The bridge to possible

A Tale of Two Ships

SD-Access and BGP EVPN Designs and Deployments on Cruise Ships

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BRKENS-2822

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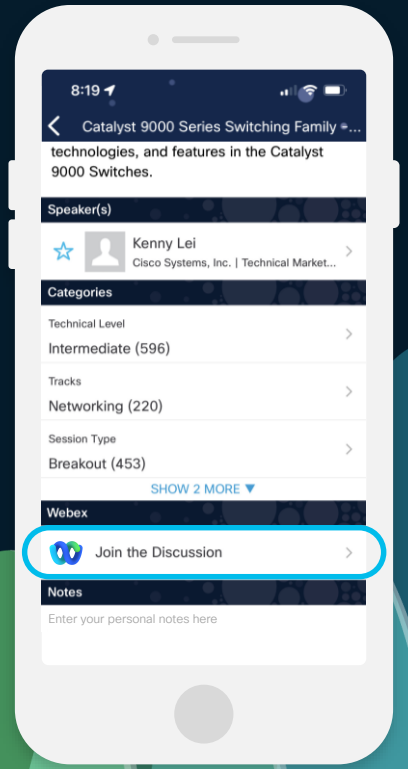


How Did the Tale of Two Ships Start?

- Network implementation started from around 2022-23
- SD-Access LISP (SDA) & BGP EVPN deployed on two ships from two different cruise lines
- Several additional ships might implement the same solutions across both fleets
- We will get to how the tale ended

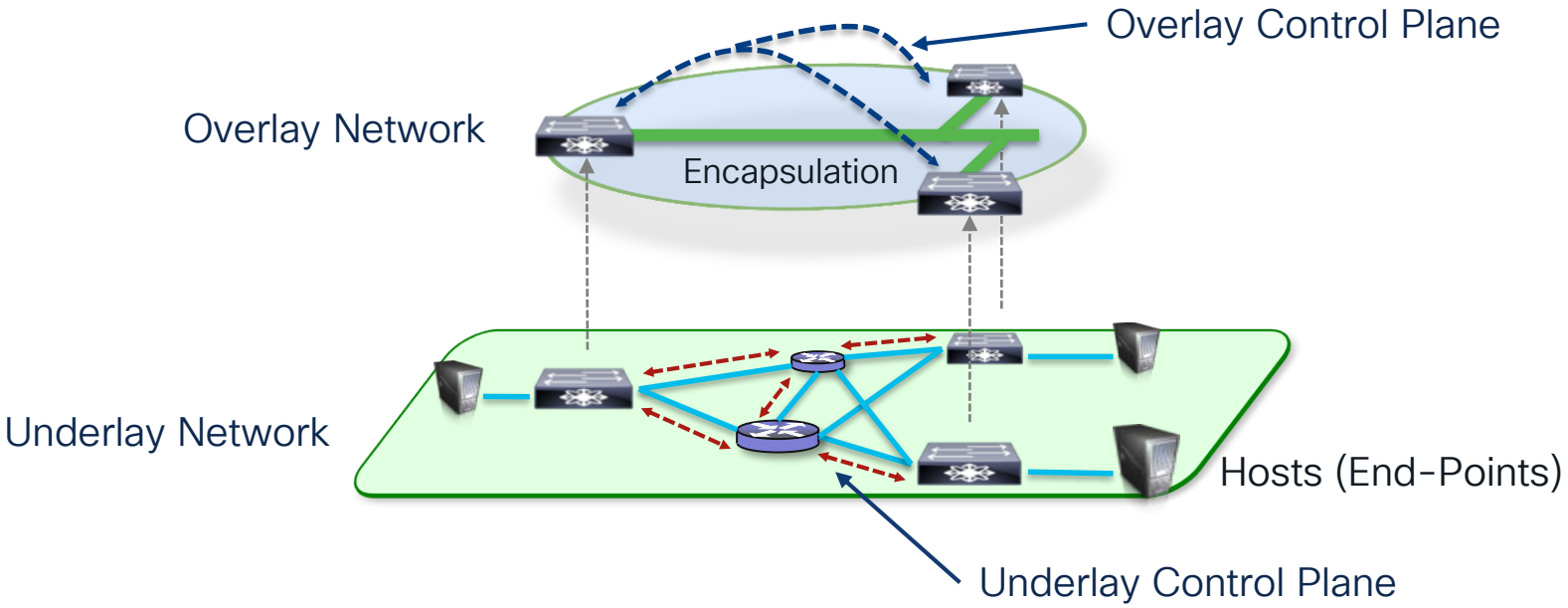
Agenda

- Fabric Choices: SD-Access vs. BGP EVPN
- Business Requirement
- Ship #1: SD-Access Solution
- Ship #2: BGP EVPN Solution
- Plan, Design, Implementation, and Support Best Practices
- Sneak Preview: Catalyst Center Orchestrated BGP EVPN

