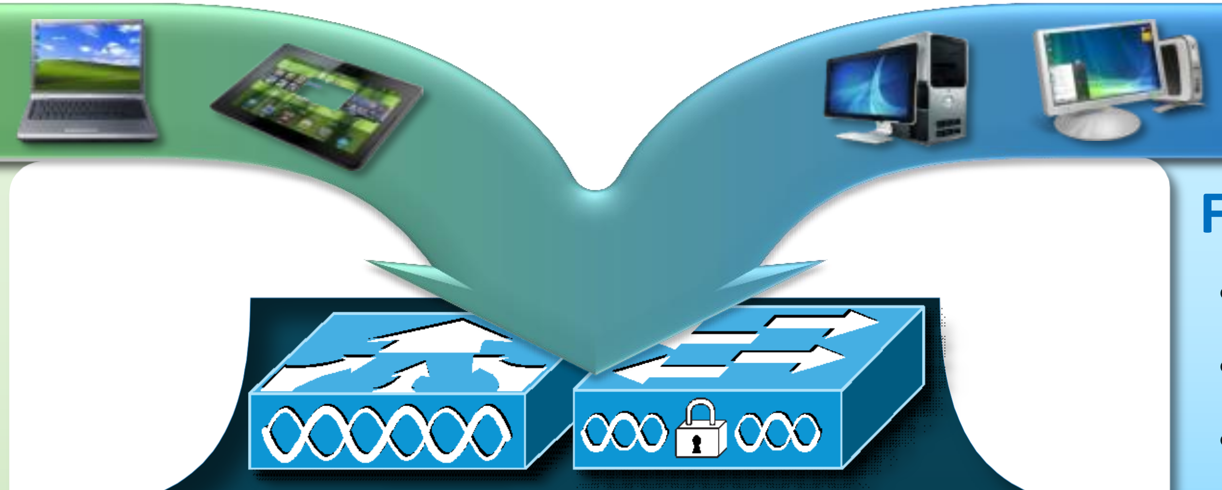
Unified Access - One Policy | One Management | One Network

Agenda – BRKARC-2665

- Evolution … Towards One Policy, One Management, One Network
- ► **Converged Access – Platform Overviews**
- Existing Wireless Deployments – Architecture Refresher
- Converged Access Architecture –
  - Terminology and Building Blocks
  - Traffic Flows and Roaming
  - High Availability
  - Quality of Service
  - Security
  - Multicast
  - NetFlow
- Converged Access Design and Deployment –
  - IP Addressing
  - Design Options
  - Deployment Examples
- Summary

Catalyst 3850 and 3650 Switches –
Single Platform for Wired and Wireless

20+ Years of IOS Richness – Now on Wireless



WIRELESS

Features:

- Centralised deployment
- L2/L3 Fast Roaming
- Clean Air
- Video Stream
- Radio Resource Management (RRM)
- Wireless Security
- Radio performance
- 802.11ac

WIRED

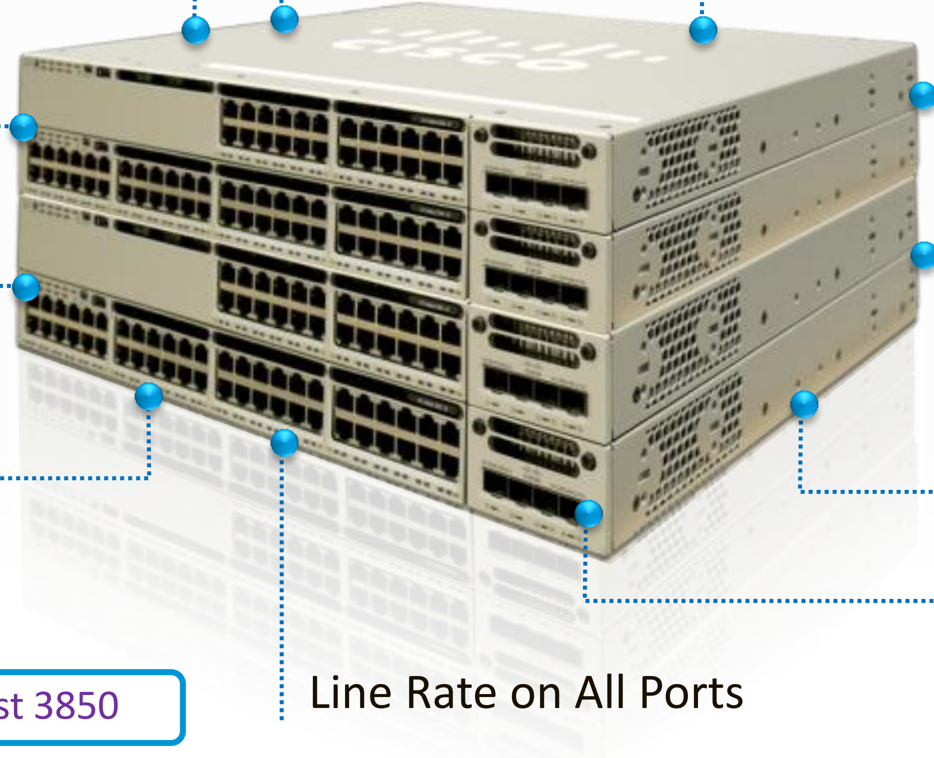
Features:

- Stacking and HA
- SGT & Advanced Identity
- Visibility and Control
- Flexible NetFlow
- Granular QoS
- Smart Operations
- EEM, scripting
- IOS-XE Modular OS

Benefits

- Built on **UADP** – Cisco's Innovative Flexparser ASIC technology
- Eliminates operational complexity
- Single 'modern' Operating System for wired and wireless

Catalyst 3850 –
Platform Overview



APs must be directly connected to Catalyst 3850

Built on Cisco’s Innovative “UADP” ASIC

New Catalyst 3650 Switch –
Platform Overview

APs must be directly connected to Catalyst 3650

Built on Cisco's Innovative "UADP" ASIC

Wireless LAN Controller (WLC) 5760 –
Platform Overview

Built on Cisco's Innovative "UADP" ASIC

Agenda – BRKARC-2665

Evolution … Towards One Policy, One Management, One Network

Converged Access – Platform Overviews

► **Existing Wireless Deployments – Architecture Refresher**

Converged Access Architecture –

- Terminology and Building Blocks
- Traffic Flows and Roaming
- High Availability
- Quality of Service
- Security
- Multicast
- NetFlow

Converged Access Design and Deployment –

- IP Addressing
- Design Options
- Deployment Examples

Summary

Converged Access Architecture – What We're Going to Cover

CA System Architecture

Roaming, HA, QoS, Security, NetFlow, Mcast

Deployment and Design

Foundational Elements for the Converged Access Solution

Converged Access –
Network Requirements Driving Wireless Evolution

We've Been Here Before…

Hotspot deployments with nomadic roaming

Standalone Access Point

Autonomous Mode

Centralised tunnelling of user traffic to controller (data plane and control plane)

System-wide coordination for channel and power assignment, rogue detection, security attacks, interference, roaming

Functionality split with CAPWAP

Controller

Cisco **Unified Wireless**

Access Point

Frees up the AP to focus on real-time communication, policy application and optimise RF & MAC functionality such as CleanAir, ClientLink

Increased scalability, Centralised policy application

Control plane functionality on NG Controller

(also possible on upgraded 5508s, WiSM2s for brownfield deployments, or NG Converged Access switches for small, branch deployments)

Cisco **Converged Access**

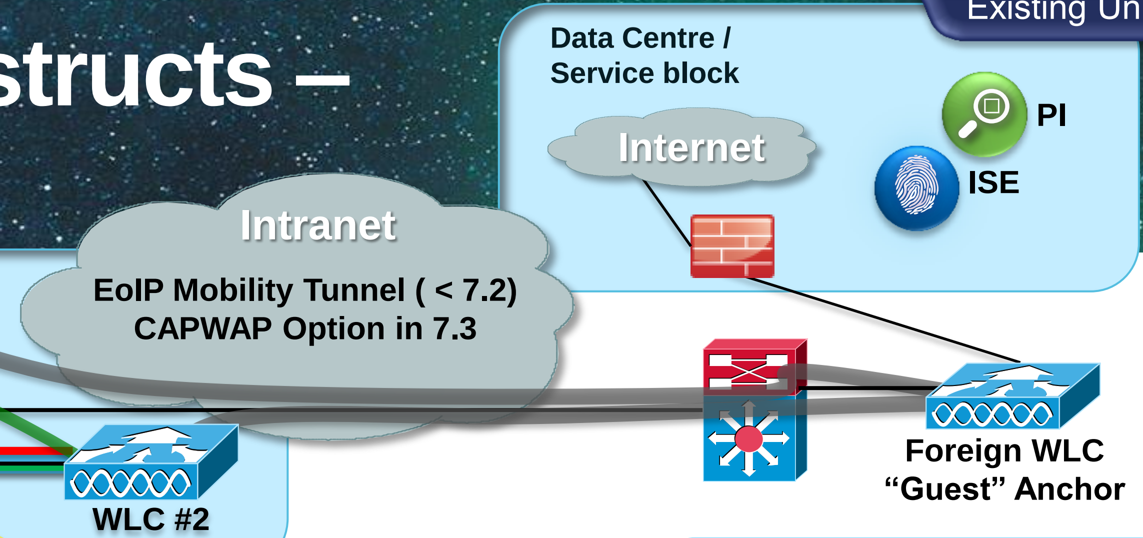
Data plane functionality on NG Switches

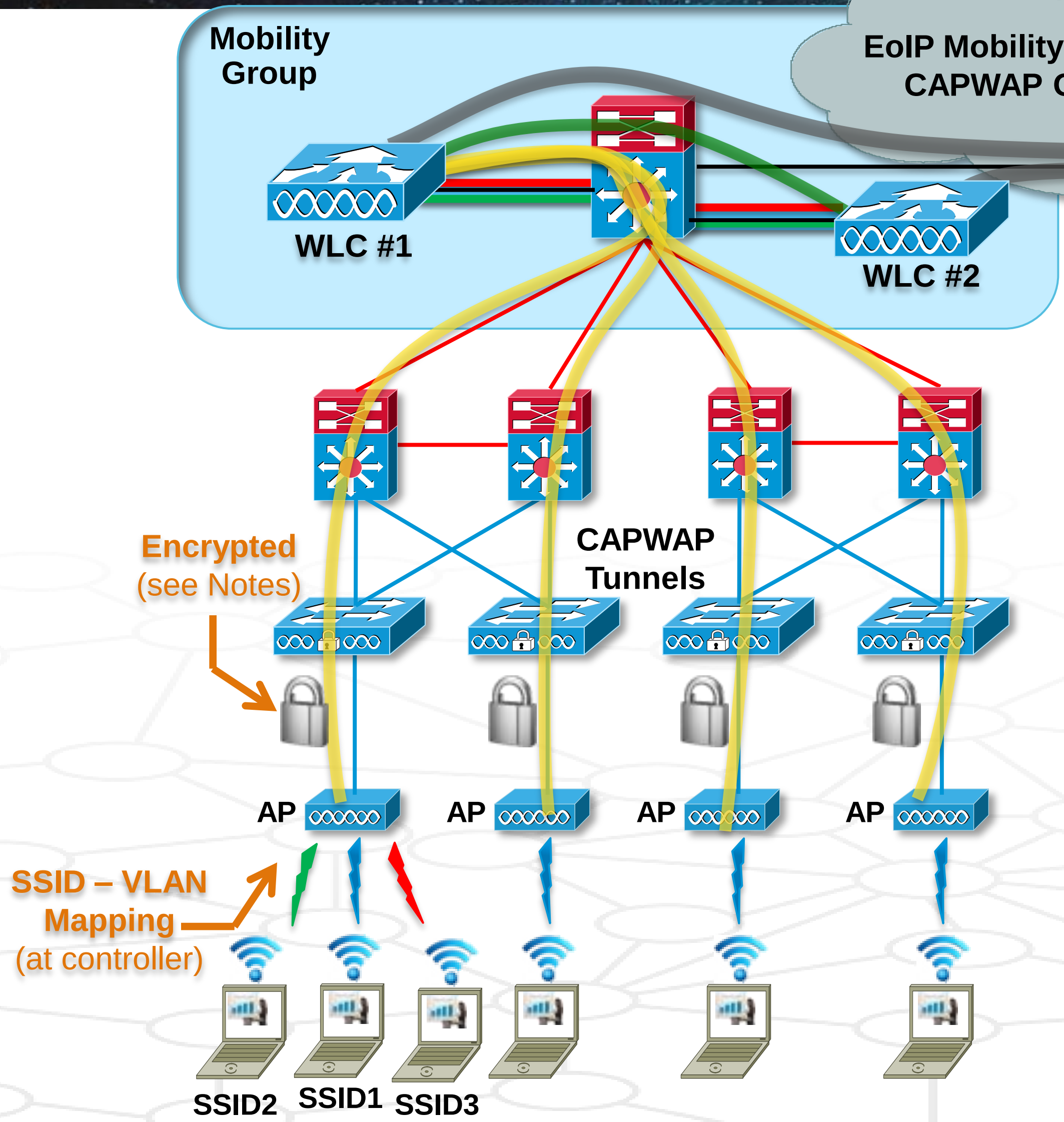
(also possible on NG Controllers, for deployments in which a centralised approach is preferred)

- **Unified wired-wireless experience (security, policy, services)**
- **Common policy enforcement, Common services for wired and wireless traffic (NetFlow, advanced QoS, and more …)**

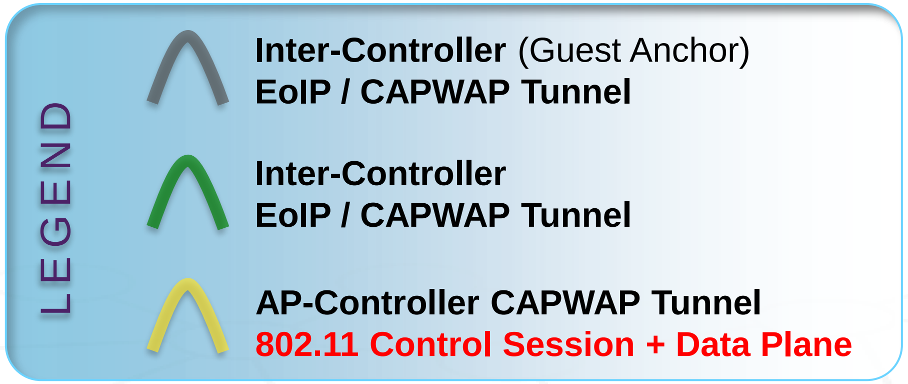
Scale and Services → **Performance and Unified Experience**

Architecture Constructs – CUWN Tunnel Types





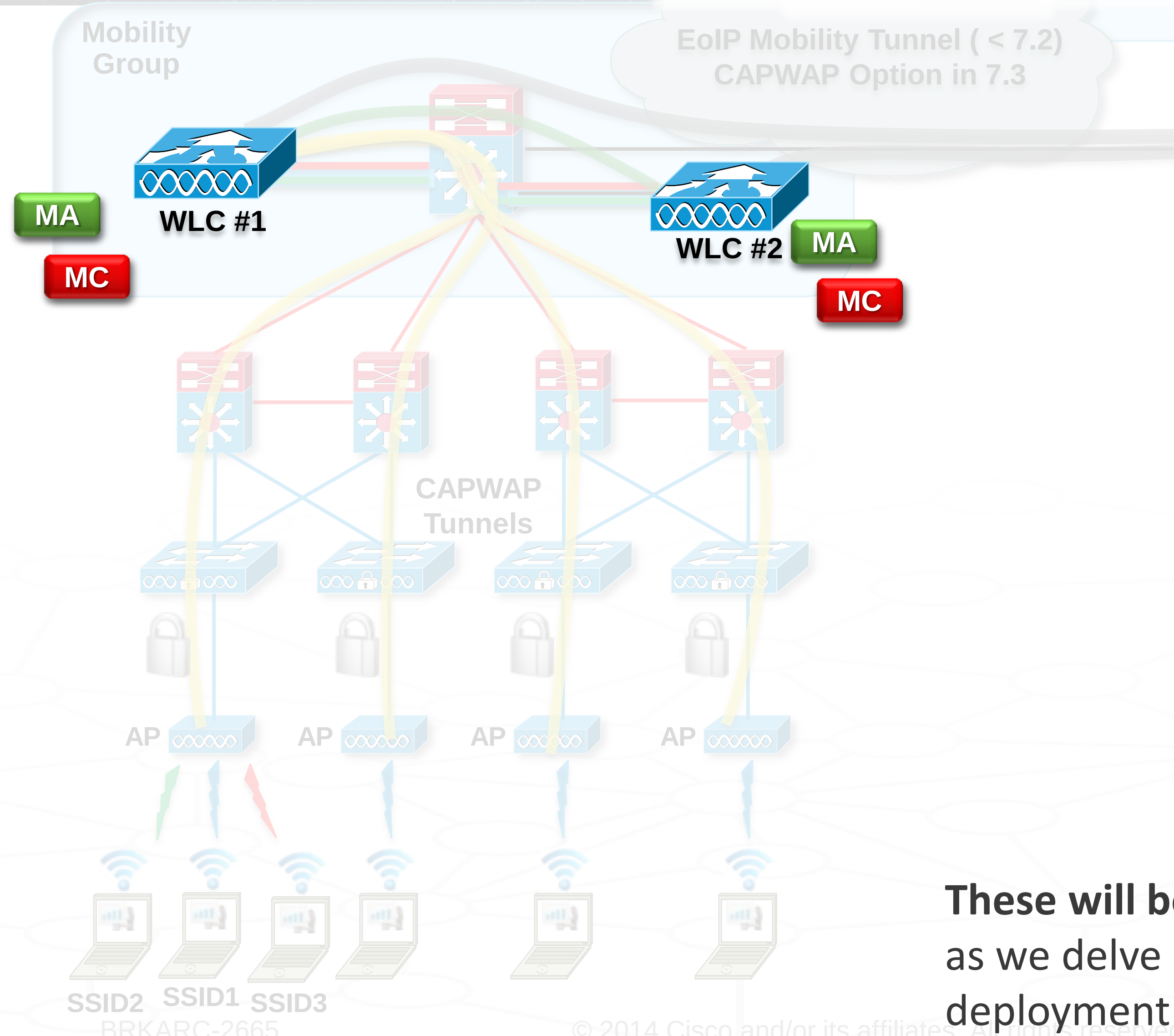
Well-known, proven architecture

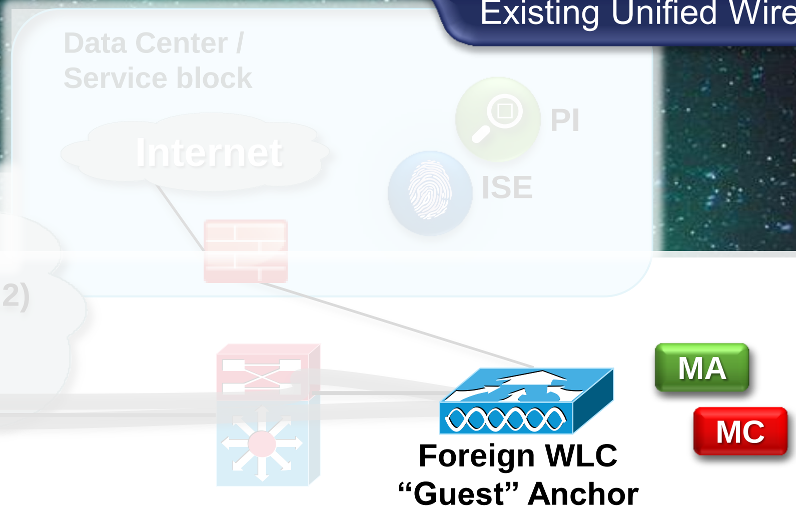


Notes –

- **AP / WLC CAPWAP Tunnels are an IETF Standard**
- UDP ports used –
  - 5246: Encrypted Control Traffic
  - 5247: Data Traffic (non-Encrypted or DTLS Encrypted (configurable)
- **Inter-WLC Mobility Tunnels**
  - EoIP – IP Protocol 97 … AireOS 7.3 introduces CAPWAP option
  - Used for inter-WLC L3 Roaming and Guest Anchor

Architecture Constructs – CUWN Control Functions





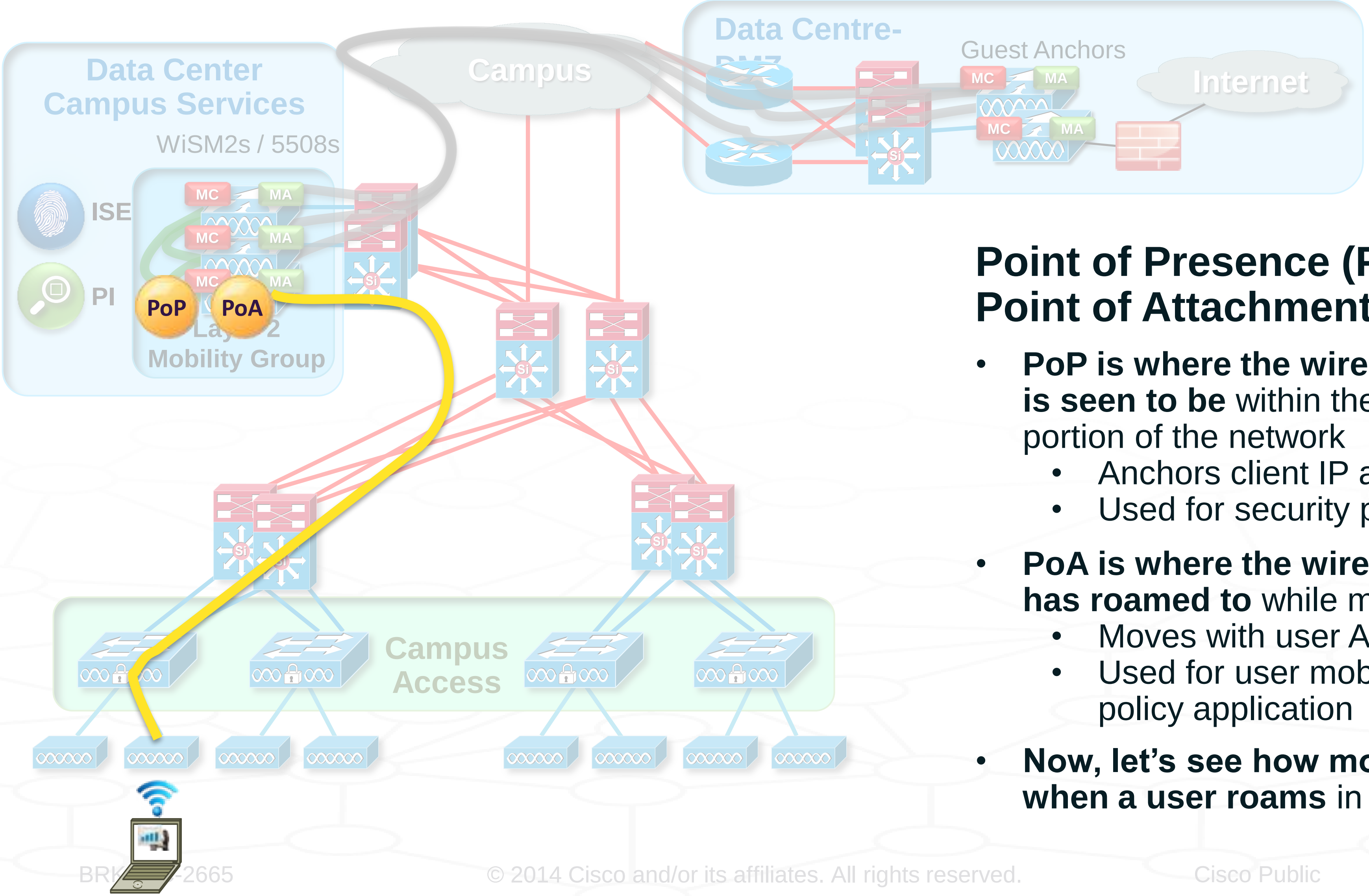
LEGEND

- **MA** — **Mobility Agent**
  Terminates CAPWAP Tunnels,
  Maintains Client Database
- **MC** — **Mobility Controller**
  Handles Roaming, RRM, WIPS, etc.

Additional details on controller functionality

These will become important later
as we delve into the Converged Access deployment …

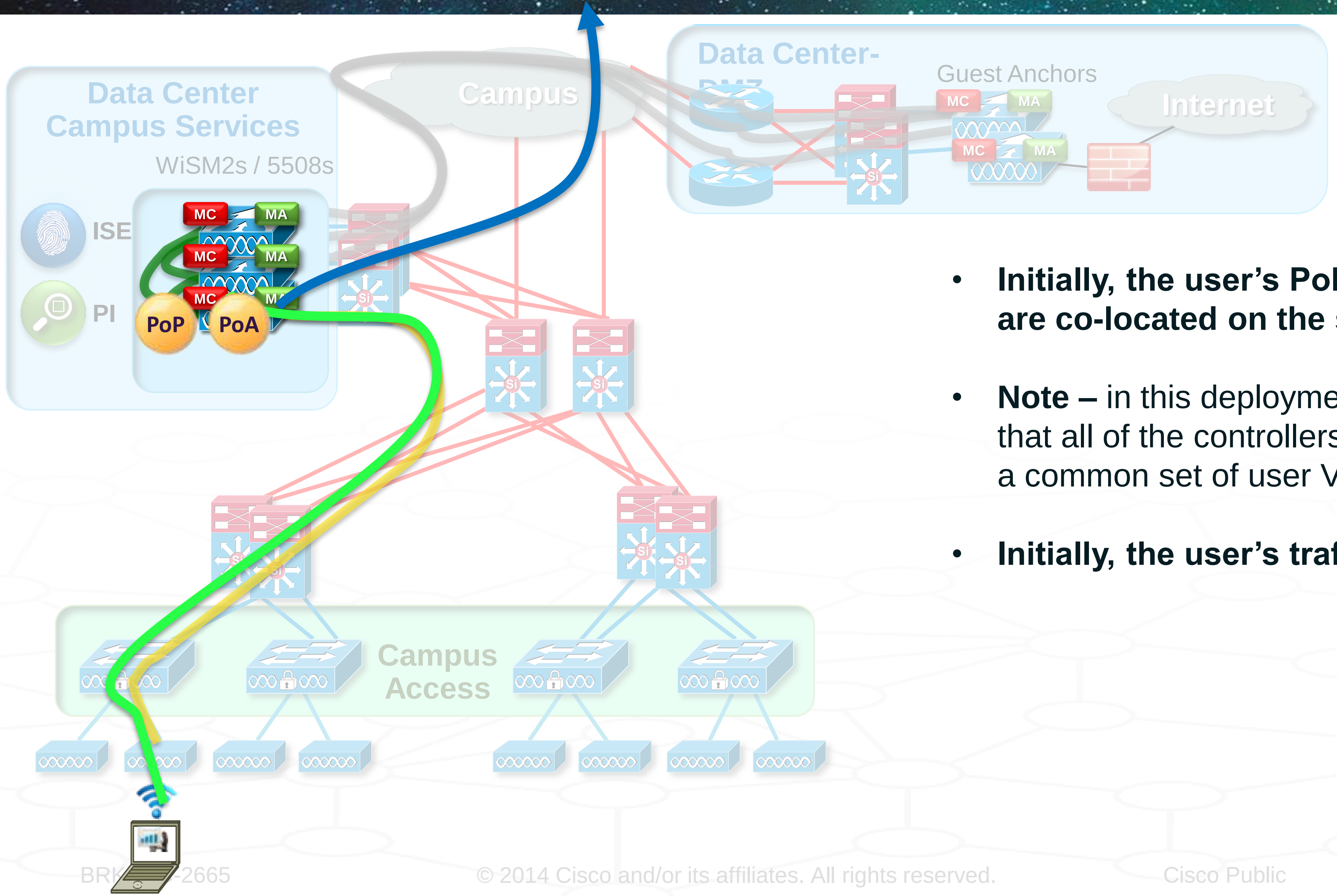
Architecture Constructs –
Point of Presence (PoP), Point of Attachment (PoA)



Point of Presence (PoP) vs. Point of Attachment (PoA) –

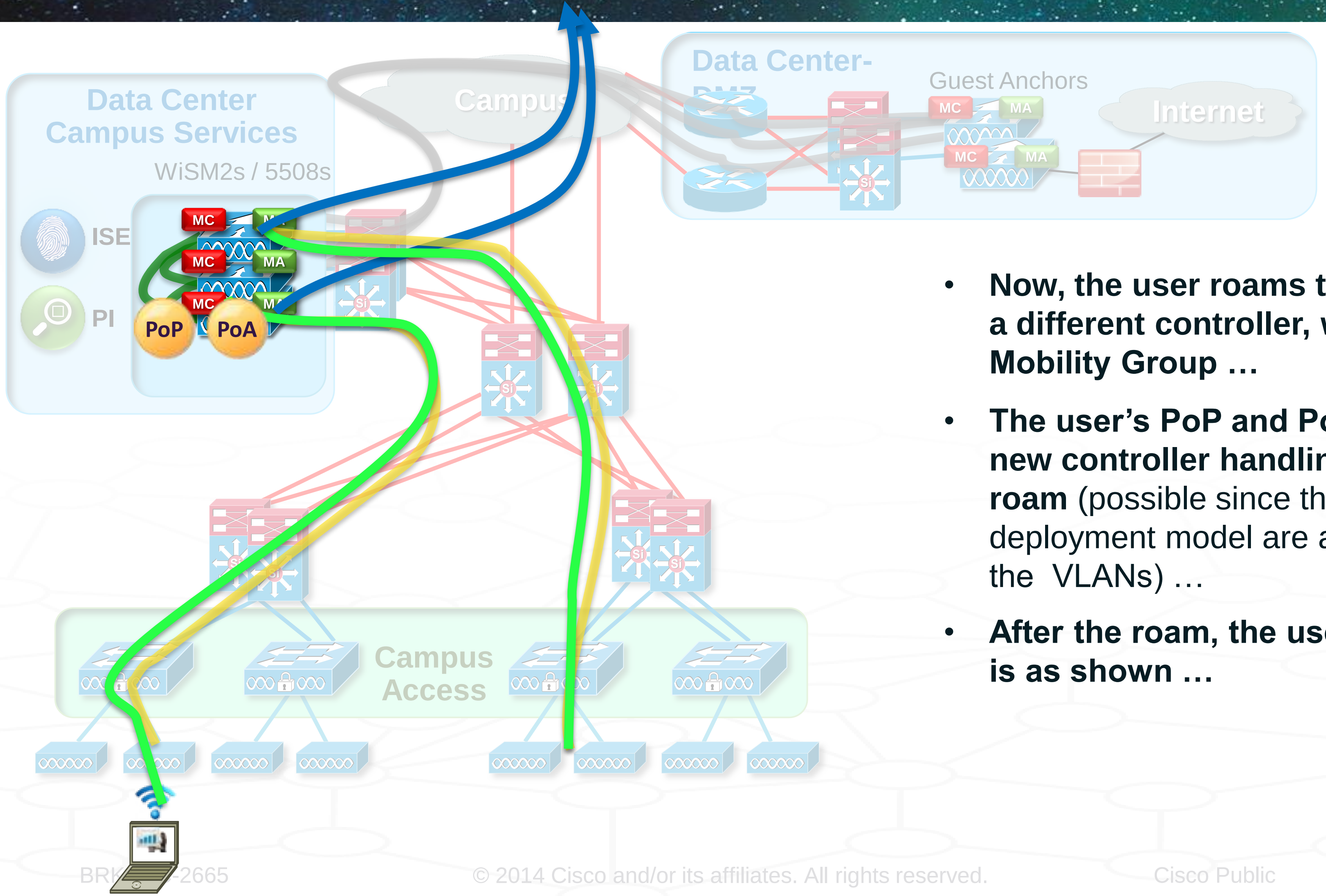
- **PoP is where the wireless user is seen to be** within the wired portion of the network
  - Anchors client IP address
  - Used for security policy application
- **PoA is where the wireless user has roamed to** while mobile
  - Moves with user AP connectivity
  - Used for user mobility and QoS policy application
- **Now, let's see how mobility works when a user roams** in this deployment model …

Architecture Constructs –
Layer 2 Roaming (Campus Deployment)



- **Initially, the user's PoP and PoA are co-located on the same controller**
- **Note –** in this deployment model, it is assumed that all of the controllers within the DC share a common set of user VLANs at Layer 2
- **Initially, the user's traffic flow is as shown …**

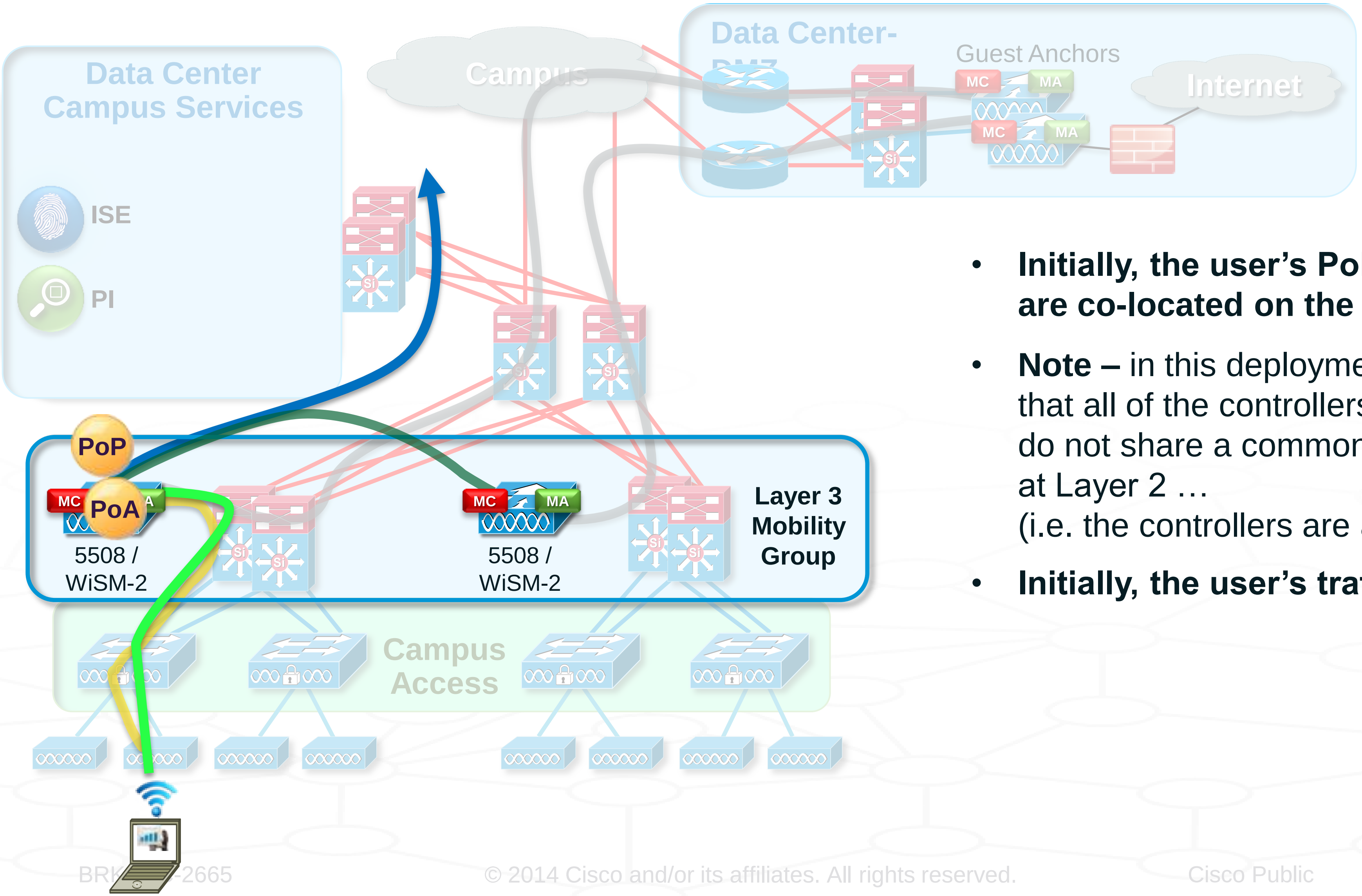
Architecture Constructs –
Layer 2 Roaming (Campus Deployment)



Move of the user's entire Mobility Context

- **Now, the user roams to an AP handled by a different controller, within the same Mobility Group …**
- **The user's PoP and PoA both move to the new controller handling that user after the roam** (possible since the controllers in this deployment model are all L2-adjacent within the VLANs) …
- **After the roam, the user's traffic flow is shown …**

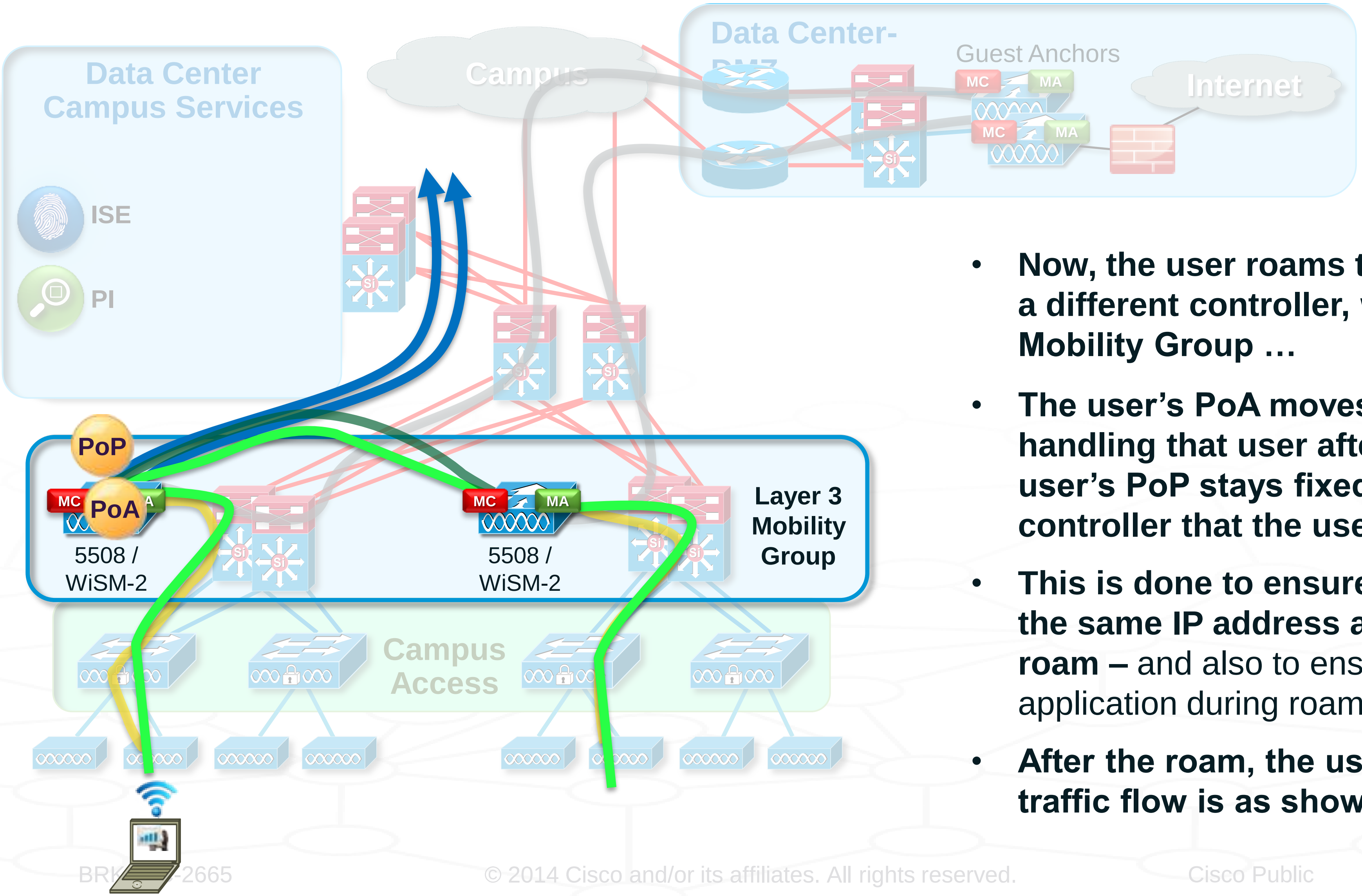
Architecture Constructs –
Layer 3 Roaming (Campus Deployment)



- **Initially, the user's PoP and PoA are co-located on the same controller**
- **Note –** in this deployment model, it is assumed that all of the controllers across the Campus do not share a common set of user VLANs at Layer 2 …
  (i.e. the controllers are all L3-separated)
- **Initially, the user's traffic flow is as shown …**

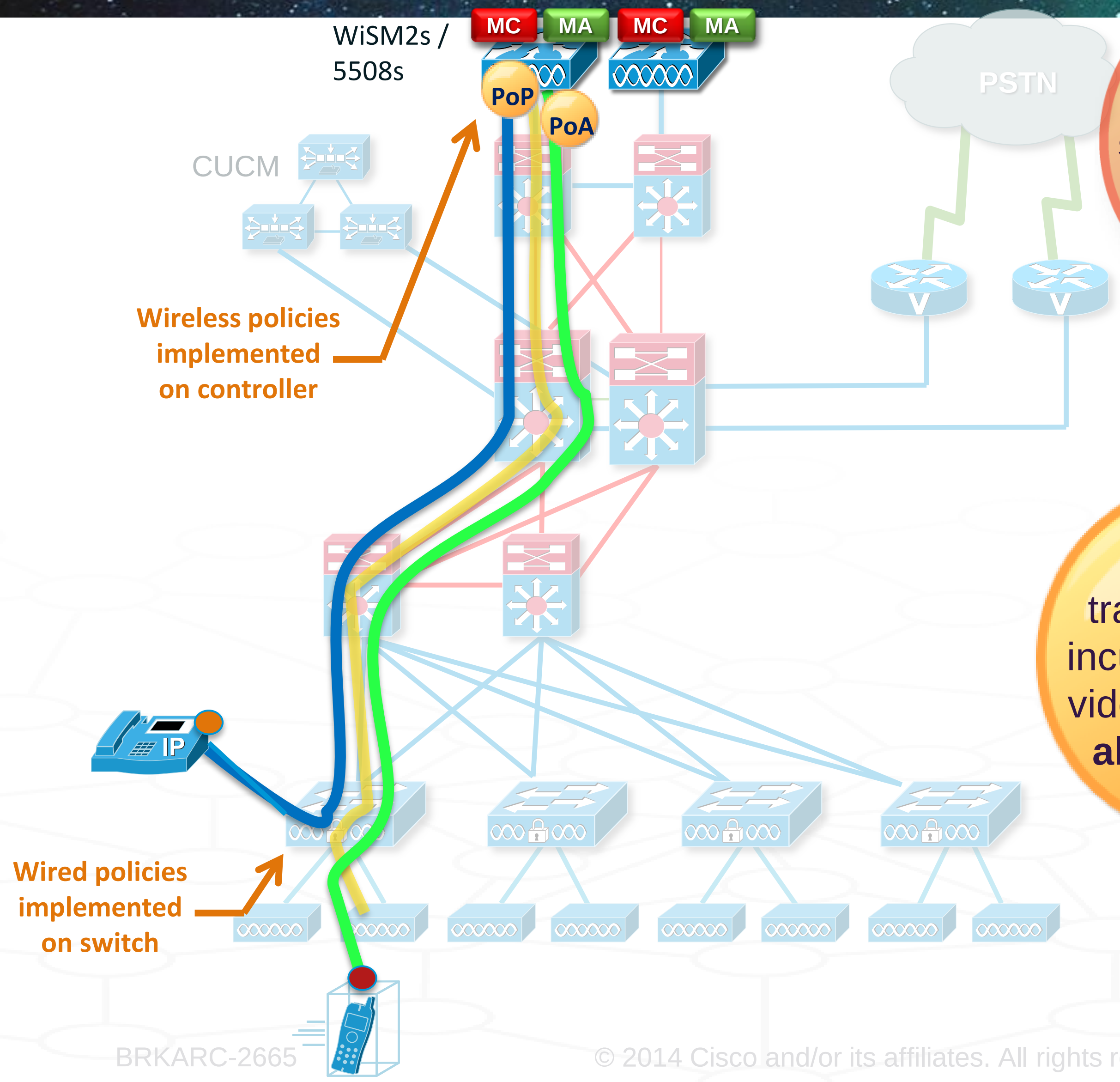
Architecture Constructs –
Layer 3 Roaming (Campus Deployment)

Symmetric Mobility Tunnelling



- **Now, the user roams to an AP handled by a different controller, within the same Mobility Group …**
- **The user's PoA moves to the new controller handling that user after the roam – but the user's PoP stays fixed on the original controller that the user associated to**
- **This is done to ensure that the user retains the same IP address across an L3 boundary roam –** and also to ensure continuity of policy application during roaming
- **After the roam, the user's traffic flow is as shown …**

Architecture Constructs –
Traffic Flow



Separate **policies and services** for wired and wireless users

The same traffic paths are incurred for voice, video, data, etc. – **all centralised**

Traffic Flows, Unified Wireless –

- In this example, a VoIP user is on today's CUWN network, and is making a call from a wireless handset to a wired handset …
- **We can see that all of the user's traffic needs to be hairpinned back through the centralized controller,** in both directions …

In this example, a total of **9 hops** are incurred for each direction of the traffic path (including the controllers – Layer 3 roaming might add more hops) …

Agenda – BRKARC-2665

Evolution … Towards One Policy, One Management, One Network
Converged Access – Platform Overviews
Existing Wireless Deployments – Architecture Refresher

Converged Access Architecture –

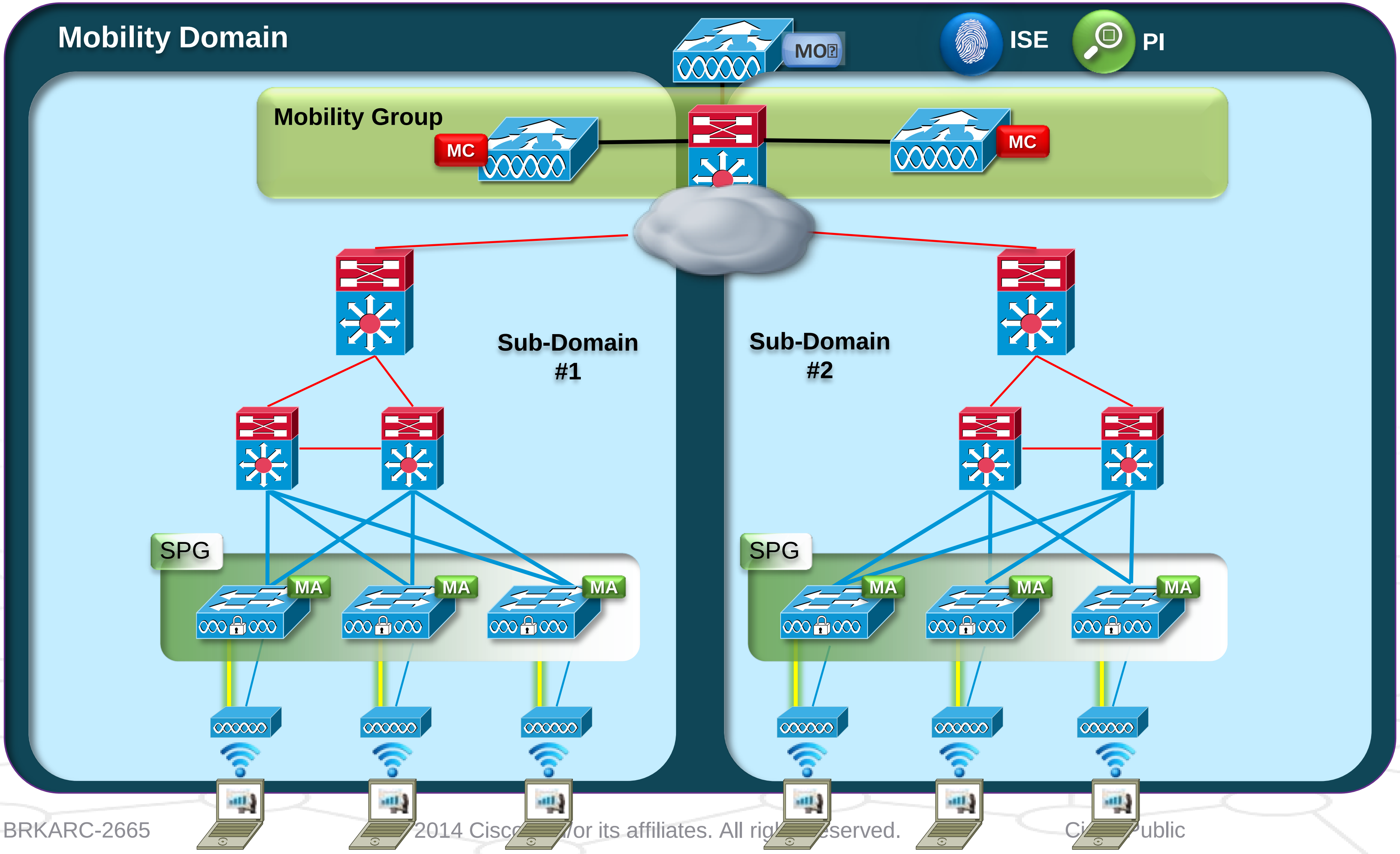
- ► Terminology and Building Blocks
- Traffic Flows and Roaming
- High Availability
- Quality of Service
- Security
- Multicast
- NetFlow

Converged Access Design and Deployment –

- IP Addressing
- Design Options
- Deployment Examples

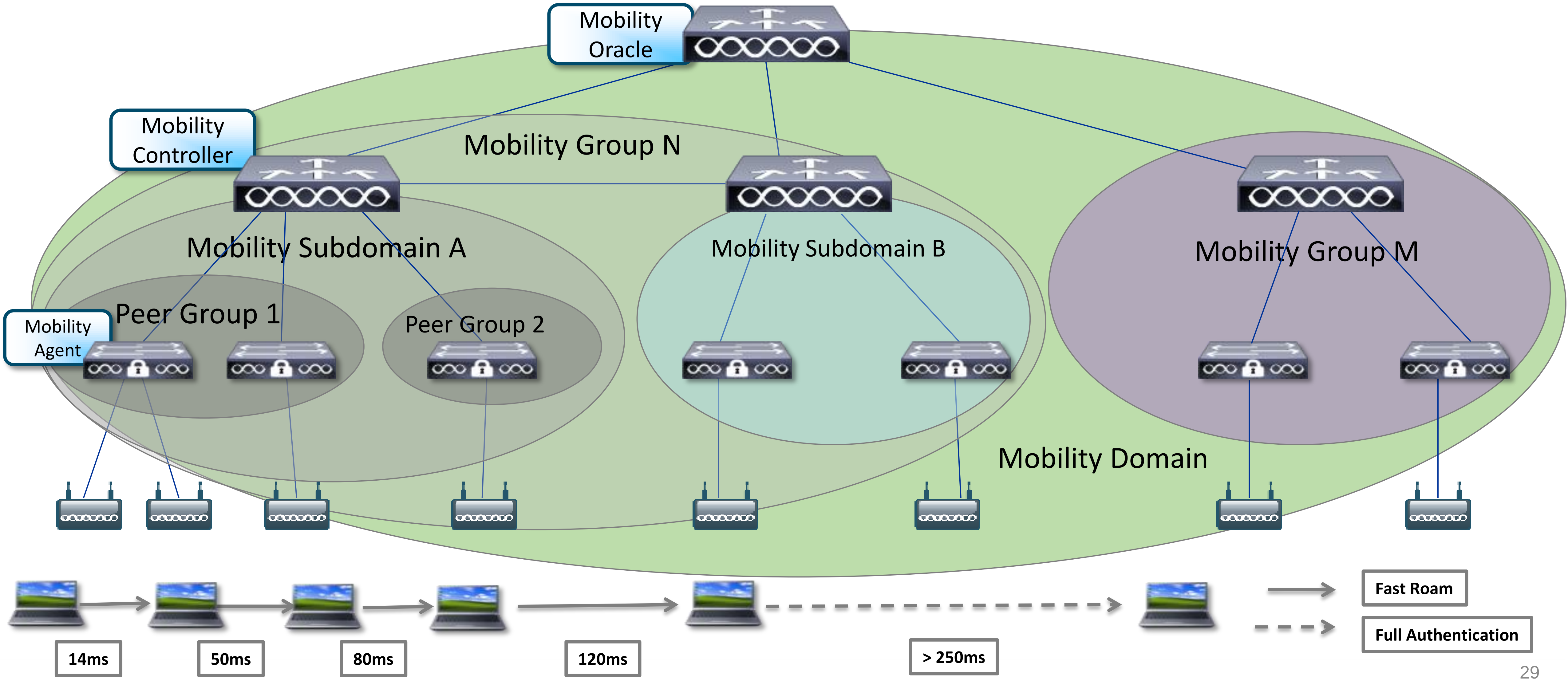
Summary

Converged Access – Deployment Overview



Converged Access – Mobility Architecture

For Your Reference



Converged Access –
Components – Physical and Logical Entities

Physical Entities –

- **Mobility Agent (MA)** – Terminates CAPWAP tunnel from AP
- **Mobility Controller (MC)** – Manages mobility within and across Sub-Domains
- **Mobility Oracle (MO)** – Superset of MC, allows for Scalable Mobility Management within a Domain

Logical Entities –

- **Mobility Groups –** Grouping of Mobility Controllers (MCs) to enable Fast Roaming, Radio Frequency Management, etc.
- **Mobility Domain** – Grouping of MCs to support seamless roaming
- **Switch Peer Group (SPG) –** Localises traffic for roams within a Distribution Block

MA, MC, Mobility Group functionality all exist in today's controllers (4400, 5500, WiSM2)

Converged Access – Physical Entities – Catalyst 3850 / 3650 Switch Stack

Best-in-Class Wired Switches – with Integrated Wireless Mobility functionality

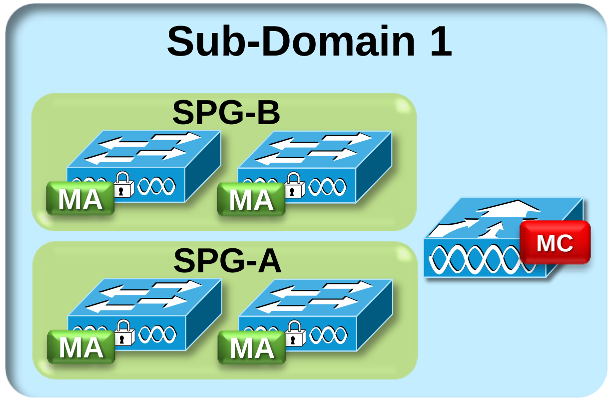
MA

- Can act as a **Mobility Agent** (MA) for terminating CAPWAP tunnels for locally connected APs …

MC

- as well as a **Mobility Controller** (MC) for other Mobility Agent (MA) switches, in small deployments
  - MA/MC functionality works on a Stack of Catalyst 3850 / 3650 Switches
  - MA/MC functionality runs on Stack Master
  - Stack Standby synchronises some information (useful for intra-stack HA)

Converged Access –
Logical Entities – Switch Peer Groups (SPGs)



- **Made up of multiple Catalyst 3x50 switches as Mobility Agents** (MAs), **plus an MC** (on controller as shown)
- **Handles roaming across SPG** (L2 / L3)
- **MAs within an SPG are fully-meshed** (auto-created at SPG formation)
- **Fast Roaming within an SPG**
- **Multiple SPGs under the control of a single MC form a Sub-Domain**

SPGs are a logical construct, not a physical one …

SPGs can be formed across Layer 2 or Layer 3 boundaries

SPGs are designed to constrain roaming traffic to a smaller area, and optimise roaming capabilities and performance

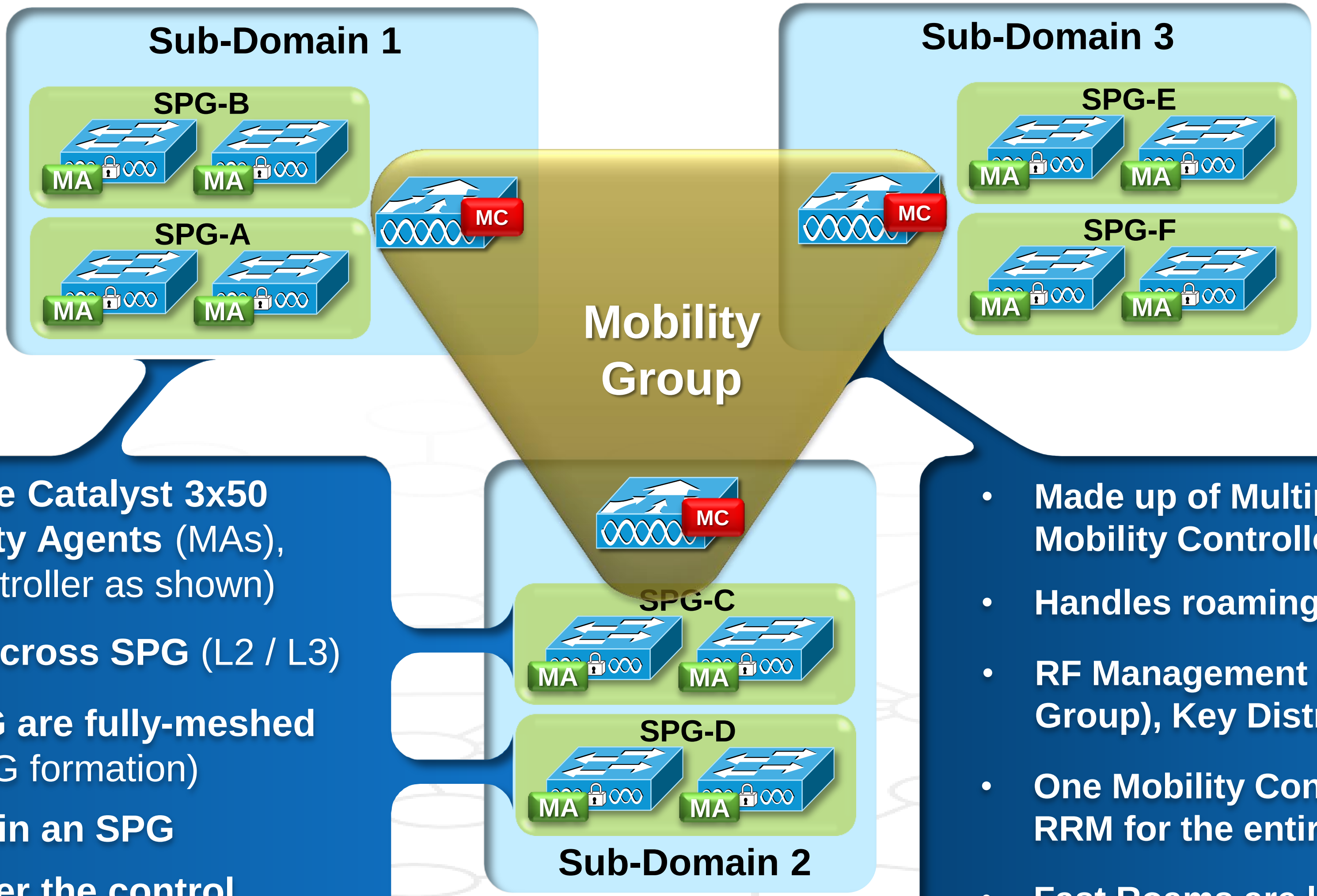
Current thinking on best practices dictates that **SPGs will likely be built around buildings, around floors within a building, or other areas that users are likely to roam most within**

Roamed traffic within an SPG moves directly between the MAs in that SPG (CAPWAP full mesh)

Roamed traffic between SPGs moves via the MC(s) servicing those SPGs

Hierarchical architecture is optimised for scalability and roaming

Converged Access –
Logical Entities – Switch Peer Groups and Mobility Group



- **Made up of multiple Catalyst 3x50 switches as Mobility Agents** (MAs), **plus an MC** (on controller as shown)
- **Handles roaming across SPG** (L2 / L3)
- **MAs within an SPG are fully-meshed** (auto-created at SPG formation)
- **Fast Roaming within an SPG**
- **Multiple SPGs under the control of a single MC form a Sub-Domain**

- **Made up of Multiple Mobility Controllers (MCs)**
- **Handles roaming across MG** (L2 / L3)
- **RF Management (RRM, handled by RF Group), Key Distribution for Fast Roaming**
- **One Mobility Controller** (MC) **manages RRM for the entire RF Group**
- **Fast Roams are limited to Mobility Group member MCs**

Converged Access – Scalability Considerations

For Your Reference

As with any solution – there are scalability constraints to be aware of …

- These are summarised below, for quick reference
- Full details on scalability – for both CUWN as well as Converged Access deployments – is located in the Reference section at the end of this slide deck

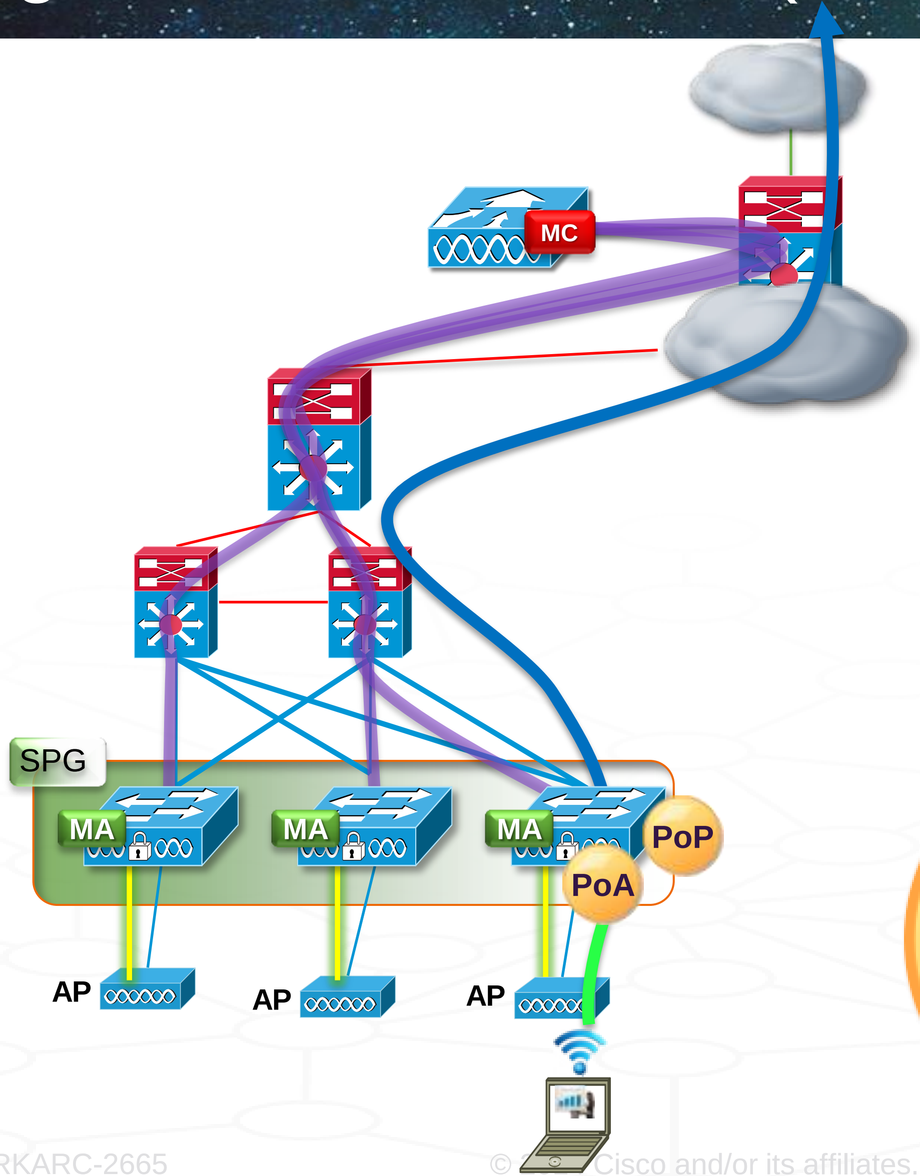
Scalability	3650 as MC (3.3.1SE)	3850 as MC (3.3.1SE)	WLC2504 (7.6)	WLC5760 (7.6)	WLC5508 (7.6)	WiSM2 (7.6)
Max APs Supported per MC	25	50	75	1000	500	1000
Max APs Supported in overall Mobility Domain	200	250	5400	72000	36000	72000
Max Clients Supported per MC	1000	2000	1000	12000	7000	15000
Max Clients Supported in overall Mobility Domain	8000	16000	72000	864000	504000	1.08M
Max number of MC in Mobility Domain	8	8	72	72	72	72
Max number of MC in Mobility Group	8	8	24	24	24	24
Max number of MAs in Sub-domain (per MC)	16	16	350	350	350	350
Max number of SPGs in Mobility Sub-Domain (per MC)	8	8	24	24	24	24
Max number of MAs in a SPG	16	16	64	64	64	64
Max number of WLANs	64	64	16	512	512	512

Agenda – BRKARC-2665

- **Evolution … Towards One Policy, One Management, One Network**
- **Converged Access – Platform Overviews**
- **Existing Wireless Deployments – Architecture Refresher**
- **Converged Access Architecture –**
  - Terminology and Building Blocks
  - ► Traffic Flows and Roaming
  - High Availability
  - Quality of Service
  - Security
  - Multicast
  - NetFlow
- **Converged Access Design and Deployment –**
  - IP Addressing
  - Design Options
  - Deployment Examples
- **Summary**

Converged Access –

Roaming – Point of Presence (PoP), Point of Attachment (PoA)



If users associate and remain stationary, this is their traffic flow

Point of Presence (PoP) vs. Point of Attachment (PoA) –

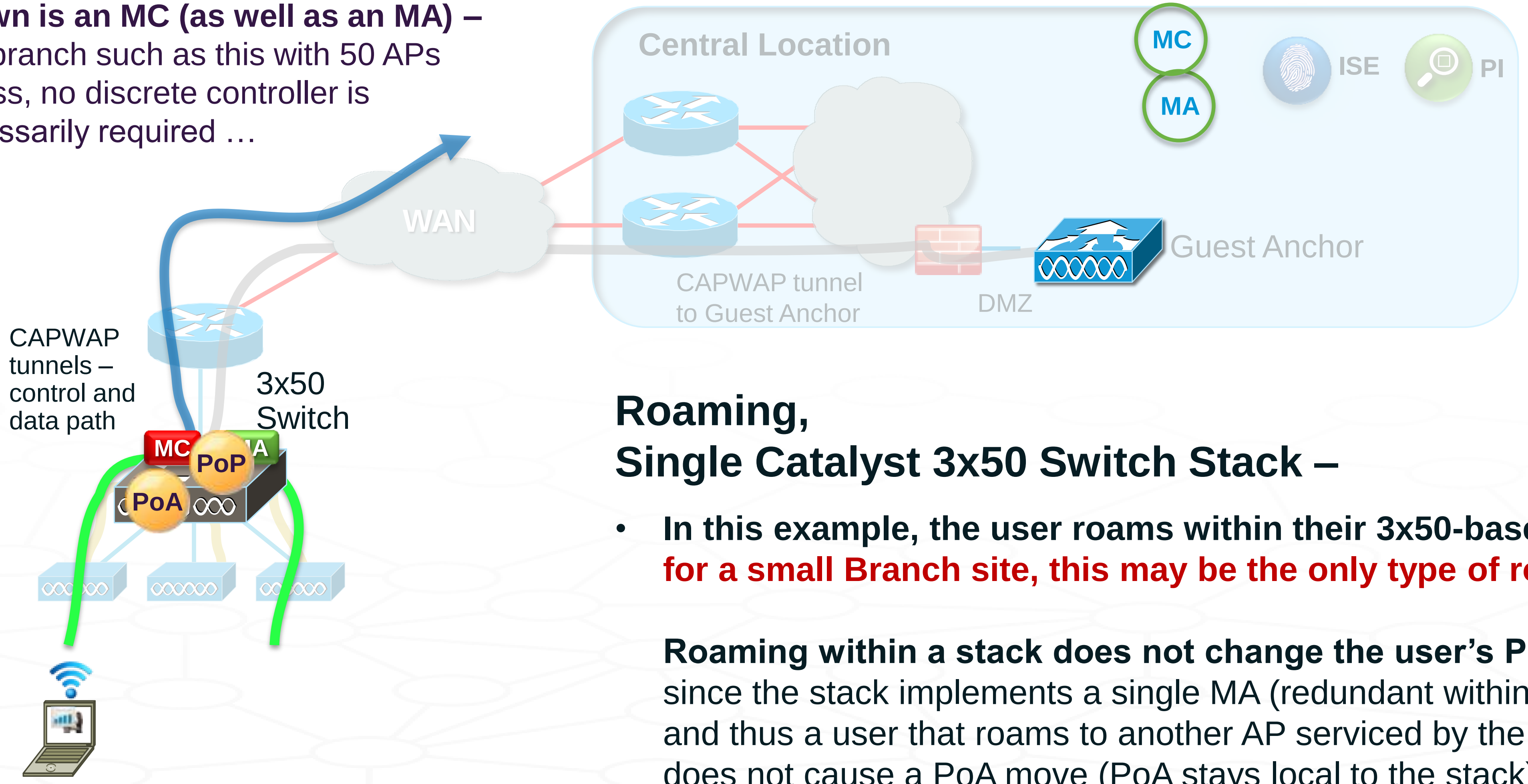
- **PoP is where the wireless user is seen to be** within the wired portion of the network
- **PoA is where the wireless user has roamed to** while mobile
- **Before a user roams, PoP and PoA are in the same place**

Note – for the purposes of illustrating roaming, we are showing the purple connections herein that indicate the connections between the MAs and their corresponding MC for the Switch Peer Group (or Groups) involved on each slide … notice that, in this example, **the traffic does NOT flow through the MC …**

Converged Access –
Traffic Flow and Roaming – Branch, Single Catalyst 3x50 Stack

Very common roaming case

Notice how the 3x50 switch stack shown is an MC (as well as an MA) – in a branch such as this with 50 APs or less, no discrete controller is necessarily required …



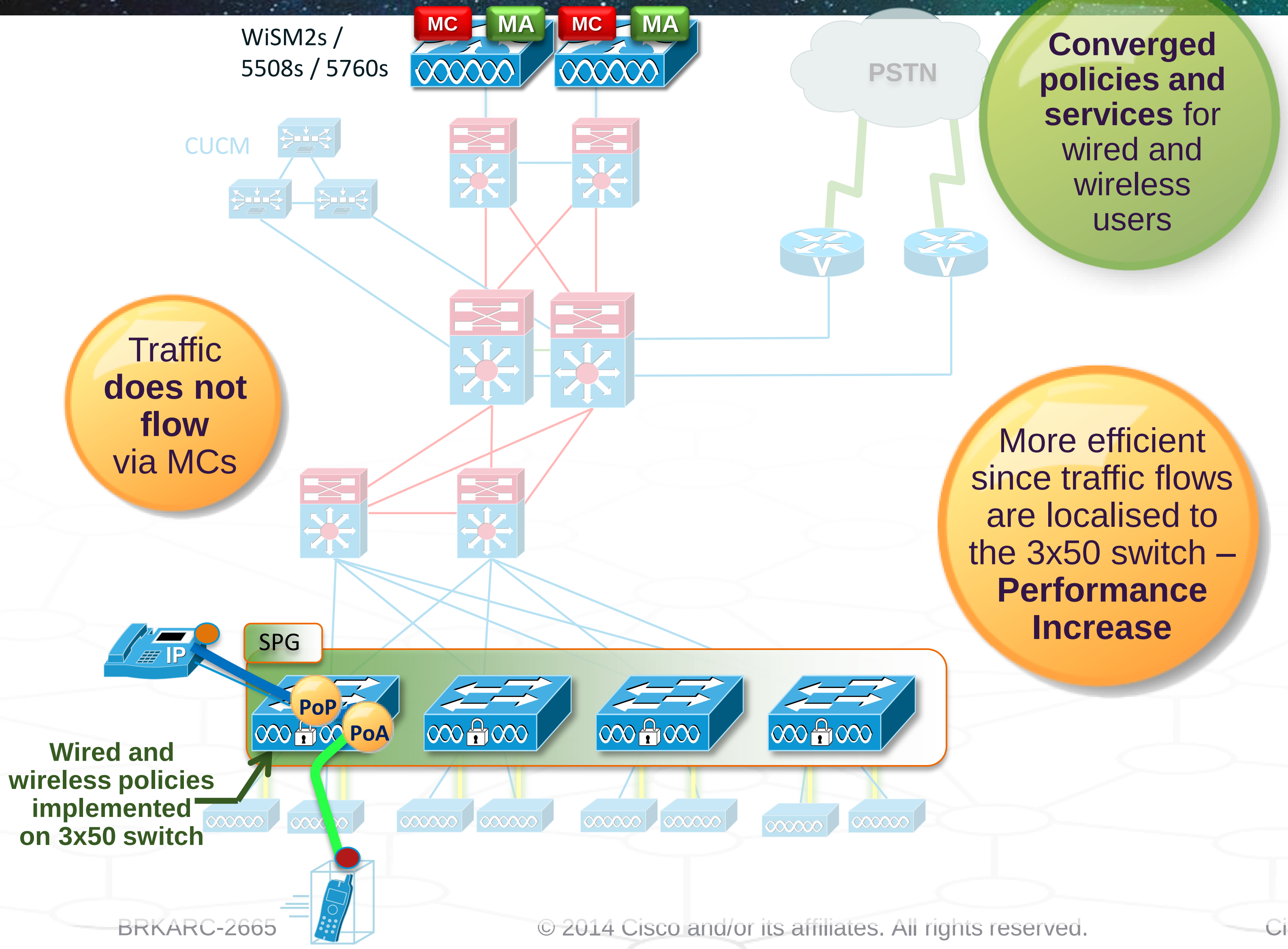
Roaming across Stack (small branch)

Roaming, Single Catalyst 3x50 Switch Stack –

- **In this example, the user roams within their 3x50-based switch stack – for a small Branch site, this may be the only type of roam**

  Roaming within a stack does not change the user's PoP or PoA – since the stack implements a single MA (redundant within the stack), and thus a user that roams to another AP serviced by the same stack does not cause a PoA move (PoA stays local to the stack)

Converged Access – Traffic Flow



Traffic Flows, Comparison (Converged Access) –

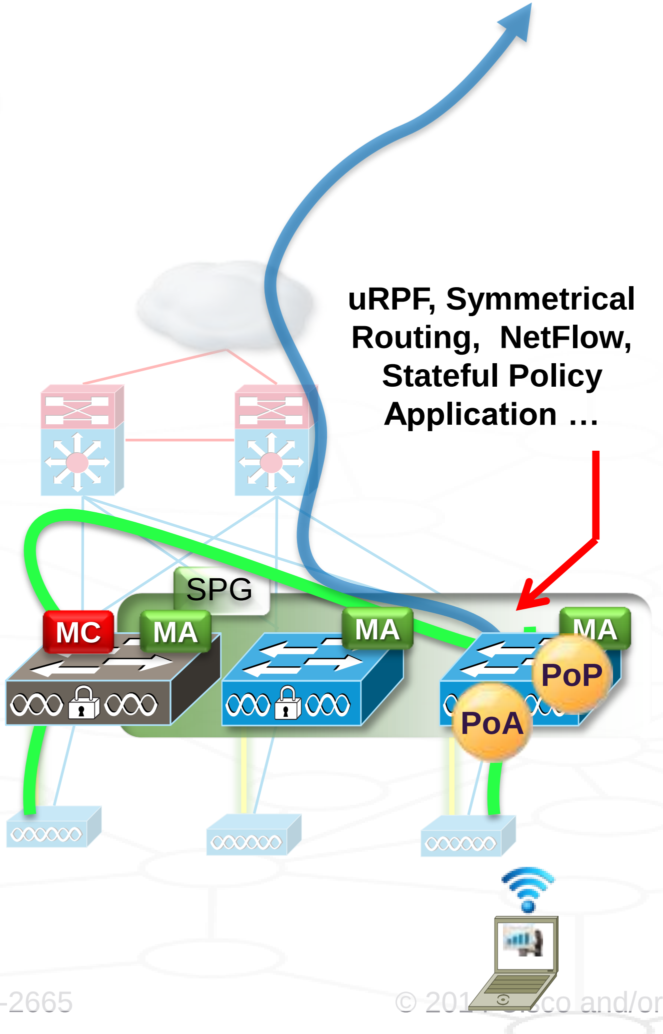
- Now, our VoIP user is on a Cisco Converged Access network, and is again making a call from a wireless handset to a wired handset …
- **We can see that all of the user's traffic is localised to their Peer Group, below the distribution layer,** in both directions …

In this example, a total of **1 hop** is incurred for each direction of the traffic path (assuming no roaming) … two additional hops may be incurred for routing …

Converged Access –
Traffic Flow and Roaming – Branch, L2 / L3 Roam (within SPG)

Very common roaming case

Roaming across Stacks (larger branch)



Roaming, Within a Switch Peer Group (Branch) –

- Now, let's examine a roam at a larger branch, with multiple 3x50-based switch stacks joined together via a distribution layer
- **In this example, the larger Branch site consists of a single Switch Peer Group – and the user roams within that SPG – again, at a larger Branch such as this, this may be the only type of roam**

The user may or may not have roamed across an L3 boundary (depends on wired setup) – **however, users are always* taken back to their PoP** for policy application

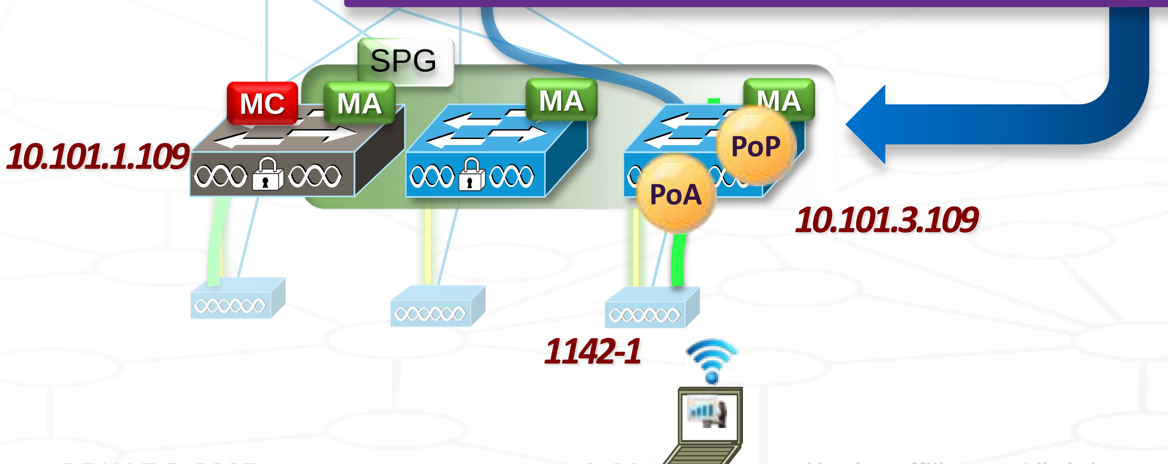
Again, notice how the 3x50 switch stack on the left is an MC (as well as an MA) in this picture – in a larger branch such as this with 50 APs or less, no discrete controller is necessarily required …

**Adjustable via setting, may be useful for L2 roams (detailed on slides in following section of this slide deck)*

Converged

Traffic Flow and

```
L09-3850s-3# show wireless client summary
Number of Local Clients : 1

MAC Address    AP Name                         WLAN State              Protocol
--------------------------------------------------------------------------------
001e.65b7.7d1a L09-AP1142-1                    2     UP                11n(5)

L09-3850s-3# show wcdb database all
        Total Number of Wireless Clients = 1
                Local Clients            = 1

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
001e.65b7.7d1a 2003   10.101.203.1    0x009350C0000000E4 RUN      LOCAL

L09-3850s-3# show wireless client mac 001e.65b7.7d1a detail

Client MAC Address : 001e.65b7.7d1a
Mobility State : Local
```



Converged A

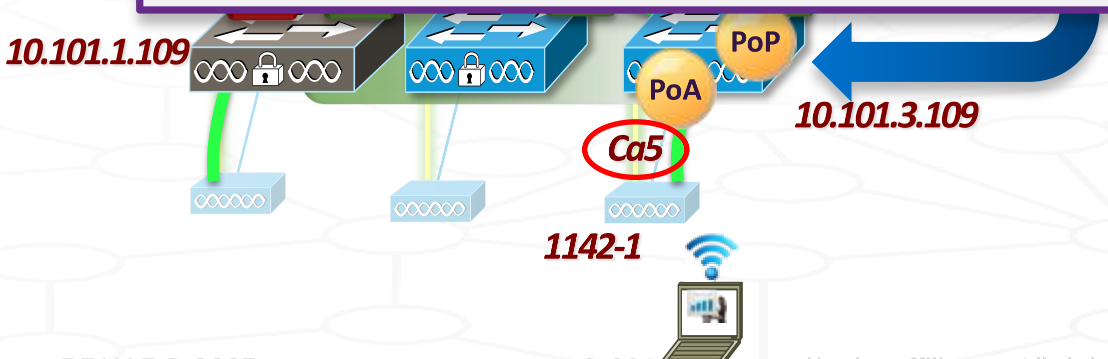
Traffic Flow and

```
L09-3850s-3# show capwap summary

Name   APName                              Type PhyPortIf Mode      McastIf
------ ----------------------------------- ---- --------- --------- -------
Ca1    -                                   mob  -         unicast   -
Ca2    -                                   mob  -         unicast   -
Ca5    L09-AP1142-1                        data Gi1/0/7   multicast Ca4
```

```
Name   SrcIP           SrcPort DestIP          DstPort DtlsEn MTU
------ --------------- ------- --------------- ------- ------ -----
Ca1    10.101.3.109    16667   10.101.1.109    16667   No     1464
Ca2    10.101.3.109    16667   10.101.2.109    16667   No     1464
Ca5    10.101.3.109    5247    10.101.3.98     31901   No     1449
```

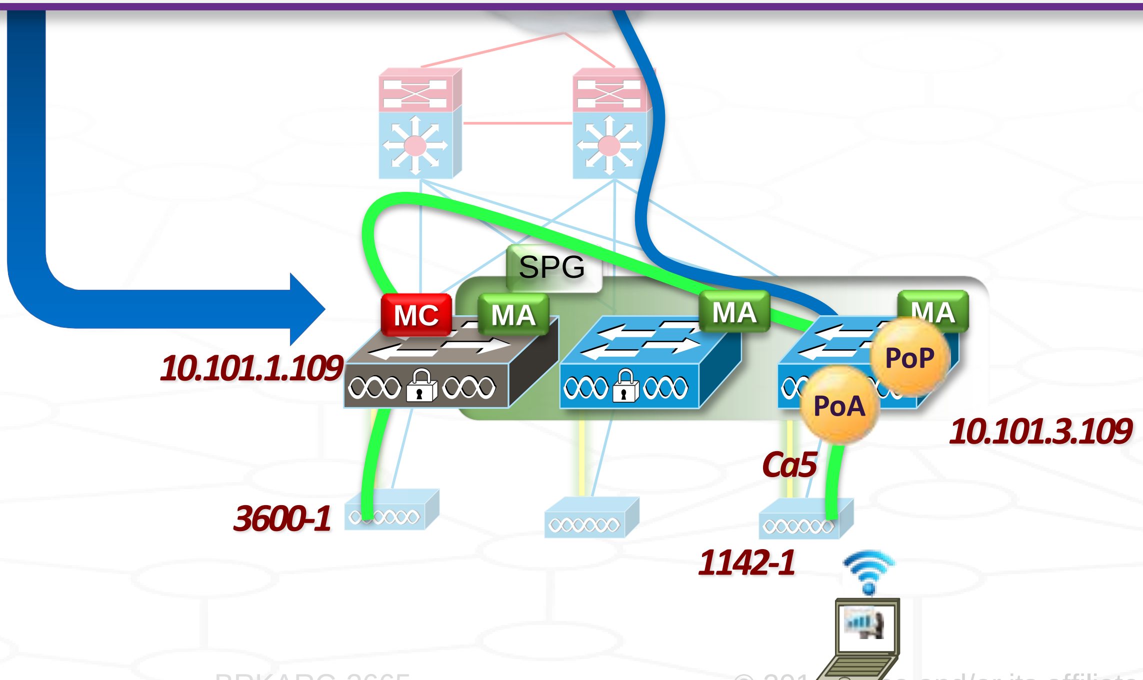
```
L09-3850s-3# show ip dhcp snooping binding
MacAddress          IpAddress        Lease(sec)  Type           VLAN  Interface
------------------  ---------------  ----------  -------------  ----  --------------------
00:1E:65:b7:7d:1a   10.101.203.1     10617       dhcp-snooping   2003  Capwap5
```

```
L09-3850s-3# show mac address dynamic | inc Ca
2003      001e.65b7.7d1a      DYNAMIC      Ca5
```



ithin SPG)

```
L09-3850-1# show wireless client summary

MAC Address    AP Name                              WLAN State            Protocol
--------------------------------------------------------------------------------
001e.65b7.7d1a 3600-1                               2    UP               11n(5)


L09-3850-1# show wcdb database all
        Total Number of Wireless Clients = 1
              Foreign Clients            = 1

Mac Address    VlanId IP Address      Src If              Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
001e.65b7.7d1a 2001   10.101.203.1    0x00C55A40000000A6 RUN      FOREIGN
```

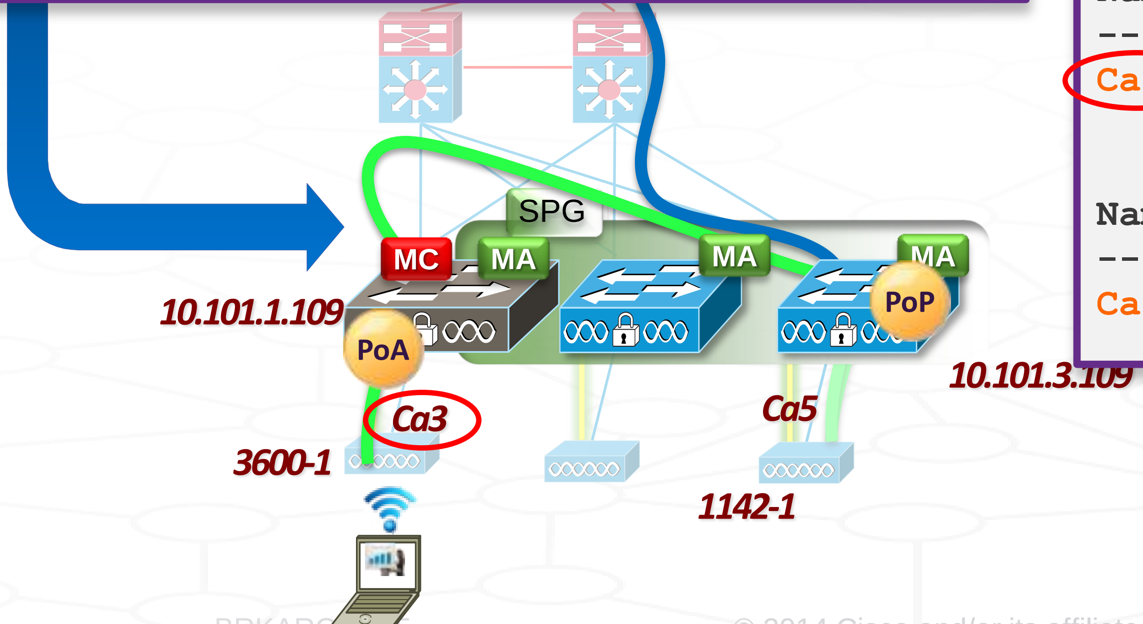


Converged Access –
Traffic Flow and Roaming – Branch, L2 / L3 Roam (within SPG)

```
L09-3850-1# show wireless client mac 001e.65b7.7d1a detail
...
Client MAC Address : 001e.65b7.7d1a
Mobility State : Foreign
Mobility Anchor IP Address : 10.101.3.109
```

```
L09-3850-1# show mac address dynamic | inc Ca
4095      001e.65b7.7d1a      DYNAMIC      Ca3
```

```
L09-3850-1# show capwap summary

Name    APName                    Type  PhyPortIf  Mode       McastIf
------  ------------------------  ----  ---------  ---------  -------
Ca3     3600-1                    data  Gi1/0/9    multicast  Ca1


Name    SrcIP          SrcPort  DestIP          DstPort  DtlsEn  MTU
-----   -------------  -------  -------------   -------  ------  -----
Ca3     10.101.1.109   5247     10.101.1.98     16370    No      1449
```



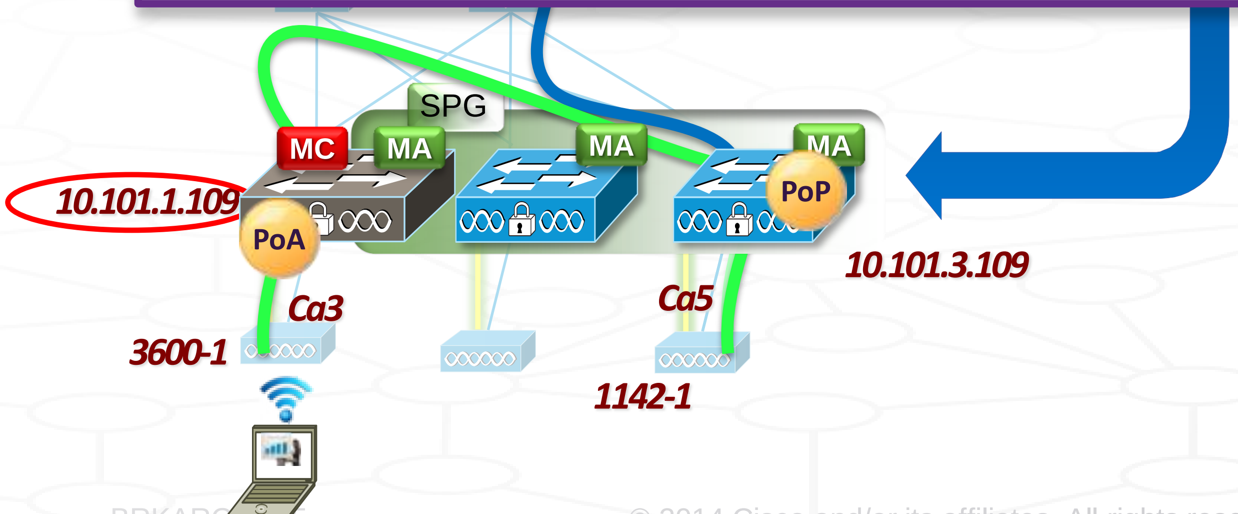
Conv

Traffic F

```
L09-3850s-3# show wireless client summary
Number of Local Clients : 1

MAC Address    AP Name                          WLAN State           Protocol
--------------------------------------------------------------------------------
001e.65b7.7d1a 10.101.1.109                      2    UP              Mobile
```

```
L09-3850s-3# show wcdb database all

Mac Address    VlanId IP Address      Src If             Auth     Mob
-------------- ------ --------------- ------------------ -------- -------
001e.65b7.7d1a  2003 10.101.203.1     0x00B72D4000000002 RUN      ANCHOR
```

```
L09-3850s-3# show wireless client mac 001e.65b7.7d1a detail
...
Client MAC Address : 001e.65b7.7d1a
Mobility State : Anchor
Mobility Foreign IP Address : 10.101.1.109
```

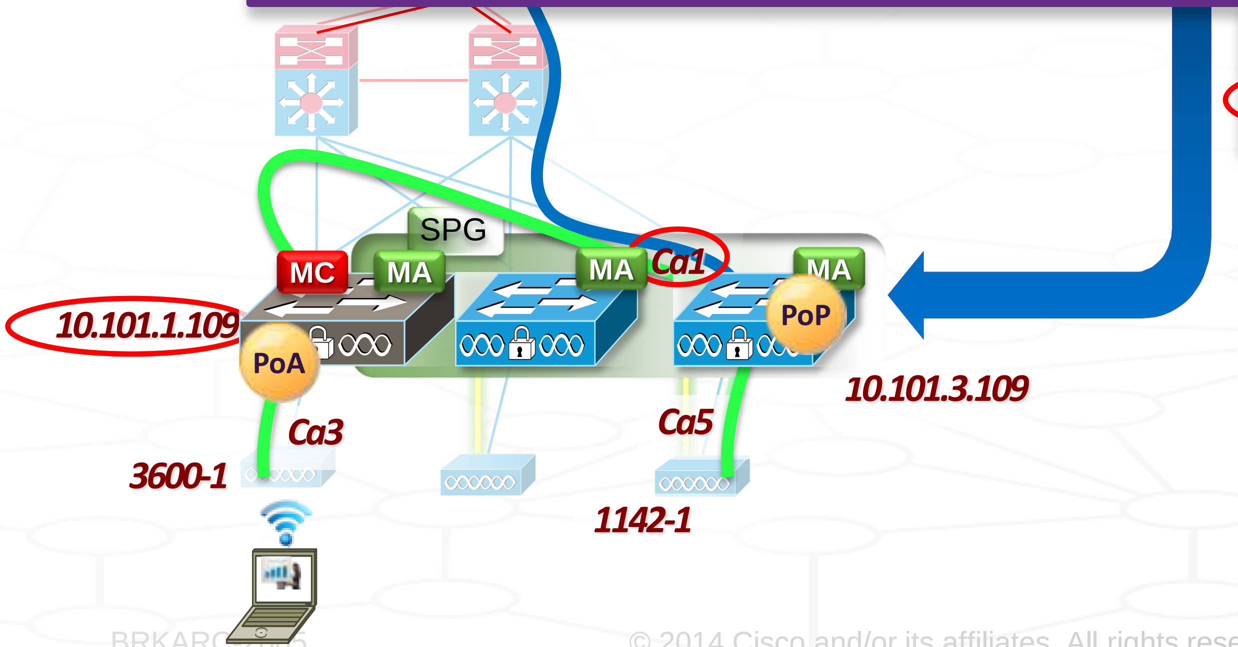


Converg
Traffic Flov

```
L09-3850s-3# show ip dhcp snooping binding
MacAddress          IpAddress        Lease(sec)  Type           VLAN  Interface
------------------  ---------------  ----------  -------------  ----  --------------------
00:1E:65:b7:7d:1a   10.101.203.1     10720       dhcp-snooping   2003  Capwap1
```

```
L09-3850s-3# show capwap summary

Name   APName                              Type PhyPortIf Mode      McastIf
------ ----------------------------------- ---- --------- --------- -------
Ca1    -                                   mob  -         unicast   -

Name   SrcIP           SrcPort DestIP          DstPort DtlsEn MTU
------ --------------- ------- --------------- ------- ------ -----
Ca1    10.101.3.109    16667   10.101.1.109    16667   No     1464
```

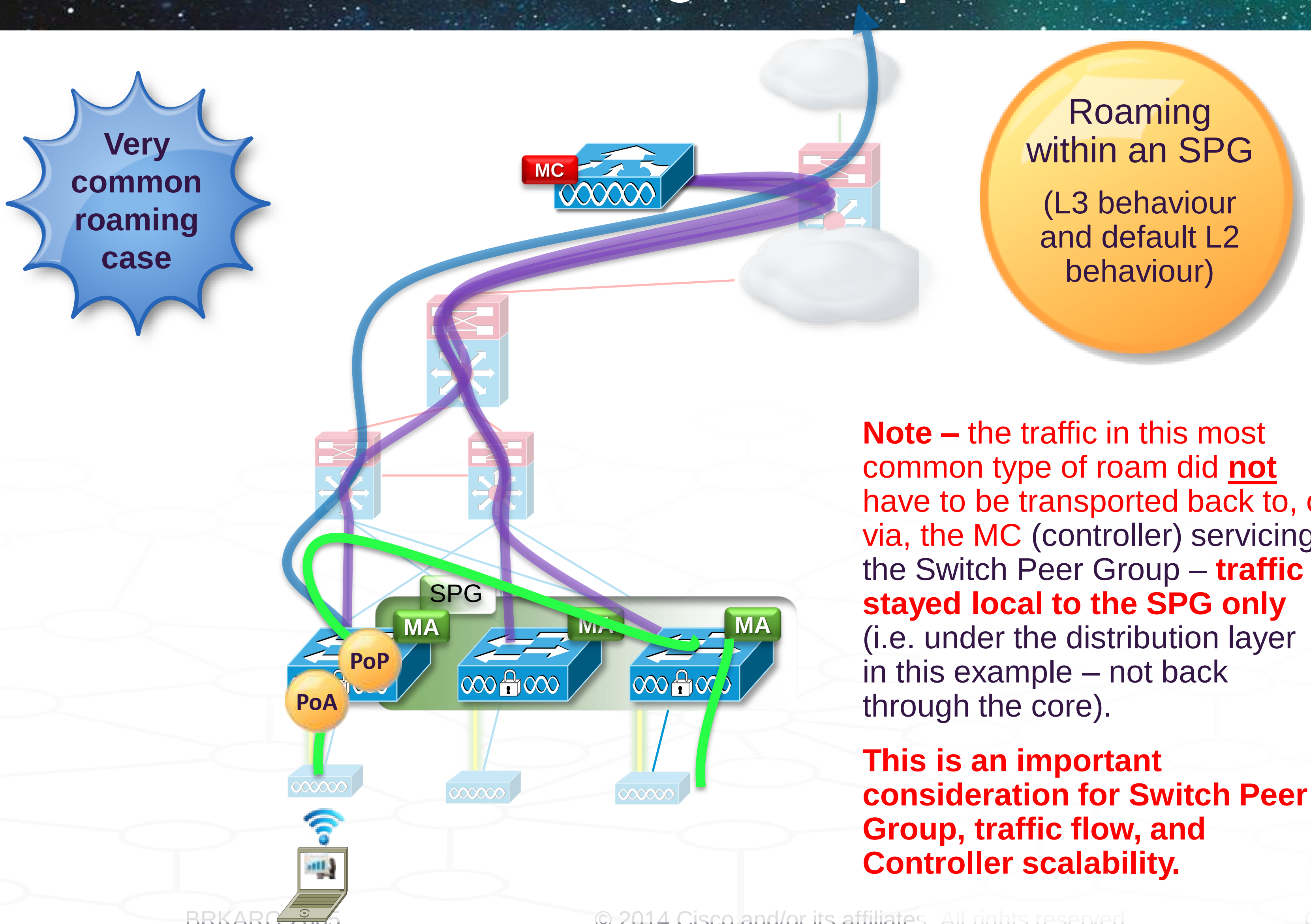
```
L09-3850s-3# show mac address dynamic | inc Ca
2003     001e.65b7.7d1a     DYNAMIC     Ca1
```



Overall observation –

This looks exactly the same as a Layer 3 inter-controller roam in CUWN …
because it is exactly the same process – Just distributed, rather than centralized …

Converged Access –
Traffic Flow and Roaming – Campus, L2 / L3 Roam (within SPG)



Note – the traffic in this most common type of roam did **not** have to be transported back to, or via, the MC (controller) servicing the Switch Peer Group – **traffic stayed local to the SPG only** (i.e. under the distribution layer in this example – not back through the core).

This is an important consideration for Switch Peer Group, traffic flow, and Controller scalability.

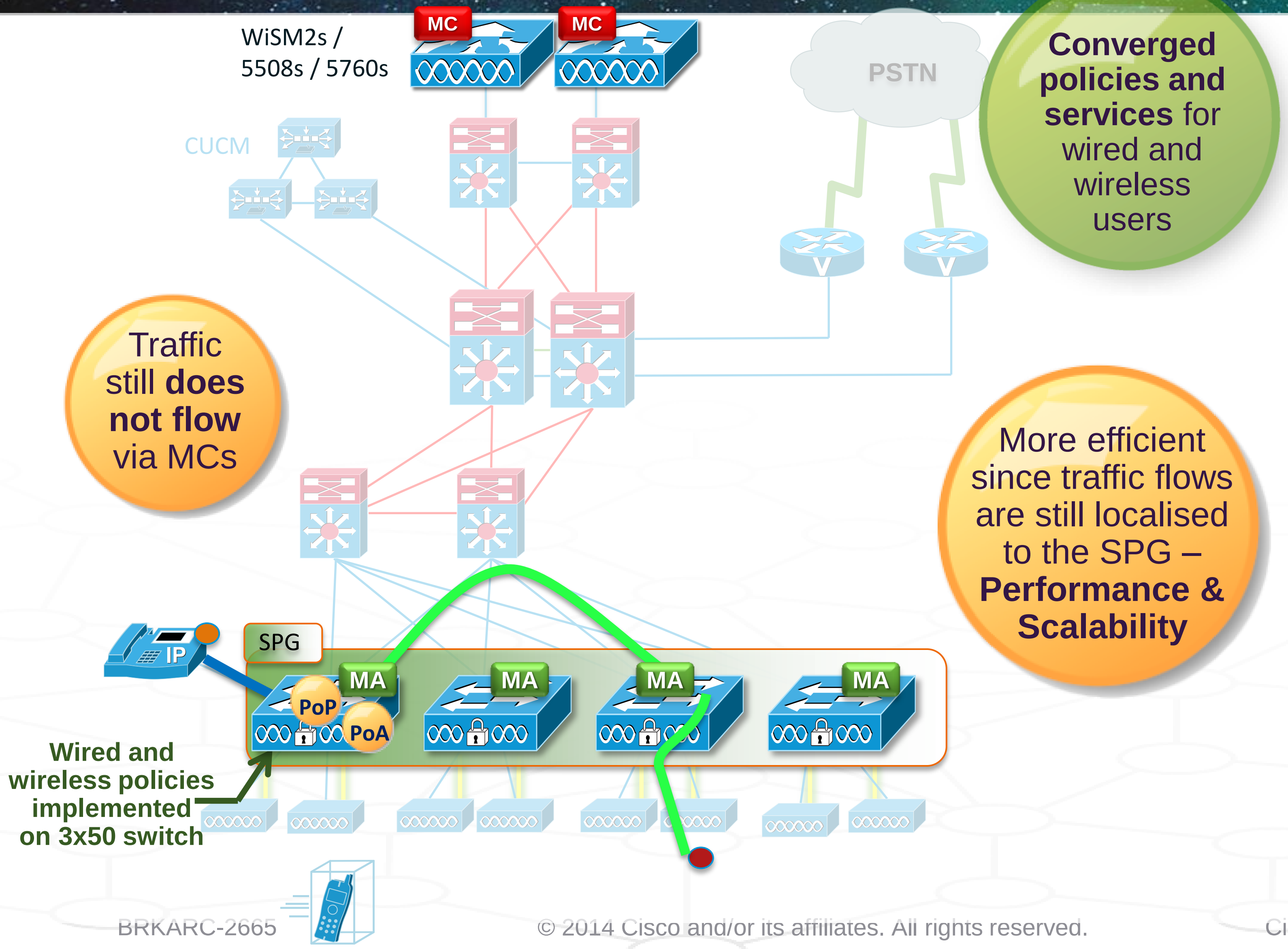
Roaming, Within an SPG (Campus) –

- Now, let's examine a few more types of user roams
- **In this example, the user roams within their Switch Peer Group –** since SPGs are typically formed around floors or other geographically-close areas, **this is the most likely and most common type of roam**

  The user may or may not have roamed across an L3 boundary (depends on wired setup) – **however, users are always* taken back to their PoP** for policy application

Cisco live!