Fabric Choices: SD-Access vs. BGP EVPN

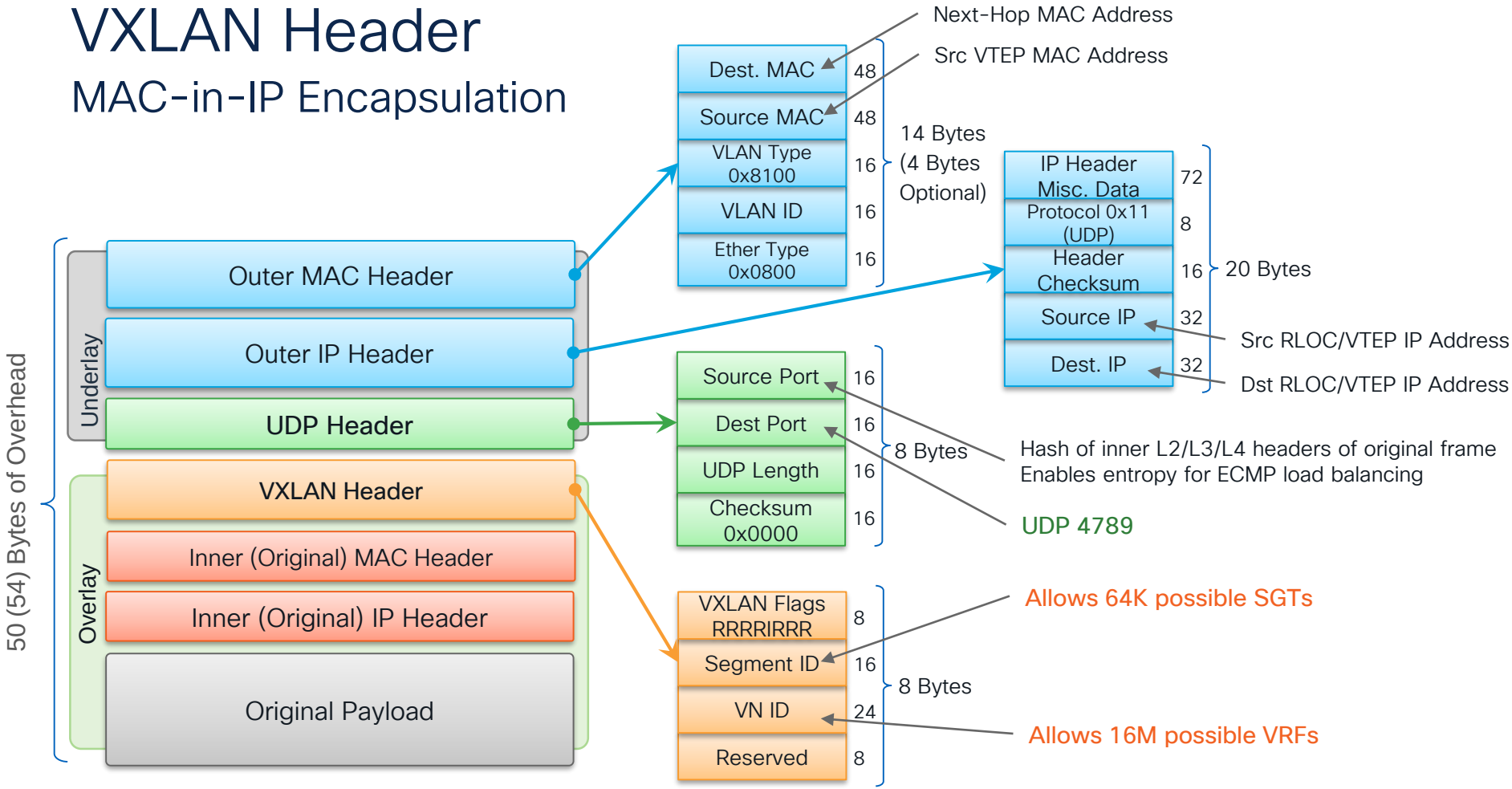
A Fabric is an Overlay

- A logical topology used to virtually connect devices, built on top of physical underlay topology
- Provides additional services not provided by the underlay