Converged Access –
Traffic Flow – with Intra-SPG Roam

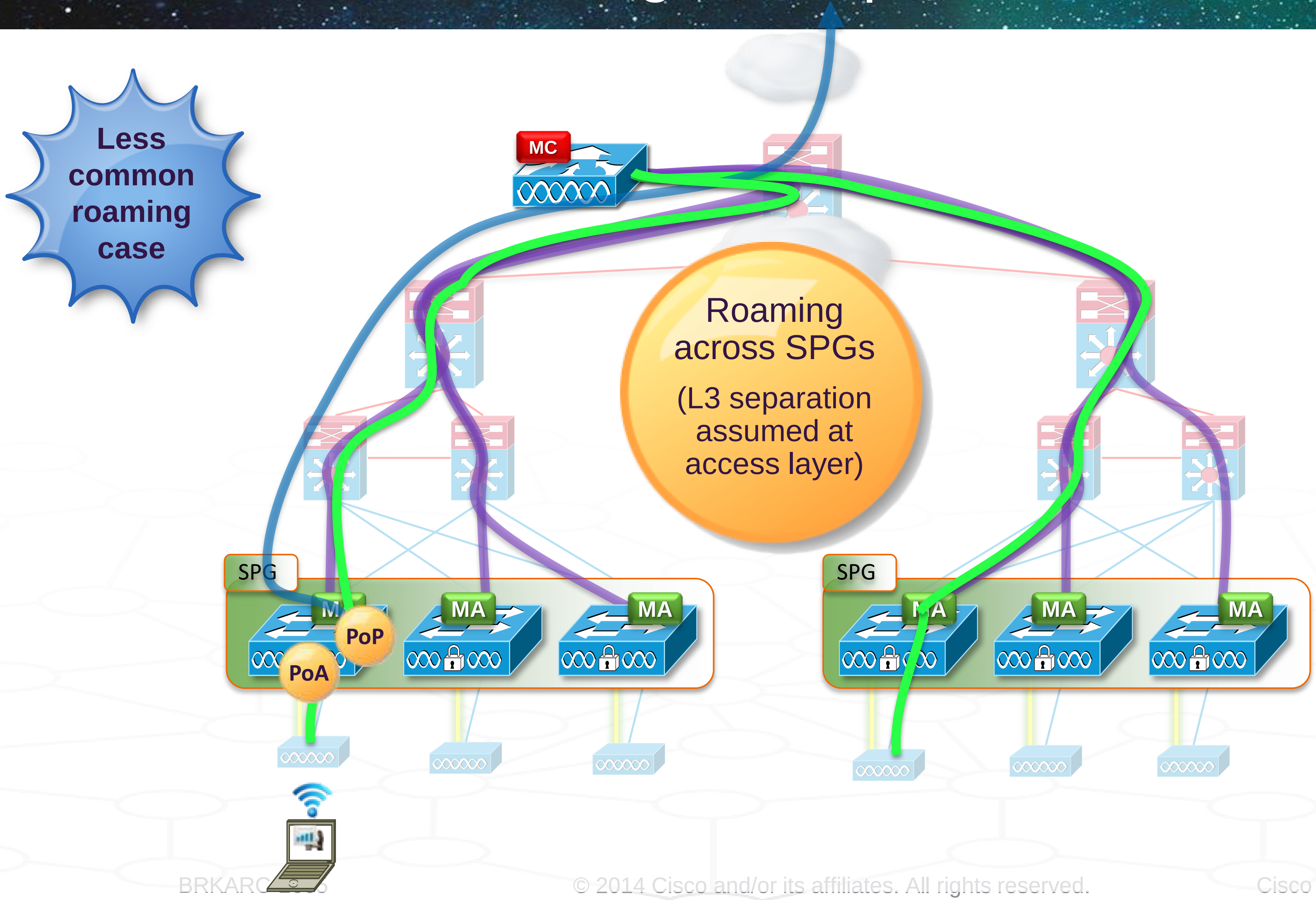


Traffic Flows, Comparison (Converged Access) –

- Now, our VoIP user on the Cisco Converged Access network roams, while a call is in progress between the wireless and wired handsets …
- **We can see that all of the user's traffic is still localised to their Switch Peer Group, below the distribution layer,** in both directions …

In this example, a total of **3 hops** is incurred for each direction of the traffic path (assuming intra-SPG roaming) … two additional hops may be incurred for routing …

Converged Access –
Traffic Flow and Roaming – Campus, L2 / L3 Roam (across SPGs)

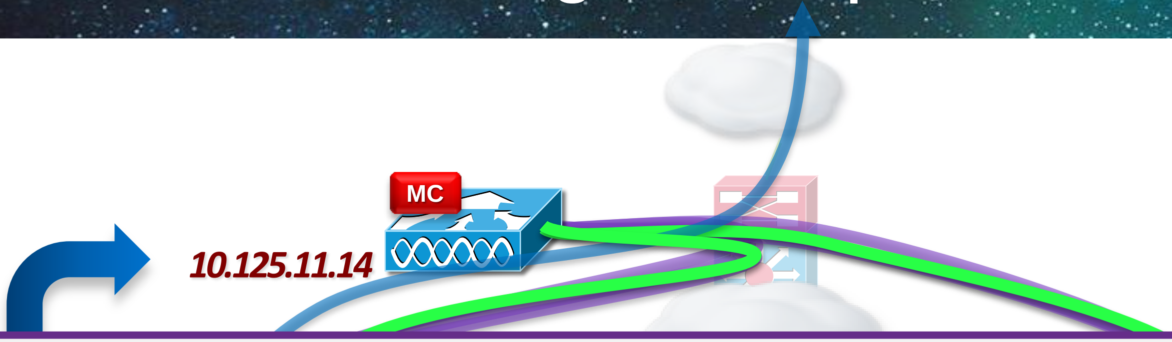


Roaming, Across SPGs (Campus) –

- Now, let's examine a few more types of user roams
- **In this example, the user roams across Switch Peer Groups –** since SPGs are typically formed around floors or other geographically-close areas, **this type of roam is possible, but less likely than roaming within an SPG**

  Typically, this type of roam will take place across an L3 boundary (depends on wired setup) – **however, users are always* taken back to their PoP** for policy application

Converged Access –
Traffic Flow and Roaming – Campus, L2 / L3 Roam (across SPGs)



Overall view – across the entire Sub-Domain controlled by the MC

```
L09-5760-1# show wireless mobility controller client summary
Number of Clients : 5

State is the Sub-Domain state of the client.
* indicates IP of the associated Sub-domain
Associated Time in hours:minutes:seconds

MAC Address     State       Anchor IP          Associated IP    Associated Time
-------------------------------------------------------------------------------
001e.65b7.7d1a  Local       10.101.1.109       10.101.6.109     00:04:36
b817.c2f0.61b2  Local       0.0.0.0            10.101.7.109     00:21:07
74e1.b65a.a8f3  Local       10.101.3.109       10.101.1.109     00:03:27
cc08.e028.6fdd  Local       0.0.0.0            10.101.1.109     00:04:57
a467.06e2.813d  Local       0.0.0.0            10.101.3.109     00:02:56
```

- Roamed client, Switch 1 to Switch 6 (inter-SPG)
- Stationary client, Switch 7
- Roamed client, Switch 3 to Switch 1 (intra-SPG)
- Stationary client, Switch 1
- Stationary client, Switch 3

Converged Access –
Traffic Flow and Roaming – L2 Roam (adjustable via setting)

```
L09-5760-1# show wireless mobility controller client summary

MAC Address      State        Anchor IP          Associated IP
---------------------------------------------------------------
001e.65b7.7d1a  Local         0.0.0.0            10.101.1.109
```

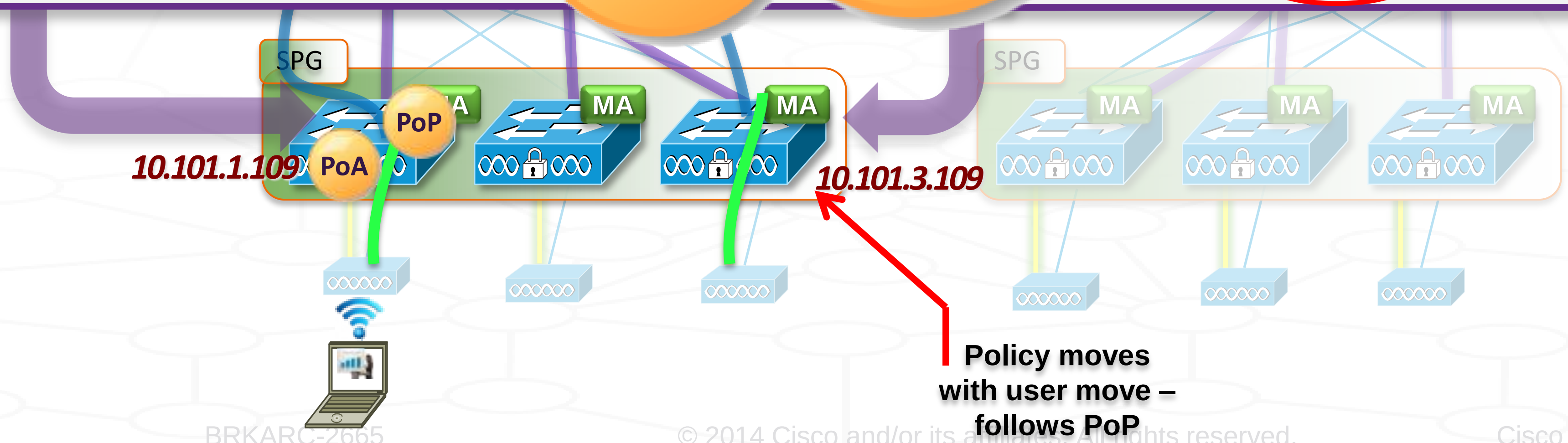
```
wlan UA-D3 4 UA-D3
 client vlan 3000
 no mobility anchor sticky
 security dot1x authenticat
 session-timeout 86400
 no shutdown
```

```
...0-1# show wireless mobility controller client summary

...ress      State        Anchor IP          Associated IP
---------------------------------------------------------------
...65b7.7d1a  Local        0.0.0.0            10.101.3.109
```

Move of th... user's enti... Mobility Context

Roaming across network

(L2 extension below distribution layer in this example)



Policy moves with user move – follows PoP

Roaming, Within an SPG (Layer 2) –

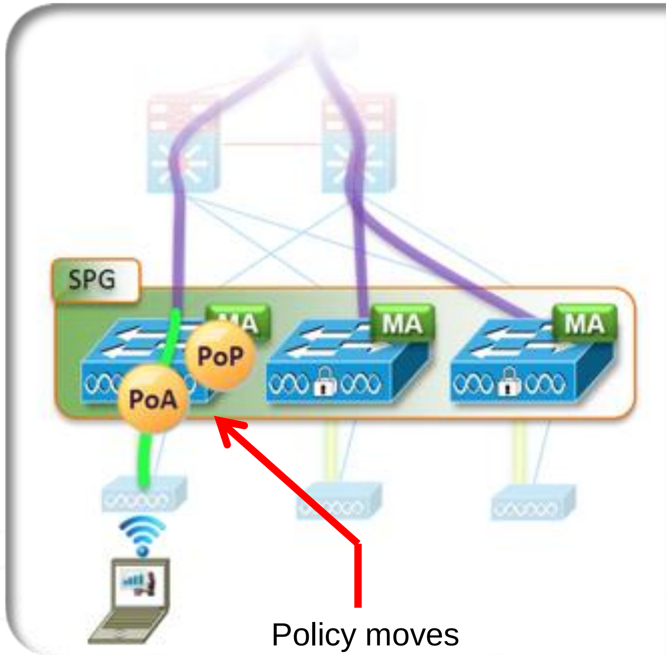
- Now, let's examine a few more types of user roams
- **In this example, the user roams within a Switch Peer Group …**

This type of L2 VLAN extension below the distribution layer may or may not be present in a given Enterprise network deployment – however, if this setup is present, an available setting allows for L2 roaming (move of both PoP and PoA)

Converged Access –
Traffic Flow and Roaming – L2 Roam (impact of policy moves)

As Noted –

- **When a user roams in a L2 environment, an optional setting allows for both the user's PoA and PoP to move**.
- The benefits that accrue to a PoP move for an L2 user roam are **reduced end-to-end latency** for the user (less traffic hops), as well as a **reduction of state held within the network** (as the user needs to be kept track of only at the roamed-to switch).
- The drawback to a PoP move for an L2 user roam are likely **increased roam times**, as user policy may be retrieved from the AAA server, and applied at the roamed-to switch. The combination of these two elements may introduce a level of non-deterministic behaviour into the roam times if this option is used.
- **Default Behaviour –**
  - **L2 Roams Disabled** – by default, all roams (whether across an L3 boundary or not) carry the user's traffic from their roamed-to switch (where the user's PoA has moved to), back to the original switch the user associated through (where the user's PoP remains). In this case, **the user's policy application point remains fixed**, and roam times are more **deterministic**.
  - However, if desired, **this behaviour can be modified via a setting to allow for an L2 roam** – assuming the network topology involved allows for the appropriate Layer 2 extension across the network.

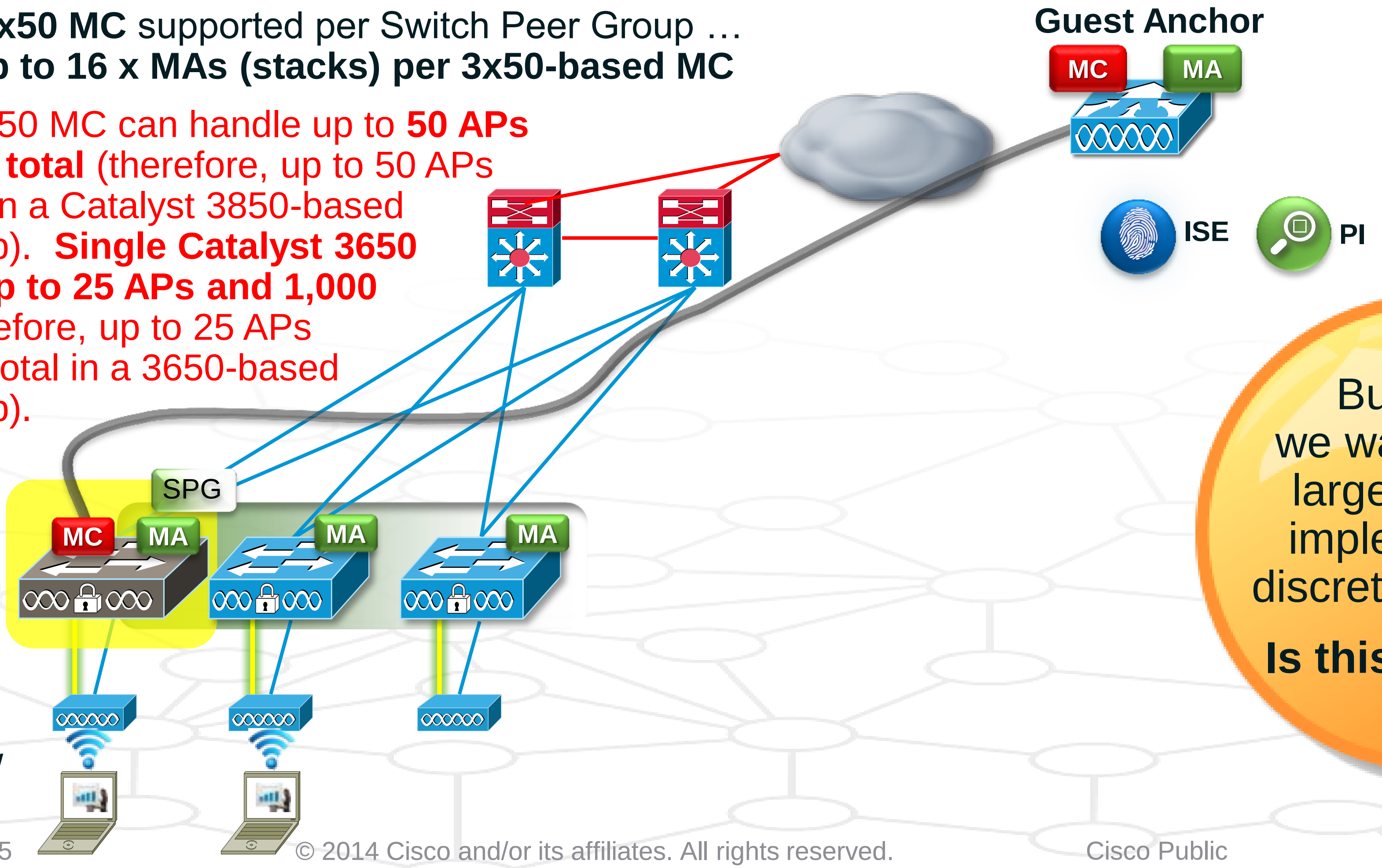


Policy moves with user move – follows PoP

Converged Access –
Catalyst 3x50-based MCs – Functionality

As we saw previously, we can also optionally use a Catalyst 3x50 switch as an MC + co-located MA for a Switch Peer Group … let's explore this in more detail –

- **Single Catalyst 3x50 MC** supported per Switch Peer Group …
- which can have **up to 16 x MAs (stacks) per 3x50-based MC**
- Single Catalyst 3850 MC can handle up to **50 APs and 2,000 clients total** (therefore, up to 50 APs and 2,000 clients in a Catalyst 3850-based Switch Peer Group). **Single Catalyst 3650 MC can handle up to 25 APs and 1,000 clients total** (therefore, up to 25 APs and 1,000 clients total in a 3650-based Switch Peer Group).
- MC handles inter-SPG roaming, RRM, Guest Access, etc.
- More scalable MC capability can be provided by 5760 / 5508 / WiSM2



But what if we want to scale larger, **without** implementing a discrete controller?

Is this possible?

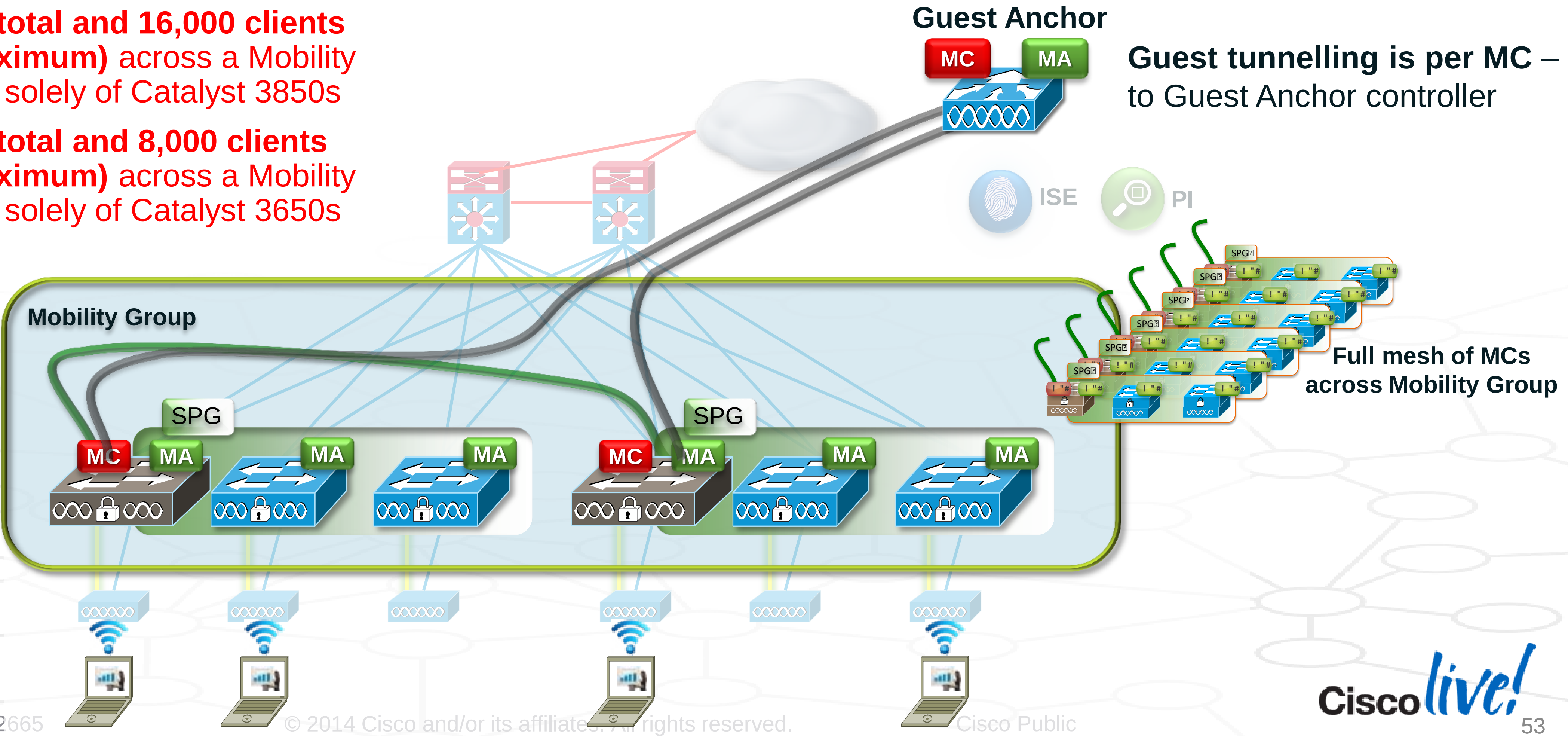
Converged Access –
Catalyst 3x50-based MCs – Scaling

Switch Peer Group / Mobility Group Scaling with Catalyst 3x50 –

- **Up to 8 x Catalyst 3x50 MCs** can be formed into a Mobility Group
- **Up to 250 APs total and 16,000 clients supported (maximum)** across a Mobility Group made up solely of Catalyst 3850s
- **Up to 200 APs total and 8,000 clients supported (maximum)** across a Mobility Group made up solely of Catalyst 3650s

Licensing is per MC not pooled across MCs

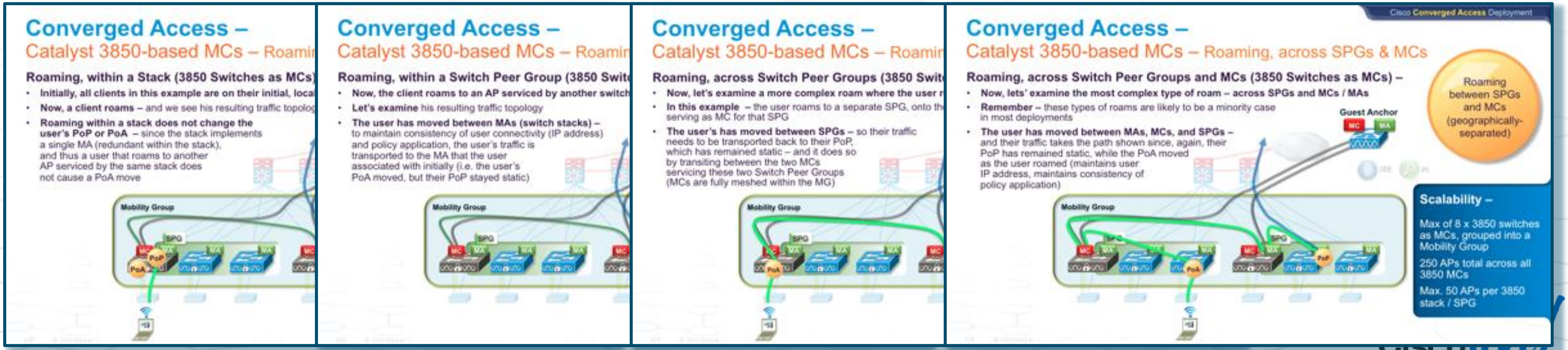
RRM, etc. is coordinated across the MCs in the same Mobility Group



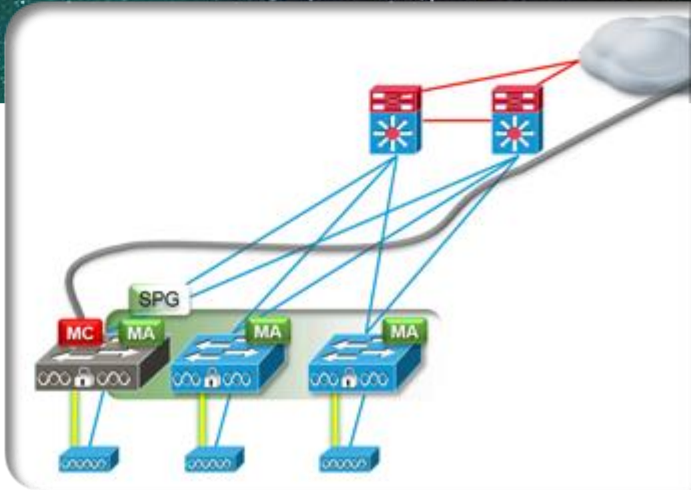
Converged Access –
Catalyst 3x50-based MCs – Roaming

There are multiple roaming scenarios with Catalyst 3x50-based MCs –

- **These replicate the traffic flow expectations seen elsewhere with Converged Access**
- **Traffic within an SPG flows directly between MAs – traffic between SPGs flows via MCs**
  - **Which, in this case,** are Catalyst 3x50 switches operating as MCs
  - **Catalyst 3x50-based MC deployments are likely to be common in branches and even possibly smaller Campuses**
  - **Larger deployments are likely to use discrete controllers** (5760, 5508, WiSM2s) as MCs, for **scalability and simplicity**
  - **Rather than detail every roaming case here, these are summarised below – Full details are given in the Reference section at the end of this slide deck …**



Converged Access –
Catalyst 3x50-based MCs – When to Use



Considerations –

- **Many larger designs (such as most Campuses) will likely utilise a discrete controller, or group of controllers, as MCs.** Combined with Catalyst 3x50 switches as MAs, this likely provides the most scalable design option for a larger network build.
- **However, if using 3x50 switches as MCs for smaller builds – and with the scaling limits detailed previously in mind – we can determine where to best use this ….**
- **Pros –**
  - **CapEx cost savings** – via the elimination of a discrete-controller-as-MC in some designs (typically, smaller use cases and deployments) … cost also needs to take into consideration licensing on the Catalyst 3x50 switches.
- **Cons –**
  - **OpEx complexity** – due to some additional complexity that comes into roaming situations when using multiple 3x50 switch-based MCs (as detailed in the preceding slide). While not insurmountable, this does need to be factored in as part of the decision process.

Roaming details provided on Reference slides

Conclusion –

In smaller designs (such as branches), the use of Catalyst 3x50 switches as MCs is likely workable.
In mid-sized designs, this may also be workable, but does lead to some additional roaming considerations (as detailed on the following slides). In large campus deployments, the use of controllers as MCs is more likely, due to economies of scale.

Cisco live!

Converged Access –
Additional Areas of Interest – Reference Material

Additional topics exist, which time precludes us covering here …

However, these are detailed in the Reference Slides which accompany this presentation …

Scalability Details – for both CUWN and Converged Access deployments

Catalyst 3x50-based MCs – Examination of Roaming details, and additional design options

Lobby Issue and Solution – Examination of issues with Building entrances / common lobbies, and their impact on client distribution, DHCP scope usage, etc. in Converged Access deployments

Please refer to these slides for additional information on these topics, and feel free to reach out to the presenter with any questions that you may have.

Agenda – BRKARC-2665

Evolution … Towards One Policy, One Management, One Network

Converged Access – Platform Overviews

Existing Wireless Deployments – Architecture Refresher

Converged Access Architecture –

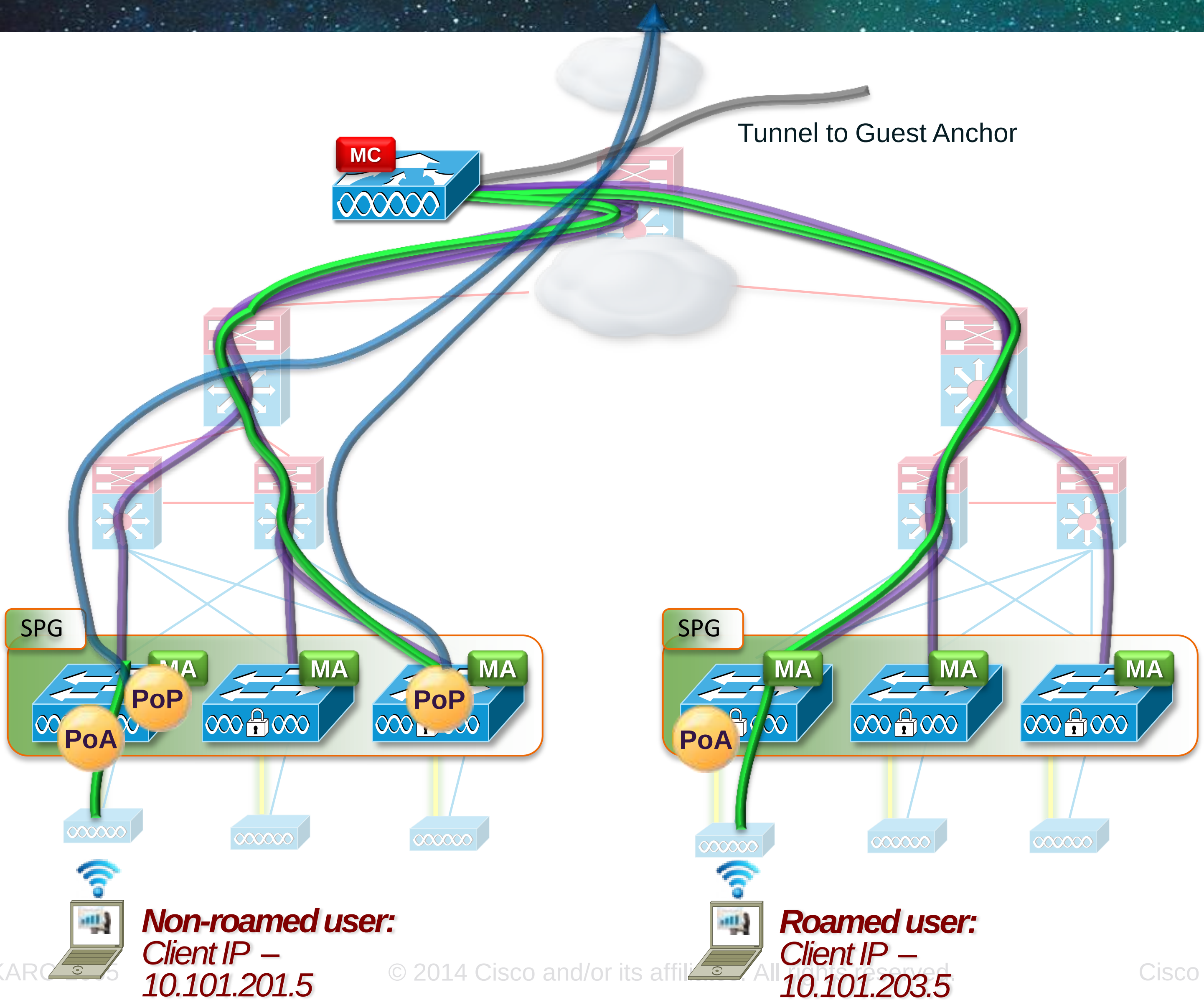
- Terminology and Building Blocks
- Traffic Flows and Roaming
- ► High Availability
- Quality of Service
- Security
- Multicast
- NetFlow

Converged Access Design and Deployment –

- IP Addressing
- Design Options
- Deployment Examples

Summary

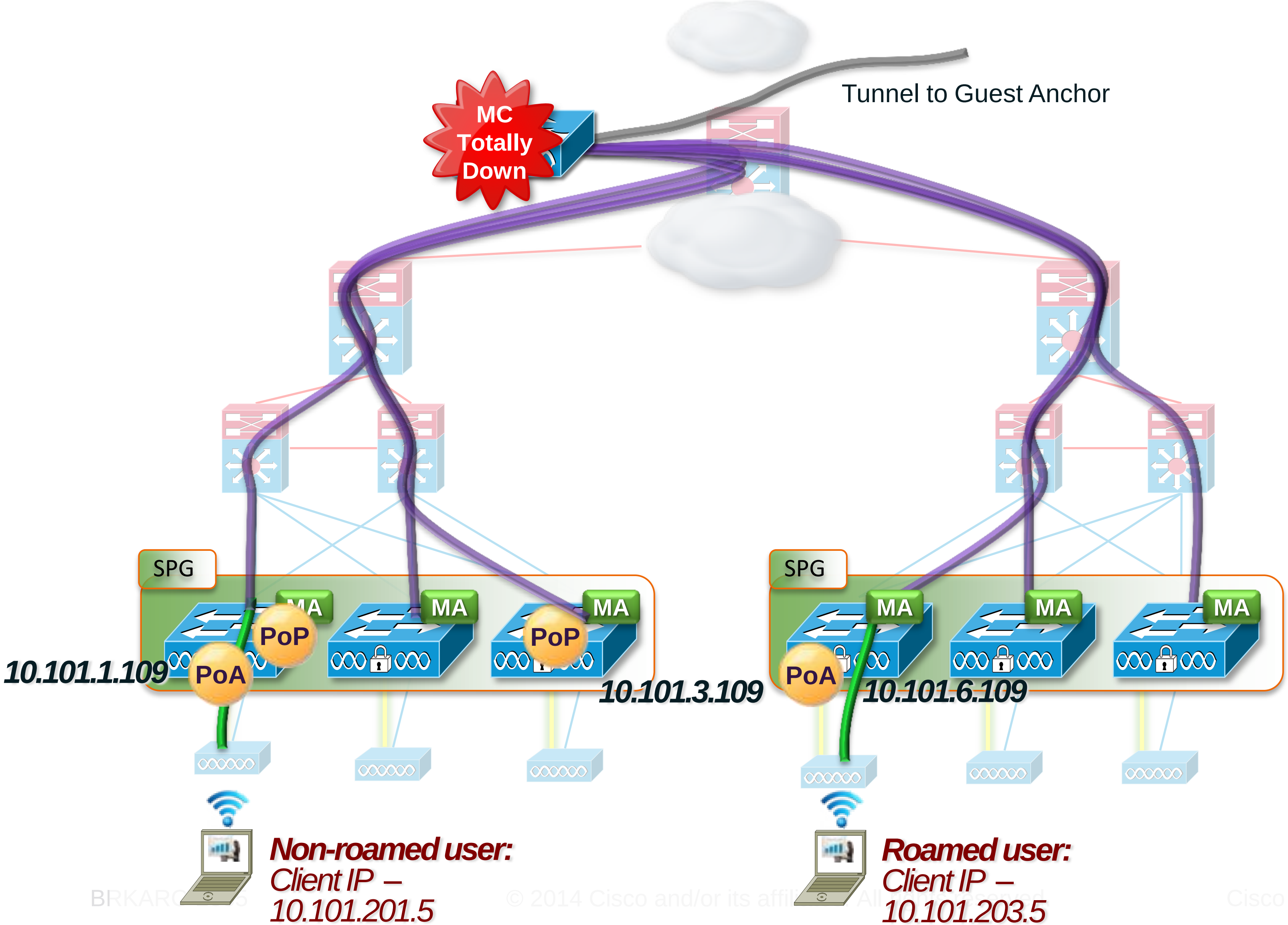
High Availability –
State Held within the Network – for Local and Roamed Users



Roamed and Local users, High Availability Considerations –

- State for users is held within the network (on MAs and MCs) – in this case, we are using a discrete controller (5760, 5508, or WiSM2) as an MC
- **In this example as shown,** we have two users – one local (non-roaming), and the other roamed across SPGs (same MC) …
- **Note that in this case, the roamed user's client IP address is associated with the IP address pool on the right-hand switch in the left-side SPG** (where the user originally associated) …

High Availability –
MC Failure – and the Effect on the MC's Sub-Domain and Anchor Connections



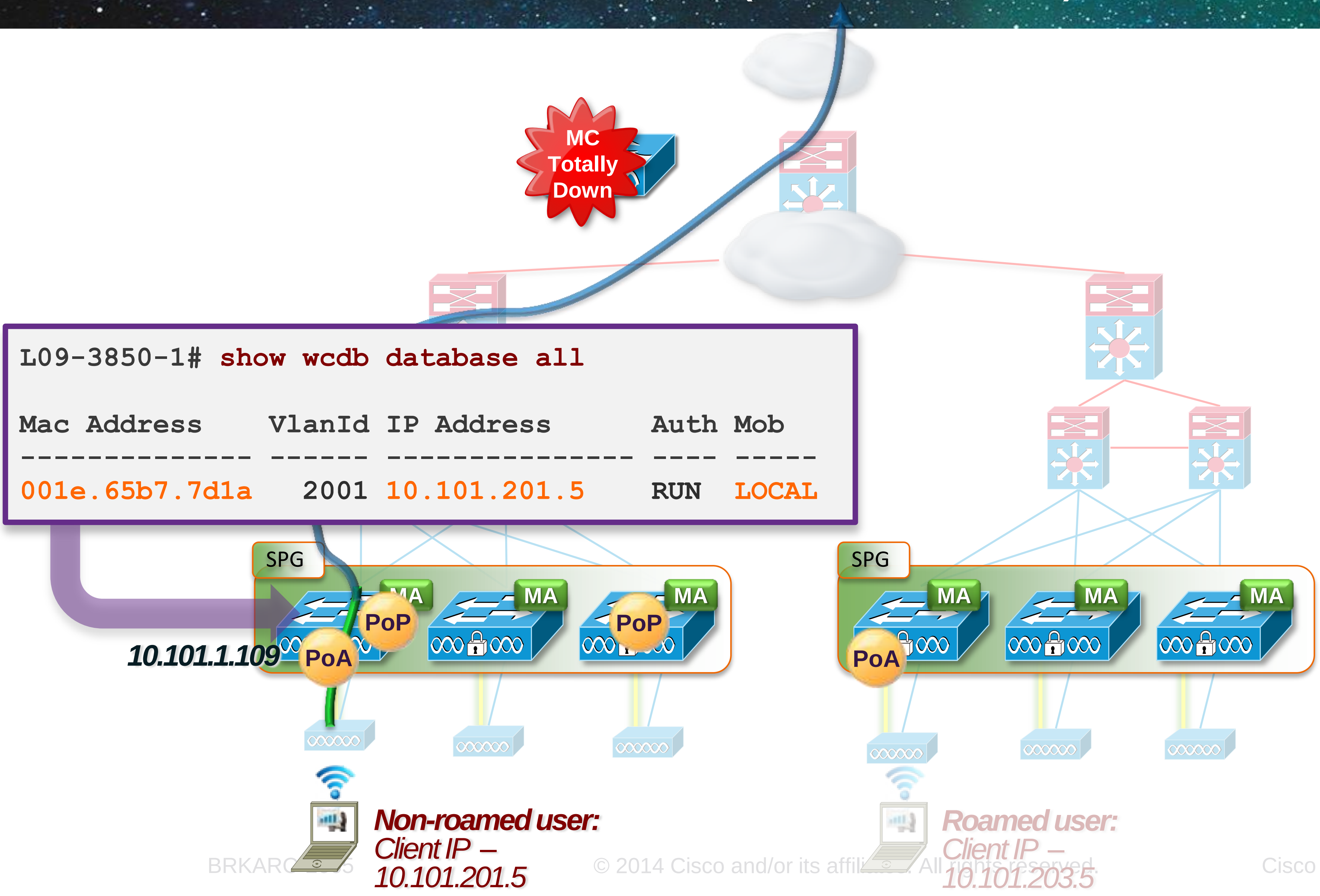
Roamed and Local users, High Availability Considerations –

- **Now, the MC fails (power down in this case)** … let's examine the effects …
- **When the MC for a given Sub-Domain goes down, all of the tunnels serviced by that MC go down** – this includes all MA-MC tunnels (purple tunnels as shown on this diagram), as well as any MC-Guest Anchor tunnel (if present – grey tunnel as shown on this diagram)

Note that all of the tunnel connections between switches within the SPGs themselves stay up – as these are pre-formed at SPG creation, and once up, do not depend on the MC to stay up …

High Availability –

MC Failure – Effect on Local (Non-Roamed) Clients



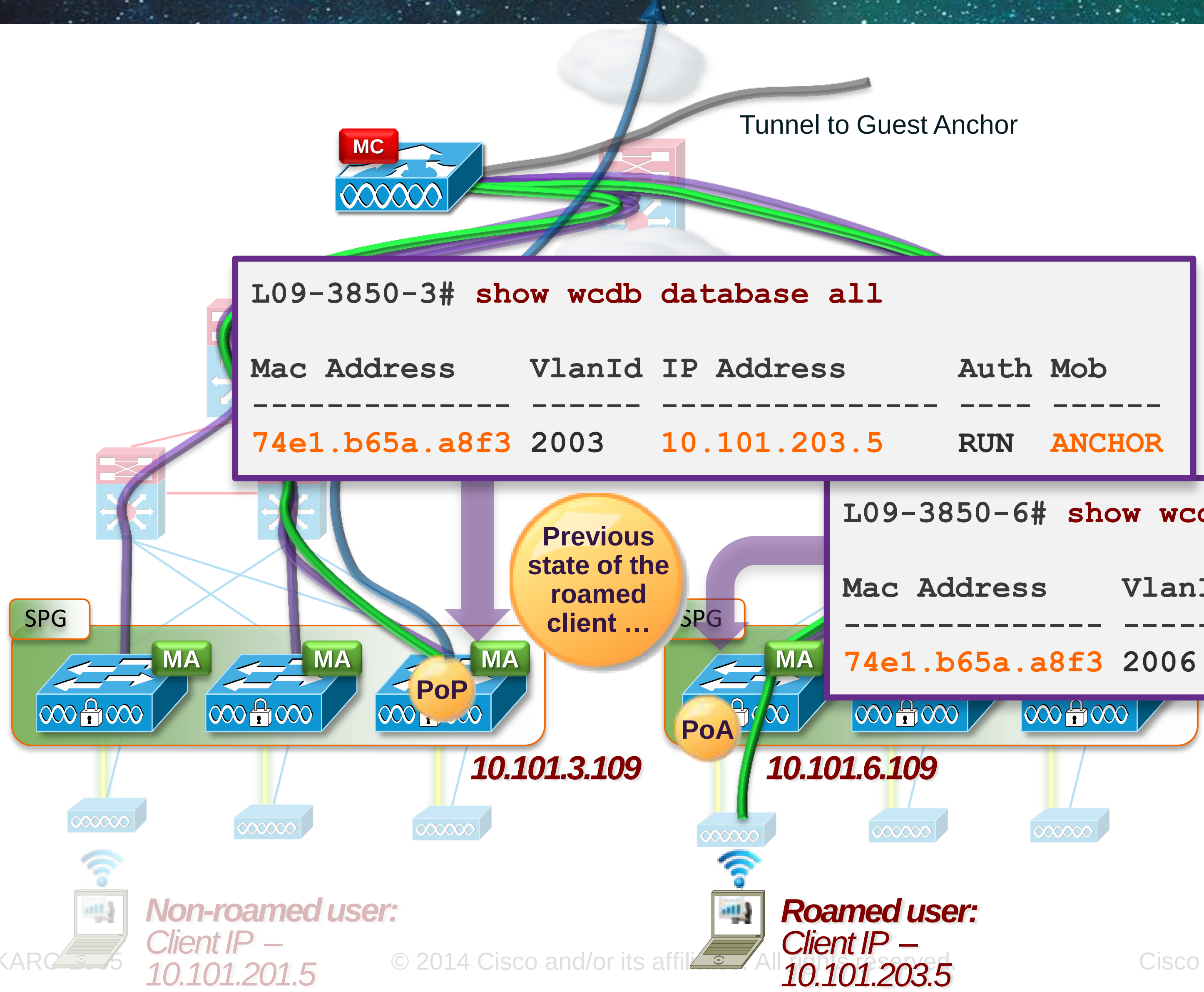

```
L09-3850-1# show wcdb database all

Mac Address      VlanId IP Address       Auth Mob
-------------- ------ --------------- ---- -----
001e.65b7.7d1a   2001 10.101.201.5     RUN  LOCAL
```

Roamed and Local users, High Availability Considerations –

- **For a local (non-roamed) user, the effect of an MC failure is not that severe …**
- **The local user still continues to operate,** as their traffic flow is terminated locally at their MA switch …
- **However, the user may be missing some services (Guest Access, RRM, Fast Roaming, etc) for the duration of the MC failure …** as these functions depend on the MC servicing the SPG(s) …

… and as well, **inter-SPG roaming will be affected**, as shown on the following slides …

High Availability –
MC Failure – Effect on Previously-Roamed Clients




```
L09-3850-3# show wcdb database all

Mac Address    VlanId IP Address      Auth Mob
-------------- ------ --------------- ---- ------
74e1.b65a.a8f3 2003   10.101.203.5    RUN  ANCHOR
```

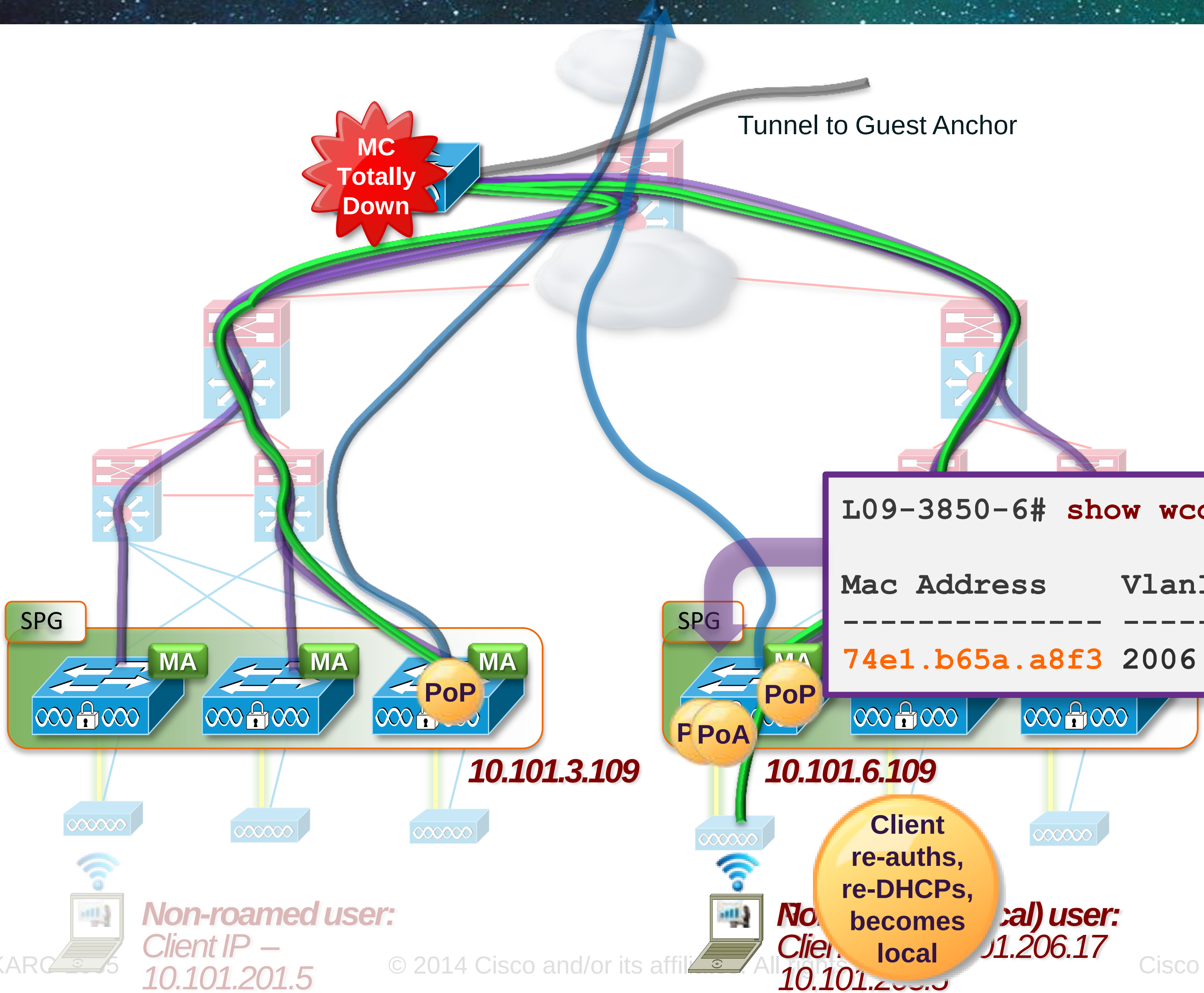
```
L09-3850-6# show wcdb database all

Mac Address    VlanId IP Address           Auth Mob
-------------- ------ -------------------- ---- -------
74e1.b65a.a8f3 2006   10.101.203.5         RUN  FOREIGN
```

Roamed and Local users, High Availability Considerations –

- **Here is a client who has roamed** from the 10.101.3.109 switch, to the 10.101.6.109 switch, as shown …

High Availability –

MC Failure – Effect on Previously-Roamed Clients



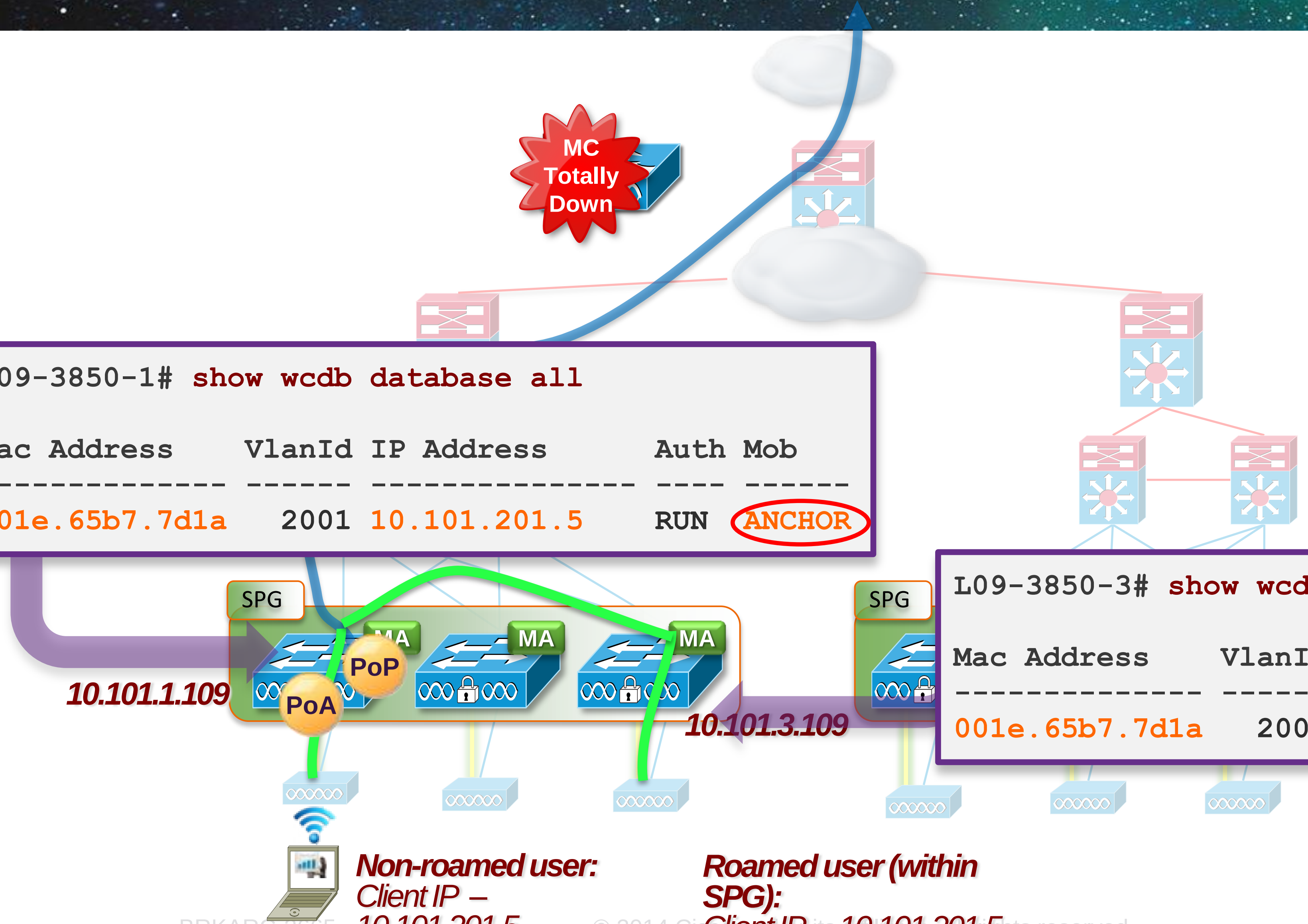

```
L09-3850-6# show wcdb database all

Mac Address    VlanId IP Address           Auth Mob
-------------- ------ -------------------- -------
74e1.b65a.a8f3 2006   10.101.206.17        RUN  LOCAL
```

Roamed and Local users, High Availability Considerations –

- For a previously-roamed client, the loss of the MC also results in the roamed client "becoming local" on their roamed-to switch, as shown …

Cisco live!

High Availability –
MC Failure – Effect on Intra-SPG Client Roams after MC Down




```
L09-3850-1# show wcdb database all

Mac Address      VlanId IP Address       Auth Mob
--------------   ------ ---------------- ---- ------
001e.65b7.7d1a     2001 10.101.201.5     RUN  ANCHOR
```

```
L09-3850-3# show wcdb database all

Mac Address      VlanId IP Address       Auth Mob
--------------   ------ ---------------- ---- -------
001e.65b7.7d1a     2003 10.101.201.5     RUN  FOREIGN
```

Non-roamed user:
Client IP – 10.101.201.5

Roamed user (within SPG):
Client IP – 10.101.201.5

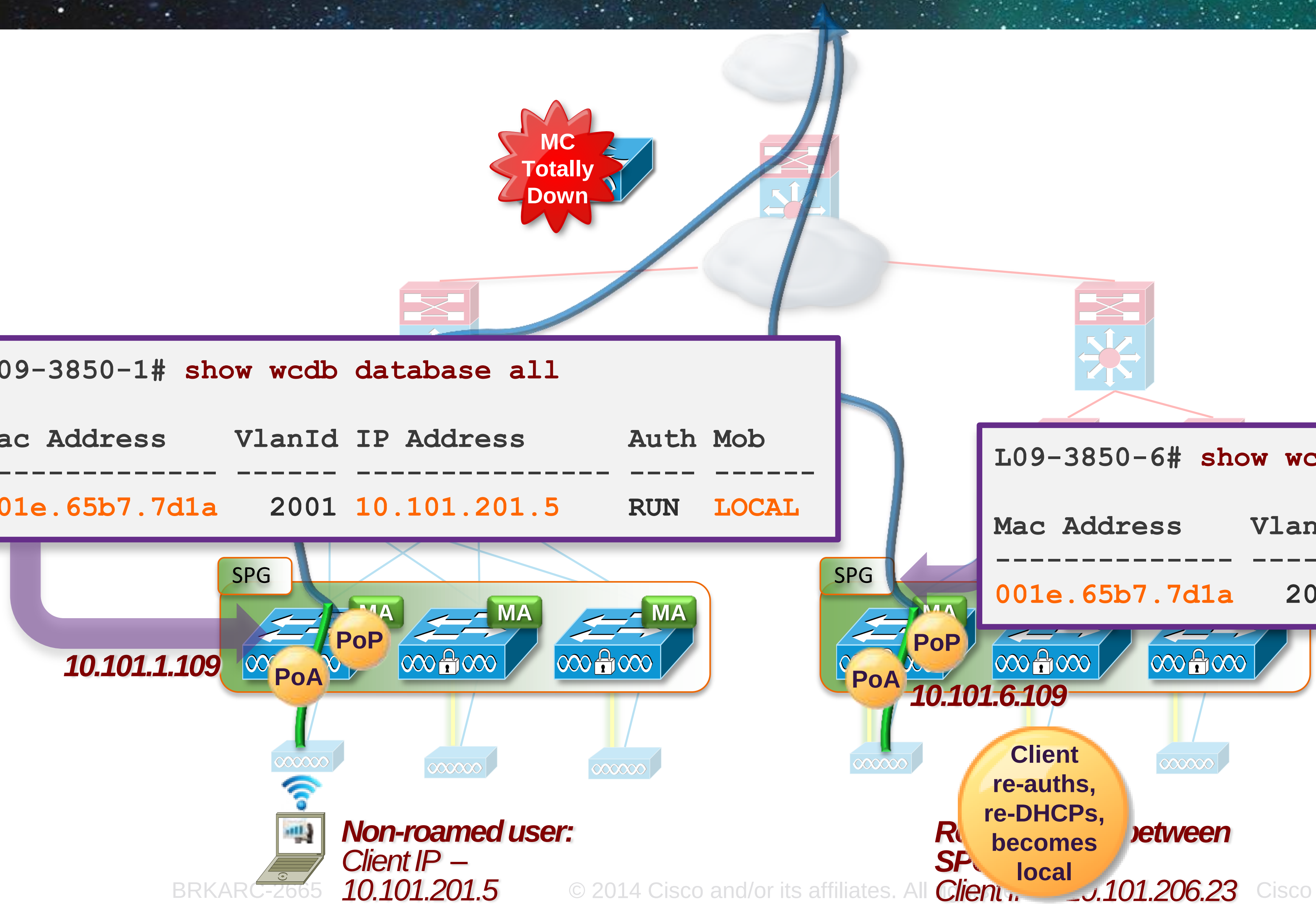
Roamed and Local users, High Availability Considerations –

- **Roaming <u>within</u> the SPG still works, even with the MC down …** since all of the connection between the MA switches within the same SPG are pre-built at SPG formation, and traffic flows between switches in the same SPG do not depend on the MC …

…ts
…er
PMKs for new clients
throughout the SPG …

High Availability –

MC Failure – Effect on Inter-SPG Client Roams after MC Down




```
L09-3850-1# show wcdb database all

Mac Address     VlanId IP Address      Auth Mob
-------------- ------ --------------- ---- ------
001e.65b7.7d1a    2001 10.101.201.5    RUN  LOCAL
```

```
L09-3850-6# show wcdb database all

Mac Address     VlanId IP Address      Auth Mob
-------------- ------ --------------- ---- ------
001e.65b7.7d1a    2006 10.101.206.23   RUN  LOCAL
```

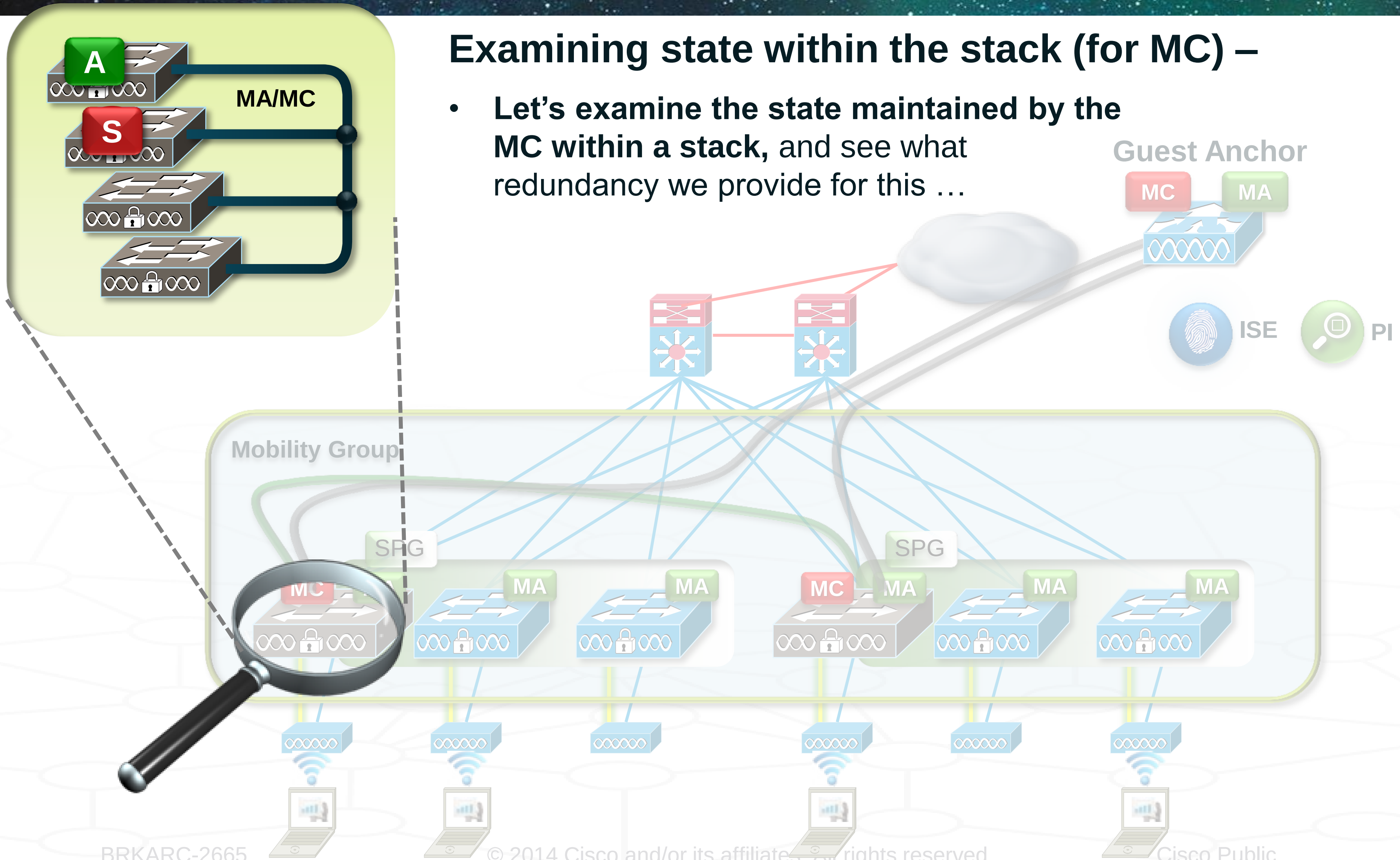
Roamed and Local users, High Availability Considerations –

- **Roaming <u>between</u> SPGs will result in a "hard roam" (re-auth, re-DHCP, change of client IP address, known as "becoming local") with the MC down …** since connection between the

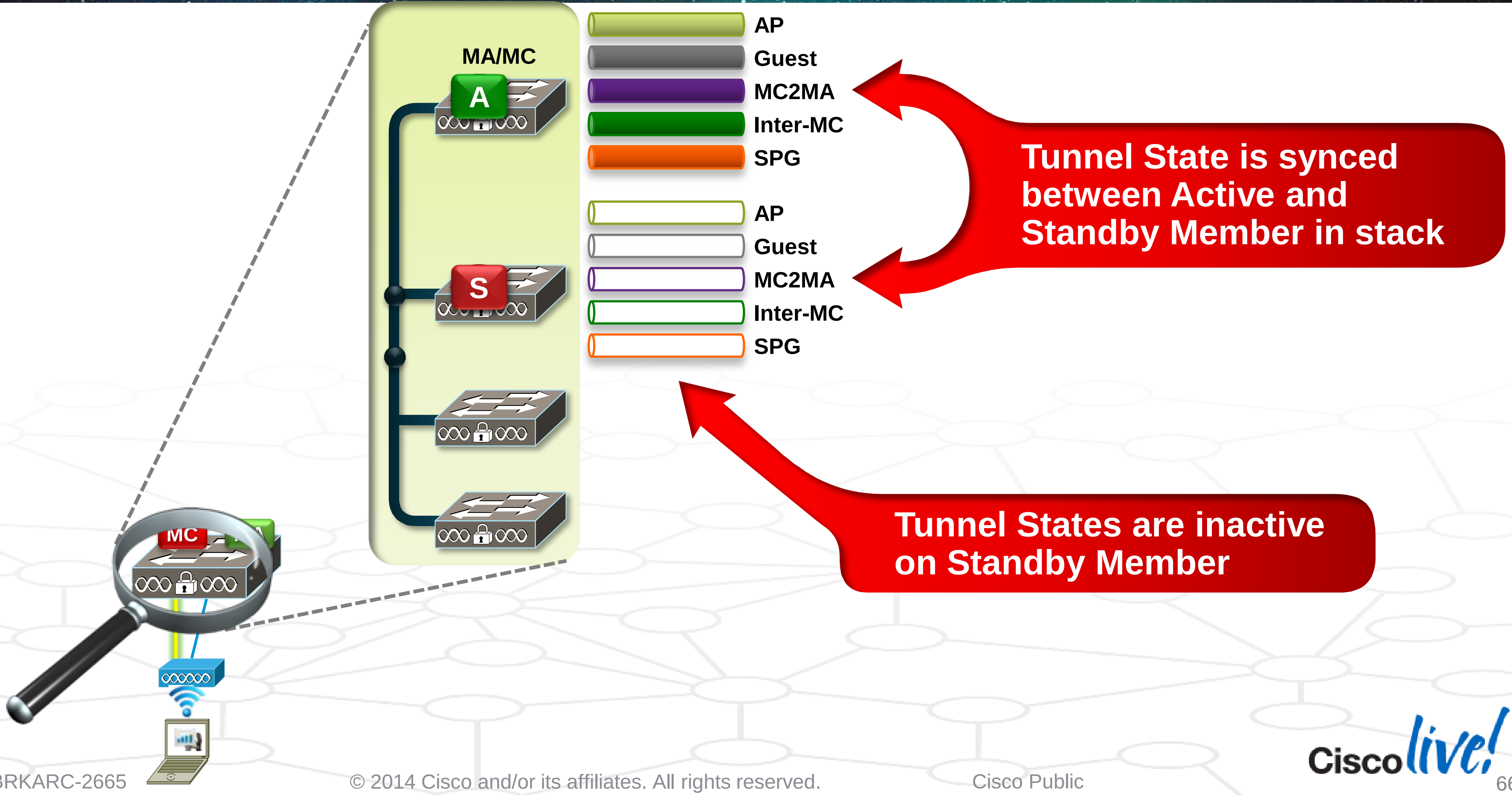
High Availability –
Catalyst 3x50-based MCs – Fault Tolerance in Stack

Examining state within the stack (for MC) –

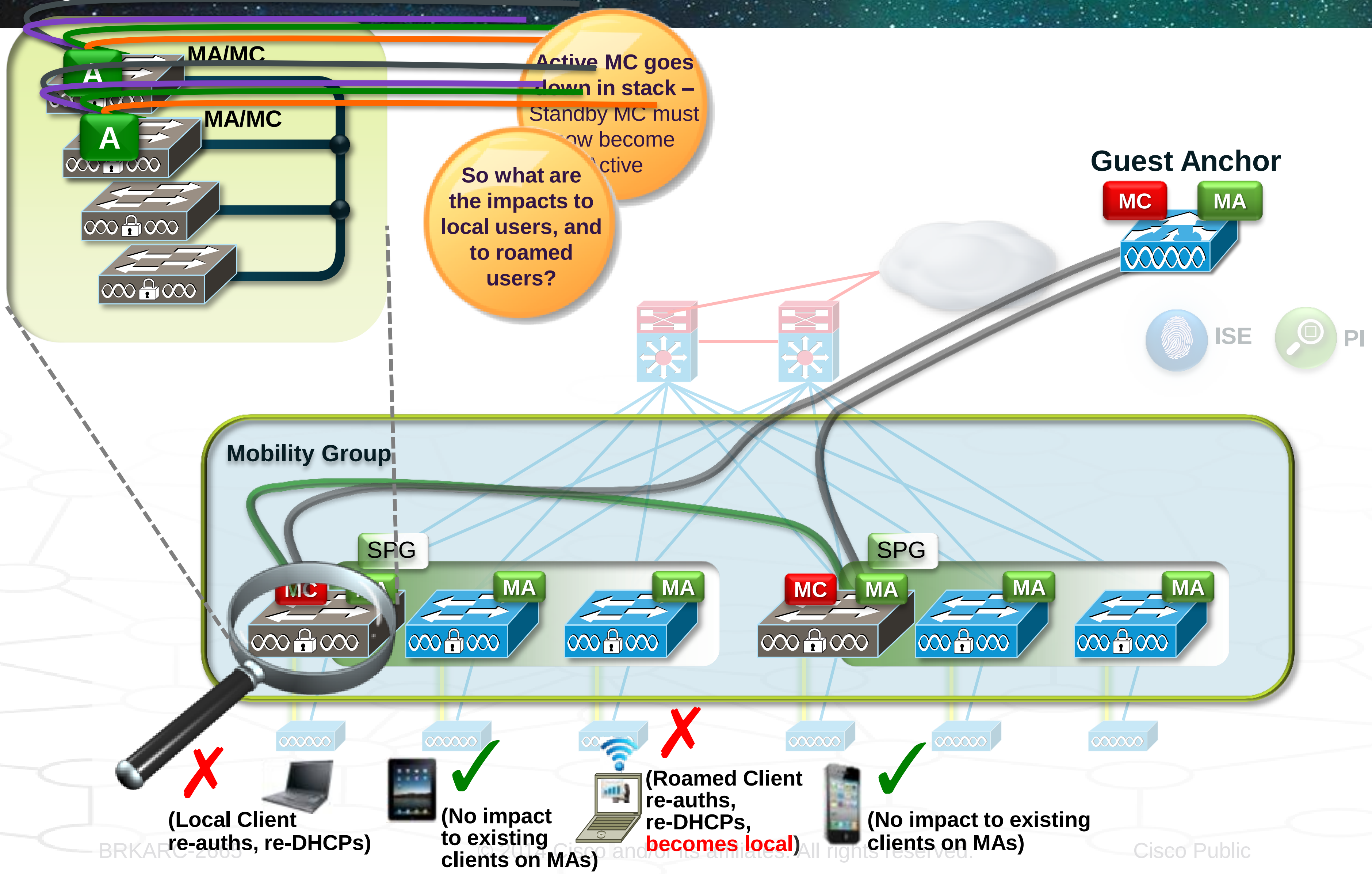
- **Let's examine the state maintained by the MC within a stack,** and see what redundancy we provide for this …



High Availability –
Catalyst 3x50-based MCs – Tunnel SSO



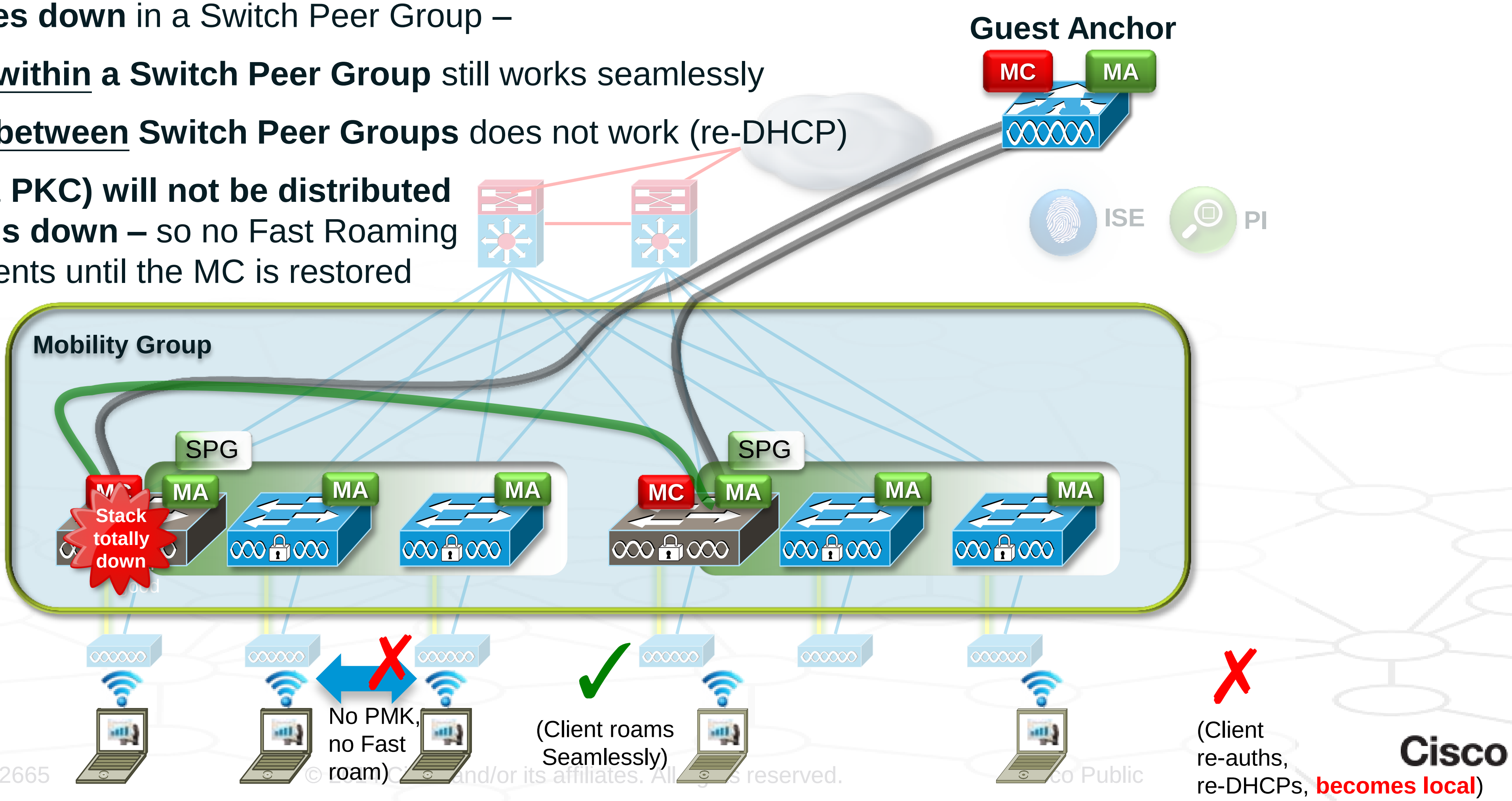
High Availability –
Catalyst 3x50-based MCs – Fault Tolerance in Stack



High Availability –
Catalyst 3x50-based MCs – Fault Tolerance across Stacks

Switch Peer Group Fault Tolerance with Catalyst 3x50 –

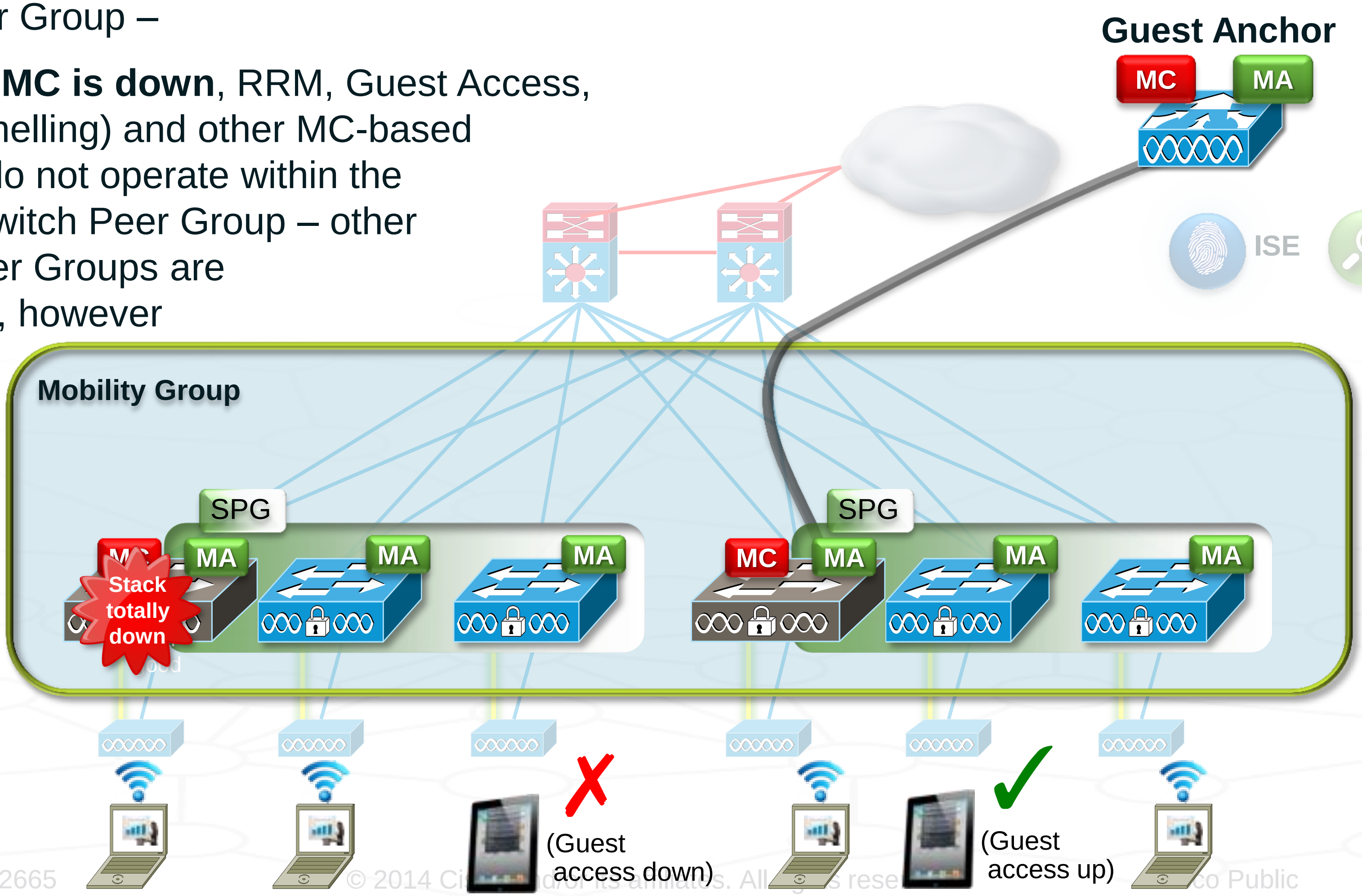
- **If an Catalyst 3x50-based stack, operating as an MC, completely goes down** in a Switch Peer Group –
  - **Roaming within a Switch Peer Group** still works seamlessly
  - **Roaming between Switch Peer Groups** does not work (re-DHCP)
  - **PMKs (via PKC) will not be distributed if the MC is down –** so no Fast Roaming for new clients until the MC is restored



High Availability –
Catalyst 3x50-based MCs – Fault Tolerance across Stacks

Switch Peer Group Fault Tolerance with Catalyst 3x50 –

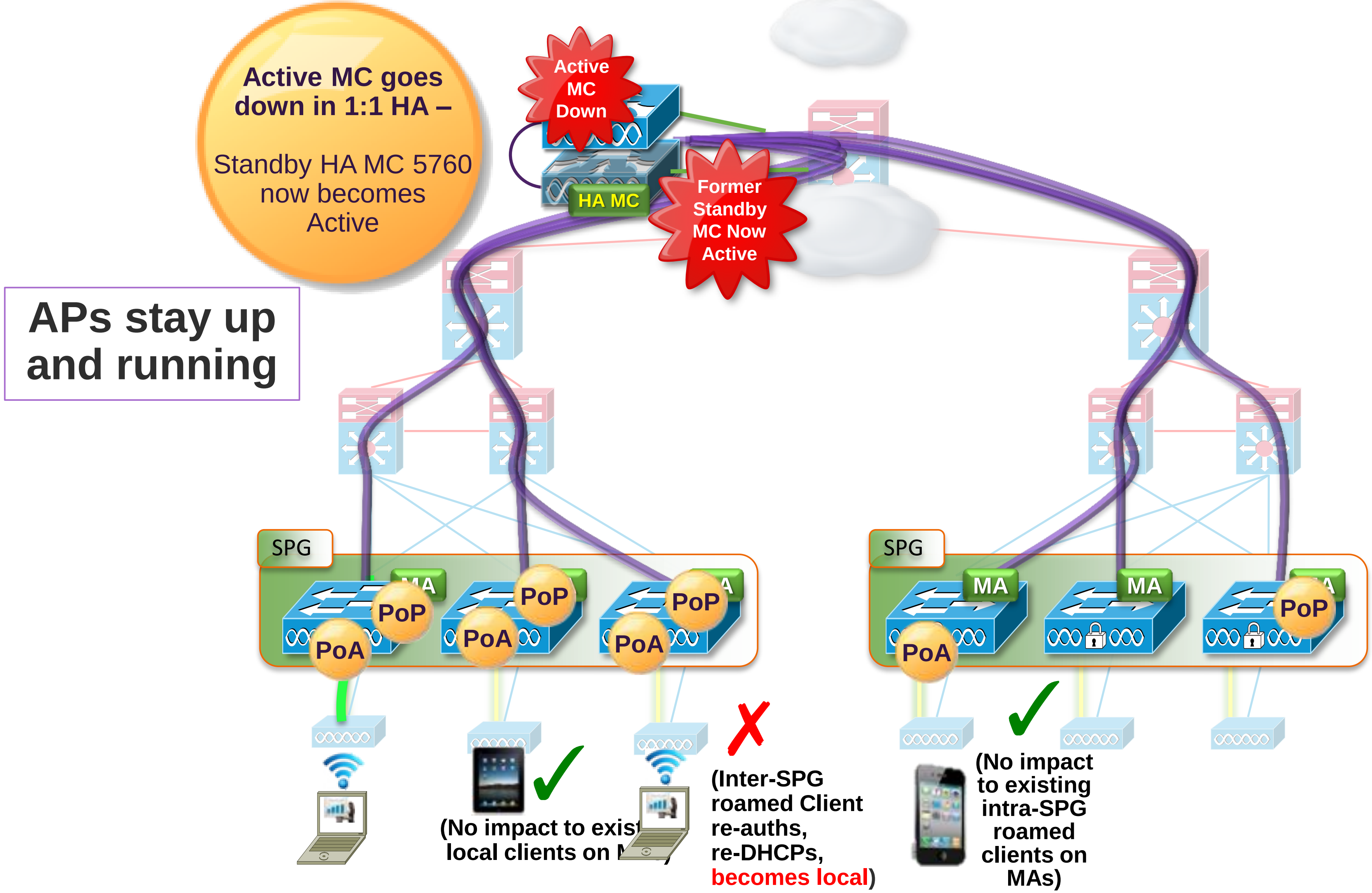
- **If an Catalyst 3x50-based MC is completely down** in a Switch Peer Group –
  - **When the MC is down**, RRM, Guest Access, (guest tunnelling) and other MC-based functions do not operate within the affected Switch Peer Group – other Switch Peer Groups are unaffected, however



High Availability –
WLC 5760

- Two 5760 units can be stacked for 1:1 redundancy, using stack cables
- One 5760 elected as Active and the other becomes Hot-Standby
- Bulk and Incremental Configuration are synchronised
- Redundancy is supported both at Port level and System level
- AP CAPWAP information is sync'd: APs will not disconnect and continue to be associated to the controller
- Significantly reduces network downtime

High Availability –
WLC 5760-based MCs – Impact on Clients



Roamed and Local users, High Availability Considerations

- **Local users on their MAs** have no impact following a HA MC failover event
- **Intra-SPG roamed users** also have no impact following the MC HA failover
- **All previously-roamed clients (inter-SPG) will result in a "hard roam" after MC failover** (re-auth, re-DHCP, change of client IP address, known as "becoming local")
- **Any new intra-SPG or inter-SPG roaming happening after MC HA failover** from local MA clients will be handled normally

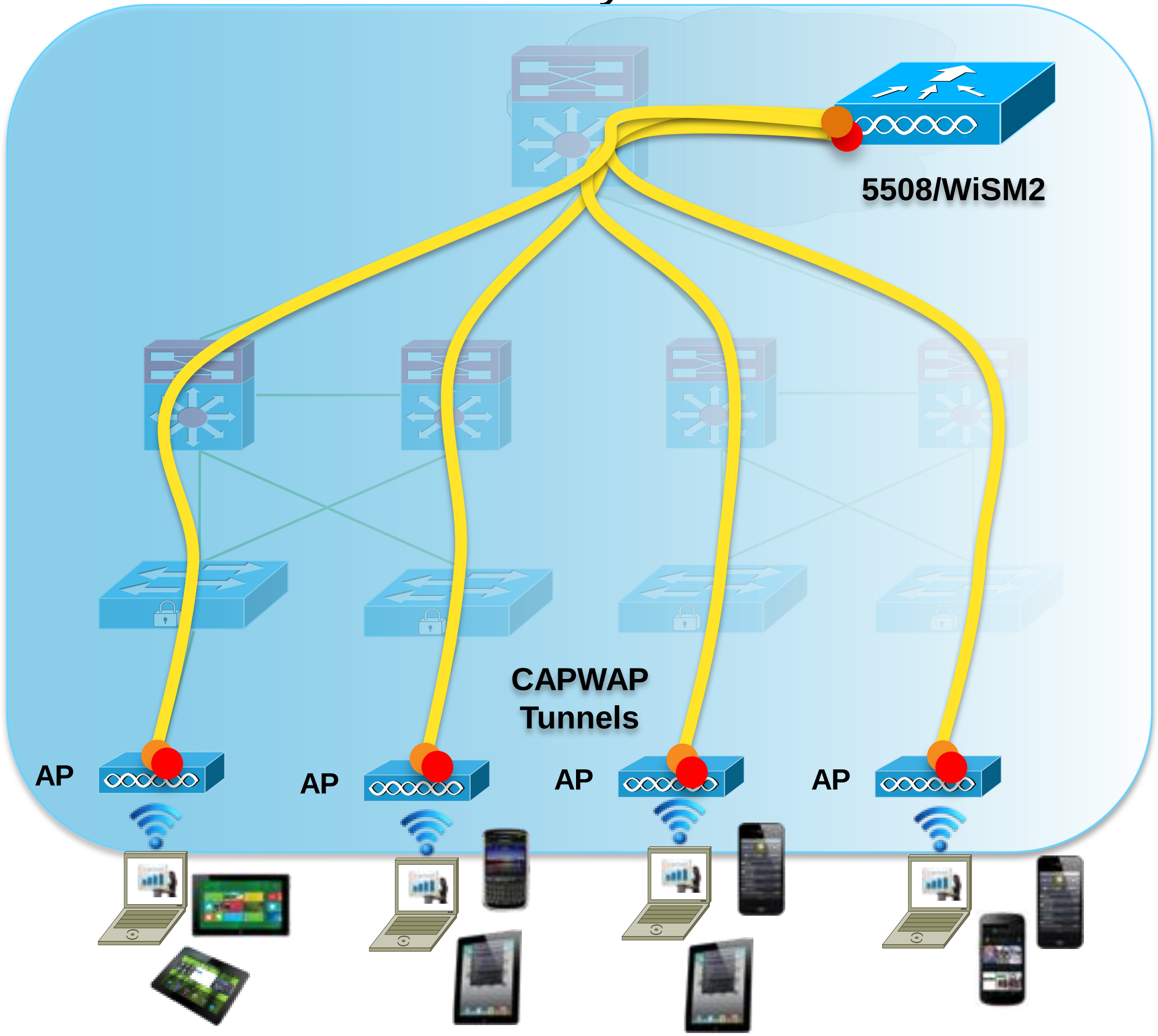
Agenda – BRKARC-2665

- **Evolution … Towards One Policy, One Management, One Network**
- **Converged Access – Platform Overviews**
- **Existing Wireless Deployments – Architecture Refresher**
- **Converged Access Architecture –**
  - Terminology and Building Blocks
  - Traffic Flows and Roaming
  - High Availability
  - ► Quality of Service
  - Security
  - Multicast
  - NetFlow
- **Converged Access Design and Deployment –**
  - IP Addressing
  - Design Options
  - Deployment Examples
- **Summary**

CUWN Architecture –

Overview – Challenges of QoS

Current Mobility Architecture



Challenges –

Overlay model with multiple points of policy application*

Limited **visibility** into applications at the edge

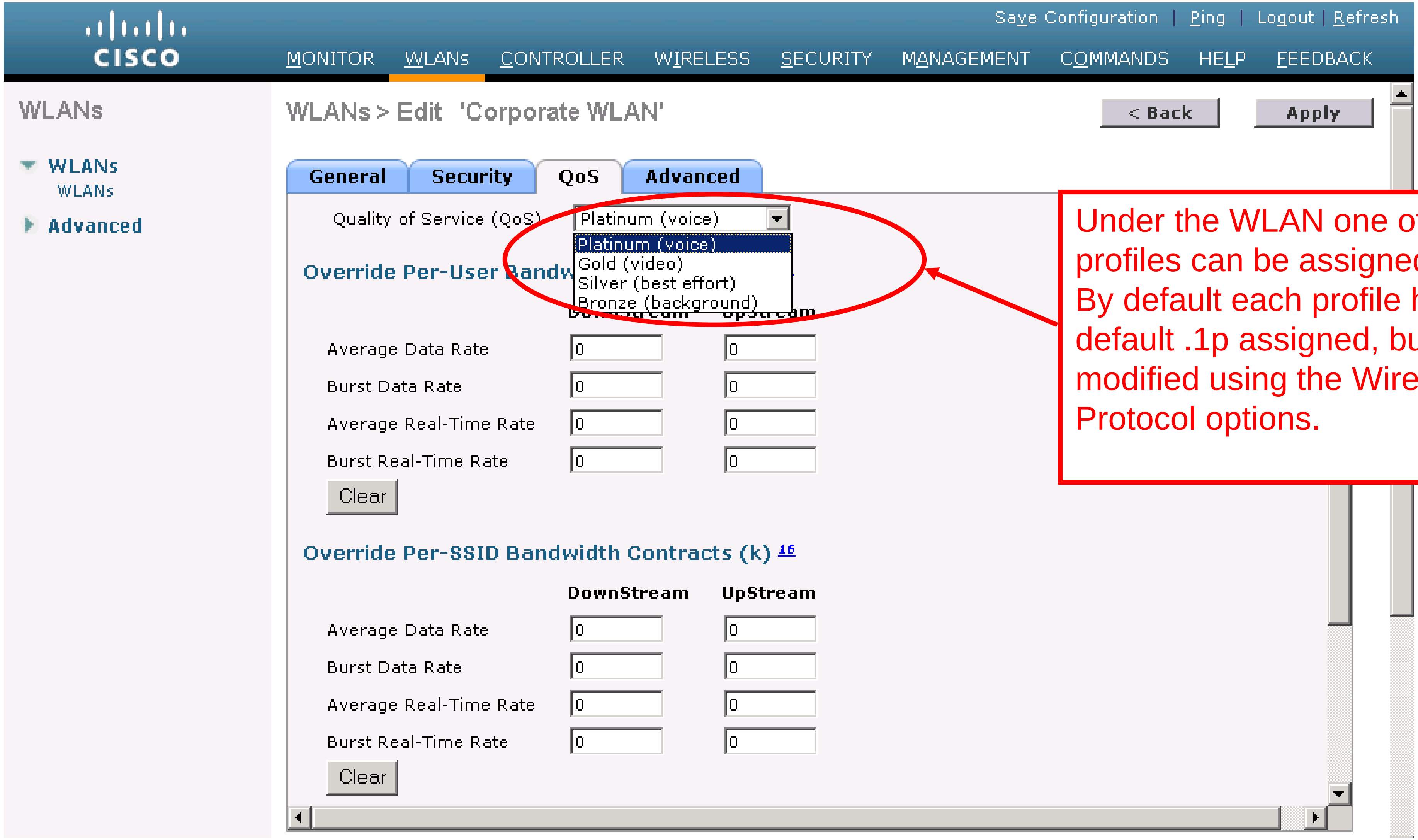
Lack of **granular classification** at the edge

Software based **QoS**

*** Overlay model applies to CUWN local mode and FlexConnect centralised mode**

Marking   Policing

Wireless QoS Today –
How It's Enabled



Under the WLAN one of four QoS profiles can be assigned.
By default each profile has a default .1p assigned, but it can be modified using the Wired QoS Protocol options.

*NOTE: Assignment of QoS profile to WLAN

How Do We Enable QoS Today?

Wired – mls-based CLI Exposes Hardware

```
C3750-X(config)# mls qos
C3750-X(config)# interface GigabitEthernet 1/0/1
C3750-X(config-if)# mls qos trust dscp

C3750-X(config)# mls qos queue-set output 1 buffers 15 30 35 20
C3750-X(config)# mls qos queue-set output 1 threshold 1 100 100 100 100
C3750-X(config)# mls qos queue-set output 1 threshold 2 80 90 100 400
C3750-X(config)# mls qos queue-set output 1 threshold 3 100 100 100 400
C3750-X(config)# mls qos queue-set output 1 threshold 4 60 100 100 400
C3750-X(config)# mls qos srr-queue output dscp-map queue 1 threshold 3 32 40 46

C3750-X(config)# mls qos srr-queue output dscp-map queue 2 threshold 1 16 18 20 22
C3750-X(config)# mls qos srr-queue output dscp-map queue 2 threshold 1 26 28 30 34 36 38
C3750-X(config)# mls qos srr-queue output dscp-map queue 2 threshold 2 24
C3750-X(config)# mls qos srr-queue output dscp-map queue 2 threshold 3 48 56
C3750-X(config)# mls qos srr-queue output dscp-map queue 3 threshold 3 0
C3750-X(config)# mls qos srr-queue output dscp-map queue 4 threshold 1 8
C3750-X(config)# mls qos srr-queue output dscp-map queue 4 threshold 2 10 12 14

C3750-X(config)# interface range GigabitEthernet1/0/1-48
C3750-X(config-if-range)# queue-set 1
C3750-X(config-if-range)# srr-queue banc
C3750-X(config-if-range)# priority-queue
```

NOTE: Only class based policing and marking are available today – **last box with mls cli - Cat 3750**

QoS – What's New with Converged Access

Wired (Cat 3850)

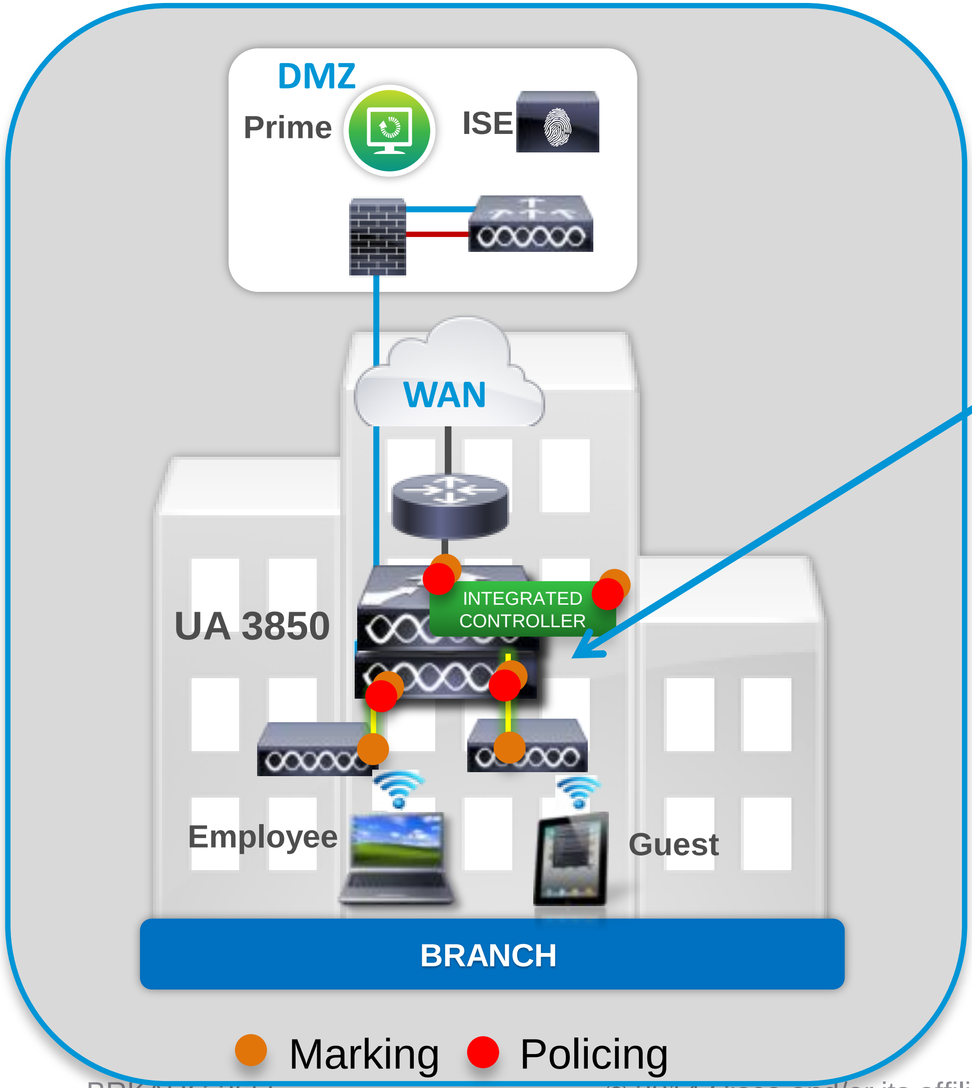
- Modular QoS based CLI (MQC)
  - Alignment with 4500E series (Sup6, Sup7)
  - Class-based Queueing, Policing, Shaping, Marking
- More Queues
  - Up to 2P6Q3T queueing capabilities
  - Standard 3750 provides 1P3Q3T
  - Not limited to 2 queue-sets
  - Flexible MQC Provisioning abstracts queueing hardware

Wireless (Cat 3x50 & CT 5760)

- Granular QoS control at the wireless edge
  - Tunnel termination allows customers to provide QoS treatment per SSIDs, per-Clients and common treatment of wired and wireless traffic throughout the network
- Enhanced Bandwidth Management
  - Approximate Fair Drop (AFD) Bandwidth Management ensures fairness at Client, SSID and Radio levels for NRT traffic
- Wireless Specific Interface Control
  - Policing capabilities Per-SSID, Per-Client upstream*** and downstream
  - AAA support for dynamic Client based QoS and Security policies
- Per SSID Bandwidth Management

*** **NOT** available on CT 5760 at FCS

QoS – What's New with Converged Access



Wireless (Cat 3x50 & CT 5760)

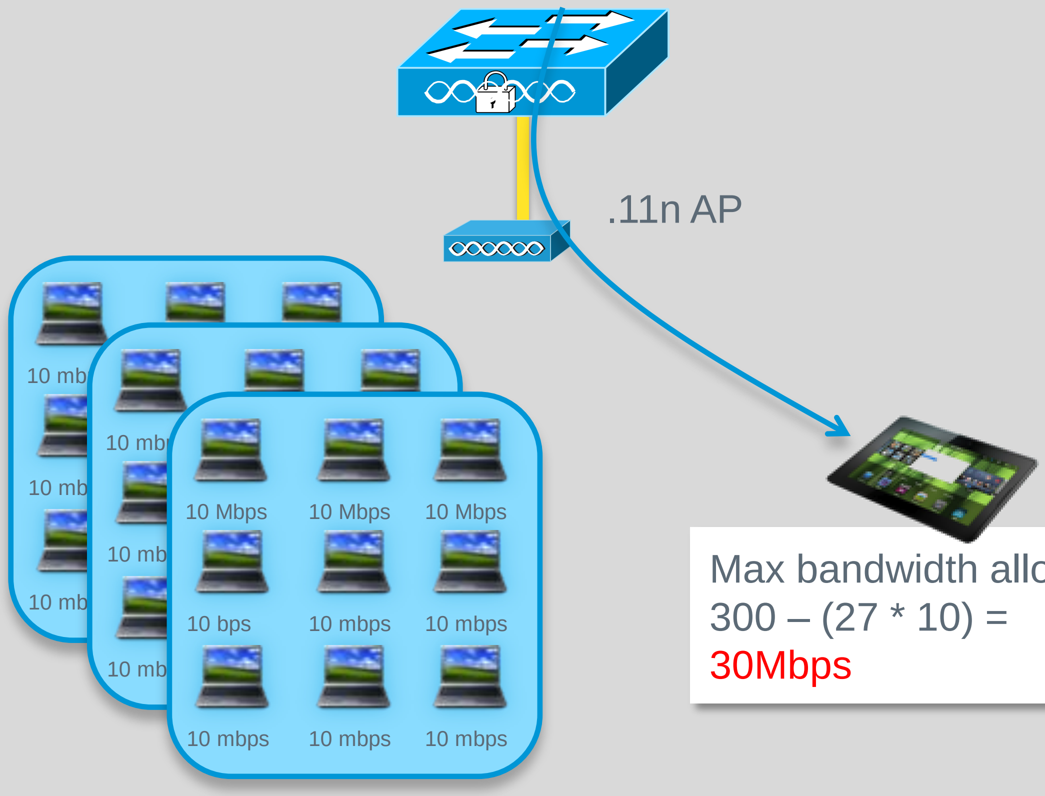
- Granular QoS control at the wireless edge
  - Tunnel termination allows customers to provide QoS treatment per SSIDs, per-Clients and common treatment of wired and wireless traffic throughout the network
- Enhanced Bandwidth Management
  - Approximate Fair Drop (AFD) Bandwidth Management ensures fairness at Client, SSID and Radio levels for NRT traffic
- Wireless Specific Interface Control
  - Policing capabilities Per-SSID, Per-Client upstream* and downstream
  - AAA support for dynamic Client based QoS and Security policies
- Per SSID Bandwidth Management

*Not currently supported on the CT 5760

QoS – What's New with Converged Access

With the CT 5760 or CAT 3850 / 3650

Usage based fair allocation without configuration



Max bandwidth allowed:
300 – (27 * 10) =
30Mbps

Wireless (Cat 3x50 & CT 5760)

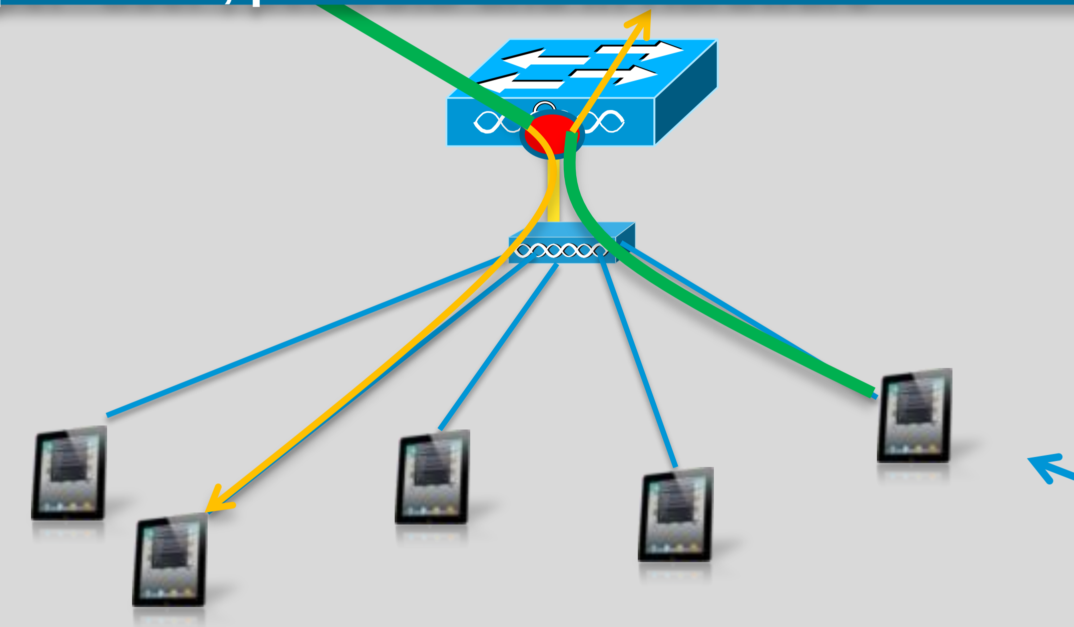
- Granular QoS control at the wireless edge
  - Tunnel termination allows customers to provide QoS treatment per SSIDs, per-Clients and common treatment of wired and wireless traffic throughout the network
- Enhanced Bandwidth Management
  - Approximate Fair Drop (AFD) Bandwidth Management ensures fairness at Client, SSID and Radio levels for NRT traffic
- Wireless Specific Interface Control
  - Policing capabilities Per-SSID, Per-Client upstream* and downstream
  - AAA support for dynamic Client based QoS and Security policies
- Per SSID Bandwidth Management

*Not currently supported on the CT 5760

QoS – What's New with Converged Access

With the 3850 / 3650

Bidirectional policing at the edge
per- user , per-SSID and in Hardware



- SSID: BYOD
- QoS policy on 3850 used to police each client bidirectionally
- Policy can be sent via AAA to provide specific per-client policy
- Allocate Bandwidth or police/shape SSID as a whole

Wireless (Cat 3x50 & CT 5760)

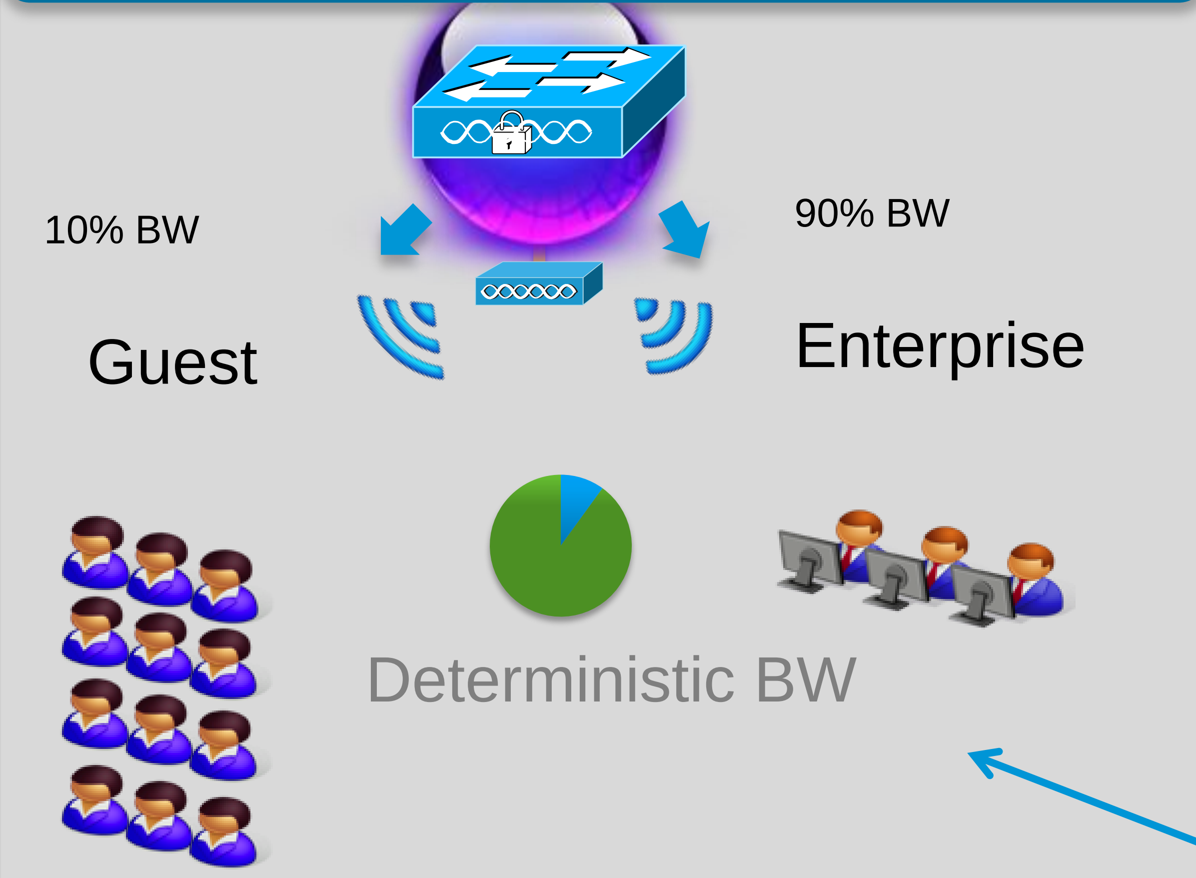
- Granular QoS control at the wireless edge
  - Tunnel termination allows customers to provide QoS treatment per SSIDs, per-Clients and common treatment of wired and wireless traffic throughout the network
- Enhanced Bandwidth Management
  - Approximate Fair Drop (AFD) Bandwidth Management ensures fairness at Client, SSID and Radio levels for NRT traffic
- Wireless Specific Interface Control
  - Policing capabilities Per-SSID, Per-Client upstream* and downstream
  - AAA support for dynamic Client based QoS and Security policies
- Per SSID Bandwidth Management

*Not currently supported on the CT 5760

QoS – What's New with Converged Access

With the CT 5760 or CAT 3850 / 3650

Deterministic bandwidth is allocated per SSID



Wireless (Cat 3x50 & CT 5760)

- Granular QoS control at the wireless edge
  - Tunnel termination allows customers to provide QoS treatment per SSIDs, per-Clients and common treatment of wired and wireless traffic throughout the network
- Enhanced Bandwidth Management
  - Approximate Fair Drop (AFD) Bandwidth Management ensures fairness at Client, SSID and Radio levels for NRT traffic
- Wireless Specific Interface Control
  - Policing capabilities Per-SSID, Per-Client upstream*** and downstream
  - AAA support for dynamic Client based QoS and Security policies
- Per SSID Bandwidth Management

QoS – What's New with Converged Access –

MQC Provides a Unified Provisioning Language

```
C3750-X(config)# mls qos
C3750-X(config)# interface GigabitEthernet 1/0/1
C3750-X(config-if)# mls qos trust dscp

C3750-X(config)# mls qos queue-set output 1 buffers 15 30 35 20
C3750-X(config)# mls qos queue-set output 1 threshold 1 100 100 100 100
C3750-X(config)# mls qos queue-set output 1 threshold 2 80 90 100 400
C3750-X(config)# mls qos queue-set output 1 threshold 3 100 100 100 400
C3750-X(config)# mls qos queue-set output 1 threshold 4 60 100 100 400
C3750-X(config)# mls qos srr-queue output dscp-map queue 1 threshold 3 32 40 46

C3750-X(config)# mls qos srr-queue output dscp-map queue 2 threshold 1 16 18 20 22
C3750-X(config)# mls qos srr-queue output dscp-map queue 2 threshold 1 26 28 30 34 36 38
C3750-X(config)# mls qos srr-queue output dscp-map queue 2 threshold 2 24
C3750-X(config)# mls qos srr-queue output dscp-map queue 2 threshold 3 48 56
C3750-X(config)# mls qos srr-queue output dscp-map queue 3 threshold 3 0
C3750-X(config)# mls qos srr-queue output dscp-map queue 4 threshold 1 8
C3750-X(config)# mls qos srr-queue output dscp-map queue 4 threshold 2 10 12 14

C3750-X(config)# interface range GigabitEthernet1/0/1-48
C3750-X(config-if-range)# queue-set 1
C3750-X(config-if-range)# srr-queue bandwidth share 1 30 35 5
C3750-X(config-if-range)# priority-queue out
```

```
policy-map 3850-QoS

class PRIORITY-QUEUE
  priority level 1
   police rate percent 20

class CONTROL-MGMT-QUEUE
  bandwidth remaining percent 30
  queue-limit dscp cs2  percent 80
  queue-limit dscp cs3  percent 90
  queue-limit dscp cs6  percent 100

class TRANSACTIONAL-DATA-QUEUE
  bandwidth remaining percent 5
  queue-limit dscp af23 percent 80
  queue-limit dscp af22 percent 90
  queue-limit dscp af21 percent 100

class BULKDATA-QUEUE
  bandwidth remaining percent 35
  queue-limit dscp af13 cs1 percent 80
  queue-limit dscp af12 percent 90
  queue-limit dscp af11 percent 100
```

*NOTE: Only class based policing and marking are available today **– last box with mls cli - Cat 3750**

Wireless Queuing and Approximate Fair Drop (AFD)

Application Visibility – Without Control –

Catalyst 3x50

```
flow record fr-avc
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match flow direction
 match application name
 match wireless ssid
 collect counter bytes long
 collect counter packets long
collect wireless ap mac address
collect wireless client mac address
end
```

```
flow monitor fm-avc
  record fr-avc
  cache timeout inactive 200
end
```