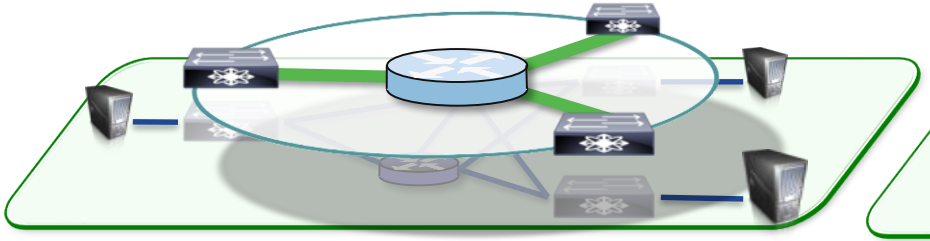
VXLAN Header

MAC-in-IP Encapsulation



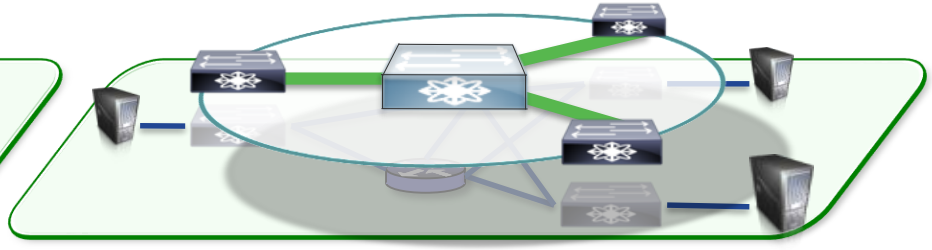
Fabrics with VXLAN Encapsulation

VXLAN Provides a Network with Segmentation & Scale



SDA LISP

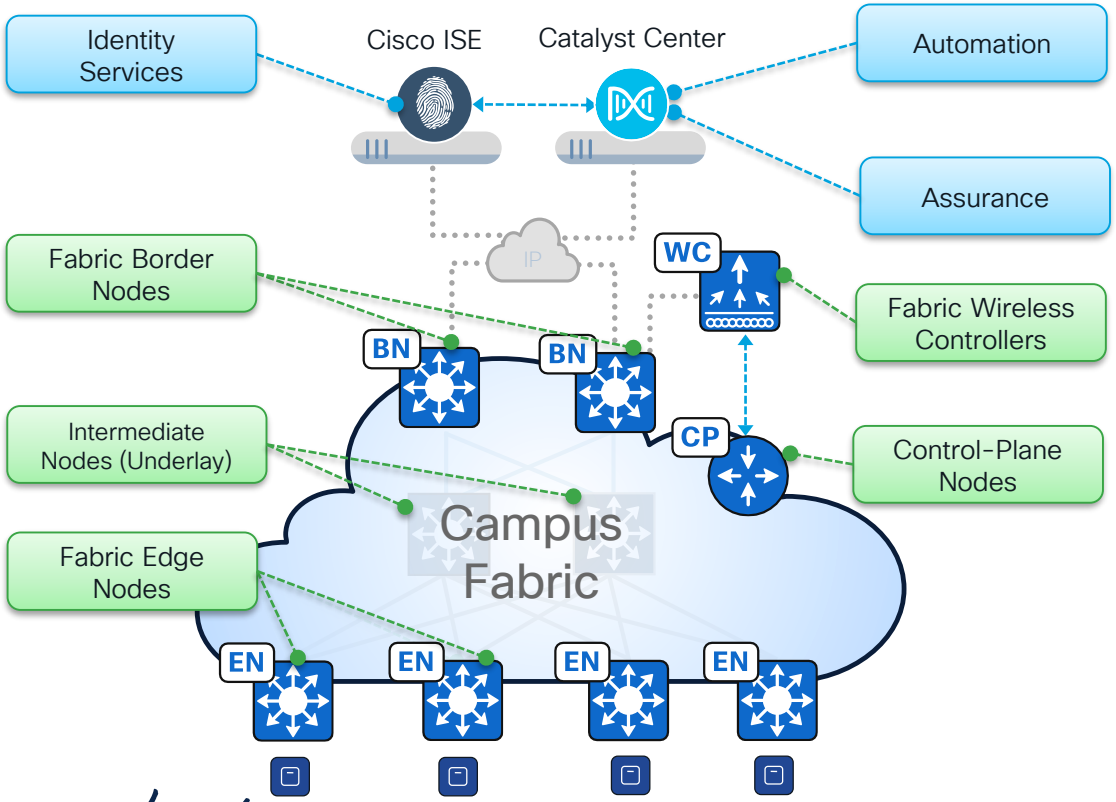
- Network Simplification Lightweight, extensible, massive scale with rapid convergence. Single overlay for wired/wireless
- Mobility First Requirement Fabric Integrated Wireless, L2 mobility, enhanced wireless performance
- Segmentation Zero-Trust Architecture with Micro and Macro Segmentation. Unified Wired + Wireless policy