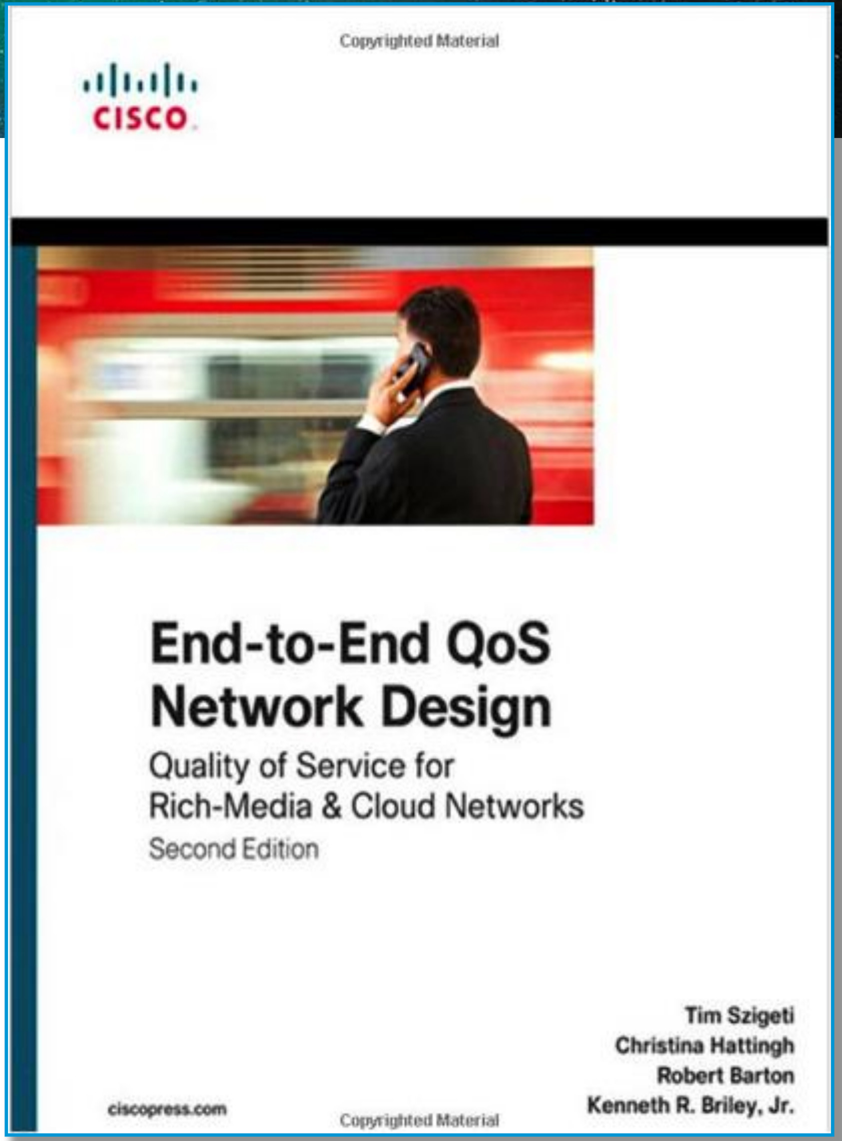
```
wlan <>
  ip flow mon fm-avc input
  ip flow mon fm-avc output
end
```

```
Cat3850# sh avc client 8c70.5a20.35b4 top 10 application agg
Cumulative Stats:

No.  AppName        Packet-Count         Byte-Count           AvgPkt-Size
        usage%
--------------------------------------------------------------------------------
        --
1    http           69451                72146465             1038         67
2    youtube        16284                17117601             1051         15
3    rtmpe           9349                 9266013              991          8
4    hulu            8096                 7974952              985          7
5    unknown         1686                  126067              74           0
6    rtmp            1593                 1723269             1081          2
7    netflix         1305                 1371679             1051          1
8    ssl              937                  530577              566          0
9    dns              748                  70418                94           0
10   facebook         512                  372629              727          0


Last Interval(90 seconds) Stats:

No.  AppName        Packet-Count         Byte-Count           AvgPkt-Size
        usage%
--------------------------------------------------------------------------------
        ---
1    http           65410                68322192             1044         78
2    rtmpe           8812                 9242082             1048         11
3    youtube         5752                 6262985             1088          7
4    rtmp            1593                 1723269             1081          2
5    netflix         1305                 1371679             1051          2
6    unknown          797                   76004               95          0
7    dns              265                   29420              111          0
8    flash-video      206                  196639              954          0
9    ssl              148                   62384              421          0
10   hulu              82                   25238              307          0
```

Quality of Service –
Recommended Reading

- **Comprehensive QoS design guidance for PINs and platforms –**
  - **Campus** Catalyst 3750 / 4500 / 6500
  - **WLAN** WLC 5508 / Catalyst 3850/3650
  - **Data Centre** Nexus 1000V / 2000 / 5500 / 7000
  - **WAN & Branch** Cisco ASR 1000 / ISR G2
  - **MPLS VPN** Cisco ASR 9000 / CRS-3
  - **IPSec VPNs** Cisco ISR G2

- **ISBN:** 1-58714-369-0



Agenda – BRKARC-2665

Evolution … Towards One Policy, One Management, One Network

Converged Access – Platform Overviews

Existing Wireless Deployments – Architecture Refresher

Converged Access Architecture –

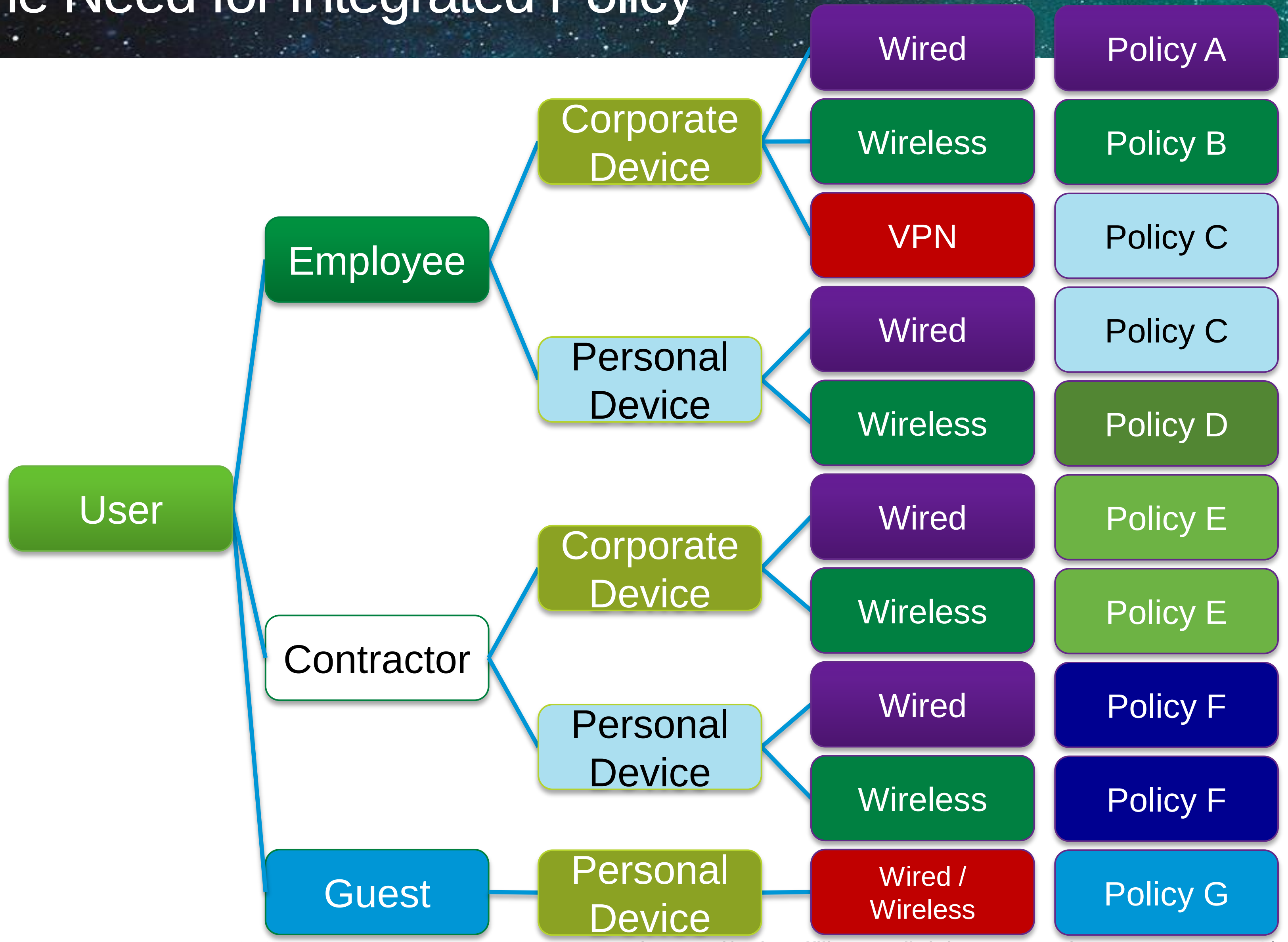
- Terminology and Building Blocks
- Traffic Flows and Roaming
- High Availability
- Quality of Service
- ► Security
- Multicast
- NetFlow

Converged Access Design and Deployment –

- IP Addressing
- Design Options
- Deployment Examples

Summary

Converged Access –
The Need for Integrated Policy



How to **define and apply** security policy **consistently** across every device on the network?

Policy Definition – Where?

Distributed and/or Centralised

- On-Device Policy
  - AAA services (mandatory)
  - Local Policy Objects
  - Local Policy
  - Users
- Central Policy
  - Users / External Databases
  - Central Policy Objects
  - Central Policy and Control
  - Profiling
- Typically a Combination of both

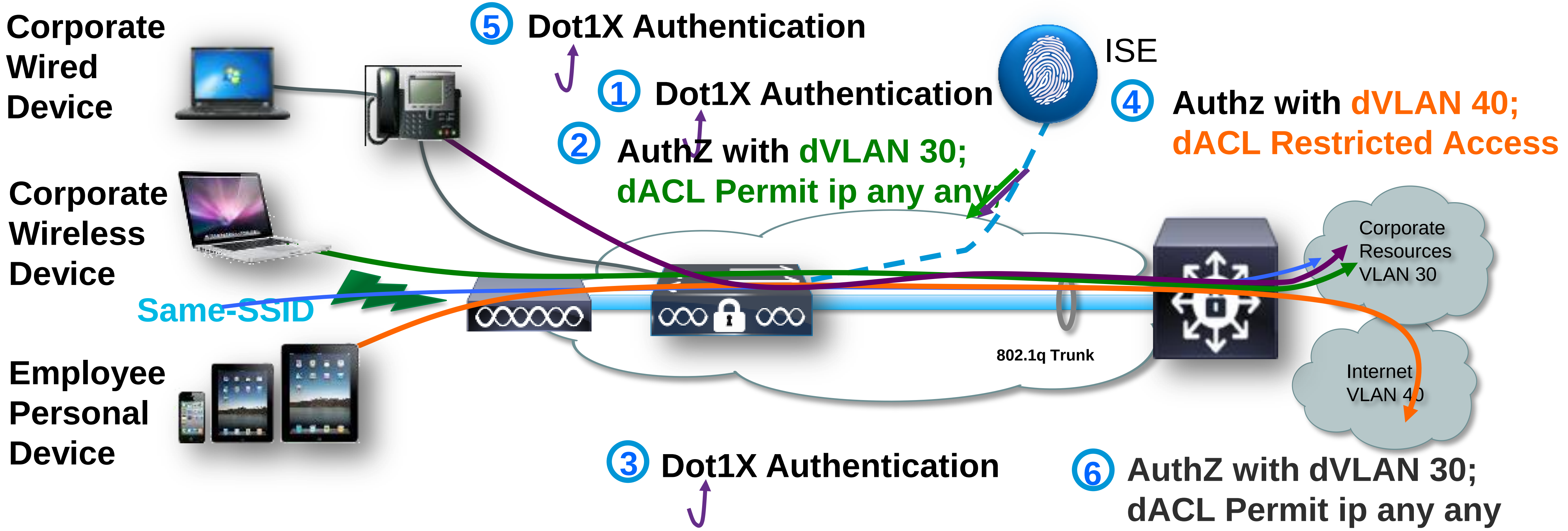
Today – Inconsistent Central Policy Definition

One Policy to the Rescue!

Feature		
ACL Application	dACL, Filter-ID, per-User ACL	Airespace-ACL-Name
VLAN Assignment	Tunnel-Type, Tunnel-Medium-Type, Tunnel-Private-Group-ID	As with wired but PLUS Airespace-Interface-name
QoS	Platform dependent ☹ (C3PL, MQC, …)	Airespace-QoS-Level, Airespace-DSCP

C3PL: Cisco Classification Configuration Policy Language
MQC: Modular QoS CLI

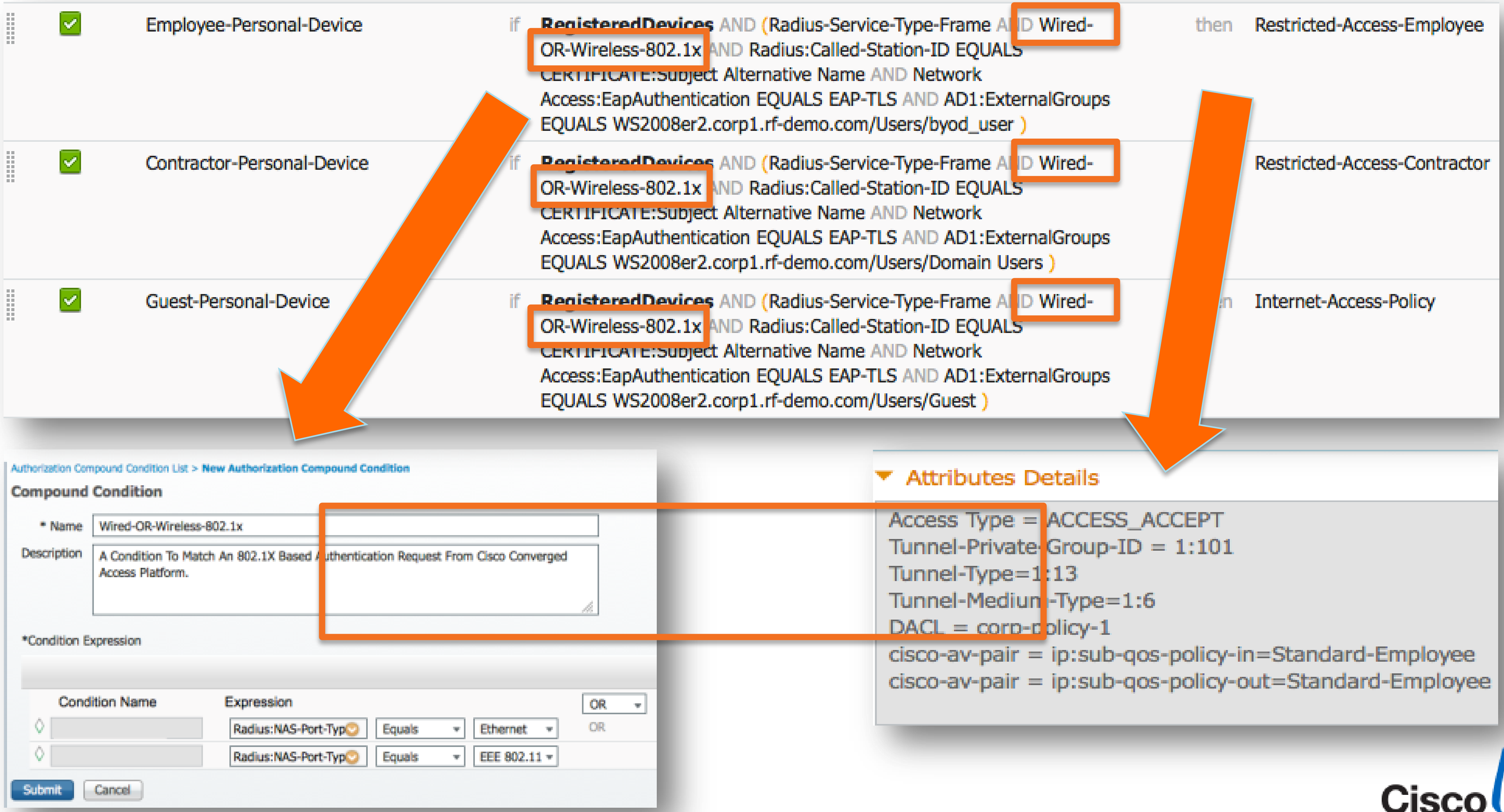
One Policy –
Wired and Wireless



- Employee using the same SSID, can be associated to different VLAN interfaces and policy after EAP authentication
- Employee using corporate wired and wireless device with their AD user id can be assigned to same VLAN 30 to have full access to the network
- Employee using personal iDevice with their AD user id can be assigned to VLAN 40 and policy to access internet only

ISE Policy Definition Example –

Same Authorisation Policy for Wired AND Wireless



Converged Access –
Security Features



	Catalyst 3650 & 3850	CT5760	CT5508
BYOD Functionality	YES	YES	YES
Rogue detect / classify / contain, RDLP	YES	YES	YES
Port Security	YES	YES	NO
IP Source Guard	YES	YES	NO
Dynamic ARP Insp.	YES	YES	NO
LDAP, TACACS+, RADIUS	YES	YES	YES
LSC and MIC	YES	YES	YES
AP dot1x EAP-FAST	YES	YES	YES
Secure Fast Roaming	YES	YES	YES
802.1X-rev-2010 (MACsec / MKA)	H/W Ready	H/W Ready	NO

Converged Access –

Security Features, continued

	Catalyst 3650 & 3850	CT5760	CT5508
IP Theft, DHCP Snooping, Data Gleaning	YES	YES	YES
IOS ACL	YES	YES	YES
Adaptive wIPS, WPS	YES	YES	YES
CIDS	YES	YES	YES
TrustSec SGT / SGACL	YES	YES	SXP
Guest Access	YES	YES	YES
IPv6 RA Guard	YES	YES	NO
MFP	YES	YES	YES
IP Device Tracking	YES	YES	NO
CoPP	Static	Static	NO

Agenda – BRKARC-2665

- **Evolution … Towards One Policy, One Management, One Network**
- **Converged Access – Platform Overviews**
- **Existing Wireless Deployments – Architecture Refresher**
- **Converged Access Architecture –**
  - Terminology and Building Blocks
  - Traffic Flows and Roaming
  - High Availability
  - Quality of Service
  - Security
  - ► Multicast
  - NetFlow
- **Converged Access Design and Deployment –**
  - IP Addressing
  - Design Options
  - Deployment Examples
- **Summary**

Multicast on Converged Access WLC –
Default State

- Multicast forwarding is disabled on CA Controller by default –

  Multicast frames received at the controller level are not forwarded to / from APs

- IGMP Snooping is disabled –

  The Controller does not know which AP needs multicast forwarding

- Both Multicast forwarding and IGMP snooping are needed, use the following commands –

  (config)# **wireless multicast** enables IP mcast

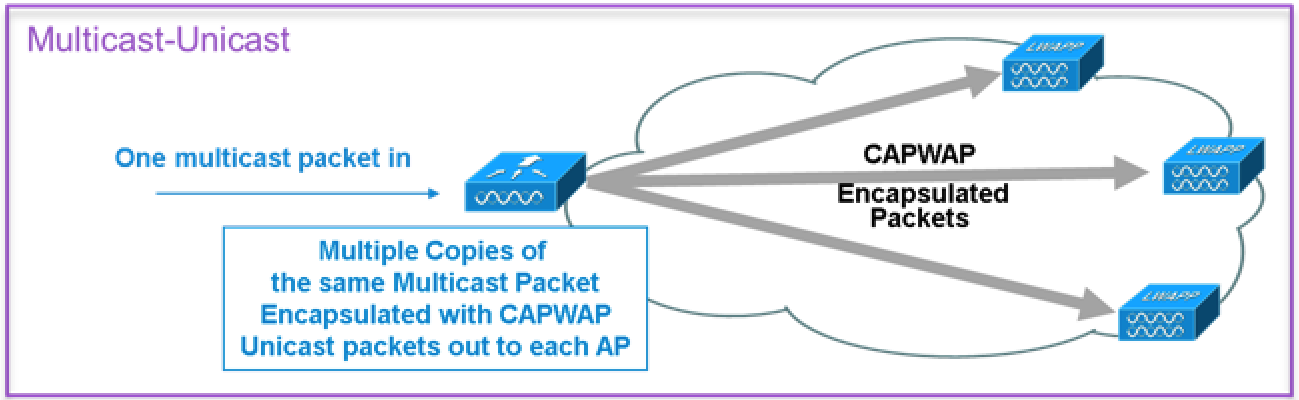
  (config)# **ip igmp snooping** enables snooping for IPv4

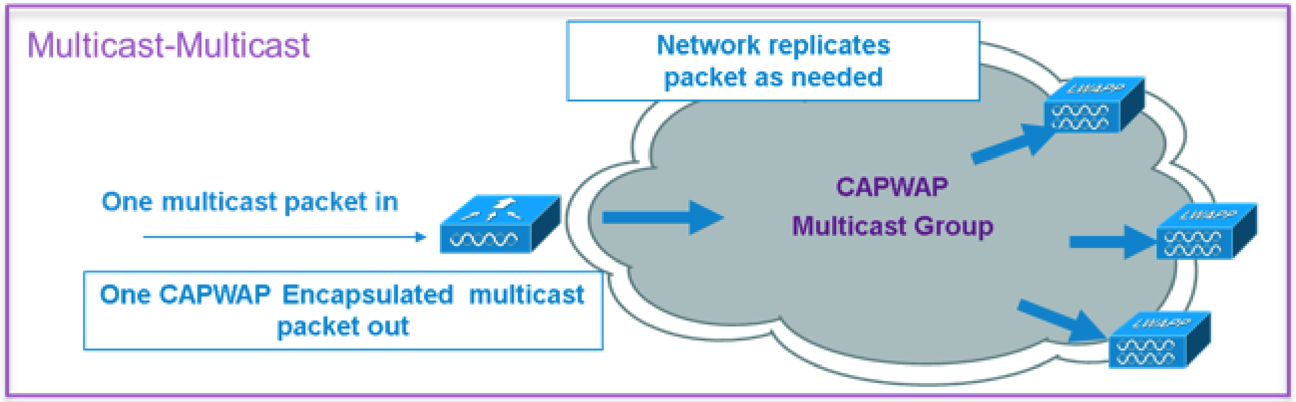
  (congig)# **ipv6 mld snooping** enables snooping for IPv6

- As in CUWN, CAPWAP multicast-multicast mode can be configured on the Controller –

  (config)# **ap capwap multicast <ip mcast @>**

  By default multicast-unicast is used

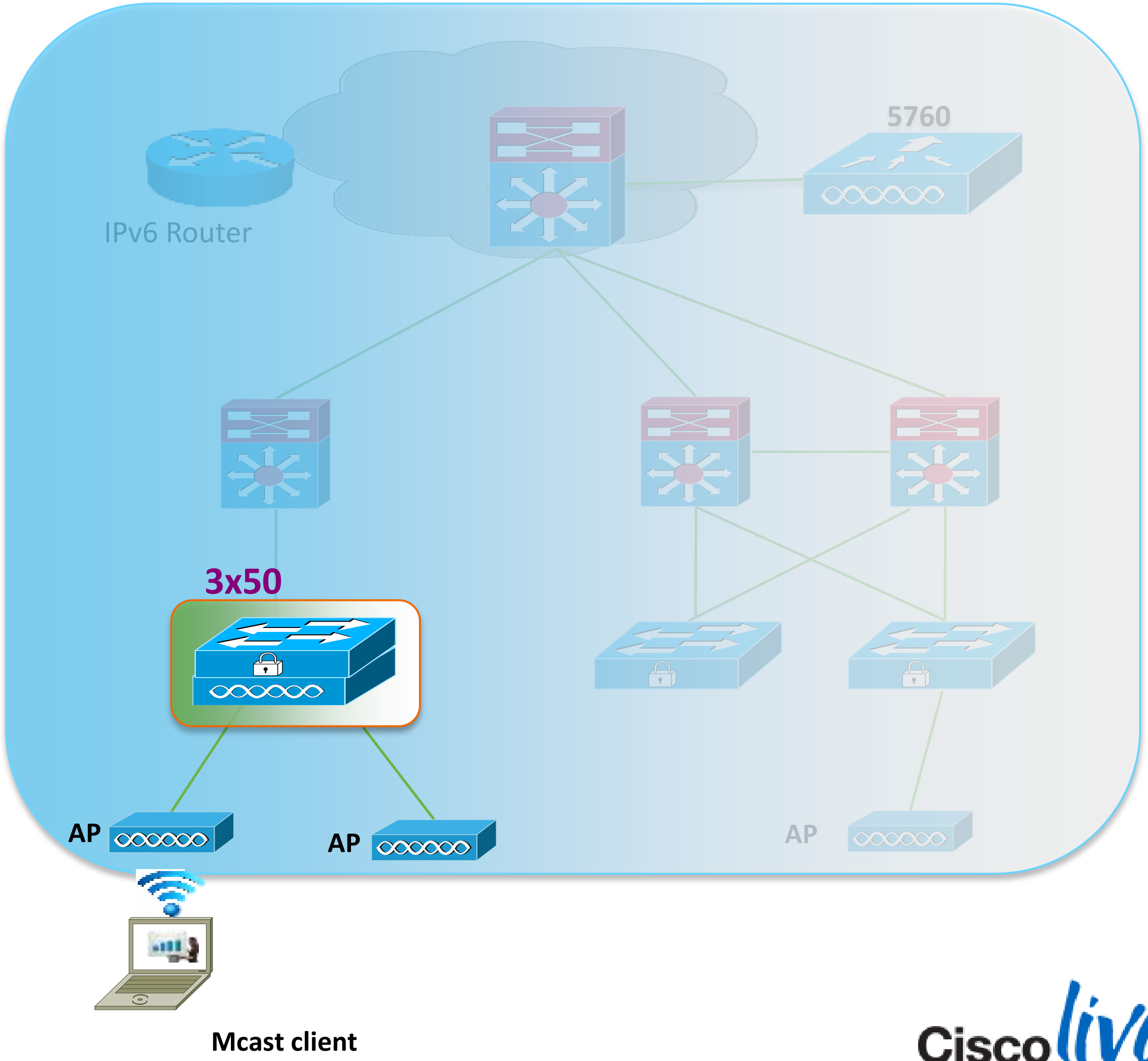




Multicast on Converged Access WLC –
Roaming – Intra-WLC

- Intra-WLC roaming –

1. WLC notifies IOS with client move notification
2. IOS updates the capwap ports for MGIDs (groups) to which the client was subscribed
3. WLC checks with the Medianet configuration and AP capability to see if the group should be allowed in the new AP.
4. If allowed, WLC adds all the new MGID to the new AP and deletes the client reference from the MGID from the old AP.

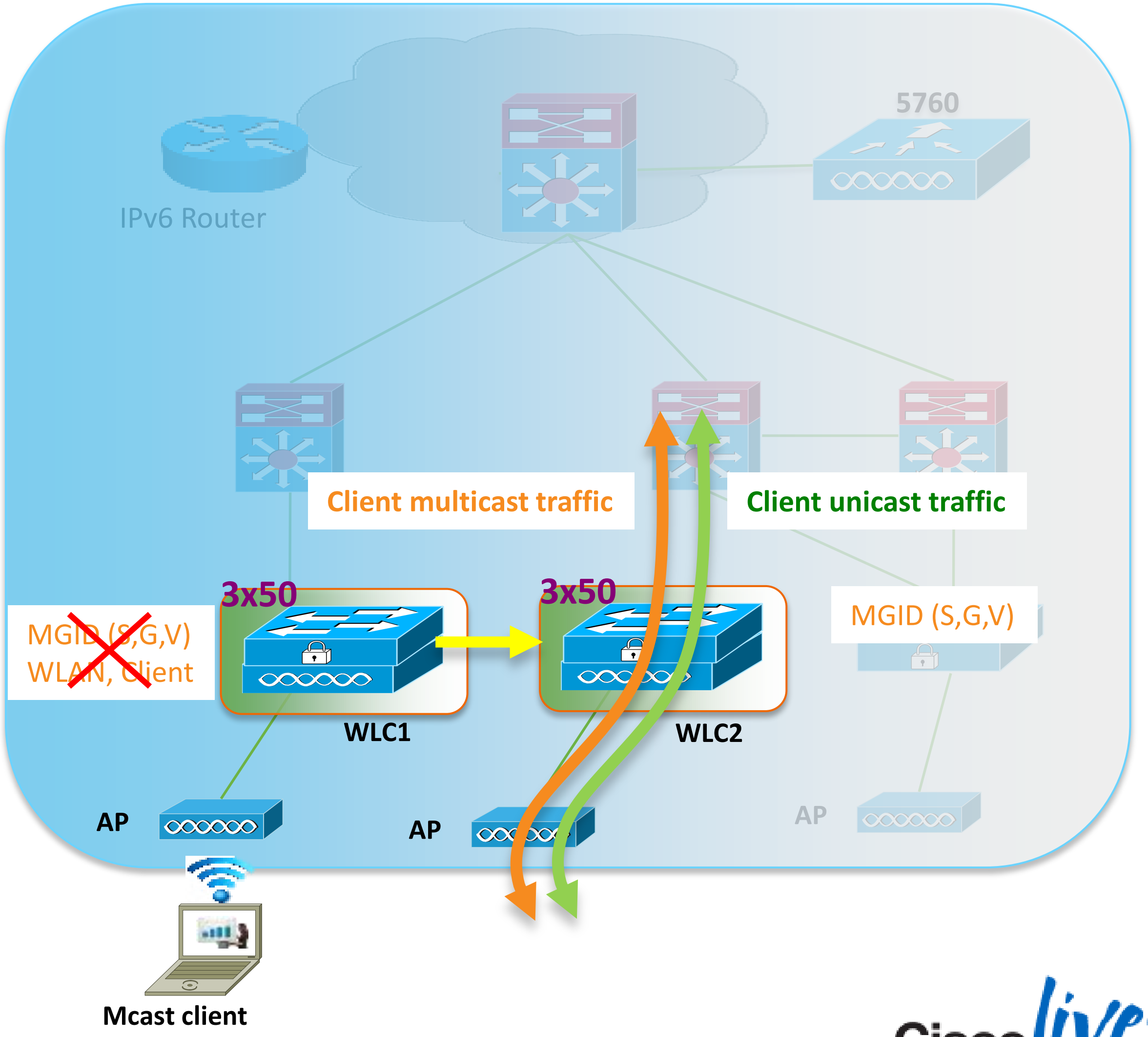


Multicast on Converged Access WLC –

Roaming – Inter-WLC, Layer 2

- Inter-WLC Layer 2 roaming, Sticky Anchoring disabled –

1. WLC in switch1/WLC1 moves all the group info in the mobility handoff payload to the switch2 /WLC2
2. WLC in switch2/WLC2 creates new MGID as if igmp report packets from the client has arrived
3. Old switch1/WLC1 removes all the client references as if a leave message was received
4. Multicast traffic flows through the new controller

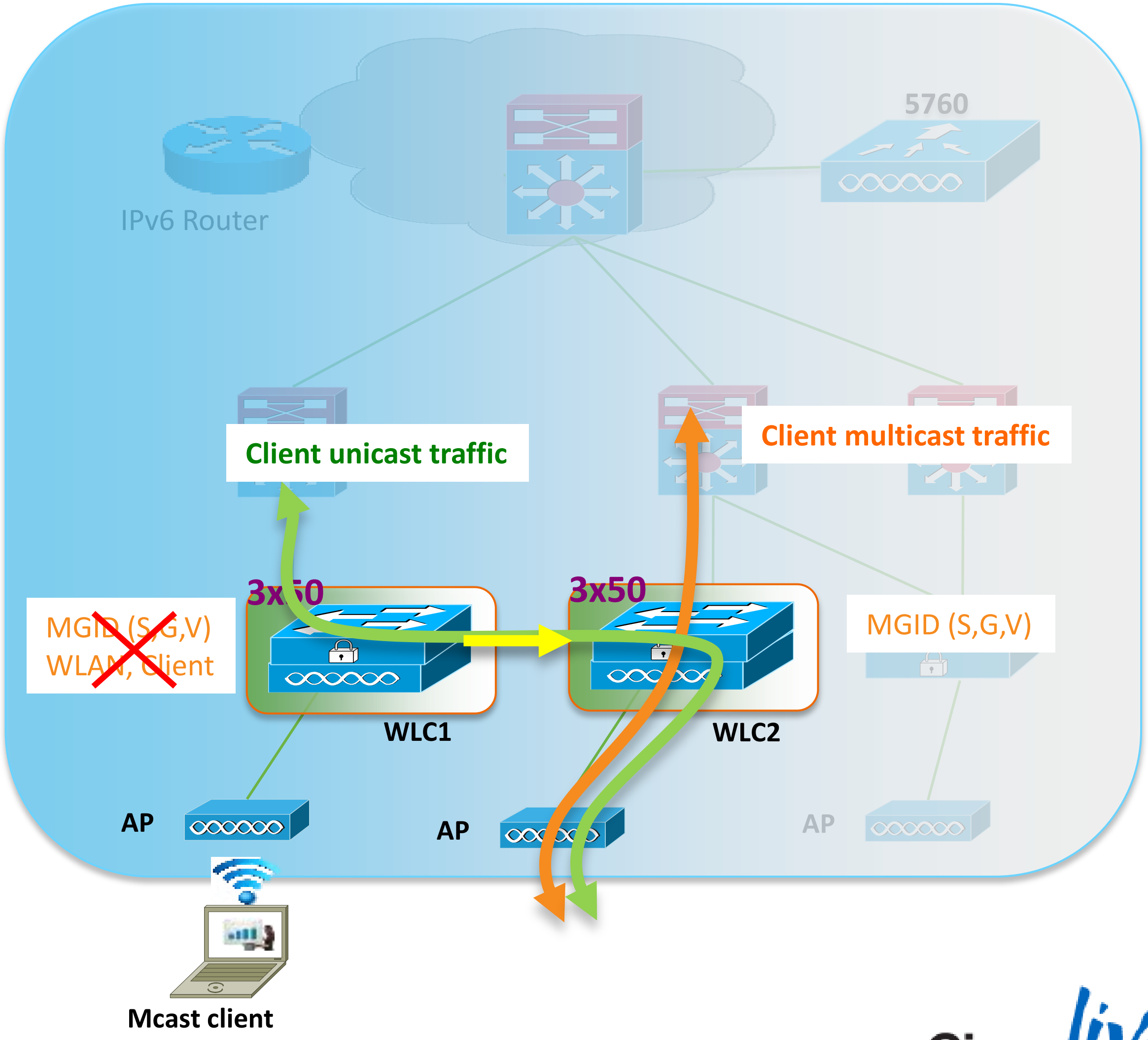


Multicast on Converged Access WLC –

Roaming – Inter-WLC, Layer 2

- Inter-WLC Layer 2 roaming,
  Sticky Anchoring enabled (default) –

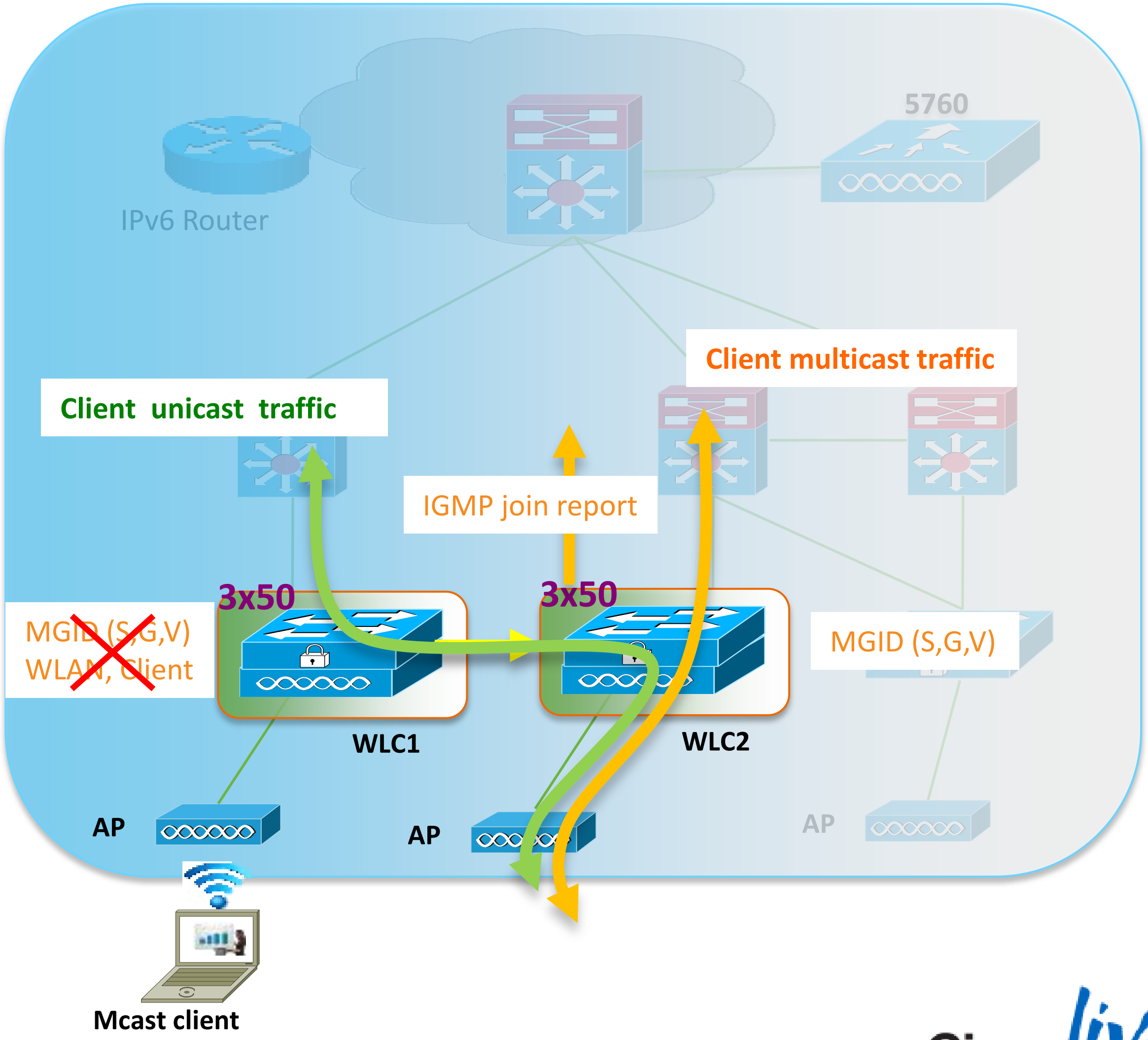
1. WLC in switch1 / WLC1 moves all the multicast group info in the mobility handoff payload to the switch2 / WLC2. Unicast info is copied.
2. WLC in switch2 / WLC2 creates new MGID as if igmp report packets from the client has arrived
3. Old switch1 / WLC1 keeps client unicast references, but drops multicast references as if a leave message was received
4. Multicast traffic flows through the new controller … but unicast traffic still goes through switch1 / WLC1 to preserve client IP



Multicast on Converged Access WLC –
Roaming – Inter-WLC, Layer 3

- Inter-WLC Layer 3 roaming –

1. WLC in switch1 / WLC1 moves all the multicast group info in the mobility handoff payload to the switch2 /WLC2. Unicast info is copied.
2. WLC in switch2 / WLC2 creates new MGID
3. Old switch1 / WLC1 removes all the client references
4. Switch2 / WLC2 sends IGMP reports based on its WLAN/VLAN mapping
5. Multicast traffic flows through the new controller … but unicast traffic still goes through switch1 / WLC1 to preserve client IP



Agenda – BRKARC-2665

Evolution … Towards One Policy, One Management, One Network

Converged Access – Platform Overviews

Existing Wireless Deployments – Architecture Refresher

Converged Access Architecture –

- Terminology and Building Blocks
- Traffic Flows and Roaming
- High Availability
- Quality of Service
- Security
- Multicast
- ► NetFlow

Converged Access Design and Deployment –

- IP Addressing
- Design Options
- Deployment Examples

Summary

Troubleshooting –
From Simple to Complex

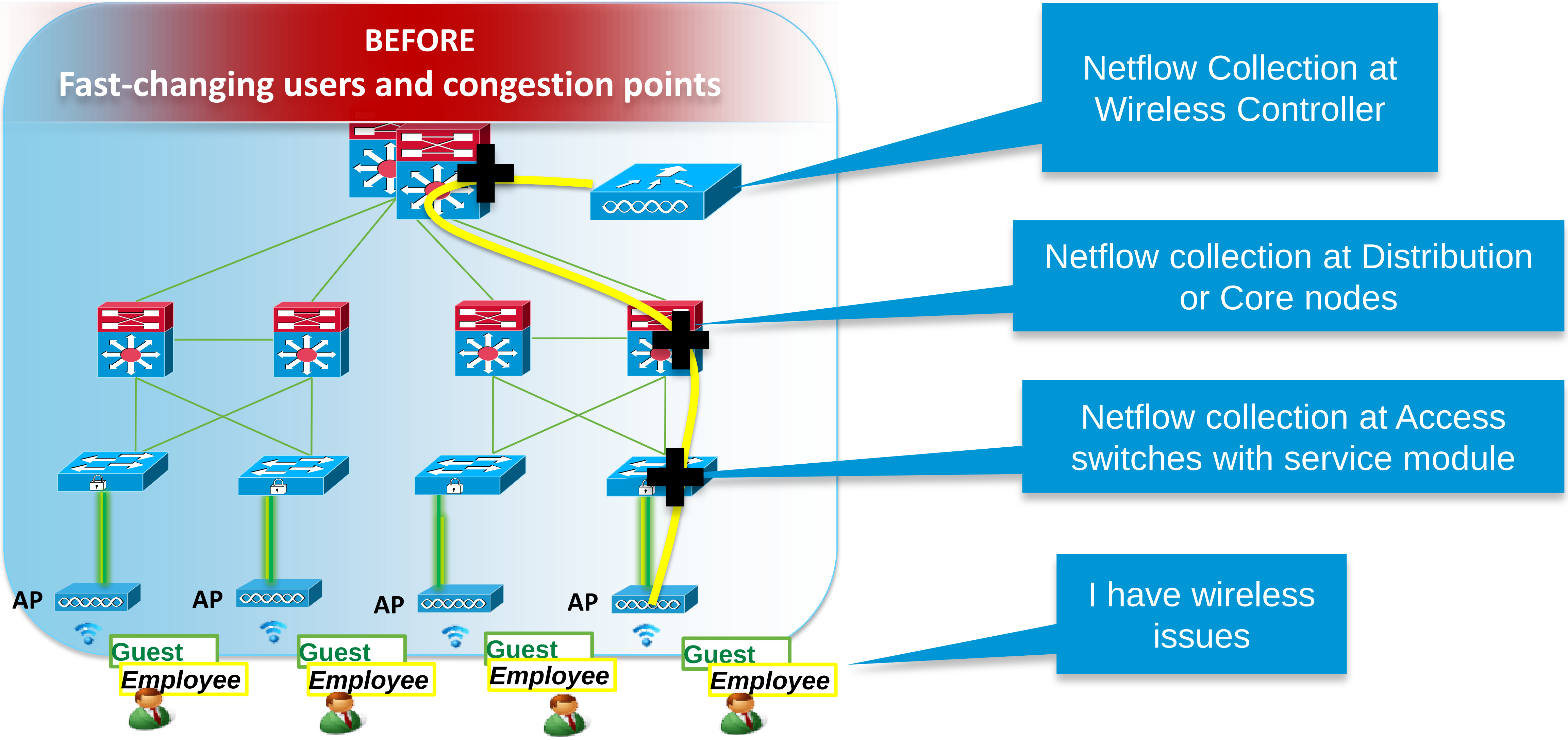
The wireless network is slow

My application is taking too long to load

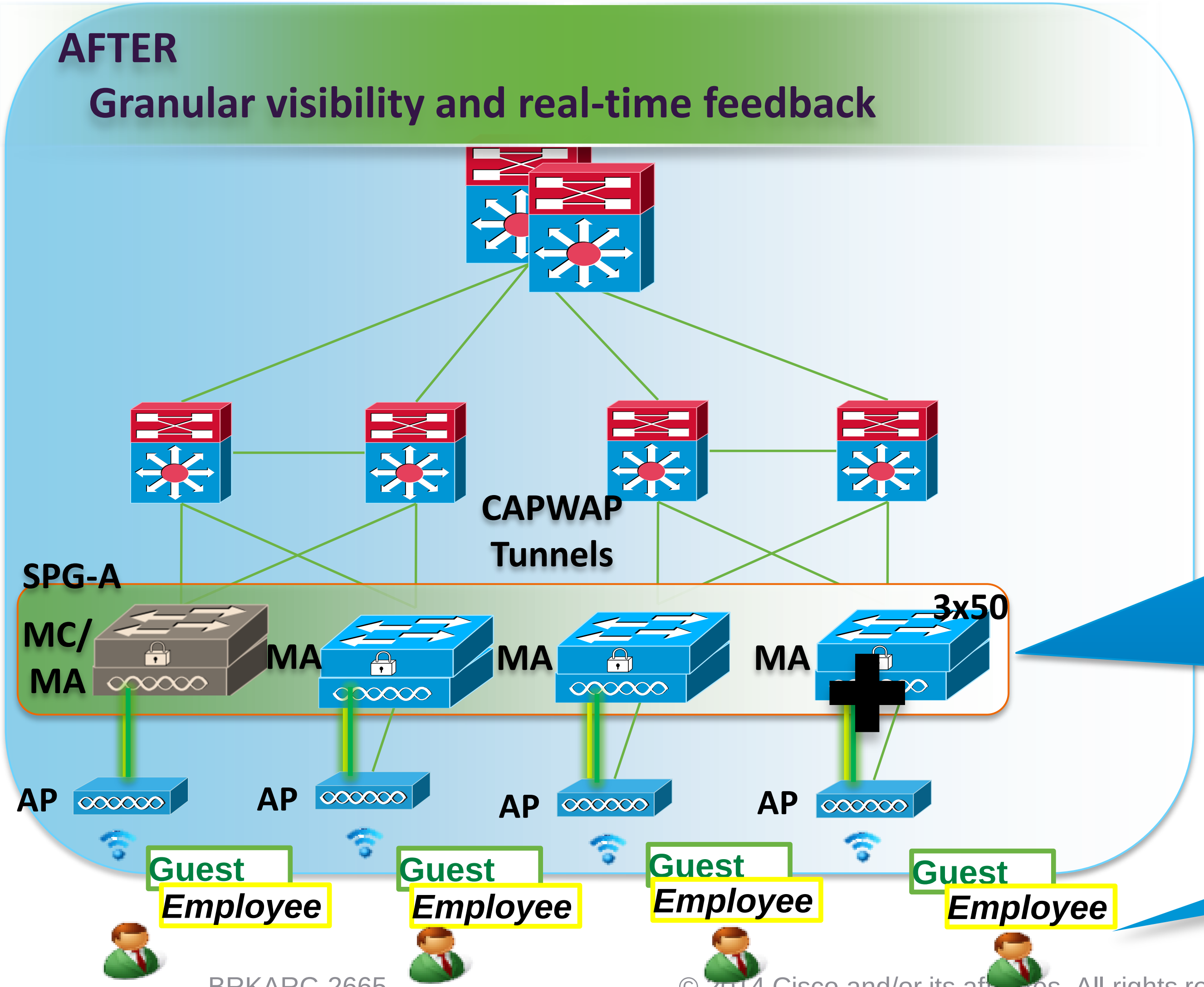
I have wireless issues

100

Troubleshooting with NetFlow –
Before Converged Access



NetFlow Visibility – For Wired and Wireless Traffic



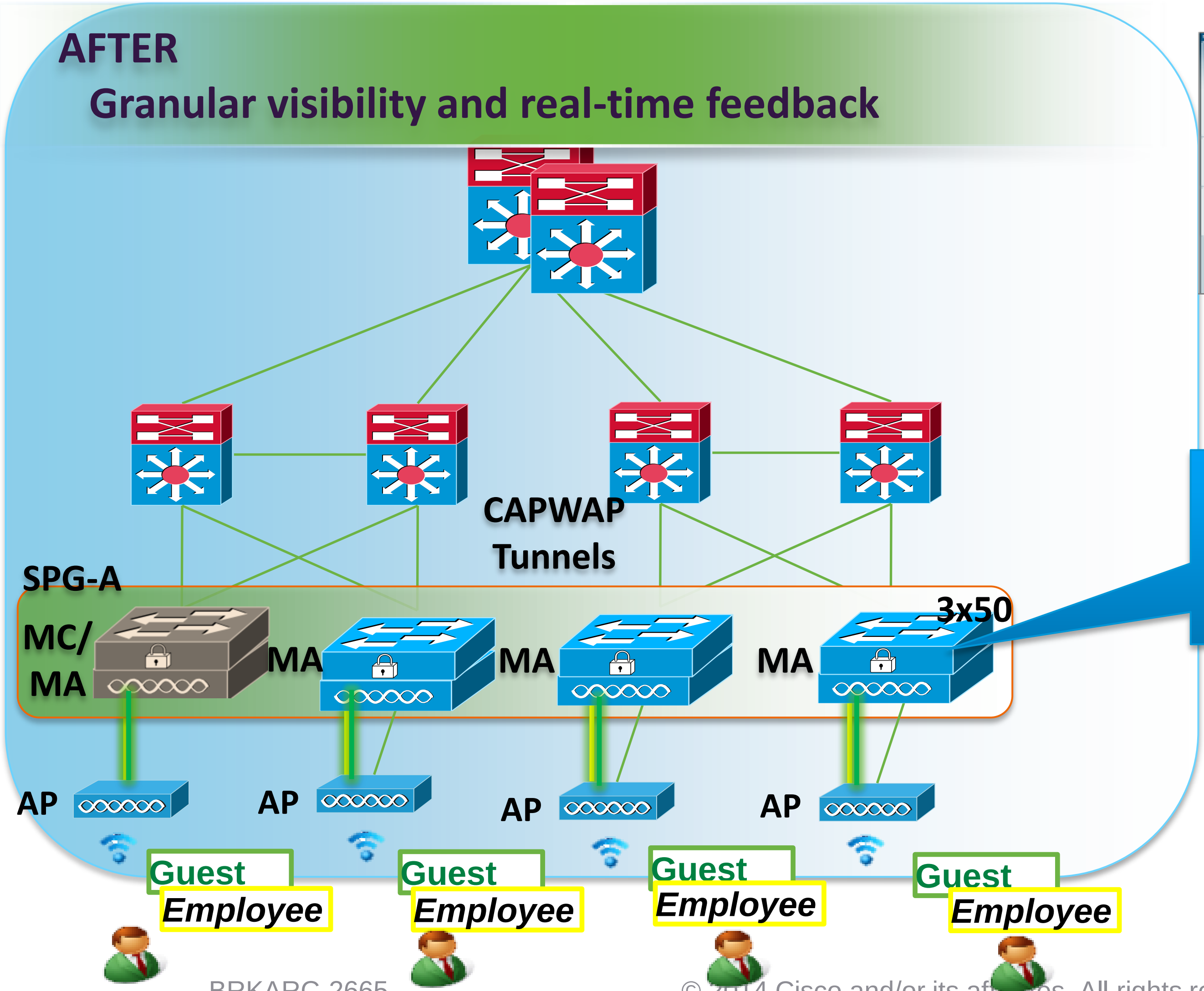
Prime Assurance Manager

Real-time Monitoring

- Unprecedented visibility to wireless traffic
  - Client
  - AP
  - SSID view
- SSID VLAN Mapping
- Top talkers

I have wireless issues

NetFlow Visibility –
For Wired and Wireless Traffic

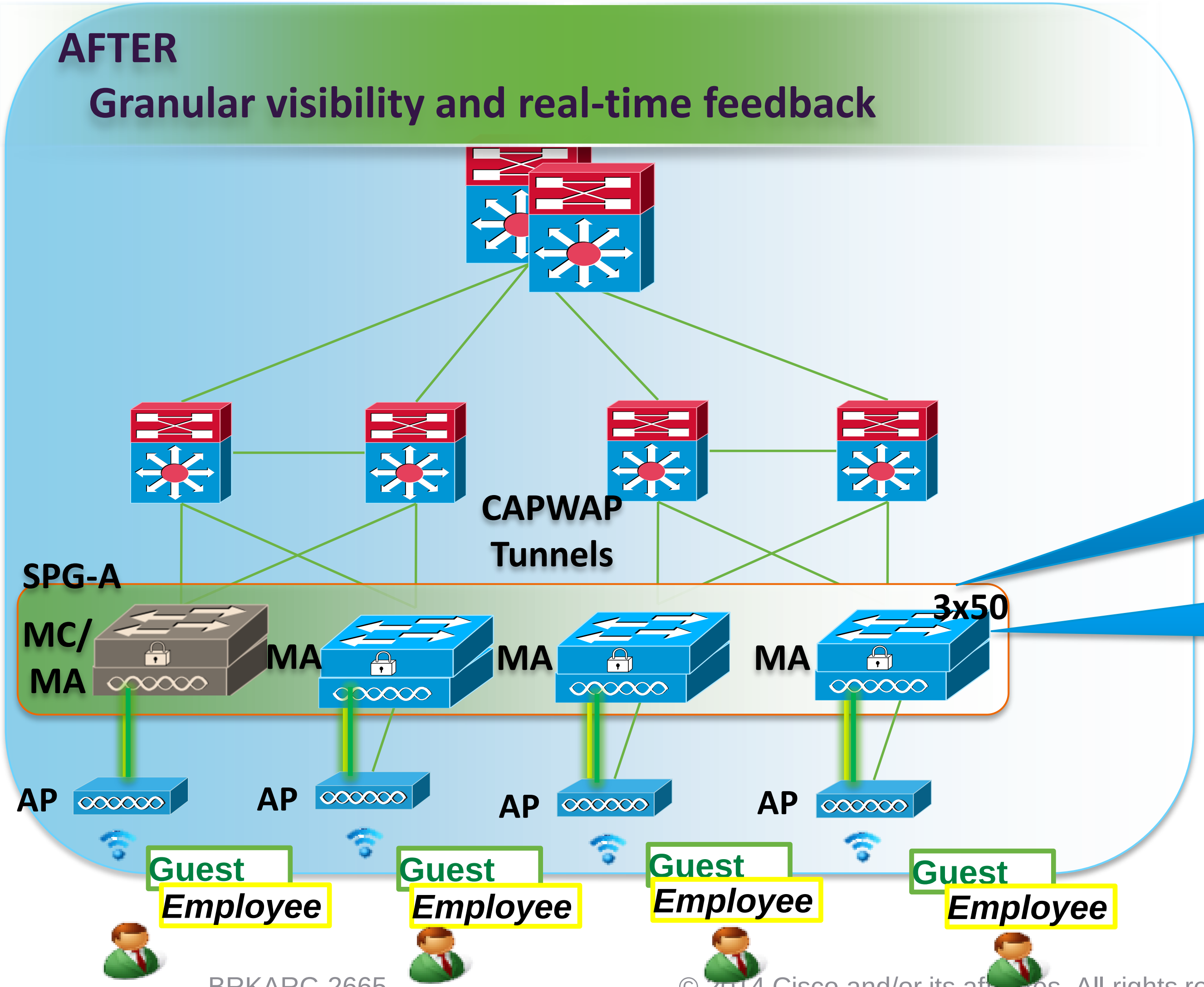


Prime Assurance Manager

```
# flow exporter CISCO-PI- COLLECTOR
# description CISCO PRIME INFRA FNF COLLECTOR
# destination 10.100.1.82 transport udp 2055 source vlan 4093
```