BGP EVPN

- One Fabric Architecture (Campus & DC) Operational ease with a single familiar protocol
- Multi-vendor interoperability Vendor-agnostic solution
- Flexibility Customizable overlay network types and topologies

SD-Access Fabric Roles



- **Network Automation** – Simple GUI and APIs for intent-based Automation of wired and wireless fabric devices
- **Network Assurance** – Data Collectors analyze Endpoint to Application flows and monitor fabric network status
- **Identity Services** – NAC & ID Services (e.g. ISE) for dynamic Endpoint to Group mapping and Policy definition
- **Control-Plane Nodes** – Map System that manages Endpoint to Device relationships
- **Fabric Border Nodes** – A fabric device (e.g. Core) that connects External network(s) to the SD-Access fabric
- **Fabric Edge Nodes** – A fabric device (e.g. Access or Distribution) that connects Wired Endpoints to the SD-Access fabric
- **Fabric Wireless Controller** – A fabric device (WLC) that connects Fabric APs and Wireless Endpoints to the SD-Access fabric

Enterprise Campus BGP EVPN Drivers

Industry Standard	✓ Multi-vendor IT strategy
One Fabric Architecture	✓ Unified operation across network infrastructure
Proven and Scalable	✓ BGP protocol history. Minimum new learning curve
Hierarchical Fabric Domain	✓ Multi-tier overlay network architecture
Flexible Overlay	✓ Use-case driven. Customized overlay networks types & topologies

BGP EVPN System Roles

BORDER-GATEWAY:
A gateway point of between two or more BGP EVPN administrative domain boundary

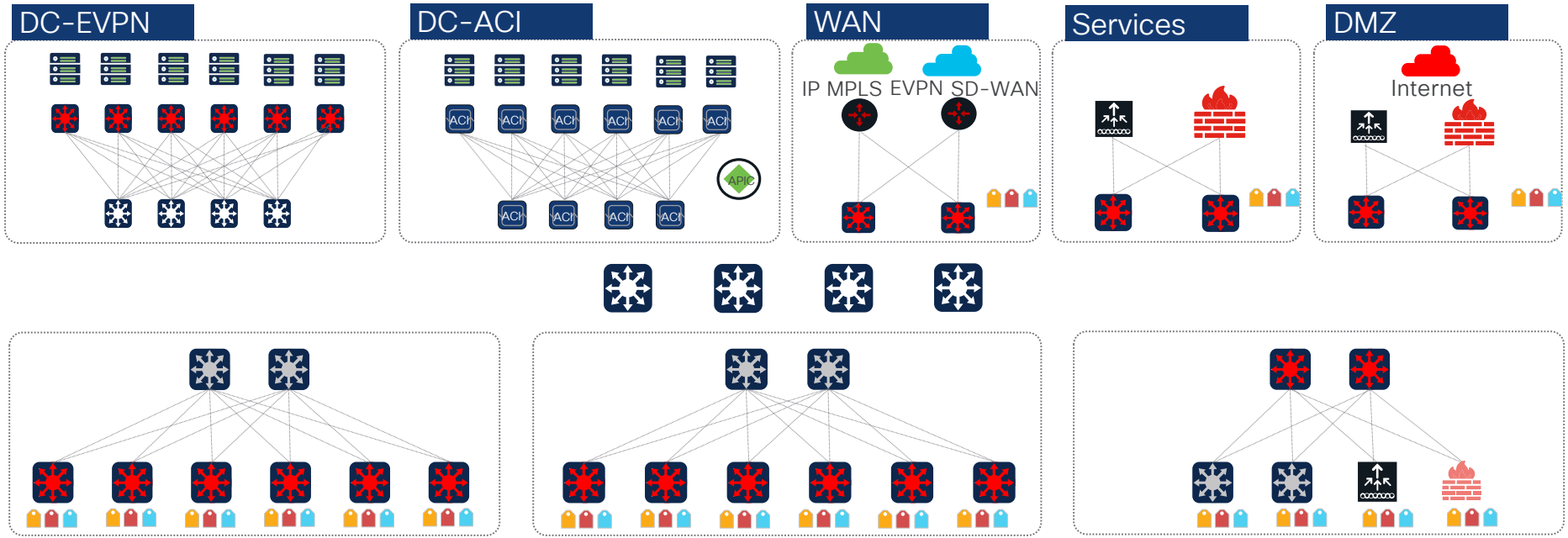
BORDER :
A gateway point of between EVPN fabric and external network domain

INTERMEDIATE :
A Layer 2 or Layer 3 (IP/MPLS) underlay network system providing basic transport and forwarding plane

SPINE :
A BGP EVPN role that reflects the L2/L3 VPN prefixes providing hierarchical neighbor peering, learning and distribution point

VTEP (LEAF) :
An origination and termination point of VXLAN enabled overlay network

Enterprise BGP EVPN Reference Architecture



Industry Standard | Unified Fabric | Proven | Hierarchical | Flexible

SDA-LISP: Recommended by Cisco for Campus

3,600+ Campus Deployments
30% Year to Year Growth

Simple

- Industry standard-based and optimized for enterprise campus
- Configurations automated based on business intent

Efficient

- Scales to a large number of endpoints
- Rapid converge

Extensible

- Simple directory structure to map endpoints to locations
- Highly extensible to address new use cases

Wired + Wireless

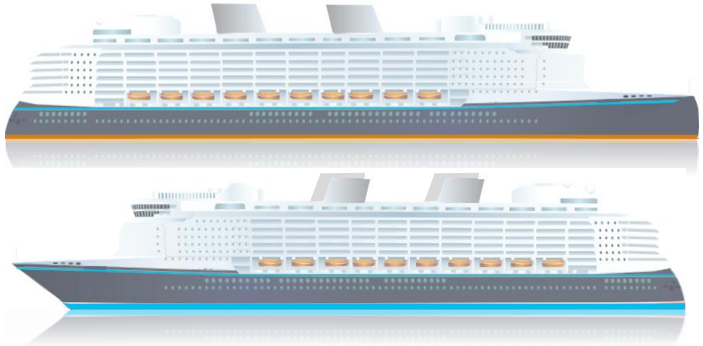
- Centralized control plane with distributed data plane
- Seamless campus wide mobility

Business Requirement

Responses to Meet Business Needs

Requirement
Business Continuity
Services to End Users
Ease of Network Deployment , Operation & Support

SD-Access



BGP EVPN

Business Continuity

- Network Downtime impacts revenue
- Network redundancy is required
- Limited network change windows
- Ships are offshore most of the time

Note: Specific to cruise line industry

Services to End Users

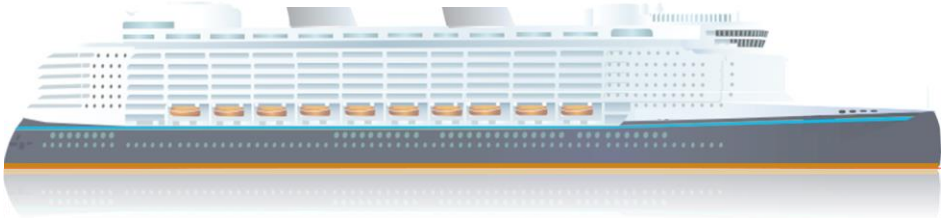
- Most endpoints are connected using wireless
- Extensive use of IP based IOT devices
- Seamless endpoint onboarding
- Ease of problem identification/troubleshooting/resolution
- Large number of APs and cabin switches