103

NetFlow Visibility –
For Wired and Wireless Traffic



Prime Assurance Manager

flow monitor WIRED-PHONE-FNF- MONITOR
record GLOBAL-FNF-POLICY
exporter CISCO-PI-COLLECTOR

flow monitor CA-WiFi-L3-SSID- FNF-MONITOR
record GLOBAL-FNF-POLICY
exporter CISCO-PI-COLLECTOR

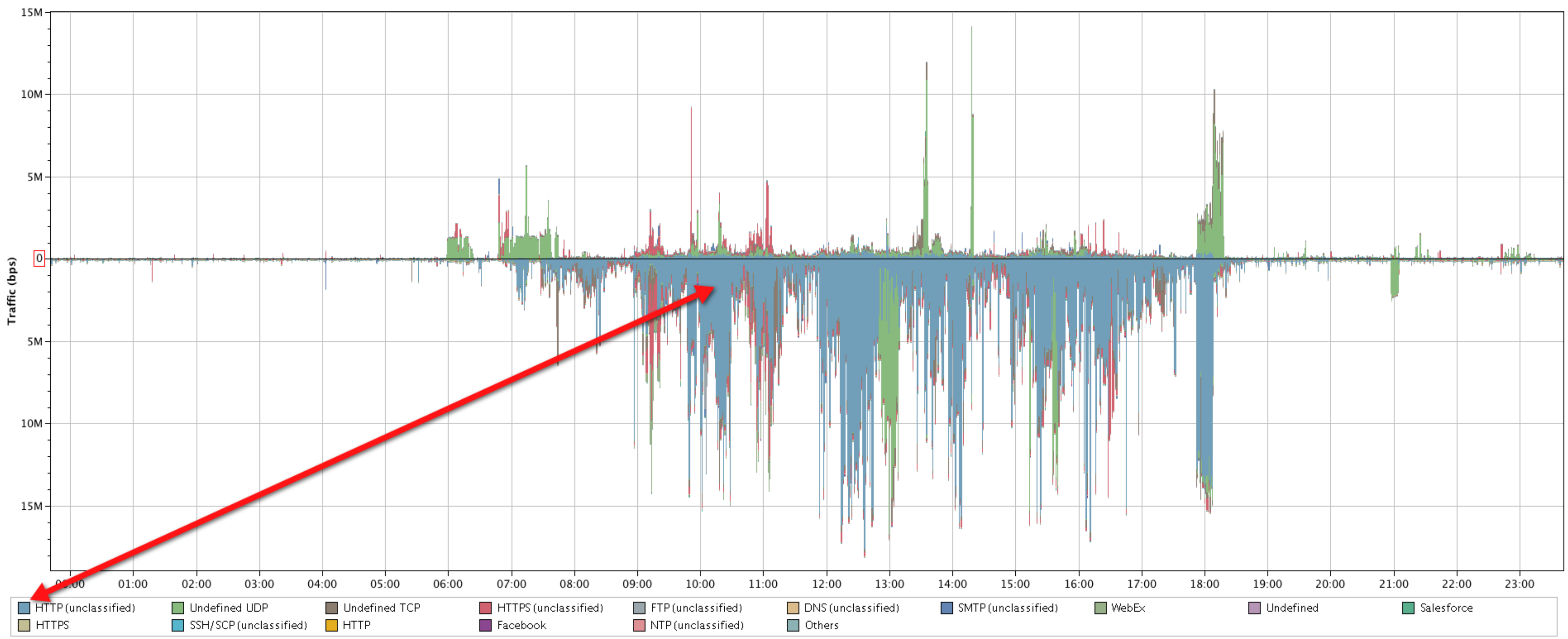
104

Capacity Planning – NetFlow-based

Traffic Statistics

	Total Bytes	Last (bps)	Mean (bps)	Peak (bps)	95th (bps)
Inbound:	147.53G	435.1k	498.51k	18.59M	2.08M
Outbound:	485.27G	6.5M	1.64M	19.43M	9.04M

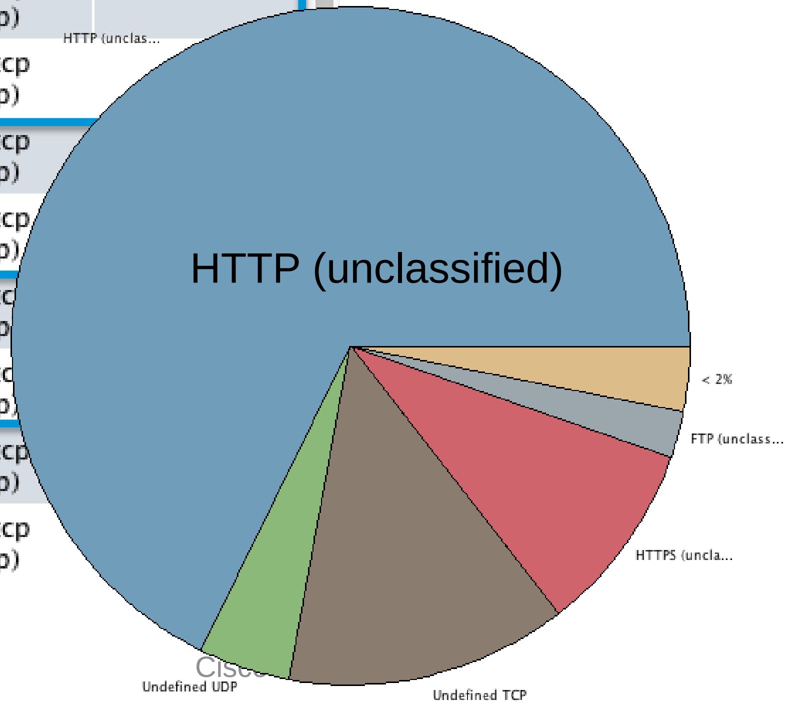
Inbound (+) and Outbound (-)



Comprehensive Visibility –
NetFlow-based

Host	Host Role	Peer	Port	Bytes
spyglass.lancope.com (209.182.184.2)	Client	vip1.g-anycast1.cachefly.net (205.234.175.175)	80/tcp (http)	76.73M
spyglass.lancope.com (209.182.184.2)	Client	mediaserver-sv5-t1-2.pandora.com (208.85.42.22)	80/tcp (http)	75.73M
spyglass.lancope.com (209.182.184.2)	Client	ragana.canonical.com (91.189.91.13)	80/tcp (http)	73.18M
spyglass.lancope.com (209.182.184.2)	Client	s3-1.amazonaws.com (207.171.163.151)	80/tcp (http)	69.94M
spyglass.lancope.com (209.182.184.2)	Client	mediaserver-dc6-t1-3.pandora.com (208.85.46.23)	80/tcp (http)	69.01M
spyglass.lancope.com (209.182.184.2)	Client	mediaserver-sv5-t1-3.pandora.com (208.85.42.33)	80/tcp (http)	62.83M
spyglass.lancope.com (209.182.184.2)	Client	mediaserver-sjl-t1-2.pandora.com (208.85.41.12)	80/tcp (http)	
spyglass.lancope.com (209.182.184.2)	Client	65.121.209.25	80/tcp (http)	
spyglass.lancope.com (209.182.184.2)	Client	91.197.45.9	80/tcp (http)	
spyglass.lancope.com (209.182.184.2)	Client	mediaserver-sjl-t1-1.pandora.com (208.85.41.11)	80/tc (http	
spyglass.lancope.com (209.182.184.2)	Client	mediaserver-sv5-t1-1.pandora.com (208.85.42.21)	80/tc (http)	
spyglass.lancope.com (209.182.184.2)	Client	cds56.mia9.msecn.net (65.54.93.59)	80/tcp (http)	
spyglass.lancope.com (209.182.184.2)	Client	cds115.mia9.msecn.net (65.54.93.118)	80/tcp (http)	

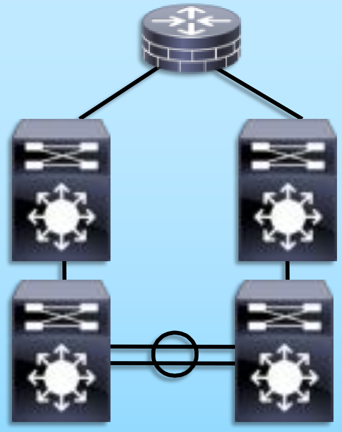
Lancope
Network Performance + Security Monitoring™



106

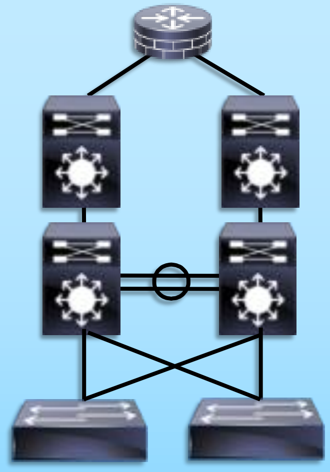
NetFlow –
Evolution for Wired and Wireless

NetFlow Today



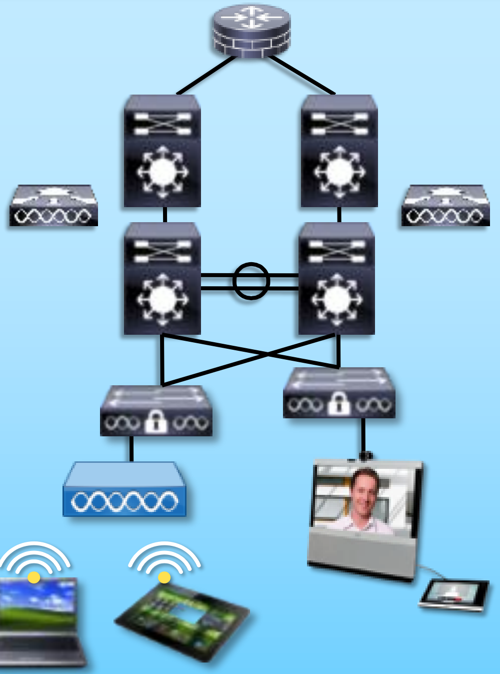
- Used in Distribution/WAN
- Use Cases: Capacity Planning, Application Visibility

NetFlow in Wired Access



- End-to-End Visibility: L2, East-West Traffic, App ID, **UserID, PoE, Device Type***
- Use Case: Collaboration, Security, Capacity Planning

NetFlow in Converged Access



- Converged Access Visibility: **SSID, AP Name, Client ID, Device Type***
- Use Case: BYOD, Mobility, Collaboration, Security, Capacity Planning

** Some enhancements on roadmap*

Agenda – BRKARC-2665

Converged Access –
IP Addressing – Options

Multiple options exist for how to assign user subnets in Converged Access

Several possible IP addressing deployment models exist for wired / wireless use …

Option 1 – Separate wired and wireless VLANs, per wiring closet

Option 2 – Merged wired and wireless VLANs, per wiring closet

Option 3 – Separate wired VLANs per wiring closet, spanned wireless VLAN across multiple wiring closets (below a single distribution)

There are trade-offs between each of these IP addressing design models ….

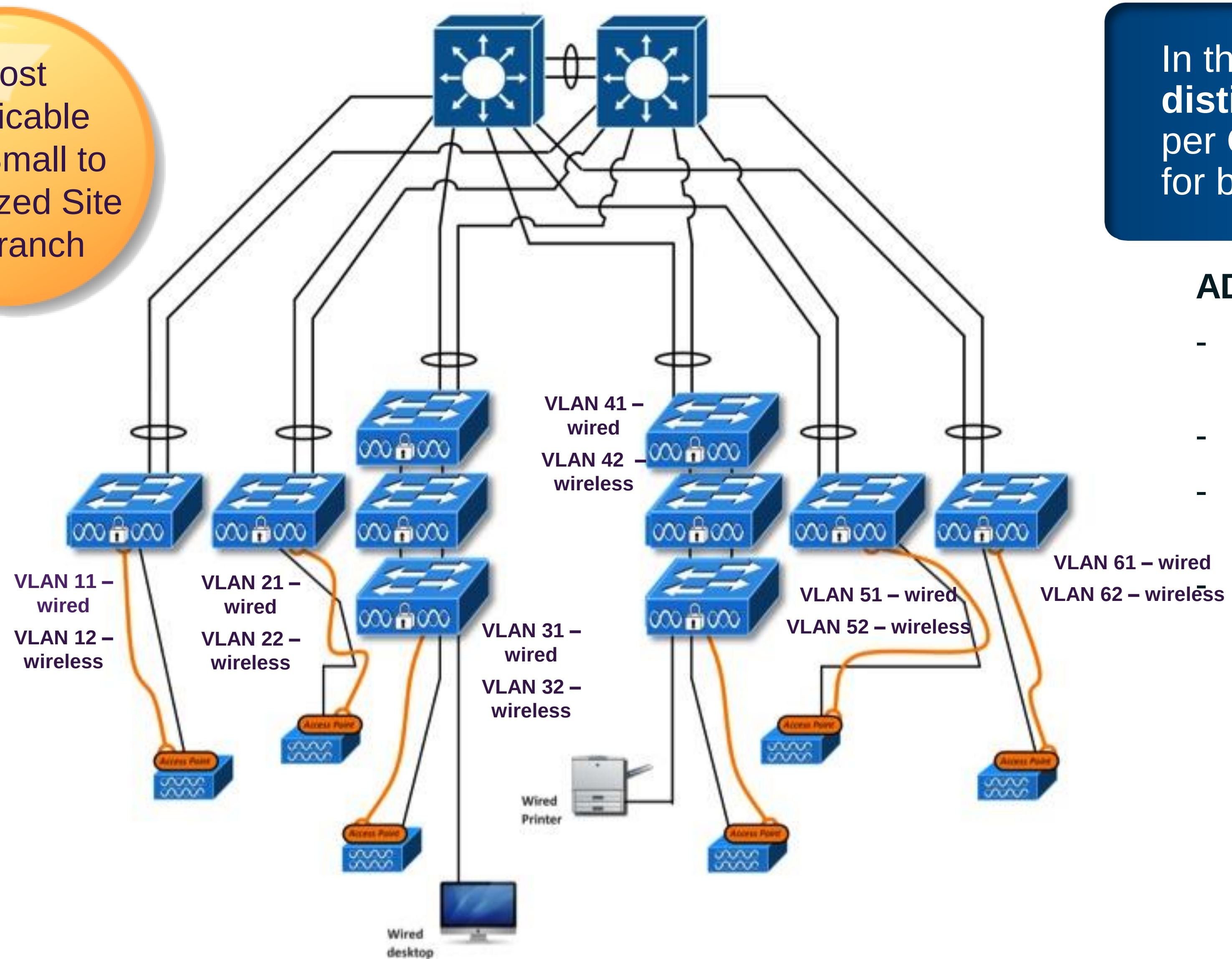
All of the models presented here have been tested and validated.

This is a customer / partner design choice based on current deployment and requirements.

Converged Access – IP Addressing – Option 1

OPTION 1 – Separate VLANs / subnets per wiring closet, for wired and wireless

Most Applicable to a Small to Mid-Sized Site or Branch



In this design option, **separate and distinct subnets** are configured per Converged Access wiring closet, for both wired and wireless users

ADVANTAGES –

- Easy to understand – maps well to user expectations for wired design
- Can match any wired deployment (L2 / L3)
- Can create separate wired and wireless policies based on VLAN
- Eliminates DHCP contention wired/wireless

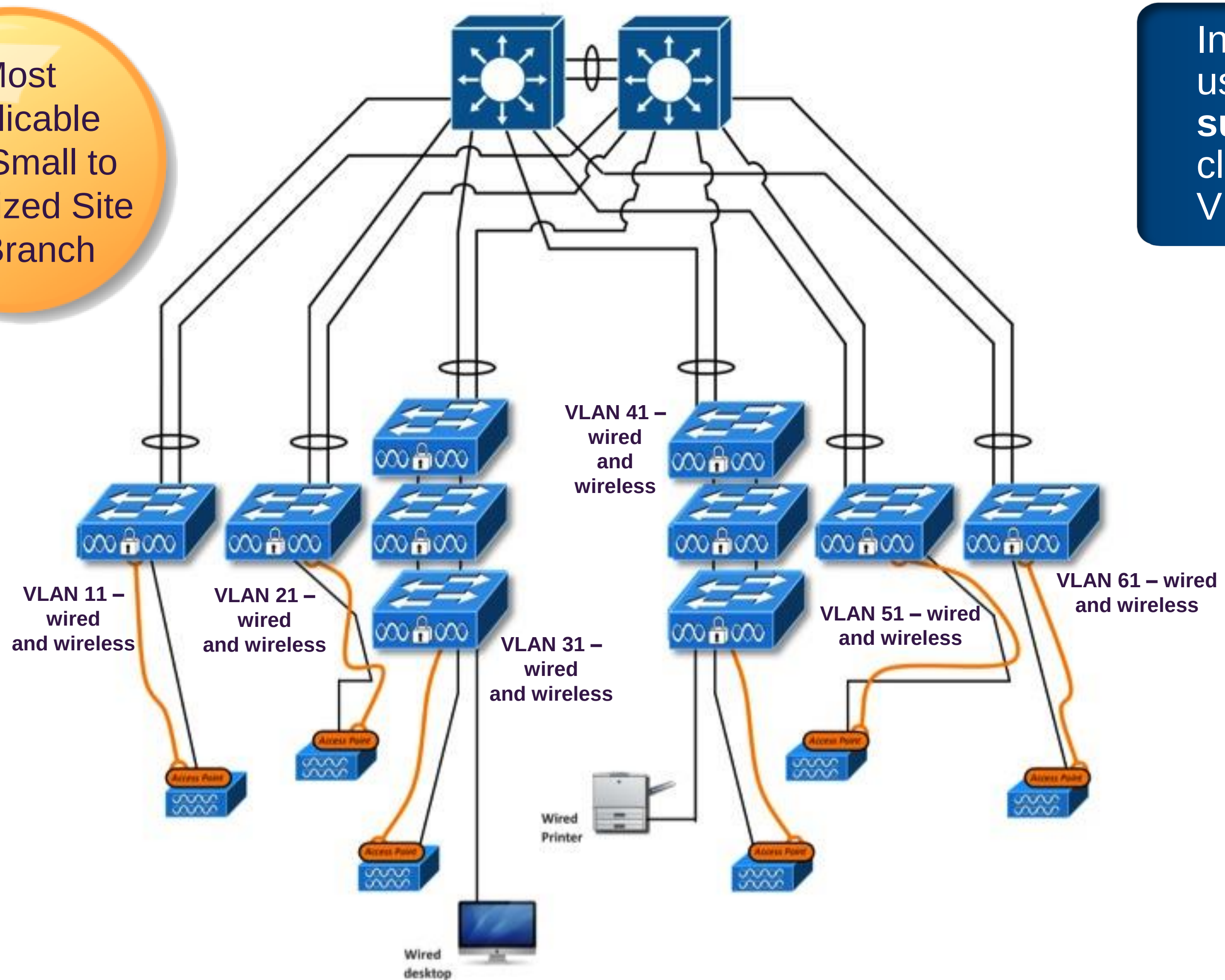
CONSIDERATIONS –

- May lead to more subnets required
- May be hard to size wireless subnets for number of anticipated wireless clients, per wiring closet (may lead to wasted IP address space for wireless use, potentially)

Converged Access – IP Addressing – Option 2

OPTION 2 – Merged VLANs / subnets per wiring closet, for wired and wireless

Most Applicable to a Small to Mid-Sized Site or Branch



In this design option, wired and wireless users and devices **share common subnets** per Converged Access wiring closet (i.e. one or more wired / wireless VLANs per wiring closet)

ADVANTAGES –

- Leads to fewer subnets req'd vs. Option 1

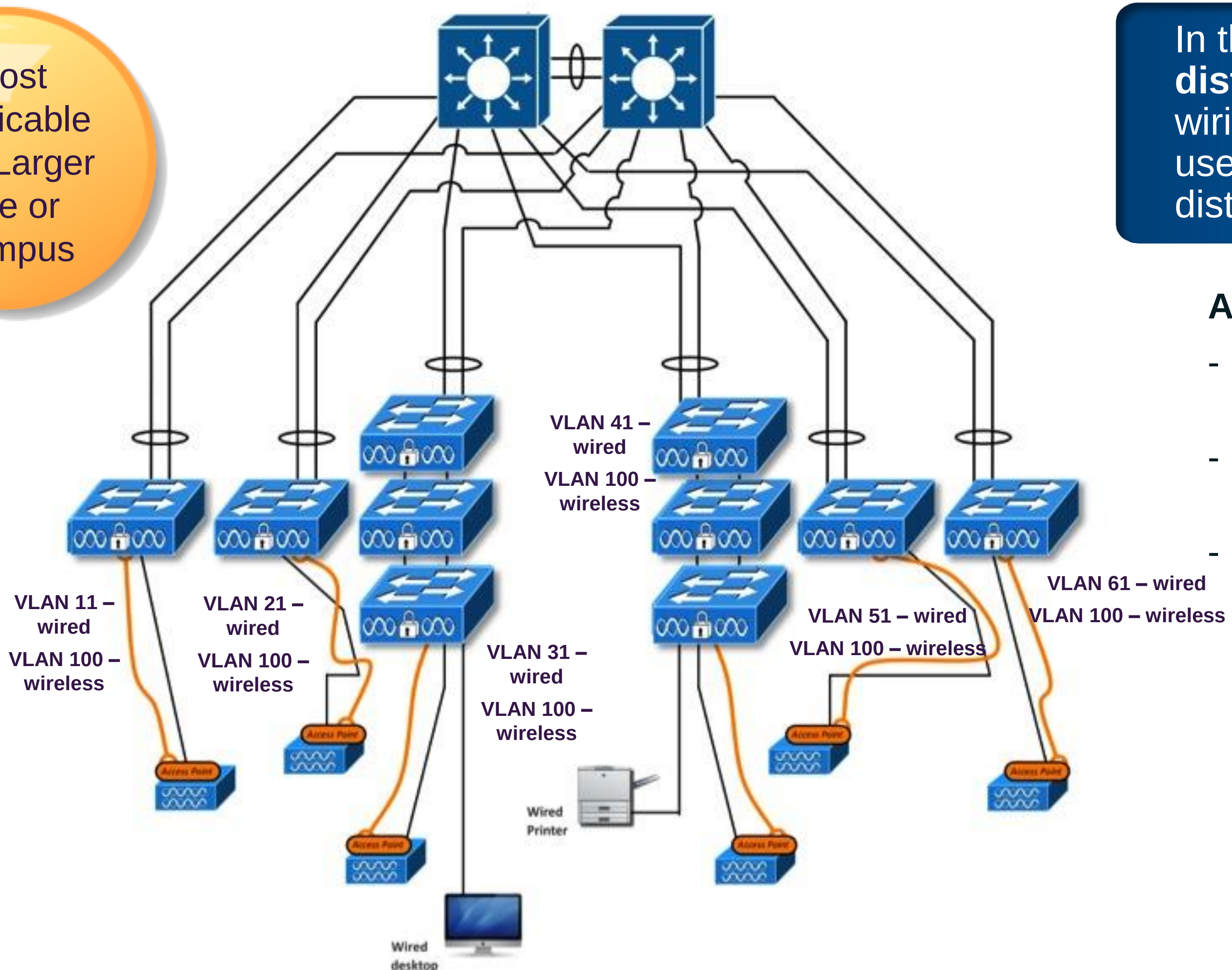
CONSIDERATIONS –

- Potential dual-attached device issues (possible client-side bridging issues)
- No longer possible to apply separate per-VLAN policies for wired / wireless
- May be hard to size combined subnets appropriately for number of wired / wireless clients, per wiring closet (may be slightly more efficient vs. Option 1)
- Possible DHCP contention, wired / wireless

Converged Access – IP Addressing – Option 3

OPTION 3 – Separate wired VLANs / subnets per wiring closet, with wireless VLAN spanned

Most Applicable to a Larger Site or Campus



In this design option, **separate and distinct subnets** per Converged Access wiring closet for both wired and wireless users, with wireless spanned below he distribution layer

ADVANTAGES –

- Can create separate wired and wireless policies based on VLAN
- Leads to fewer subnets req'd vs. Option 1 (only one wireless subnet below dist.)
- Easier to size wireless subnet(s) below distribution layer (closer correspondence to IP addressing in the CUWN model)

CONSIDERATIONS –

- Optimised with VSS, or other similar single-switch-equivalent model, at distribution (to avoid L2 loops)
- Topology differs, wired vs. wireless

Agenda – BRKARC-2665

Evolution … Towards One Policy, One Management, One Network
Converged Access – Platform Overviews
Existing Wireless Deployments – Architecture Refresher

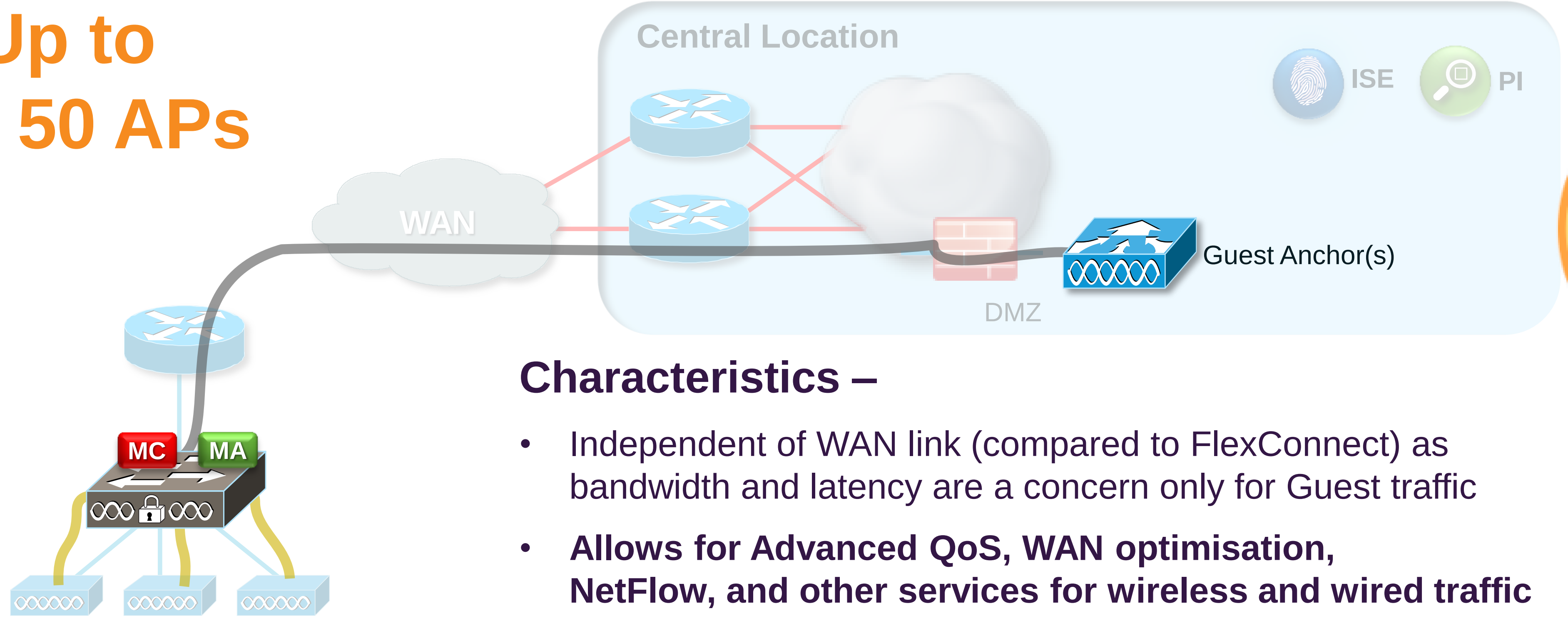
Converged Access Architecture –
- Terminology and Building Blocks
- Traffic Flows and Roaming
- High Availability
- Quality of Service
- Security
- Multicast
- NetFlow

Converged Access Design and Deployment –
- IP Addressing
- ► Design Options
- Deployment Examples

Summary

Converged Access – Small Branch
No Discrete Controllers, Catalyst 3x50s as MCs / MAs

Up to 25 / 50 APs



Applicable to a Small Branch Deployment

Characteristics –

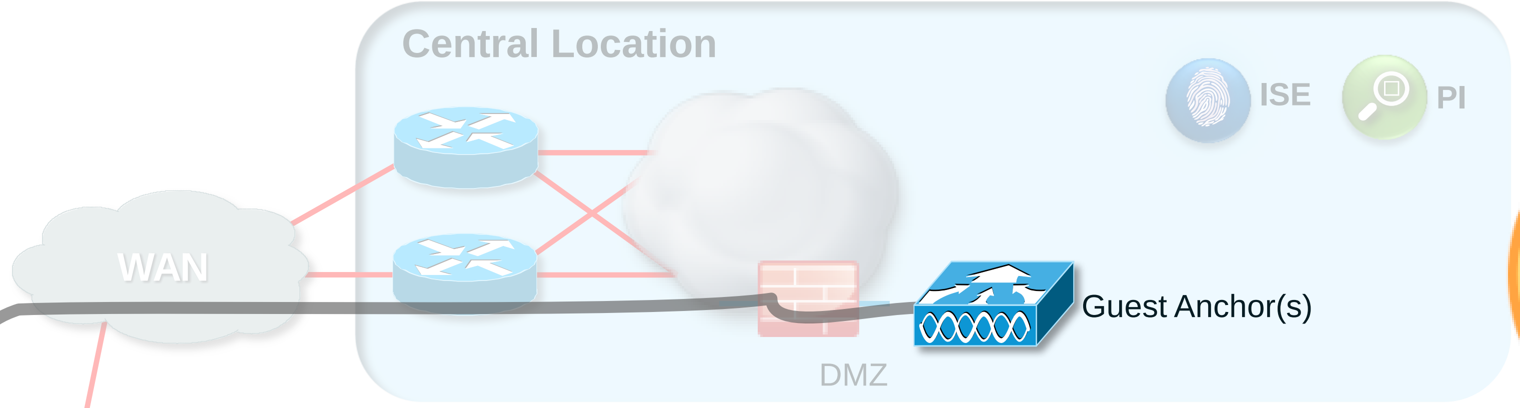
- Independent of WAN link (compared to FlexConnect) as bandwidth and latency are a concern only for Guest traffic
- **Allows for Advanced QoS, WAN optimisation, NetFlow, and other services for wireless and wired traffic**
- **Supports Layer 3 roaming**
- **Supports VideoStream and optimised multicast**
- **Good availability due to MA/MC redundancy within the 3x50 stack** – provides wireless continuity with either WAN outage or switch failure within the stack

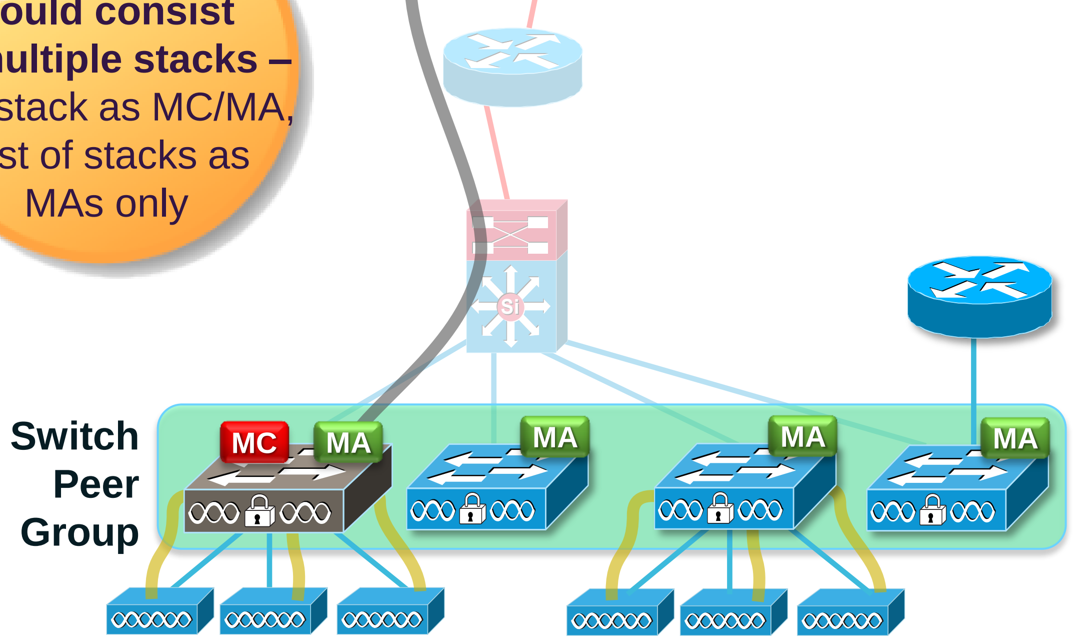
Converged Access – Small / Medium Branch

No Discrete Controllers, Catalyst 3x50s as MCs / MAs, Single SPG

Up to 25 / 50 APs

Deployment could consist of multiple stacks – one stack as MC/MA, rest of stacks as MAs only





Applicable to a Small to Medium Branch Deployment

Characteristics –

- **No discrete controllers deployed, even with multiple wiring closets**
- Allows for Advanced QoS, WAN optimisation, NetFlow, and other services for wireless ad wired traffic
- Supports Layer 3 roaming
- Supports VideoStream and optimised multicast
- **Good availability due to MA/MC redundancy within the switch stacks** – provides wireless continuity with either WAN outage or switch failure within the stack

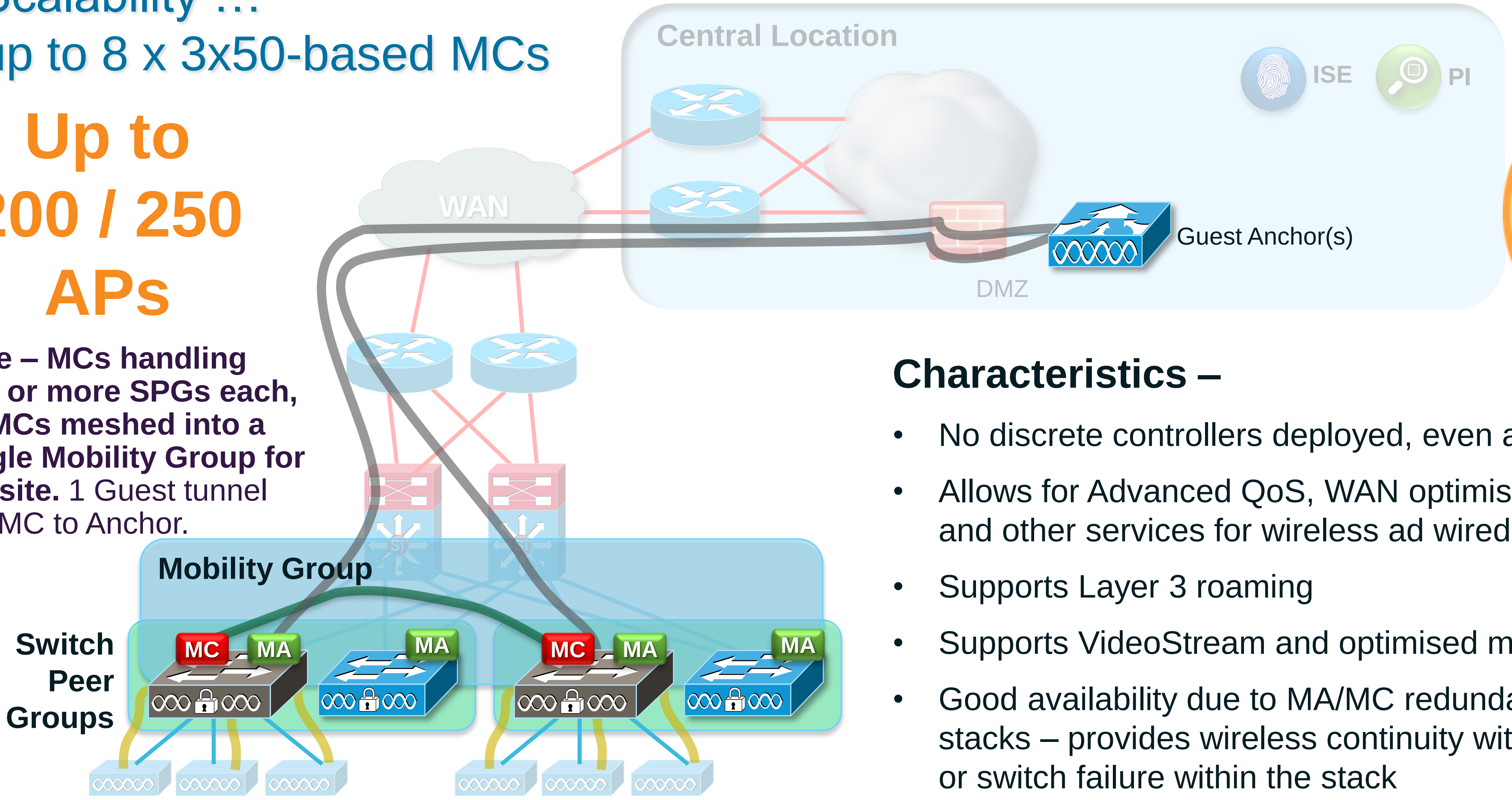
Cisco live!

Converged Access – Large Branch
No Discrete Controllers, Catalyst 3x50s as MCs / MAs, Multiple SPGs

Scalability …
up to 8 x 3x50-based MCs

Up to 200 / 250 APs

Note – MCs handling one or more SPGs each, all MCs meshed into a single Mobility Group for the site. 1 Guest tunnel per MC to Anchor.



Applicable to a Larger Branch Deployment

Characteristics –

- No discrete controllers deployed, even at a larger branch
- Allows for Advanced QoS, WAN optimisation, NetFlow, and other services for wireless ad wired traffic
- Supports Layer 3 roaming
- Supports VideoStream and optimised multicast
- Good availability due to MA/MC redundancy within the switch stacks – provides wireless continuity with either WAN outage or switch failure within the stack

Converged Access – Small Campus

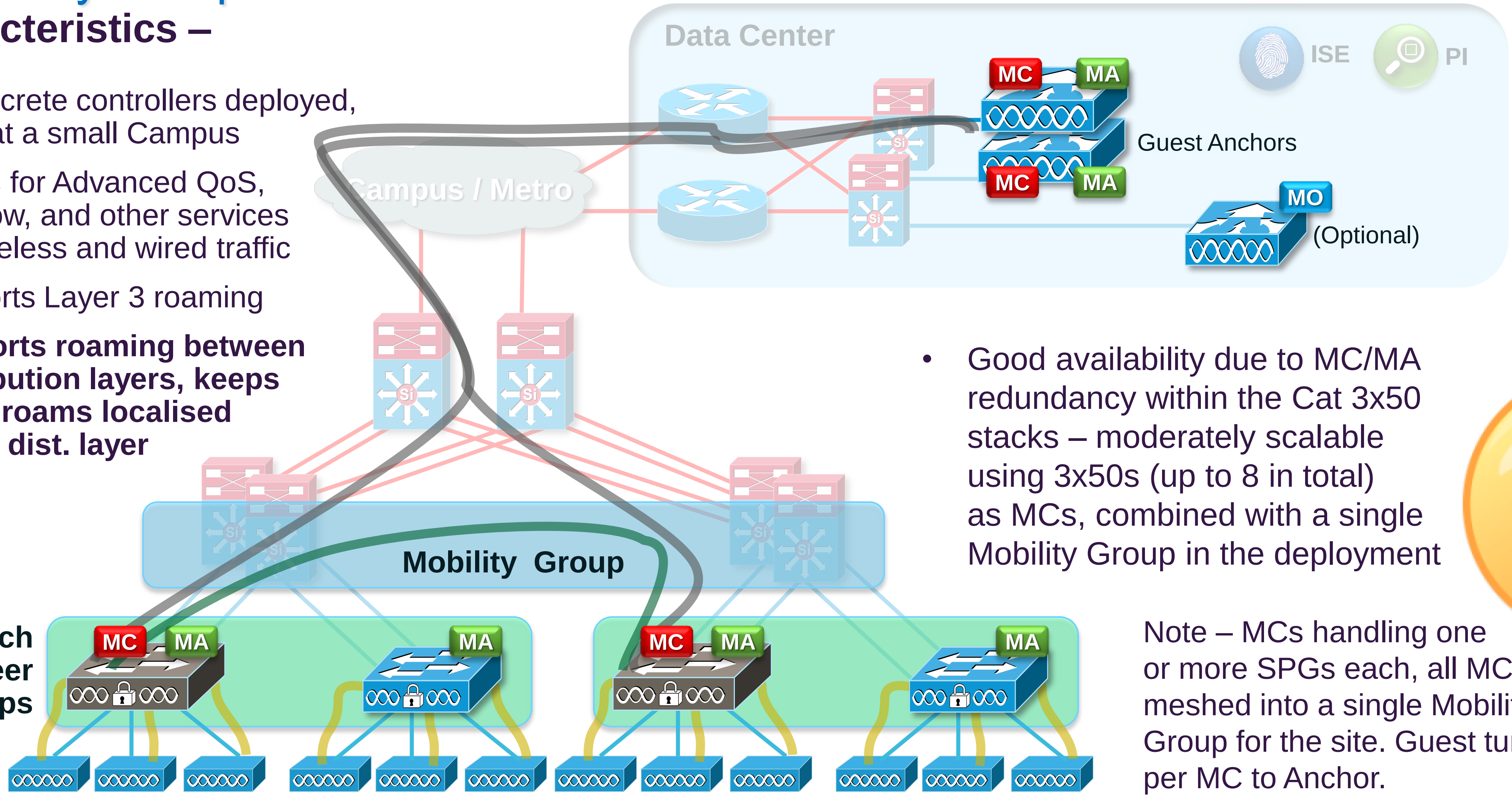
Catalyst 3x50s as MC s / MAs, Multiple SPGs

Up to 200 / 250 APs

Scalability … up to 8 x 3x50-based MCs

Characteristics –

- No discrete controllers deployed, even at a small Campus
- Allows for Advanced QoS, NetFlow, and other services for wireless and wired traffic
- Supports Layer 3 roaming
- **Supports roaming between distribution layers, keeps many roams localised below dist. layer**



- Good availability due to MC/MA redundancy within the Cat 3x50 stacks – moderately scalable using 3x50s (up to 8 in total) as MCs, combined with a single Mobility Group in the deployment

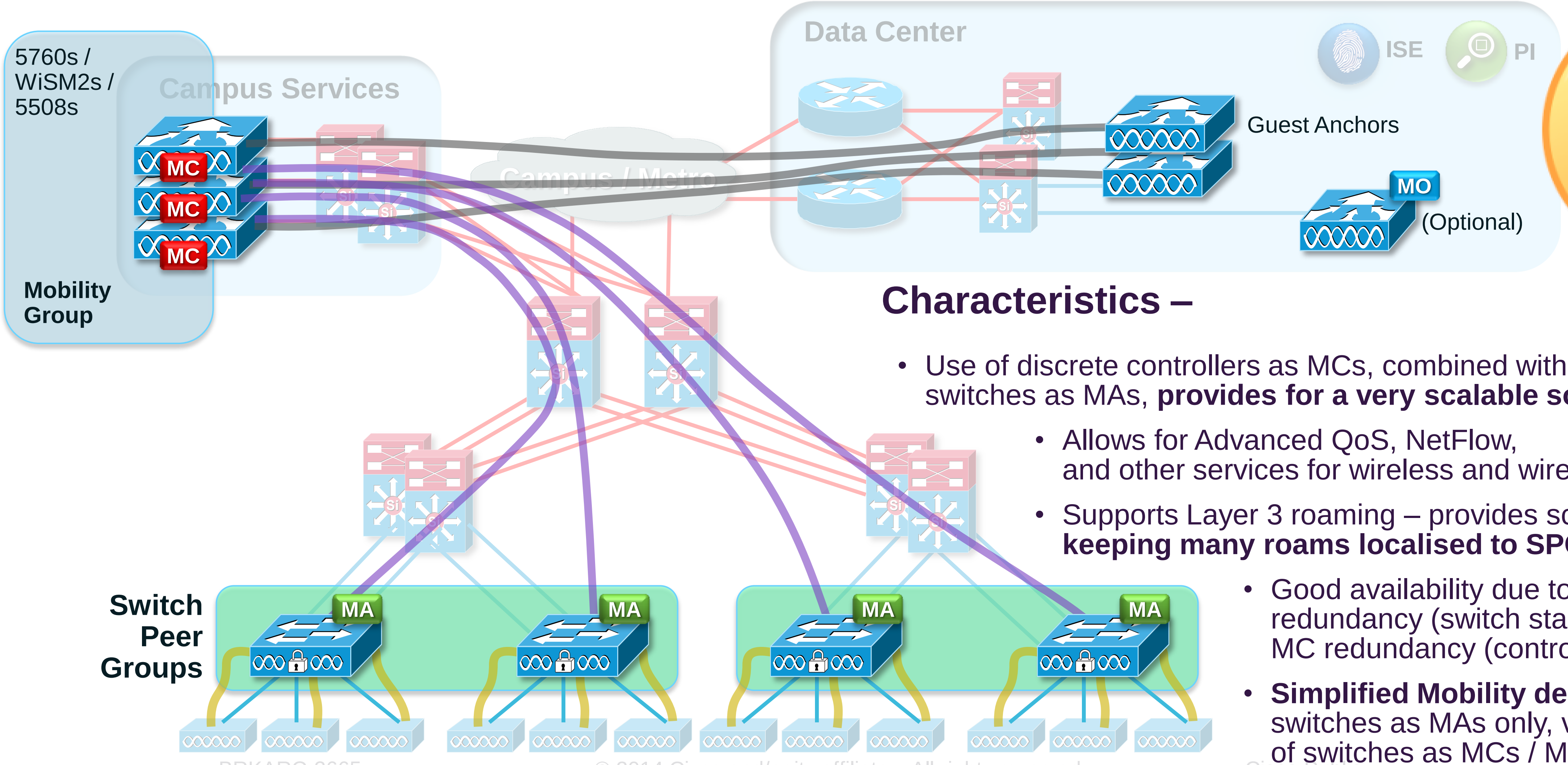
Applicable to a Small Campus Deployment

Note – MCs handling one or more SPGs each, all MCs meshed into a single Mobility Group for the site. Guest tunnel per MC to Anchor.

Converged Access – Large Campus

Centralised Controllers as MCs, 3x50s as MAs Only

>250 APs



Applicable to a Larger Campus

Characteristics –

- Use of discrete controllers as MCs, combined with Catalyst 3x50 switches as MAs, **provides for a very scalable solution**
- Allows for Advanced QoS, NetFlow, and other services for wireless and wired traffic
- Supports Layer 3 roaming – provides scalability by **keeping many roams localised to SPGs** (below dist.)
- Good availability due to MA redundancy (switch stacks) and MC redundancy (controllers)
- **Simplified Mobility deployment** using switches as MAs only, vs. the use of switches as MCs / MAs

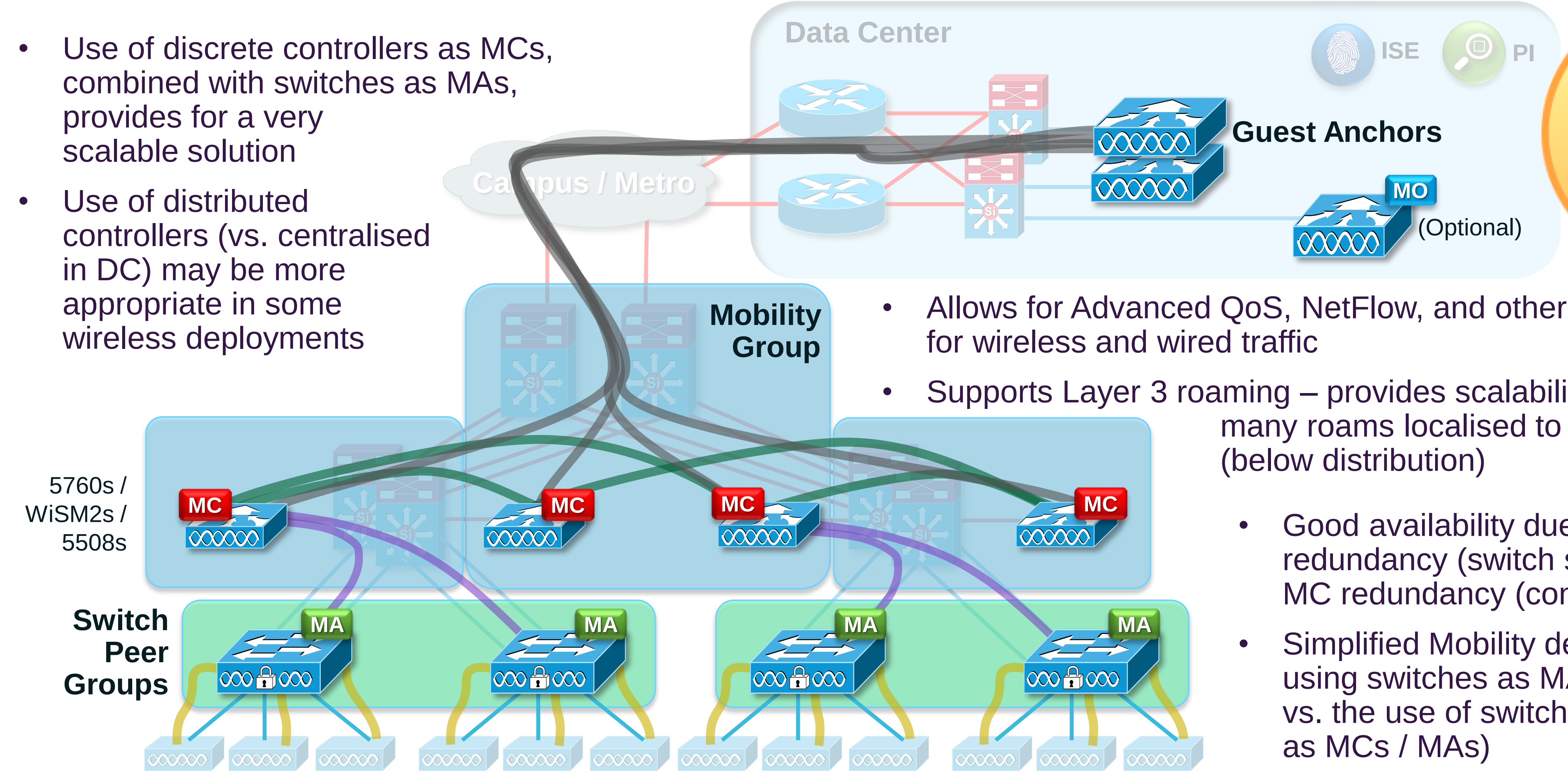
Converged Access – Large Campus

Distributed Controllers as MCs, 3x50s as MAs Only

>250 APs

Characteristics –

- Use of discrete controllers as MCs, combined with switches as MAs, provides for a very scalable solution
- Use of distributed controllers (vs. centralised in DC) may be more appropriate in some wireless deployments



Applicable to a Larger Campus

- Allows for Advanced QoS, NetFlow, and other services for wireless and wired traffic
- Supports Layer 3 roaming – provides scalability by keeping many roams localised to SPGs (below distribution)
- Good availability due to MA redundancy (switch stacks) and MC redundancy (controllers)
- Simplified Mobility deployment using switches as MAs only, vs. the use of switches as MCs / MAs)

Agenda – BRKARC-2665

Evolution … Towards One Policy, One Management, One Network
Converged Access – Platform Overviews
Existing Wireless Deployments – Architecture Refresher

Converged Access Architecture –

- Terminology and Building Blocks
- Traffic Flows and Roaming
- High Availability
- Quality of Service
- Security
- Multicast
- NetFlow

Converged Access Design and Deployment –

- IP Addressing
- Design Options
- ► Deployment Examples

Summary

Converged Access Deployment –
Before You Begin – AP Licensing

- AP licenses are applied at the MC level only (not at MA)
- As with CUWN, a valid license on the Controller is needed for an AP to register
- If MA and MC functionality are not co-located (ex MA on 3x50 and MC on 5760), the communication between MA and MC needs to be UP for AP to join
- Licenses need to be activated on the MC –
  - Converged Access adopts a honor based license mechanism
  - User needs to accept a End User License Agreement (EULA)
  - Use the following command to activate AP licenses:

```
5760-# license right-to-use activate apcount ?
<5-1000>    configure the number of adder licenses in multiples of 5
evaluation  activate evaluation license
```

Converged Access Deployment –

Before You Begin – AP Licensing

- Must run **ipservices** or **ipbase** license to activate wireless services on 3650 / 3850 –

```
3850# sh license right-to-use
 Slot#  License name   Type          Count Period left
 1      ipbase         permanent     N/A   Lifetime
 1      apcount        base          0     Lifetime
 1      apcount        adder         50    Lifetime
License Level on Reboot: ipbase
```

- The 5760 does not have activated license levels, the image is already ipservices
- Licensing on a 3850 / 3650 stack –
  - Each switch member in the stack can be licensed independently, up to 25 APs total on a 3650 stack, and up to 50 APs total on a 3850 stack
  - For best redundancy, it is ideal to enable the proper license count for each stack member, based on the number of APs that will be connected to it. So if you lose a switch, you only lose those licenses

Converged Access Deployment –
Before You Begin – How to Connect APs

- The Catalyst 3850 and 3650 support only **directly attached APs**

  APs need to be in the same VLAN as the Wireless Management interface:

```
interface GigabitEthernet1/0/1
description to_AP
switchport access vlan 31
switchport mode access
```

```
interface Vlan31
 ip address 192.168.31.42 255.255.255.0
 !
 wireless management interface Vlan31
```

  If you do not define a wireless management VLAN on the 3x50, the switch will then be transparent to AP attachment and everything will continue to operate as it does today on a 3750-X.

  As soon as you define a «wireless management interface VLAN», the Catalyst 3x50 will intercept all incoming AP CAPWAP requests, and terminate / process them at the local ASIC.

- WLC 5760 supports only NON-directly attached APs

  Same as it works today in CUWN: AP attached to a local switch (3750-X or alike) finds the centralised controller through DHCP option 43 or other methods and registers

Converged Access Deployment –
Branch Use Case – Mobility Configuration

- Management VLAN Configuration

```
interface Vlan31
 description MANAGEMENT VLAN
 ip address 192.168.31.42 255.255.255.0
```

- SVIs for client VLANs defined locally on the switch

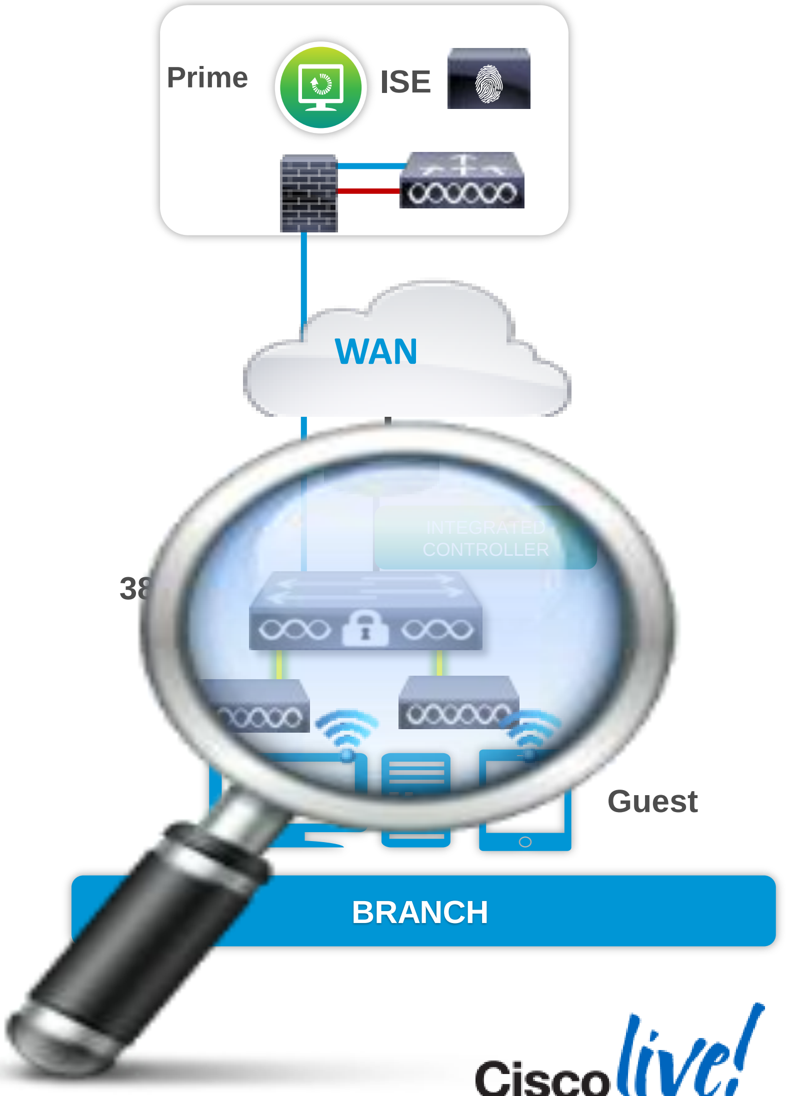
```
interface Vlan32
 description Client VLAN32
 ip address 192.168.32.2 255.255.255.0

interface Vlan33
 description Client VLAN33
 ip address 192.168.33.2 255.255.255.0
```

- Wireless Management Interface Configuration

```
3850(config)# wireless management interface VLAN31
```

This activates the MA functionality

```
3850# show wireless Interface summary
Wireless Interface Summary
AP Manager on management Interface: Enabled
Interface Name Interface Type VLAN ID IP Address      IP Netmask     MAC Address
--------------------------------------------------------------------------------
Vlan31            Management    31      192.168.31.42   255.255.255.0  2037.06ce.0a55
```



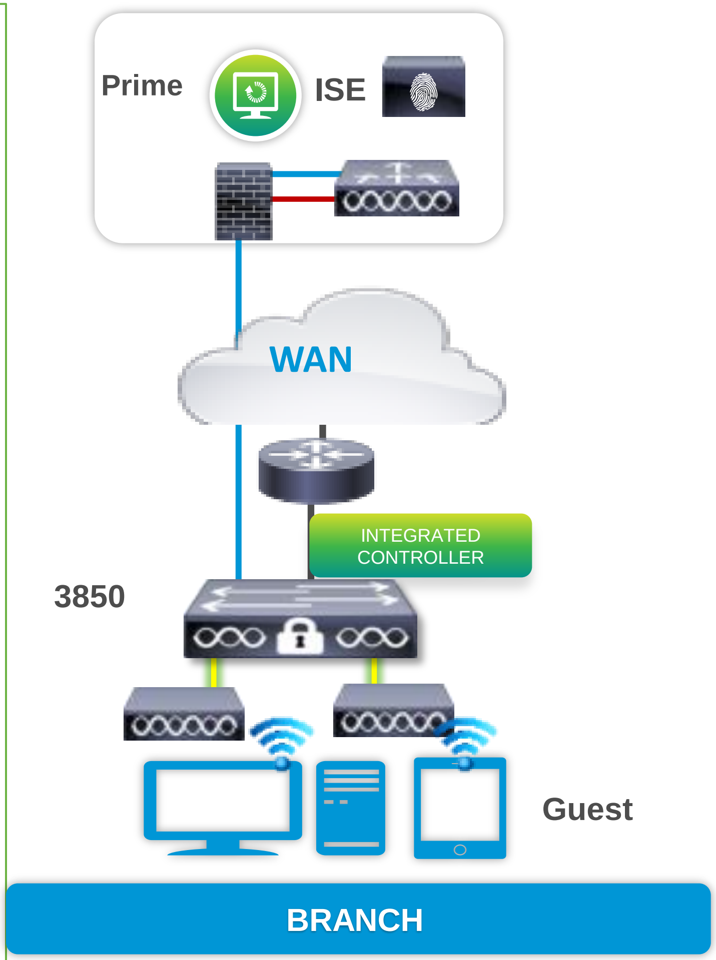
Converged Access Deployment –
Branch Use Case – Mobility Configuration, continued

- Configuring Mobility Controller

```
3850(config)# wireless mobility controller

Mobility role changed to Mobility Controller
Please save config and reboot the whole stack

3850# sh wireless mobility summary
Mobility Controller Summary:

Mobility Role                                : Mobility Controller
Mobility Protocol Port                       : 16666
Mobility Group Name                          : default
Mobility Oracle IP Address                   : 0.0.0.0
DTLS Mode                                    : Enabled
Mobility Domain ID for 802.11r               : 0xac34
Mobility Keepalive Interval                  : 10
Mobility Keepalive Count                     : 3
Mobility Control Message DSCP Value          : 0
Mobility Domain Member Count                 : 1
Link Status is Control Path Status           : Data Path Status

Controllers configured in the Mobility Domain:
IP              Public IP       Group Name       Multicast IP     Link Status
-------------------------------------------------------------------------------
192.168.31.42   -               default          0.0.0.0           UP : UP
```

This activates the MC functionality

After reboot



Converged Access Deployment –
Branch Use Case – AP Port and WLAN Configuration

- Access Point port configuration

```
interface GigabitEthernet1/0/15
     description - Access port for Access points
     switchport access vlan 31
     switchport mode access
```

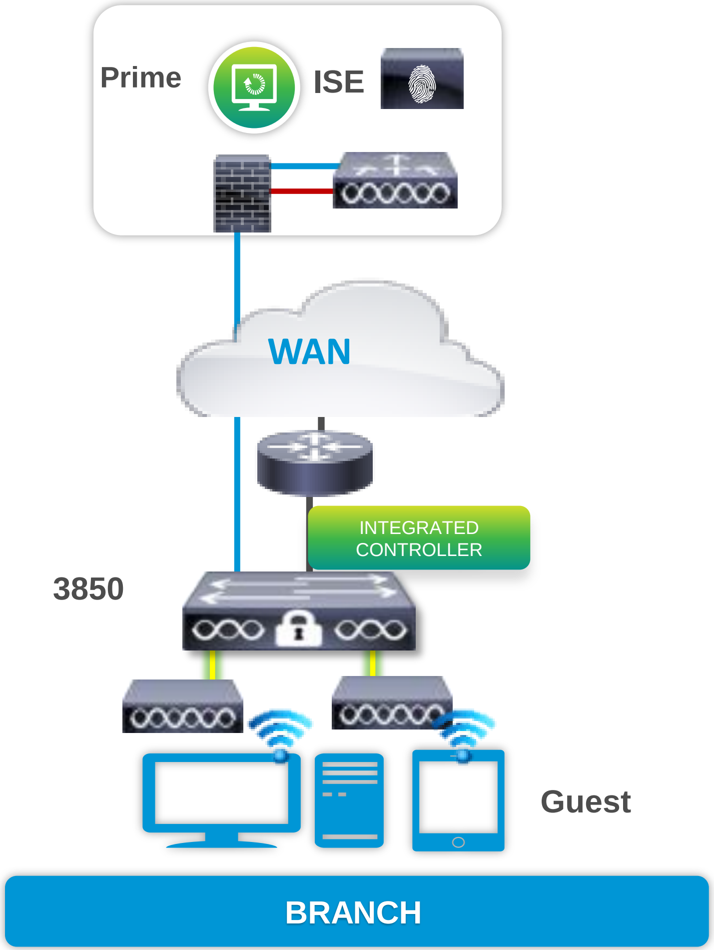
Access Points need to be configured on Wireless Management VLAN

```
3850# show ap summary
    Number of APs: 1

    Global AP User Name: Not configured
    Global AP Dot1x User Name: Not configured

AP Name                          AP Model   Ethernet MAC    Radio MAC      State
--------------------------------------------------------------------------------------
AP3502I                          3502I      c47d.4f3a.ed80  04fe.7f49.58c0 Registered
```

- WLAN Configuration

```
3850(config)# wlan WPA-PSK 4 wpa-psk
3850(config-wlan)# client vlan 32
3850(config-wlan)# no security wpa akm dot1x
3850(config-wlan)# security wpa akm psk set-key ascii 0 Cisco1234
3850(config-wlan)# no shut
```

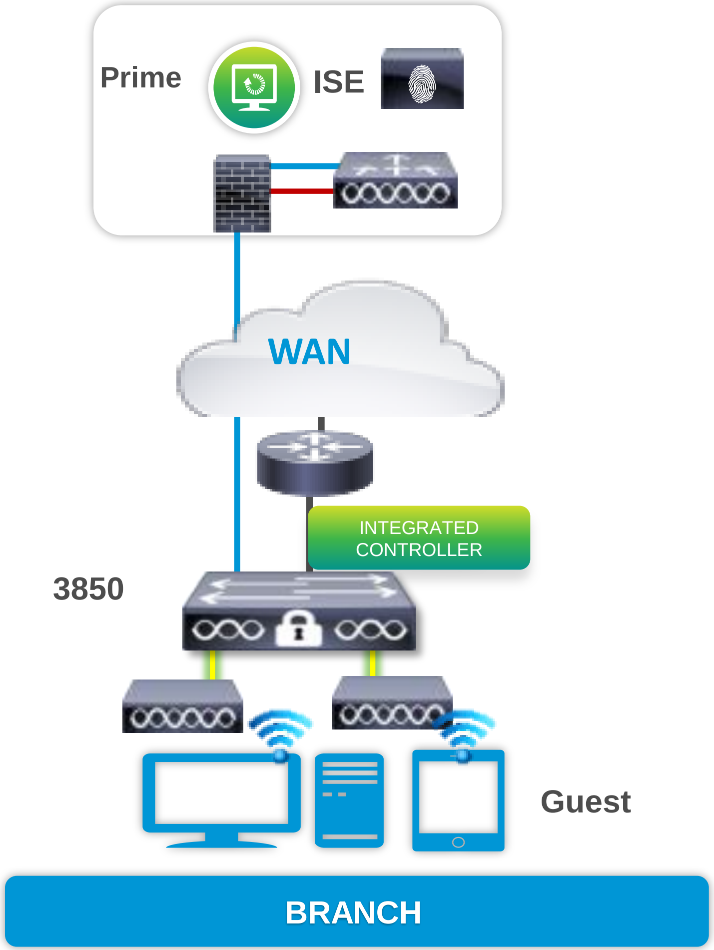
WLAN sample configuration



Converged Access Deployment –
Branch Use Case – Client Connectivity

- Client Connectivity

```
3850# sh wireless client summary

Number of Local Clients : 1

MAC Address    AP Name                            WLAN State              Protocol
-------------------------------------------------------------------------------
f81e.dfe2.e80e AP3502I                               4    UP                 11n(5)


3850# sh wcdb database all

   Total Number of Wireless Clients  = 1
       Clients Waiting to Join       = 0
       Local Clients                 = 1
       Anchor Clients                = 0
       Foreign Clients               = 0
       MTE Clients                   = 0

    Mac Address     VlanId  IP Address       Auth     Mob
   --------------  ------ ---------------  -------  -----
   f81e.dfe2.e80e    32     192.168.32.57   RUN      LOCAL
```



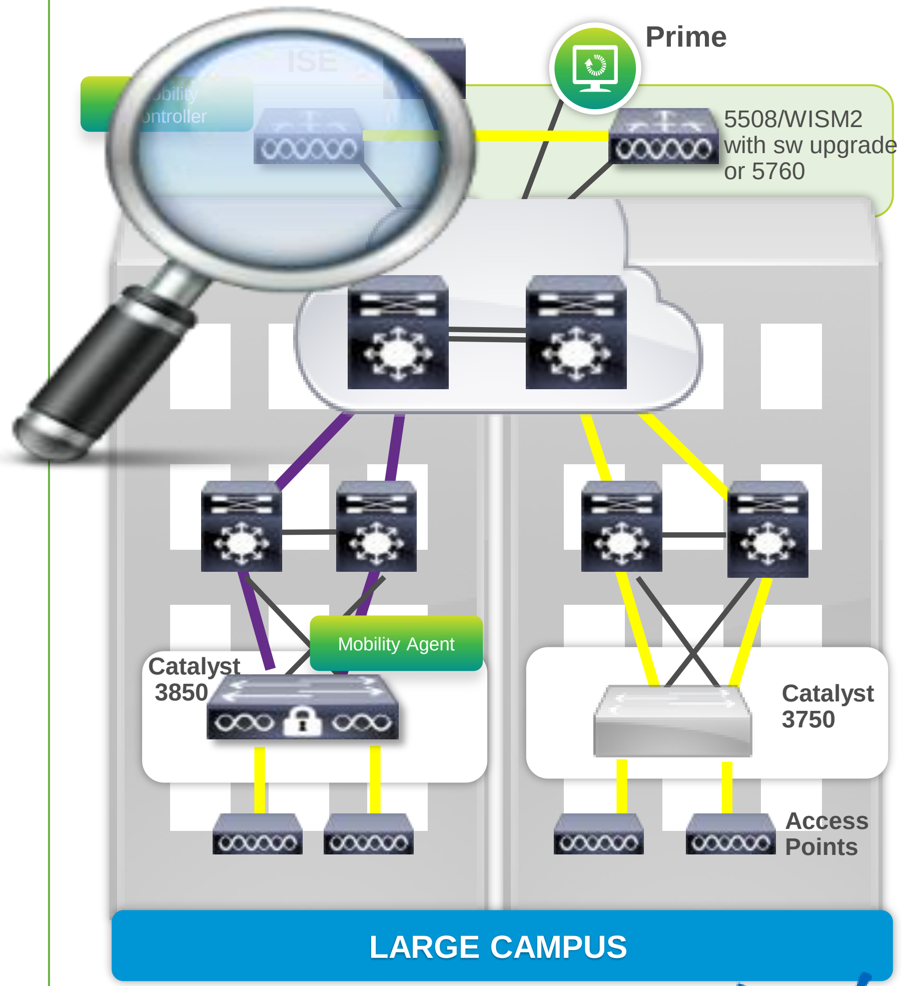
Converged Access Deployment –
Large Campus Use Case – Mobility Configuration

- Configure 5760 as MC and member of SPG

```
        interface Vlan100
         description WIRELESS MANAGEMENT VLAN
         ip address 192.168.100.42 255.255.255.0

5760(config)# wireless management interface VLAN100

5760(config)# wireless mobility controller peer-group WestBldg

5760(config)# wireless mob contr peer-group WestBldg member ip 192.168.41.44
```

- Configure 3850 as MA

```
        interface Vlan41
         description MANAGEMENT VLAN
         ip address 192.168.41.44 255.255.255.0

3850(config)# wireless management interface VLAN10

3850(config)# wireless mobility controller ip 192.168.100.42
```



Converged Access Deployment –

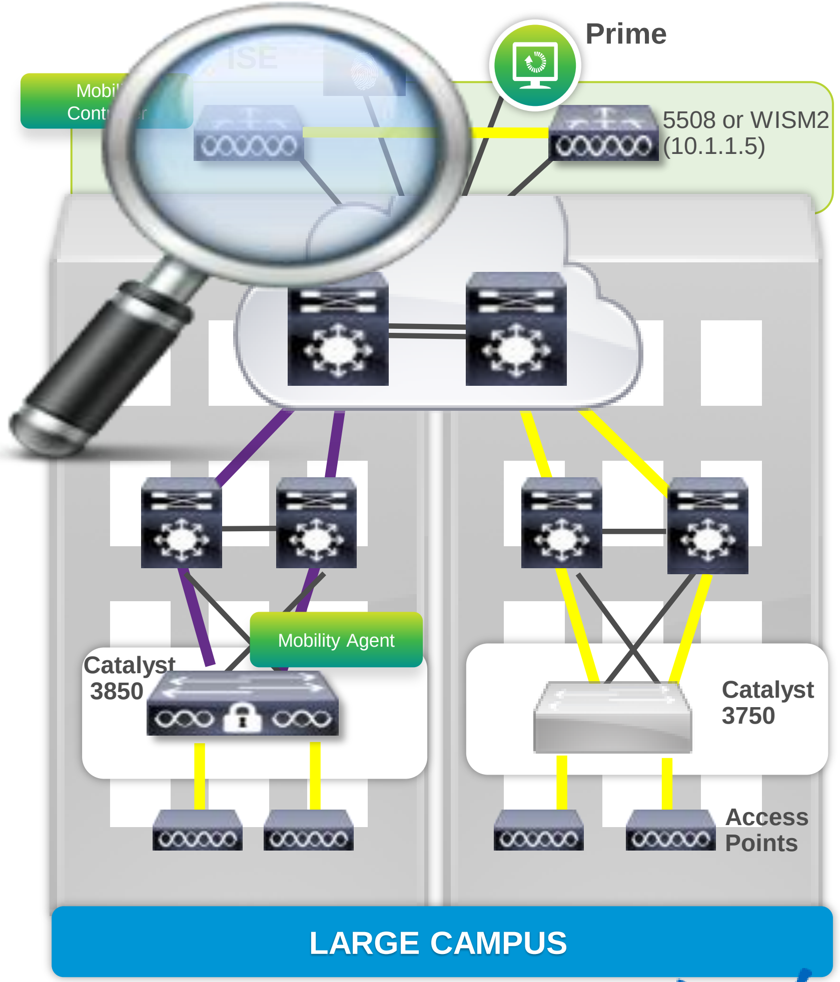
Large Campus Use Case – Mobility Configuration, continued

- Mobility Group configuration

```
5760(config)# wireless mobility group name cisco-live

5760(config)# wireless mobility group member ip 10.1.1.5
```

- Verify the configuration

```
5760# sh wireless mobility summary

Mobility Controller Summary:
Mobility Role                          : Mobility Controller
Mobility Protocol Port                 : 16666
Mobility Group Name                    : cisco-live

Controllers configured in the Mobility Domain:

IP Address        Public IP Address     Group Name            Multicast IP     Status
---------------------------------------------------------------------------------------
192.168.100.42    -                     cisco-live            0.0.0.0          UP
10.1.1.5          10.1.1.5              cisco-live            0.0.0.0          UP

Switches configured in WestBldg switch Peer Group: 1

IP Address        Public IP Address     Status
------------------------------------------------------------
192.168.41.44     192.168.41.44         UP
```



Agenda – BRKARC-2665

- **Evolution … Towards One Policy, One Management, One Network**
- **Converged Access – Platform Overviews**
- **Existing Wireless Deployments – Architecture Refresher**
- **Converged Access Architecture –**
  - Terminology and Building Blocks
  - Traffic Flows and Roaming
  - High Availability
  - Quality of Service
  - Security
  - Multicast
  - NetFlow
- **Converged Access Design and Deployment –**
  - IP Addressing
  - Design Options
  - Deployment Examples
- ► **Summary**

Bringing Together Wired and Wireless –
How Are We Addressing This Shift?

Controller

Control plane functionality on NG Controller

(also possible on upgraded 5508s, WiSM2s for brownfield deployments, or NG Converged Access switches for small, branch deployments)

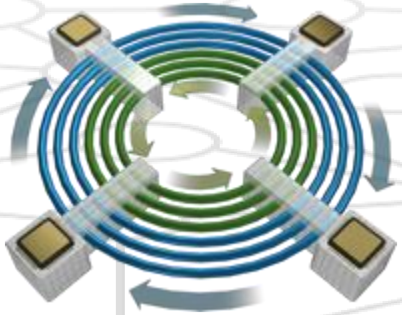
Next-Generation WLAN Controller (5760)

Data plane functionality on NG Switches

(also possible on NG Controllers, for deployments in which a centralised approach is preferred)

Next-Generation Switches (Catalyst 3850s)

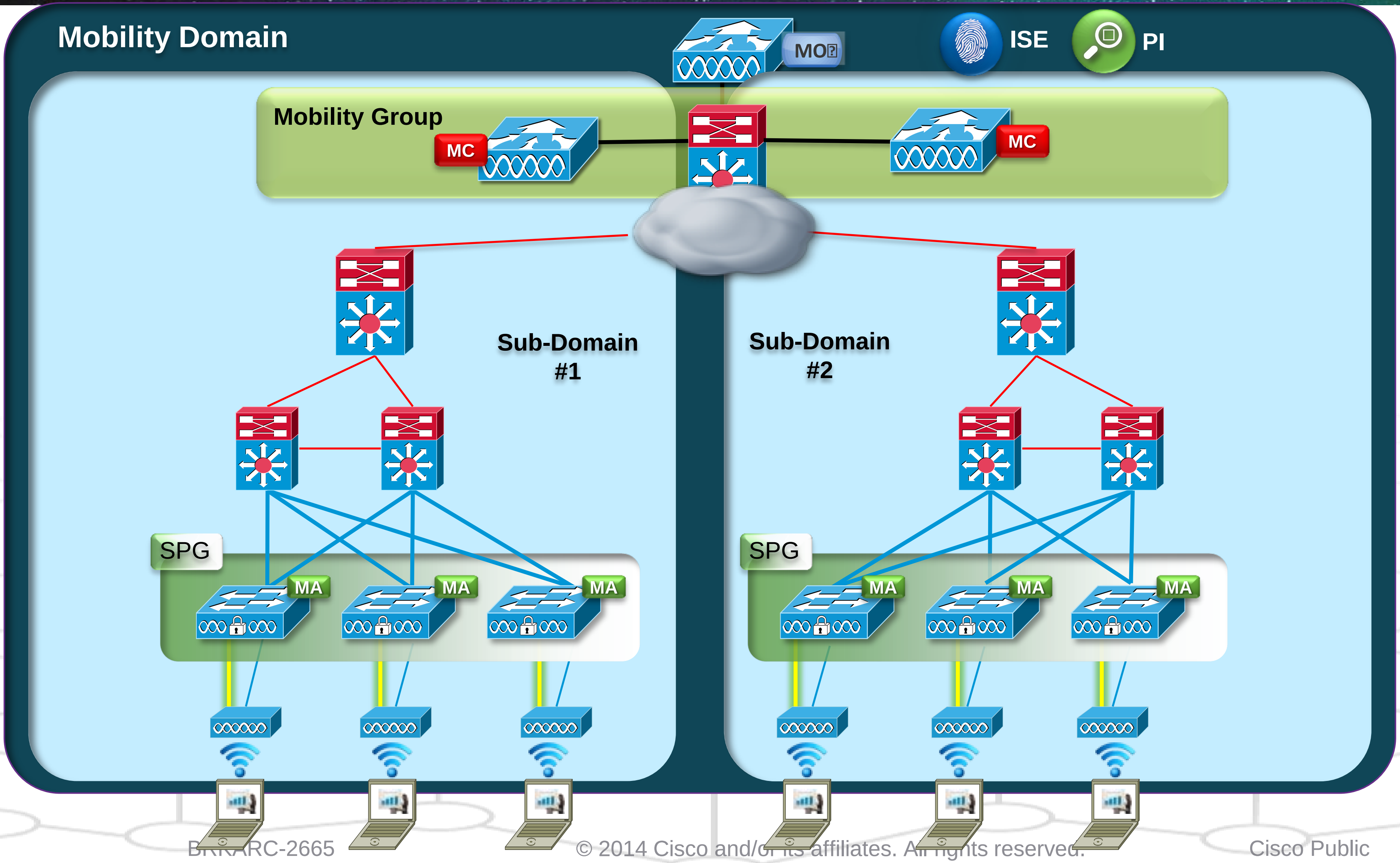
Enabled by Cisco's strength
in Silicon and Systems …
UADP ASIC



An Evolutionary Advance to Cisco's Wired + Wireless Portfolio, to address device and bandwidth scale, and services demands ….

Bringing Together Wired and Wireless –

With a Next-Generation Deployment and Solution



Cisco **Converged Access** Deployment

An Evolutionary Advance to Cisco's Wired + Wireless Portfolio, to address device and bandwidth scale, and services demands ….

Converged Access– Tell Me How I Did!

Did I Achieve My Objectives?

Do You Have a Better Understanding …

of **what Converged Access is** …

of **how Converged Access works** …

and how you would use it in your network designs?

Don’t Forget

to fill out your evaluations!




Q & A

Complete Your Online Session Evaluation

Give us your feedback and receive a Cisco Live 2014 Polo 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 www.ciscoliveaustralia.com/mobile
- Visit any Cisco Live Internet Station located throughout the venue

Polo Shirts can be collected in the World of Solutions on Friday 21 March 12:00pm - 2:00pm

Learn online with Cisco Live!

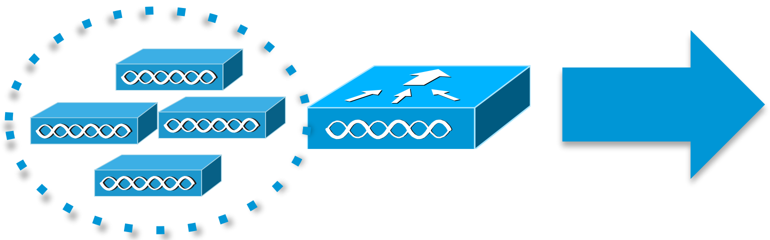
Visit us online after the conference for full access to session videos and presentations. www.CiscoLiveAPAC.com cisco™

REFERENCE MATERIAL

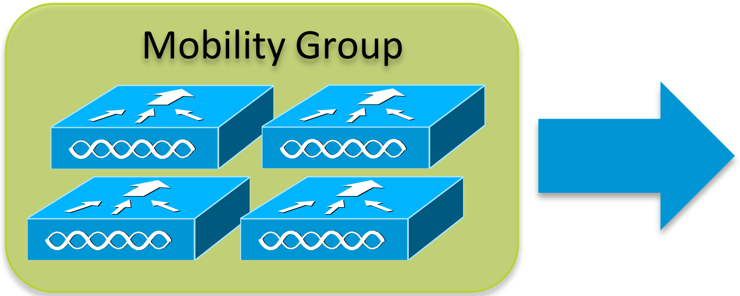
SCALABILITY

CUWN Scalability –
With CT5508 – Mobility Groups and Domains

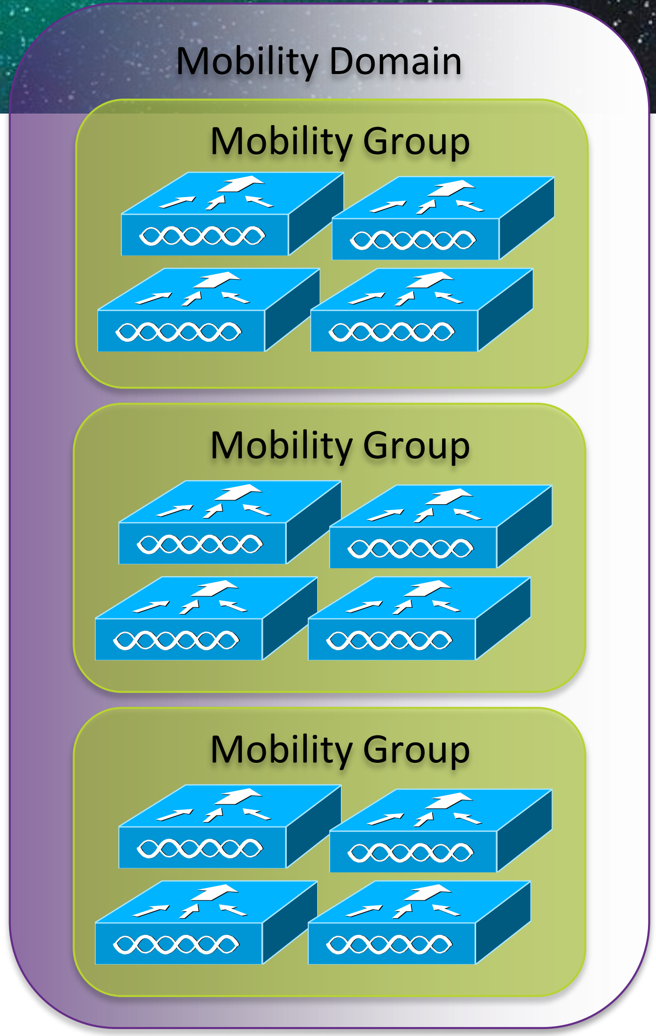
One
WLC Network



- Up to 500 APs
- Up 7K Clients
- Up to 8 GB I/O for AP Traffic



- Up to 12K APs
- Up 168K Clients
- Up to 24 WLCs in a MG
- Up to 192 GB I/O for AP Traffic



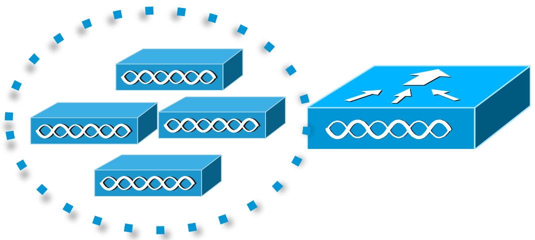
- Up to 36K APs
- Up to 504K Clients
- Up to 72 WLCs in a MD
- Up to 576GB I/O for AP Traffic

- CT5508 rel 7.6
- Max theoretical scalability numbers
- Without Considering FlexConnect

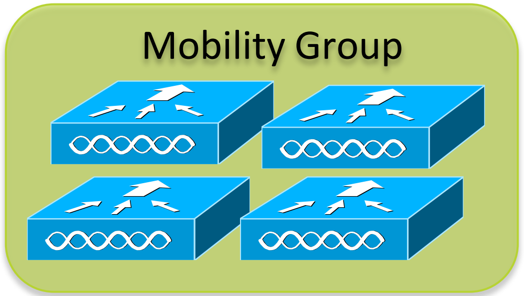
CUWN Scalability –

With WiSM-2 – Mobility Groups and Domains

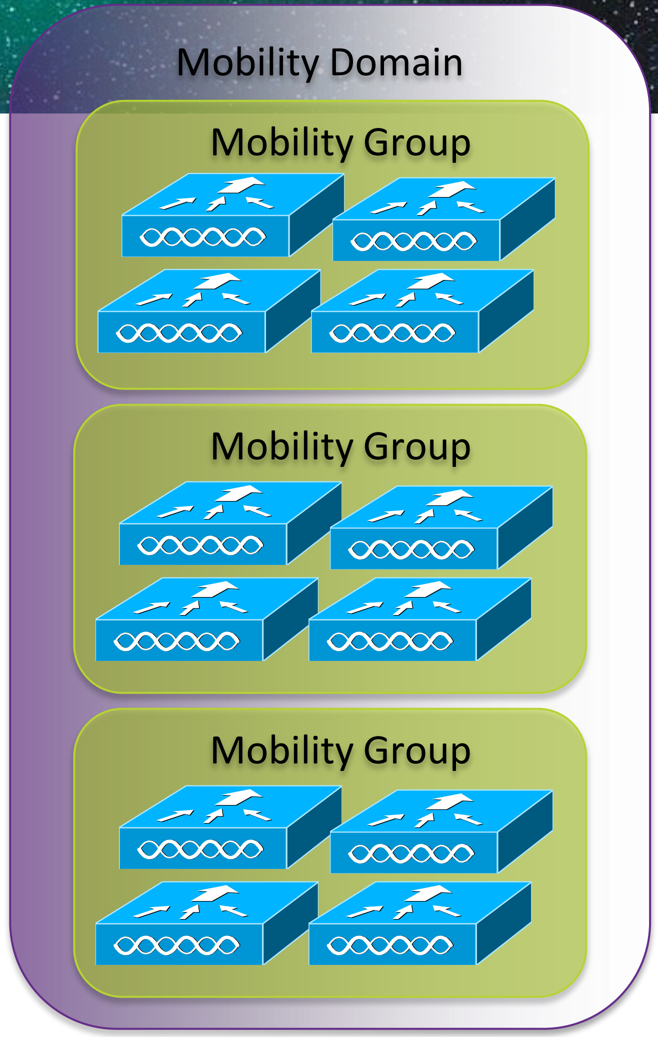
One
WLC Network



- Up to 1K APs
- Up 15K Clients
- Up to 20 GB I/O for AP Traffic



- Up to 24K APs
- Up 360K Clients
- Up to 24 WLCs in a MG
- Up to 480 GB I/O for AP Traffic

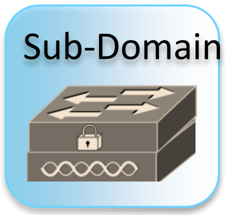


- Up to 72K APs
- Up to 1.08M Clients
- Up to 72 WLCs in a MD
- Up to 1.44TB I/O for AP Traffic

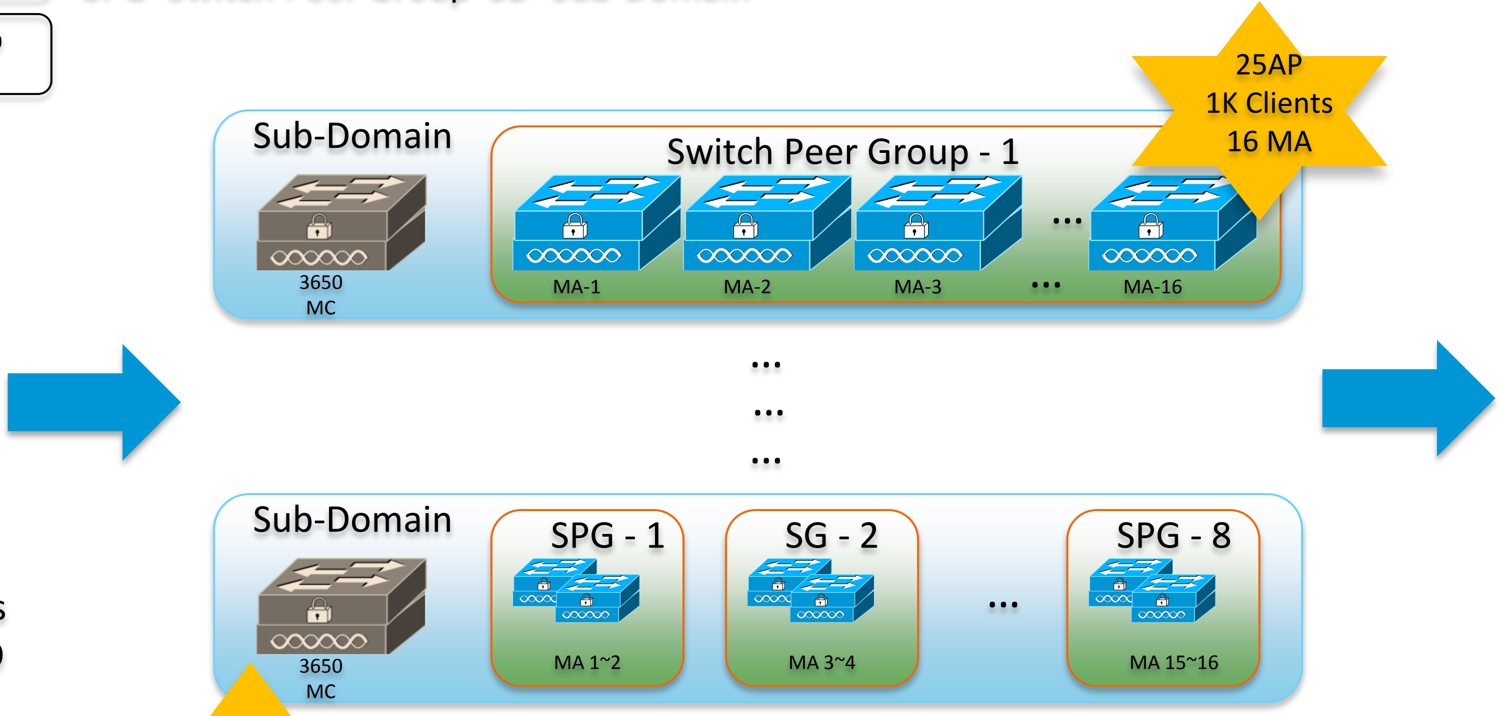
- WiSM-2 rel 7.3
- Max theoretical scalability numbers
- Without Considering FlexConnect

Converged Access Scalability –
With Catalyst 3650

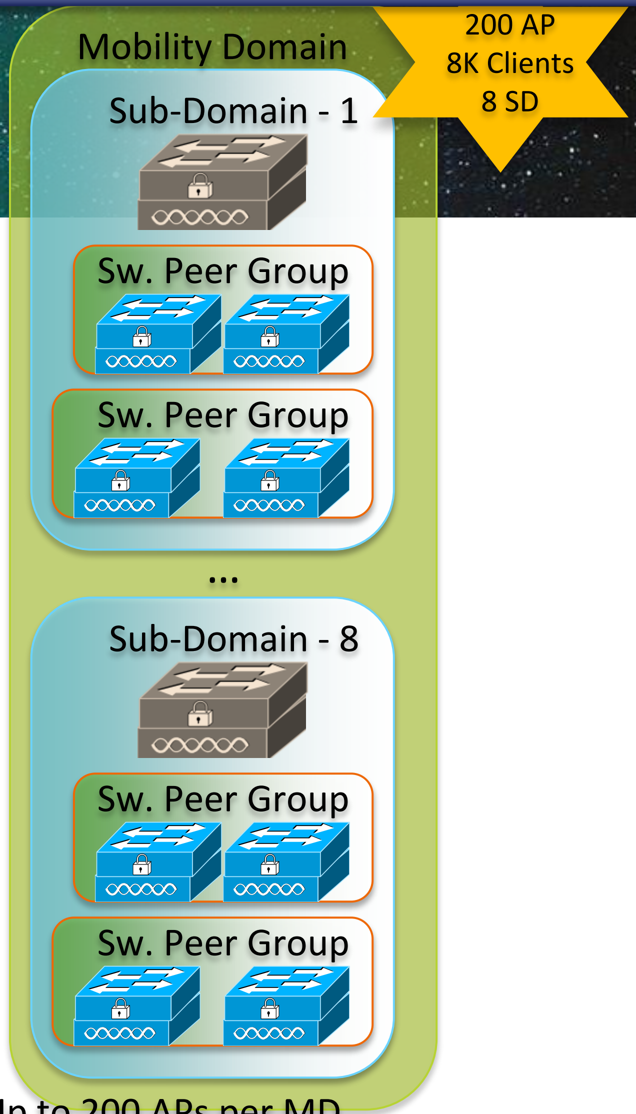
MA=Mobility Agent MC=Mobility Controller
SPG=Switch Peer Group SD=Sub-Domain



- 1 MC = 1 SD
- Up to 25 APs
- Up to 1K Clients
- Up to 20 GB I/O for AP Traffic



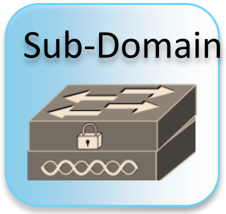
- Up to 25 APs per SPG/MC
- Up to 1K Clients per SPG/MC
- Up to 16 MAs in a SPG/MC
- Up to 8 SPGs in a SD
- Up to 25 GB I/O for AP Traffic



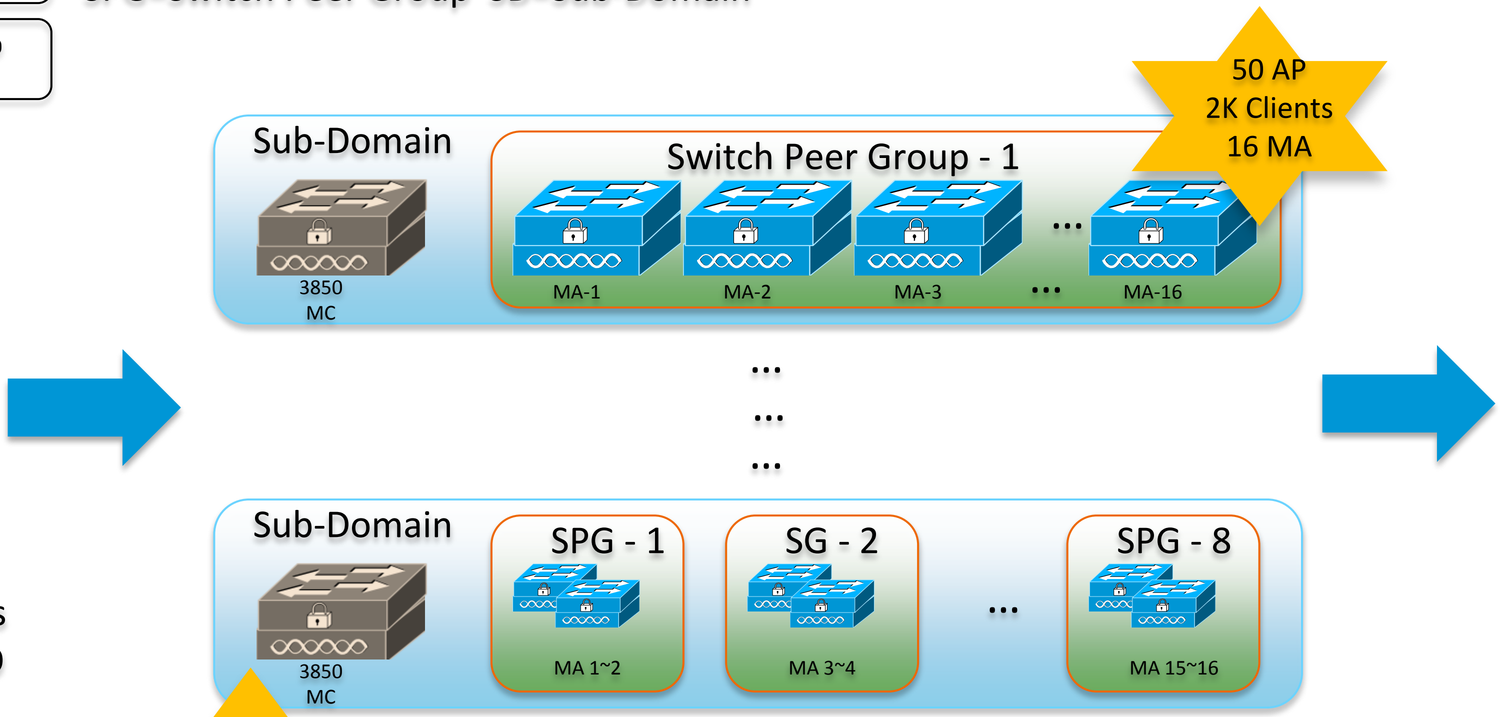
- Up to 200 APs per MD
- Up to 8 SDs per MD
- Up to 128 MAs per MD
- Up to 8K Clients per MD
- Up to 250 GB I/O for AP Traffic

Converged Access Scalability – With Catalyst 3850

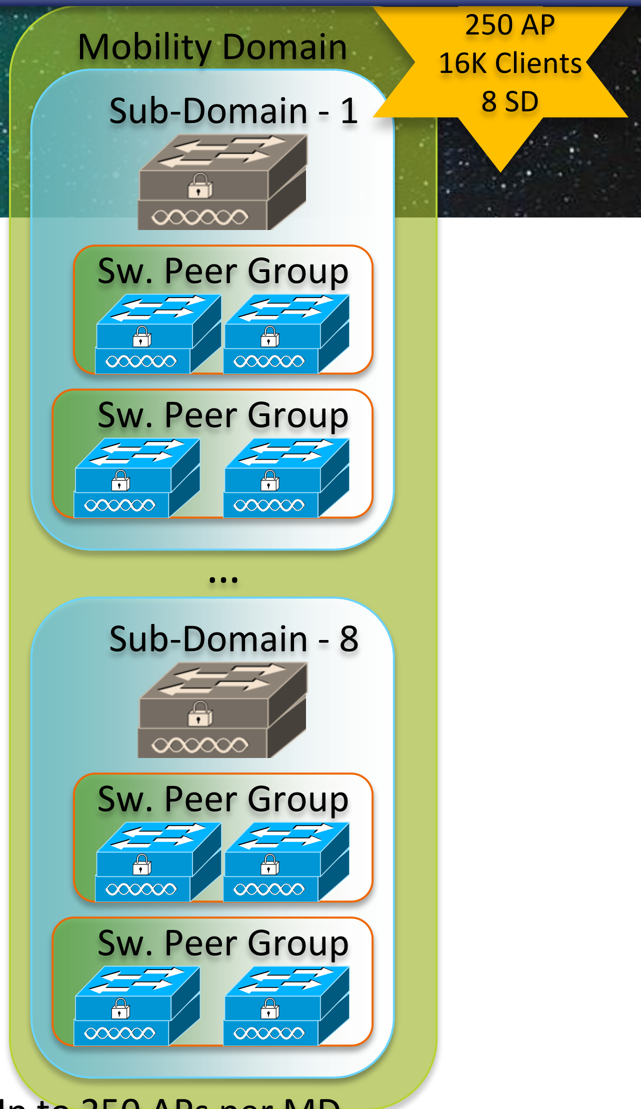
MA=Mobility Agent MC=Mobility Controller
SPG=Switch Peer Group SD=Sub-Domain



- 1 MC = 1 SD
- Up to 50 APs
- Up to 2K Clients
- Up to 40 GB I/O for AP Traffic



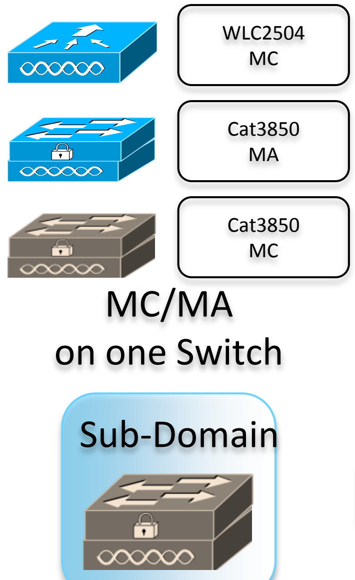
- Up to 50 APs per SPG/MC
- Up to 2K Clients per SPG/MC
- Up to 16 MAs in a SPG/MC
- Up to 8 SPGs in a SD
- Up to 50 GB I/O for AP Traffic



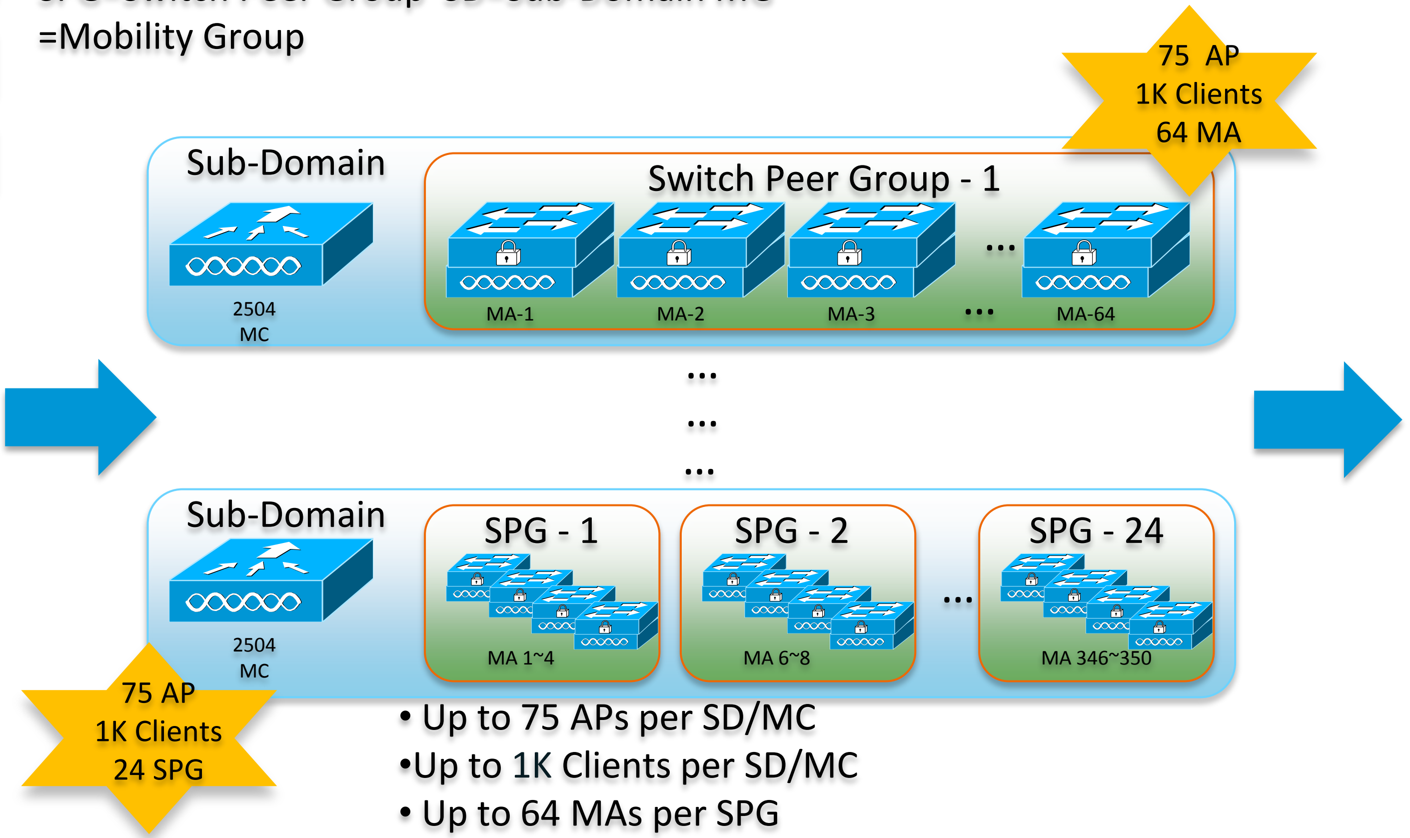
- Up to 250 APs per MD
- Up to 8 SDs per MD
- Up to 128 MAs per MD
- Up to 16K Clients per MD
- Up to 250 GB I/O for AP Traffic

Converged Access Scalability –
With WLC 2504 as MC and 3850s as MAs

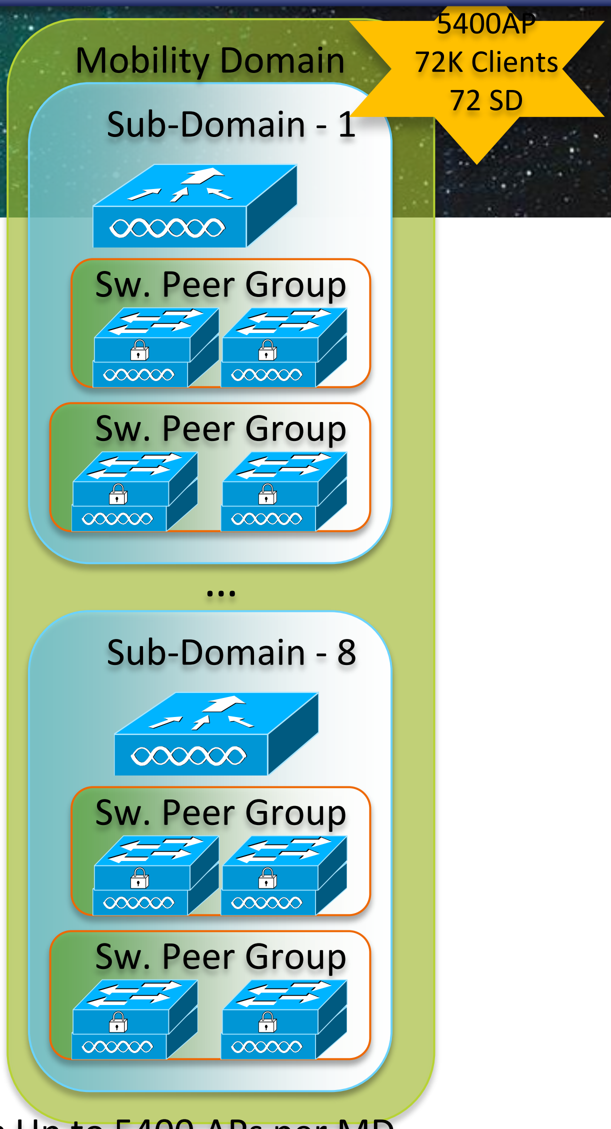
MA=Mobility Agent MC=Mobility Controller
SPG=Switch Peer Group SD=Sub-Domain MG
=Mobility Group



- 1 MC = 1 SD
- Up to 75 APs
- Up to 1K Clients
- Up to 1GB I/O for AP Traffic



- Up to 75 APs per SD/MC
- Up to 1K Clients per SD/MC
- Up to 64 MAs per SPG
- Up to 24 SPGs per SD/MC
- Up to 24 SD/MC per MG
- Up to 350 MAs per SD/MC
- Up to 75GB I/O for AP Traffic

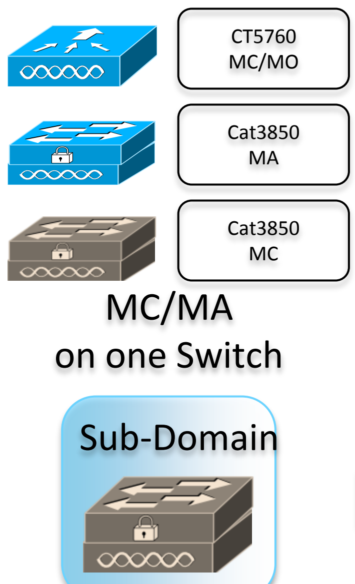


- Up to 5400 APs per MD
- Up to 72K Clients per MD
- Up to 72 SD per MD
- Up to 25,200 MAs per MD
- Up to 5.4TB I/O for AP Traffic

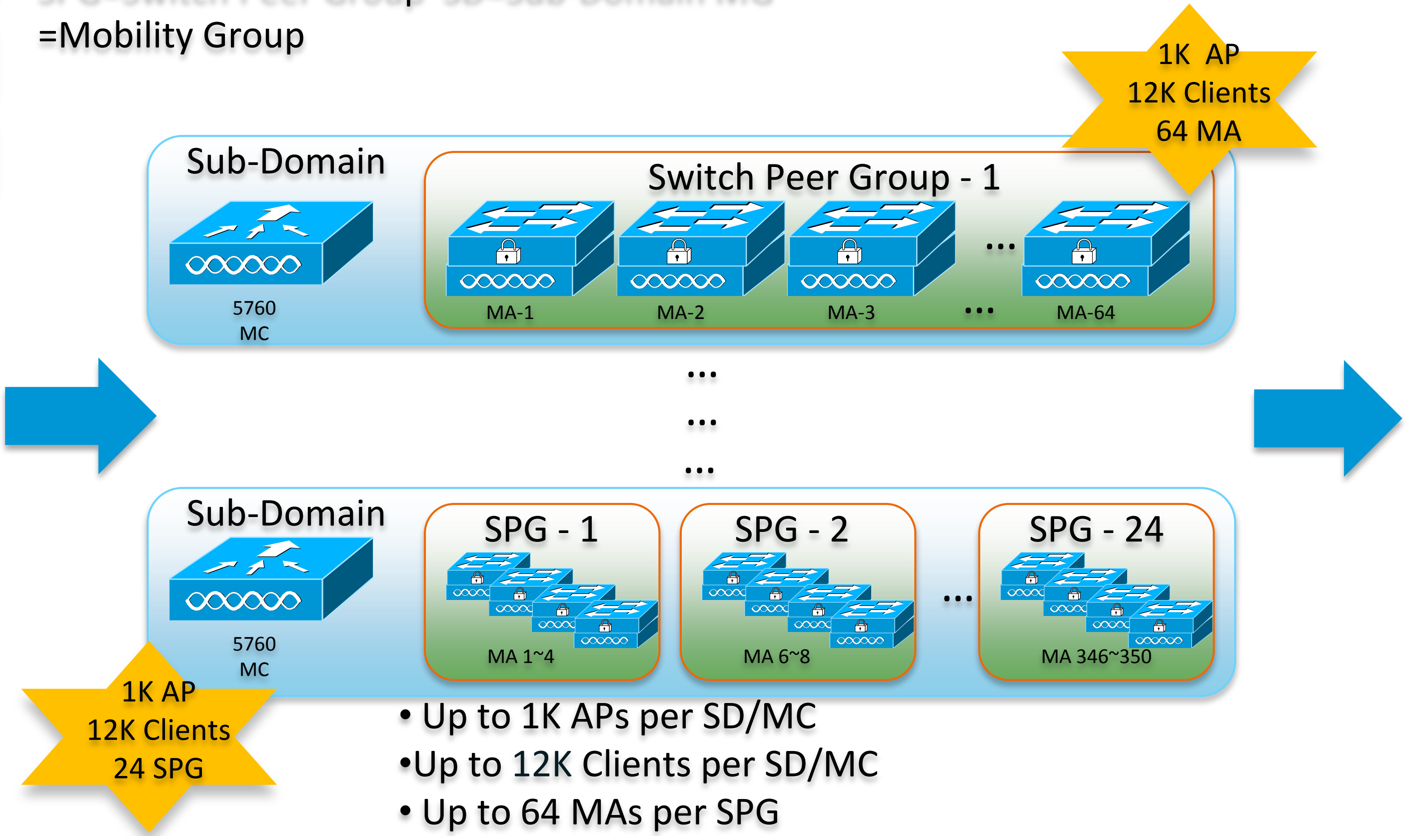
Converged Access Scalability –

With CT5760 as MC and 3850s as MAs

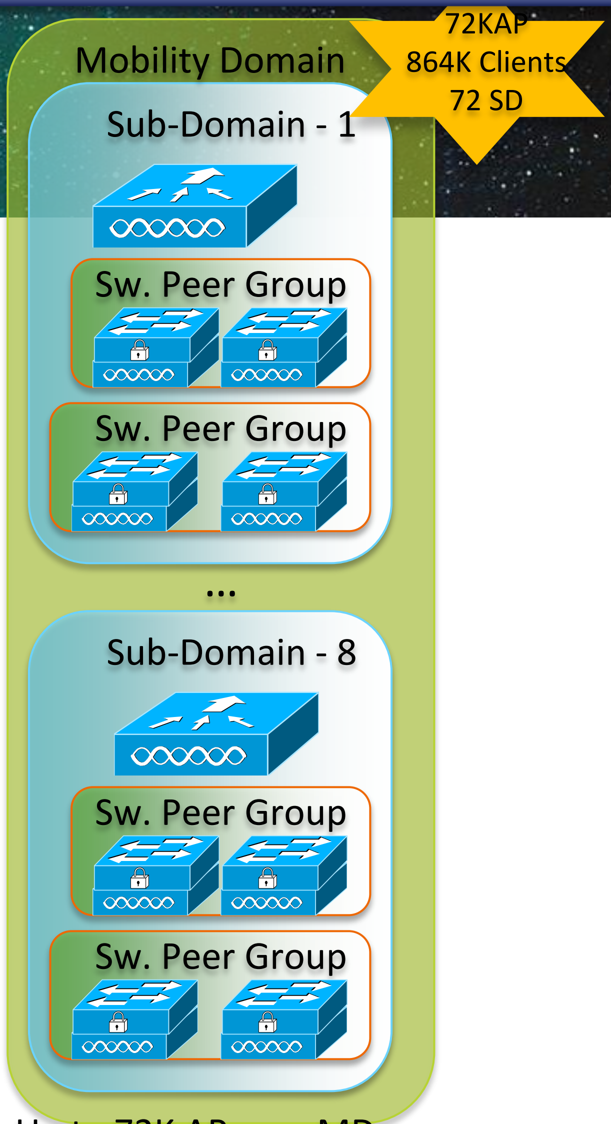
MA=Mobility Agent MC=Mobility Controller SPG=Switch Peer Group SD=Sub-Domain MG =Mobility Group



- 1 MC = 1 SD
- Up to 50 APs
- Up to 2K Clients
- Up to 40GB I/O for AP Traffic

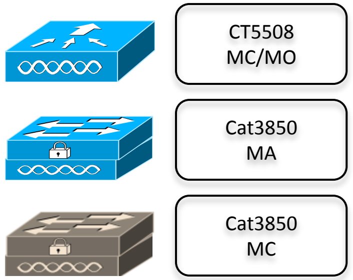


- Up to 1K APs per SD/MC
- Up to 12K Clients per SD/MC
- Up to 64 MAs per SPG
- Up to 24 SPGs per SD/MC
- Up to 24 SD/MC per MG
- Up to 350 MAs per SD/MC
- Up to 1TB I/O for AP Traffic



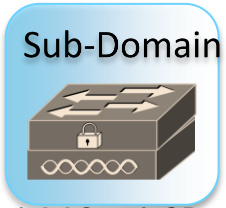
- Up to 72K APs per MD
- Up to 864K Clients per MD
- Up to 72 SD per MD
- Up to 25,200 MAs per MD
- Up to 72TB I/O for AP Traffic

Converged Access Scalability –
With CT5508 as MC and 3850s as MAs

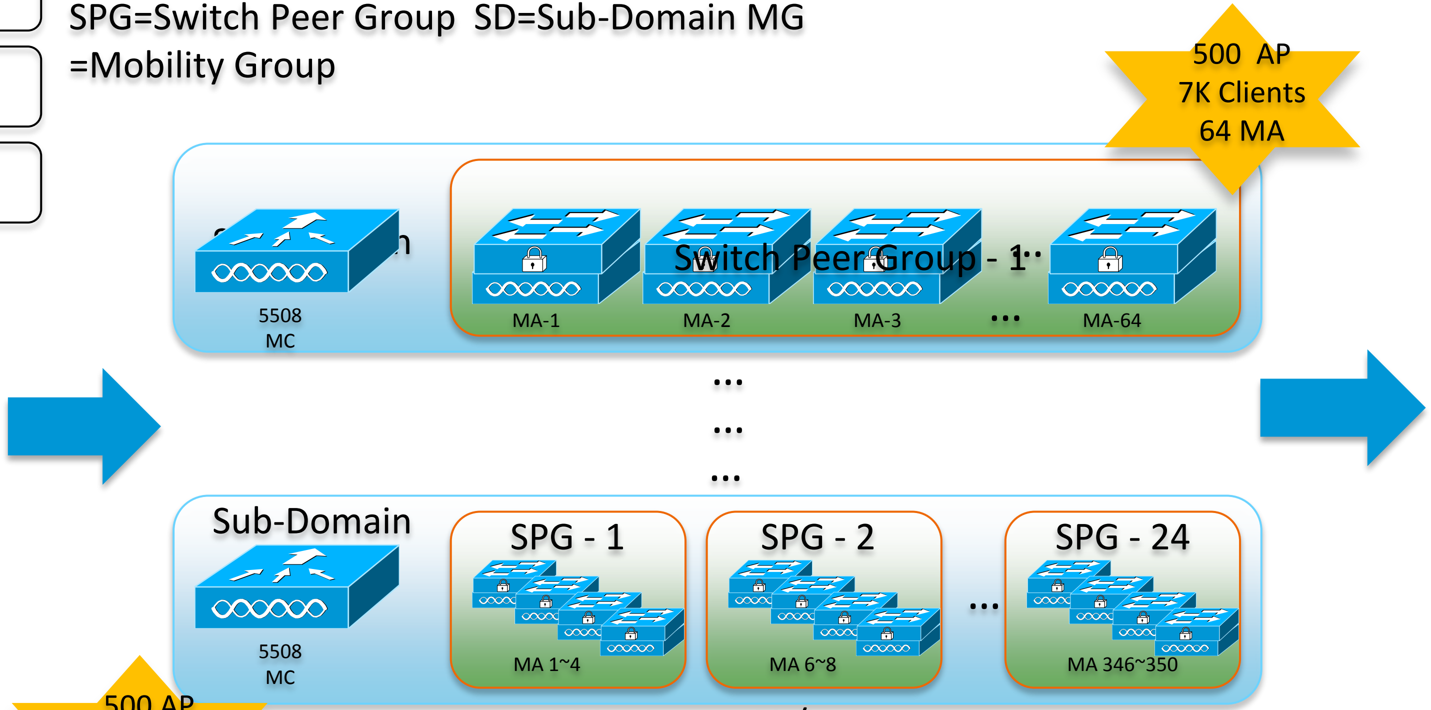


MA=Mobility Agent MC=Mobility Controller
SPG=Switch Peer Group SD=Sub-Domain MG
=Mobility Group

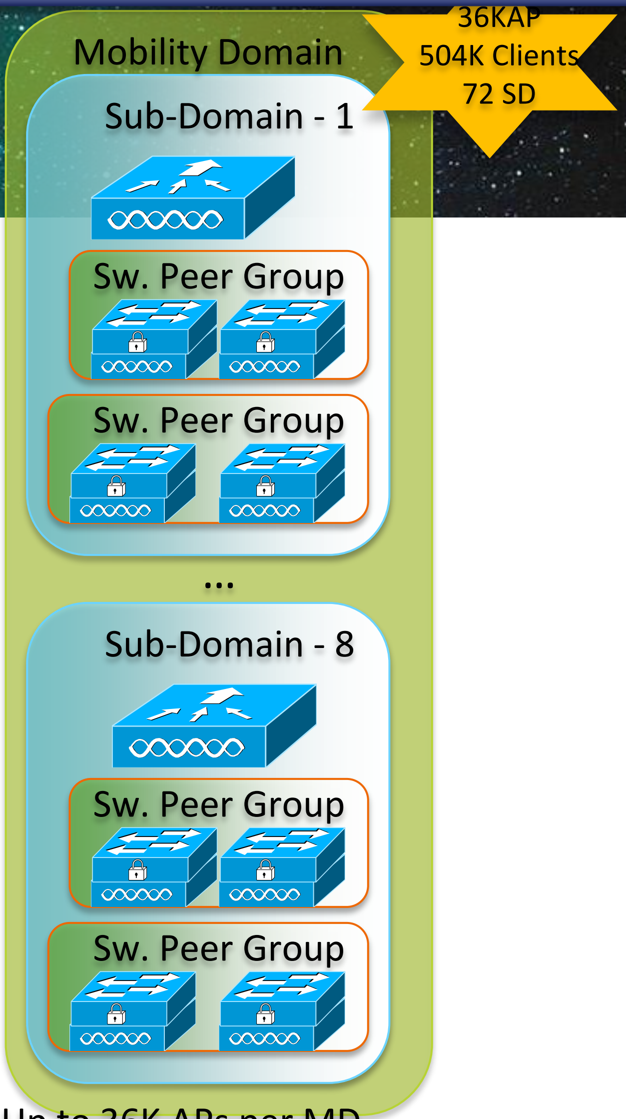
MC/MA
on one Switch



- 1 MC = 1 SD
- Up to 50 APs
- Up to 2K Clients
- Up to 40GB I/O for AP Traffic

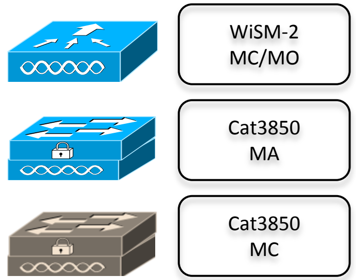


- Up to 500 APs per SD/MC
- Up to 7K Clients per SD/MC
- Up to 64MAs per SPG
- Up to 24 SPGs per SD/MC
- Up to 24 SD/MC per MG
- Up to 350 MAs per SD/MC
- Up to 500GB I/O for AP Traffic



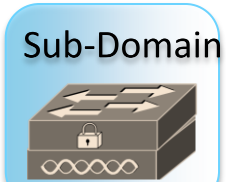
- Up to 36K APs per MD
- Up to 504K Clients per MD
- Up to 72 SD per MD
- Up to 25,200 MAs per MD
- Up to 36TB I/O for AP Traffic

Converged Access Scalability –
With WiSM-2 as MC and 3850s as MAs

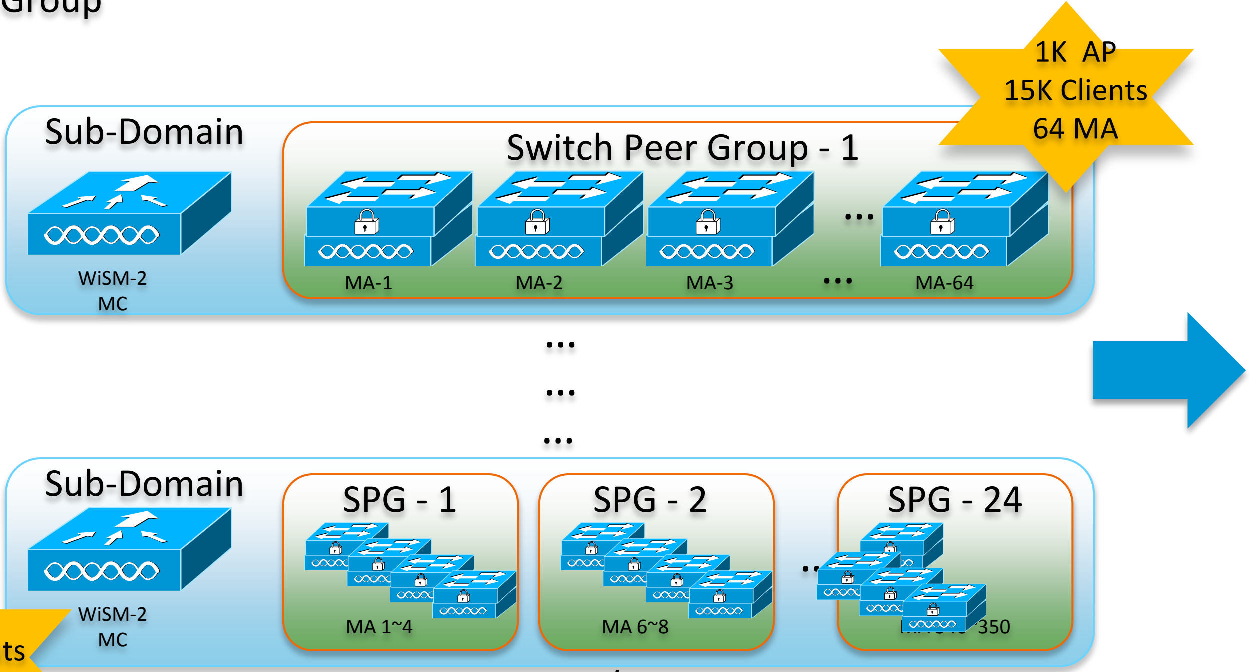


MA=Mobility Agent MC=Mobility Controller
SPG=Switch Peer Group SD=Sub-Domain MG
=Mobility Group

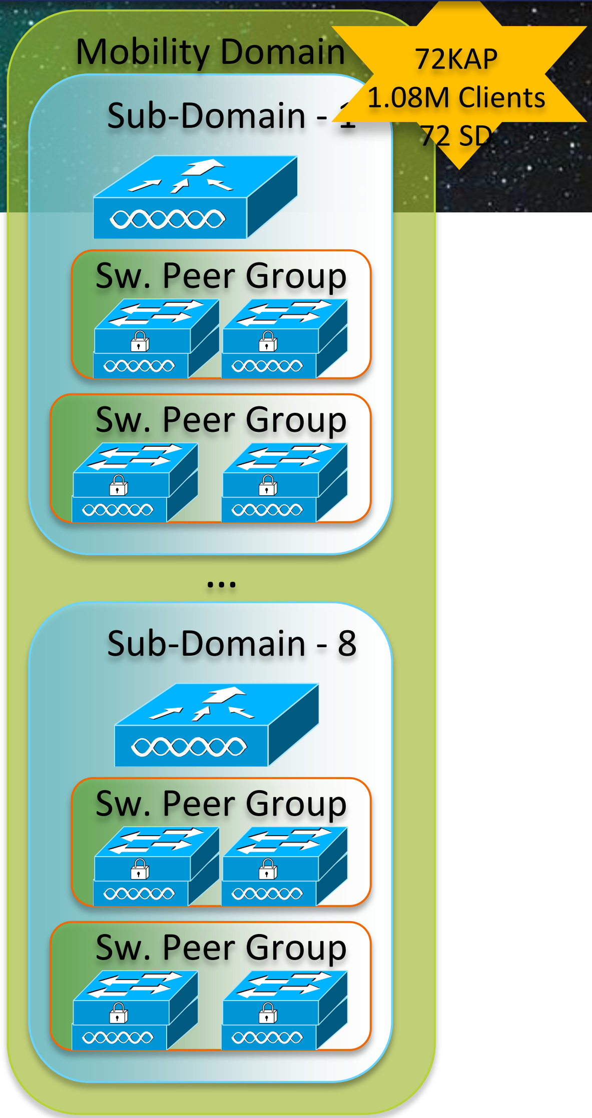
MC/MA
on one Switch



- 1 MC = 1 SD
- Up to 50 APs
- Up to 2K Clients
- Up to 40GB I/O for AP Traffic



- Up to 1K APs per SD/MC
- Up to 15K Clients per SD/MC
- Up to 16 MAs per SPG
- Up to 24 SPGs per SD /MC
- Up to 24 SD/MC per MG
- Up to 350 MAs per SD/MC
- Up to 1TB I/O for AP Traffic



- Up to 72K APs per MD
- Up to 1.08M Clients per MD
- Up to 72 SD per MD
- Up to 25,200 MAs per MD
- Up to 72TB I/O for AP Traffic

Converged Access Scalability – Summary

For Your Reference

Scalability	3650 as MC (3.3.1SE)	3850 as MC (3.3.1SE)	WLC2504 (7.6)	WLC5760 (7.6)	WLC5508 (7.6)	WiSM2 (7.6)
Max APs Supported per MC	25	50	75	1000	500	1000
Max APs Supported in overall Mobility Domain	200	250	5400	72000	36000	72000
Max Clients Supported per MC	1000	2000	1000	12000	7000	15000
Max Clients Supported in overall Mobility Domain	8000	16000	72000	864000	504000	1.08M
Max number of MC in Mobility Domain	8	8	72	72	72	72
Max number of MC in Mobility Group	8	8	24	24	24	24
Max number of MAs in Sub-domain (per MC)	16	16	350	350	350	350
Max number of SPGs in Mobility Sub-Domain (per MC)	8	8	24	24	24	24
Max number of MAs in a SPG	16	16	64	64	64	64
Max number of WLANs	64	64	16	512	512	512

REFERENCE MATERIAL

CATALYST 3850-BASED MCS – ROAMING DETAILS

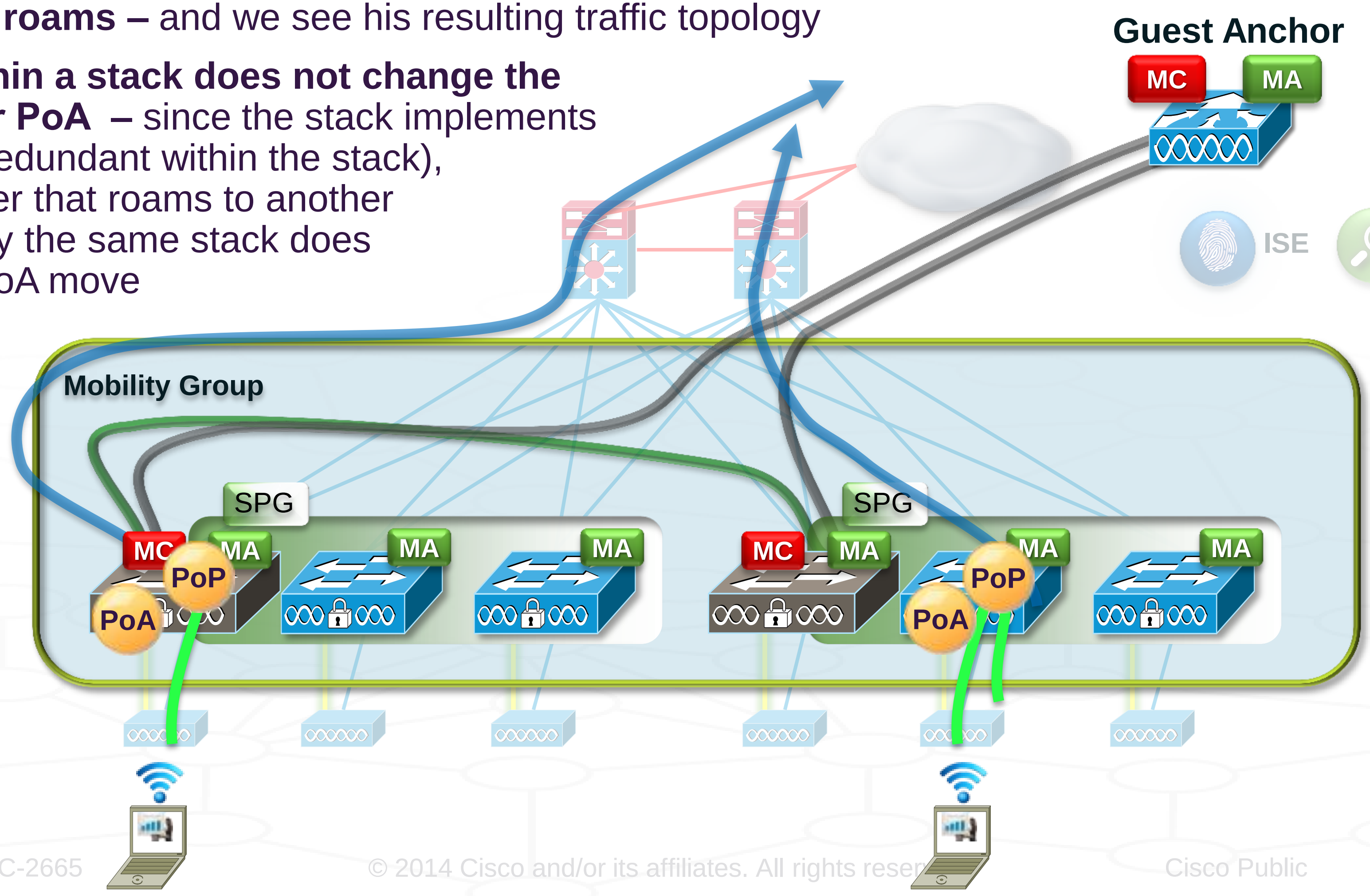
Converged Access –

Catalyst 3850-based MCs – Roaming within a Stack

Roaming, within a Stack (3850 Switches as MCs) –

- **Initially, all clients in this example are on their initial, local Converged Access switches**
- **Now, a client roams –** and we see his resulting traffic topology
- **Roaming within a stack does not change the user's PoP or PoA –** since the stack implements a single MA (redundant within the stack), and thus a user that roams to another AP serviced by the same stack does not cause a PoA move

No change to user's PoP or PoA



Scalability –

Max of 8 x 3850 switches as MCs, grouped into a Mobility Group

250 APs total across all 3850-based MCs

Max. 50 APs per 3850 stack / SPG

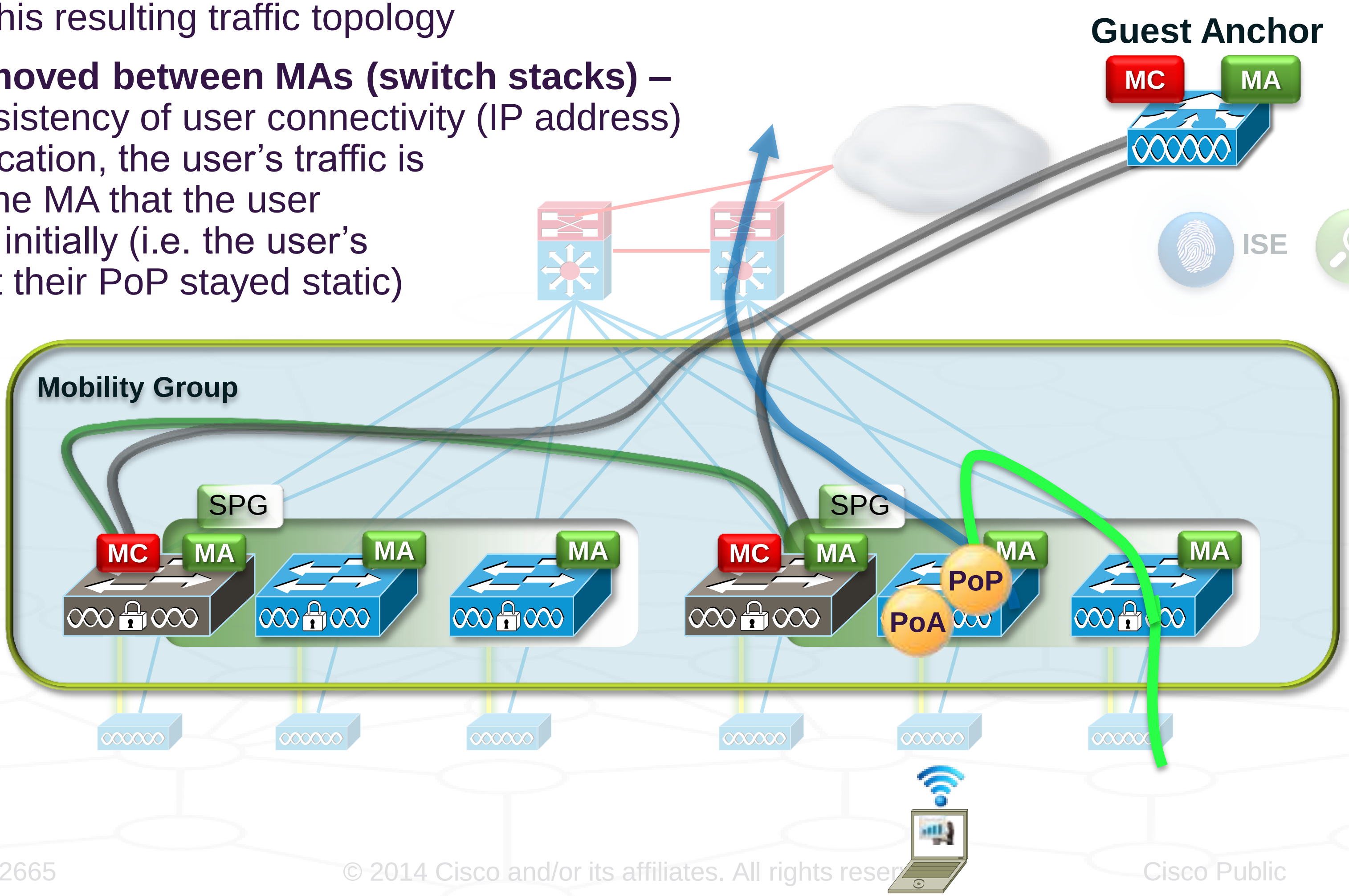
Converged Access –

Catalyst 3850-based MCs – Roaming within an SPG

Roaming, within a Switch Peer Group (3850 Switches as MCs) –

- **Now, the client roams to an AP serviced by another switch stack (within the same SPG)**
- **Let's examine** his resulting traffic topology
- **The user has moved between MAs (switch stacks) –** to maintain consistency of user connectivity (IP address) and policy application, the user's traffic is transported to the MA that the user associated with initially (i.e. the user's PoA moved, but their PoP stayed static)

Most Common Roaming Case



Scalability –

Max of 8 x 3850 switches as MCs, grouped into a Mobility Group

250 APs total across all 3850-based MCs

Max. 50 APs per 3850 stack / SPG

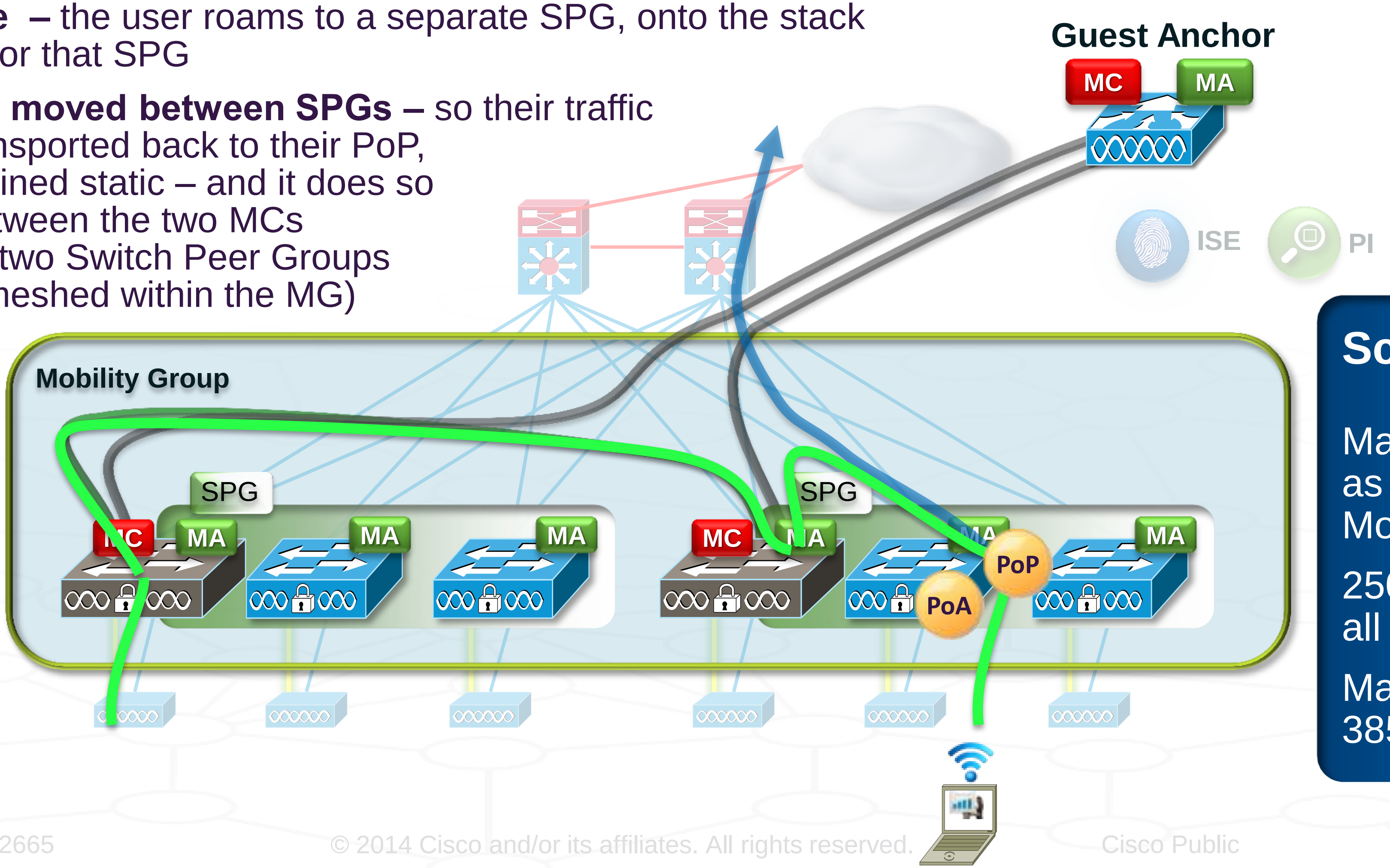
Converged Access –

Catalyst 3850-based MCs – Roaming across SPGs

Roaming, across Switch Peer Groups (3850 Switches as MCs) –

- **Now, let's examine a more complex roam where the user roams across SPGs**
- **In this example – **the user roams to a separate SPG, onto the stack serving as MC for that SPG
- **The user's has moved between SPGs –** so their traffic needs to be transported back to their PoP, which has remained static – and it does so by transiting between the two MCs servicing these two Switch Peer Groups (MCs are fully meshed within the MG)

Roaming between SPGs (geographically-separated)



Scalability –

Max of 8 x 3850 switches as MCs, grouped into a Mobility Group

250 APs total across all 3850-based MCs

Max. 50 APs per 3850 stack / SPG

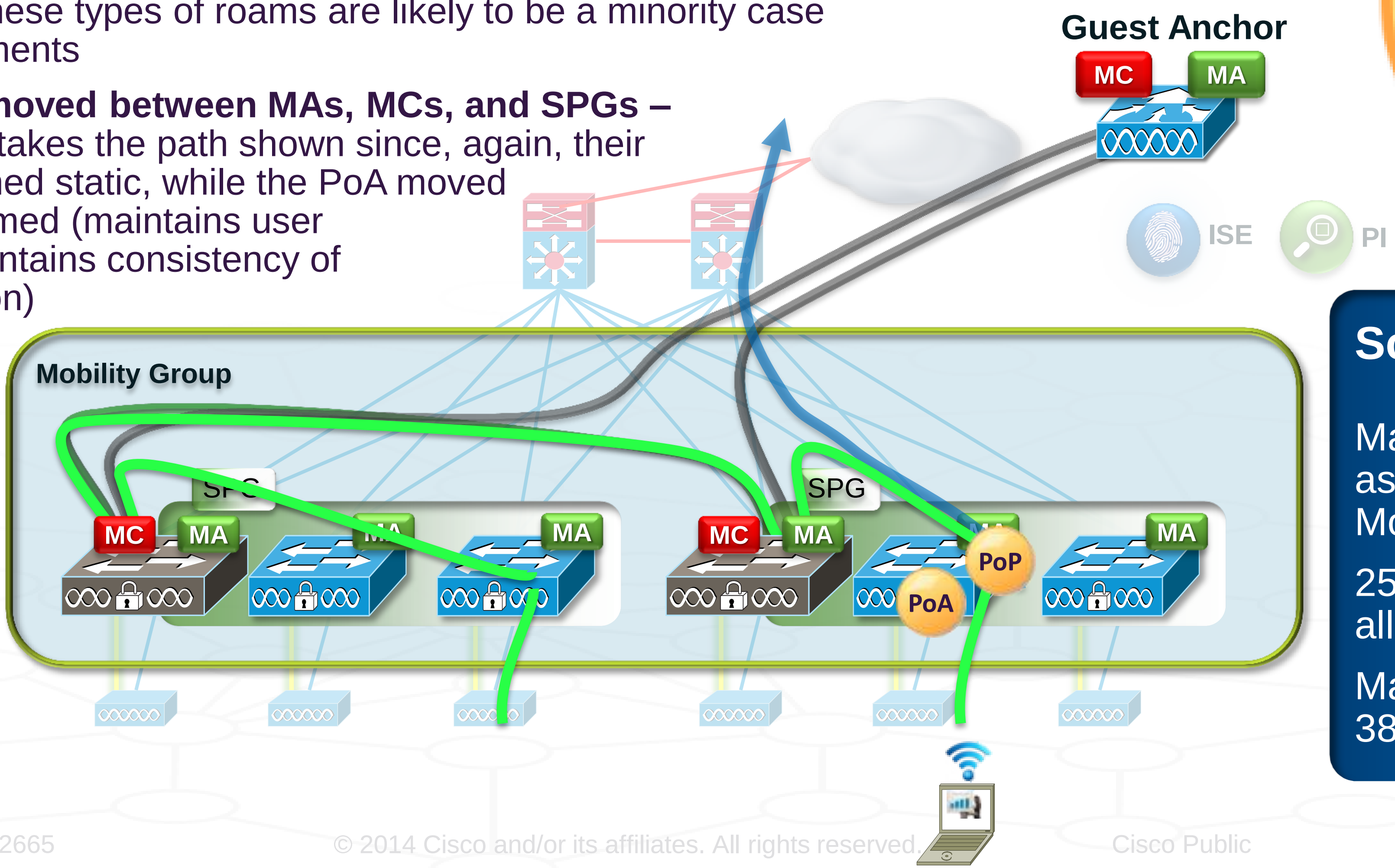
Converged Access –

Catalyst 3850-based MCs – Roaming across SPGs and MCs

Roaming, across Switch Peer Groups and MCs (3850 Switches as MCs) –

- **Now, lets' examine the most complex type of roam – across SPGs and MCs / MAs**
- **Remember –** these types of roams are likely to be a minority case in most deployments
- **The user has moved between MAs, MCs, and SPGs –** and their traffic takes the path shown since, again, their PoP has remained static, while the PoA moved as the user roamed (maintains user IP address, maintains consistency of policy application)

Roaming between SPGs and MCs (geographically-separated)



Scalability –

Max of 8 x 3850 switches as MCs, grouped into a Mobility Group

250 APs total across all 3850-based MCs

Max. 50 APs per 3850 stack / SPG

REFERENCE MATERIAL

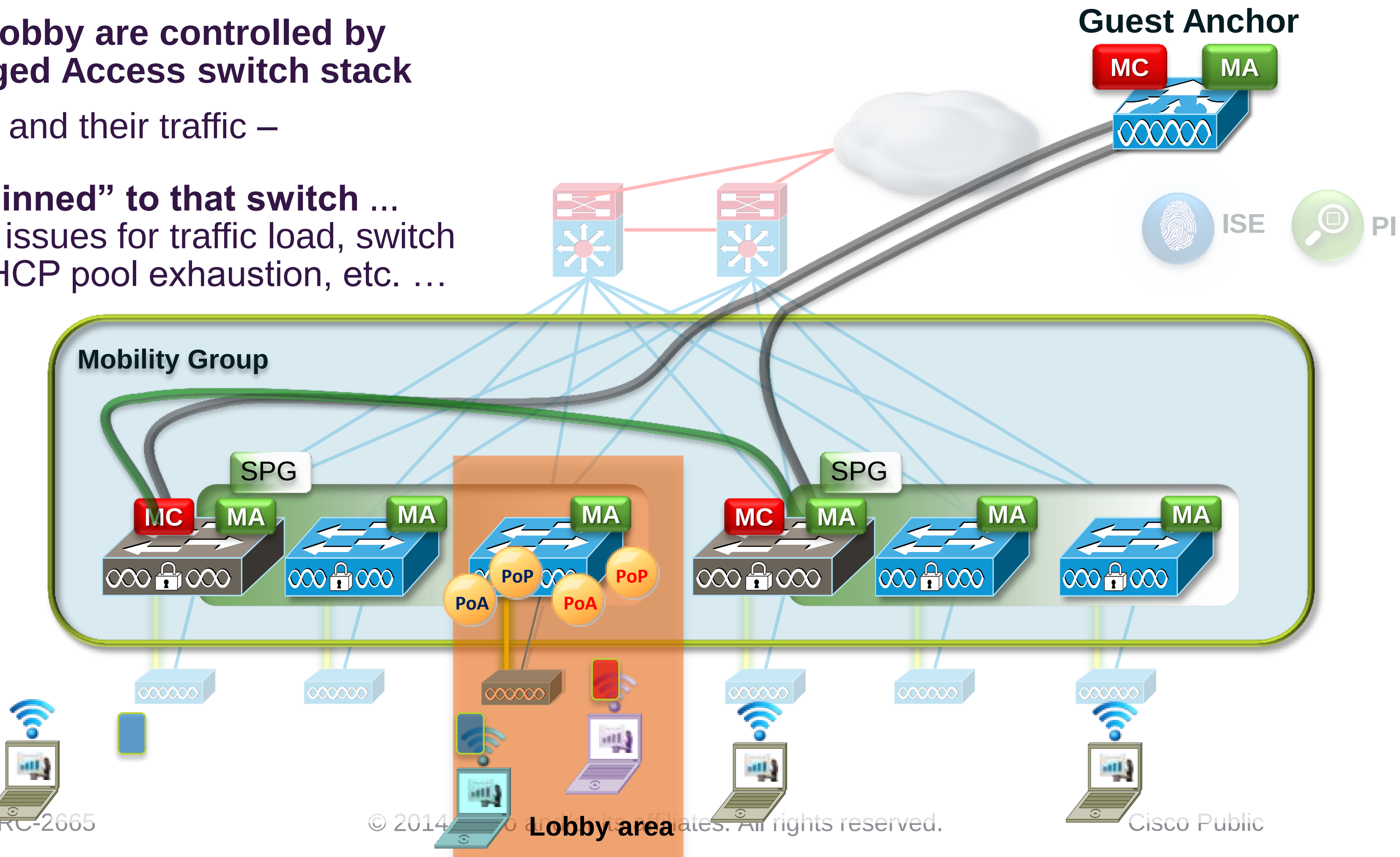
LOBBY ISSUE / SOLUTION

Converged Access –
Common Building Access – The "Lobby Issue"

What happens when –

- **Everyone enters the building** via a common lobby
- **APs in that lobby are controlled by one Converged Access switch stack**
- All the users, and their traffic –
  - **Gets "pinned" to that switch ...** causing issues for traffic load, switch load, DHCP pool exhaustion, etc. …

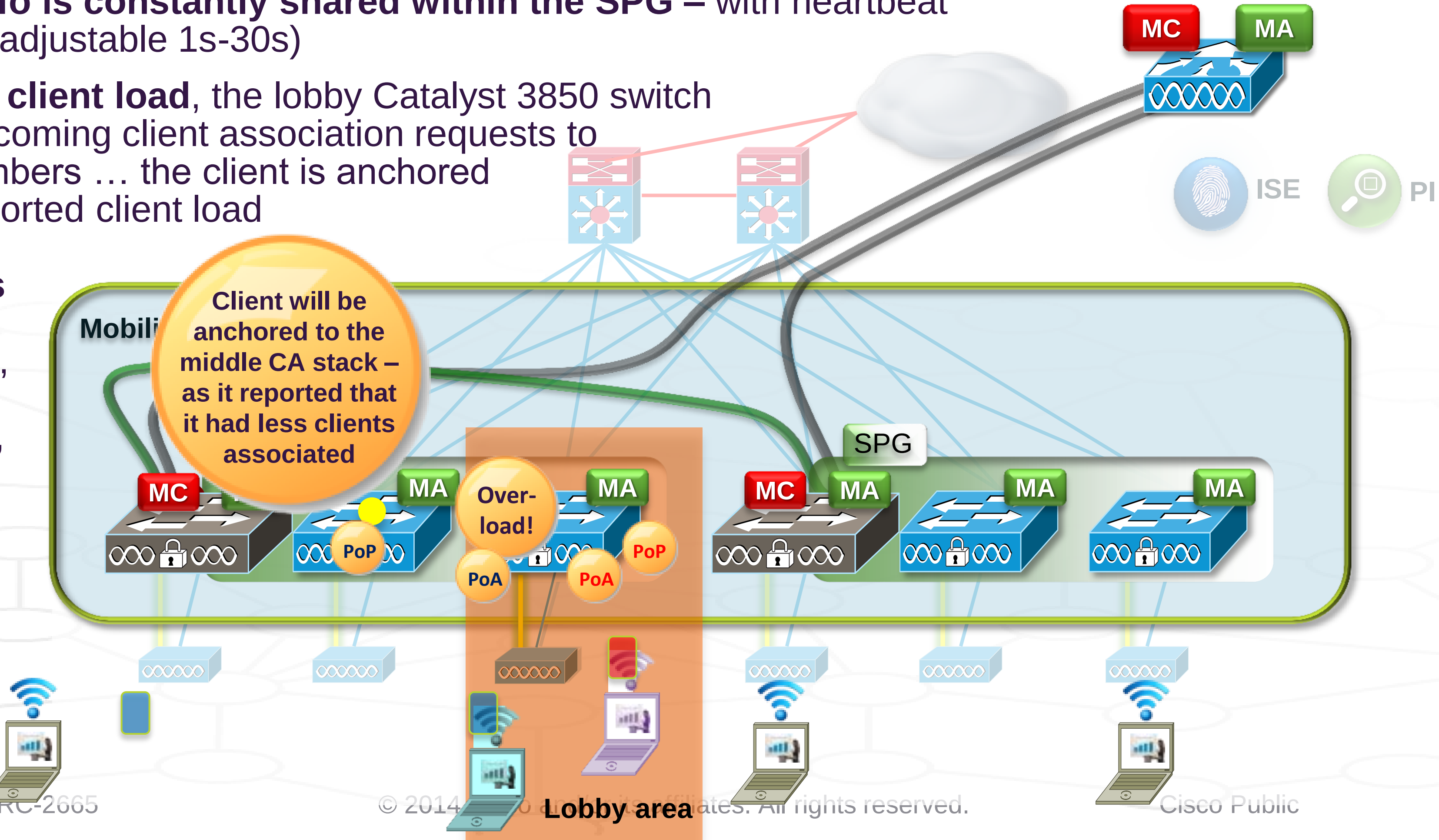
Many users could end up "staying in the lobby" logically



Converged Access –
Common Building Access – The "Lobby Solution"

What can we do to address this issue?

- **User client association can be distributed** across Converged Access switches in the Switch Peer Group
- **User load info is constantly shared within the SPG –** with heartbeat (10s default, adjustable 1s-30s)
- **At a defined client load**, the lobby Catalyst 3850 switch distributes incoming client association requests to it's SPG members … the client is anchored based on reported client load
  - **Addresses** traffic load, switch load, DHCP pool exhaustion, etc.



Cisco live!

Converged Access –
Common Building Access – The "Lobby Solution", Detail

- **What**: when configured, the client first PoA is load balanced across the switches in the SPG. When the client joins, the switch checks if its load is over a configurable threshold and send a message to anchor the client to least loaded switch in the SPG.
- **Why**: large number of clients could potentially attach to a single MA whose APs are situated close to the front door / lobby. This would result into congestion at that home switch, whereas other MAs would be under-utilised. This is even worse if the client's data path is anchored at the home switch.
- **How to configure it**: the feature is ON by DEFAULT and it's possible to change the threshold value. By default is 50% (of the max client allowed)

  To configure a different threshold use the following command on a per MA basis –

```
3850(config)# wireless mobility load-balance threshold ?

 <100-2000>  Threshold value for number of clients that can be anchored locally
```


REFERENCE MATERIAL

DEPLOYMENT

Converged Access Deployment –
IOS-XE 3.2.0 (FCS) vs. AireOS – Feature Comparison

Additional Features included

7.2	7.3	7.4
AP 3600 support IPv6/dual stack 'client Mobility' ISE 1.1 MnR OKC/PKC	AP 2600 support Right-To-Use Adder Licenses	AP 1600 support

IOS XE 3.2.0 features are based on AireOS features 7.0.116.0

Features NOT included

7.2	7.2 MR1	7.3	7.4
CleanAir enhancement Limit # of Clients per radio and per SSID Wi-Fi Direct AP Groups/Profile ph2 SXP	802.11r HTTP sensor	AP SSO Bid. Rate Limiting 11n Voice CAC Video CAC ISE 1.2: DHCP sensor Hot spot 2.0 PMIPv6 MAG	AVC Bonjour Services Dir. Neighbour List (11k) N+1 with HA SKU Modules on AP3600 802.11w for local mode

Converged Access Deployment –
IOS-XE 3.2.X (Maintenance) vs. AireOS – Feature Comparison

Additional Features included

7.2

AP 3600 support
IPv6/dual stack 'client Mobility'
ISE 1.1 MnR
OKC/PKC

7.3

AP 2600 support
Right-To-Use Adder Licenses

7.4

AP 1600 support

Maintenance Releases

PI 2.0 support (3.2.3)
Captive Portal Bypassing (3.2.3)
GUI enhancements (3.2.2)
Fast SSID change (3.2.2)
CoA for BYOD support (3.2.2)

IOS XE 3.2.x features are based on AireOS features 7.0.116.0

Features NOT included

7.2

CleanAir enhancement
Limit # of Clients per radio and per SSID
Wi-Fi Direct
AP Groups/Profile ph2
SXP

7.2 MR1

802.11r
HTTP sensor

7.3

AP SSO
Bid. Rate Limiting
11n Voice CAC
Video CAC
ISE 1.2: DHCP sensor
Hot spot 2.0
PMIPv6 MAG

7.4

AVC
Bonjour Services Dir.
Neighbour List (11k)
N+1 with HA SKU
Modules on AP3600
802.11w for local mode

Converged Access Deployment –

IOS-XE **3.3.0** vs. AireOS – Feature Comparison

Additional Features included

IOS XE 3.3 features are based on AireOS features 7.4

Features NOT included

7.4	7.5
The "C" in AVC	Client SSO
Device Sensor (HTTP and DHCP)	Wireless Policy Classification engine
Hot Spot 2.0	Bonjour phase 2
IPv6 Source Guard	Guest Access sleeping clients
LSC (Local Signed Certificate)	OEAP split tunnelling
CMX (see next slide)	

Converged Access Deployment –
IOS-XE **3.3.1** vs. AireOS – Feature Comparison

Additional Features included

7.5

802.11ac Module for 3600

7.6

AP 3700
802.11ac Module for 3600

IOS XE 3.3 features ... AireOS features 7.4

3.3.1 is the Recommended release*

Features NOT ...ded

The "C" in AVC
Device Sensor (HTTP and DHCP)
Hot Spot 2.0
IPv6 Source Guard
LSC (Local Signed Certificate)
CMX (see next slide)

7.5

Client SSO
Wireless Policy Classification engine
Bonjour phase 2
Guest Access sleeping clients
OEAP split tunneling

CISCO™