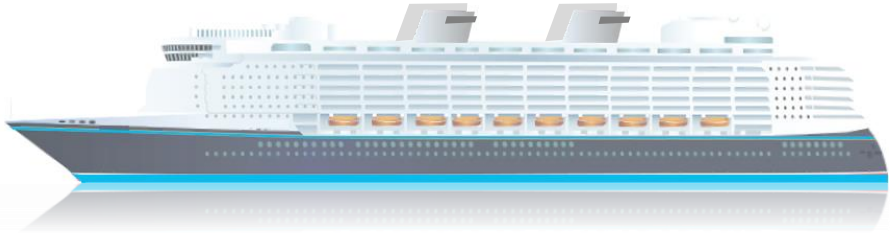
Ease of Network Deployment / Operation / Support

- Standard based network architecture
- Tight timeline for network implementation
- Secured endpoint admission control
- Security segmentation
- Onboard + Onshore IT support model

Two Cruise Ships: Similar Physical Configuration

- Passengers & Crews: 3,000 – 4,500
- Wired & Wireless Endpoints: up to 10,000
- Network Domains: Data Centers (servers) + Campus (passengers, crews)
- Network Infrastructure: Green field implementation



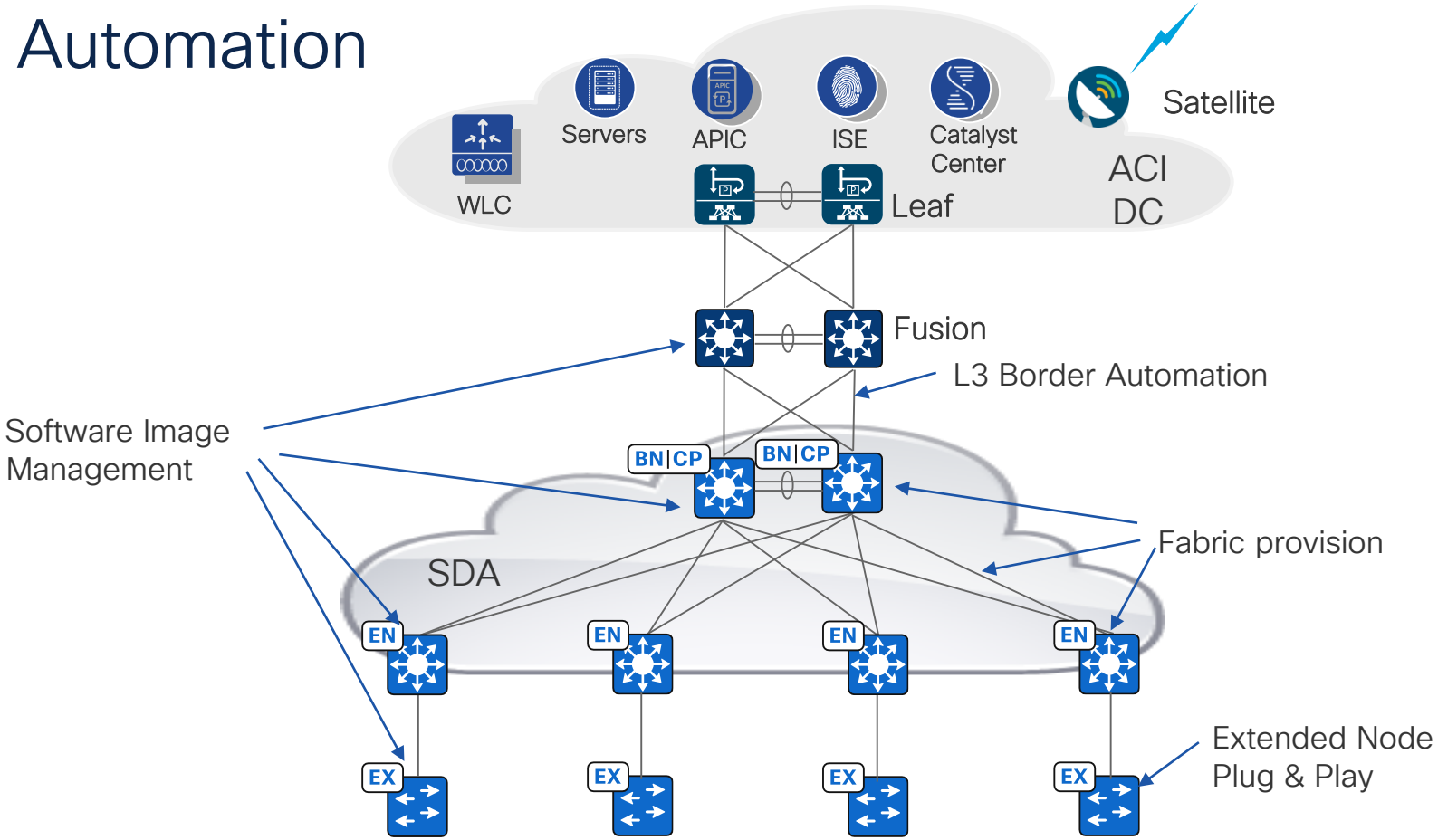


Ship #1: SD-Access Solution

Challenges & Solutions

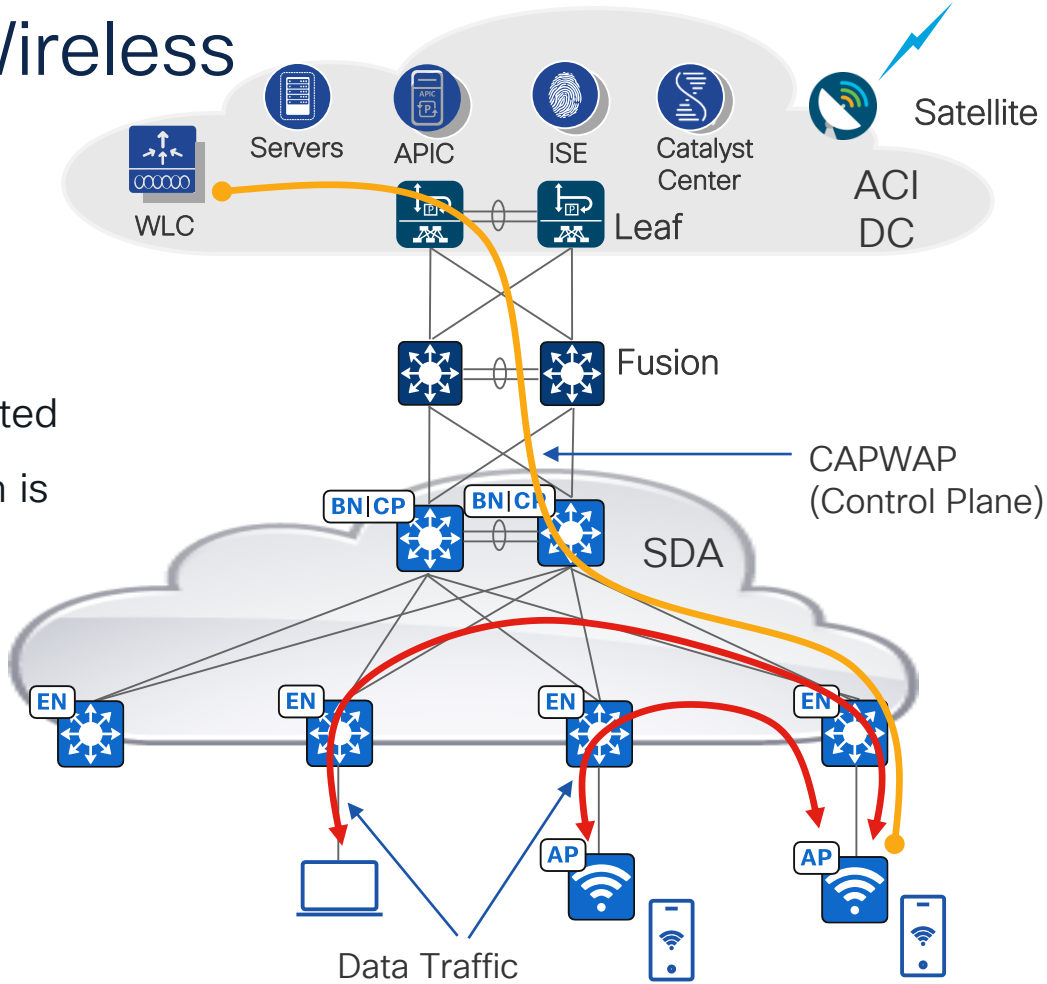
Automation, Assurance, TrustSec, Wire/Wireless integrated in Fabric	Catalyst Center / SDA
Limited Satellite Bandwidth	Catalyst Center Air-Gap
Extended Nodes Exceeding Limit	Fabric Zone
Need L2 Connectivity to Servers	Layer 2 Virtual Network
Survivability for Critical Services	Spread Network Devices Across Fire Zones

Fabric Automation



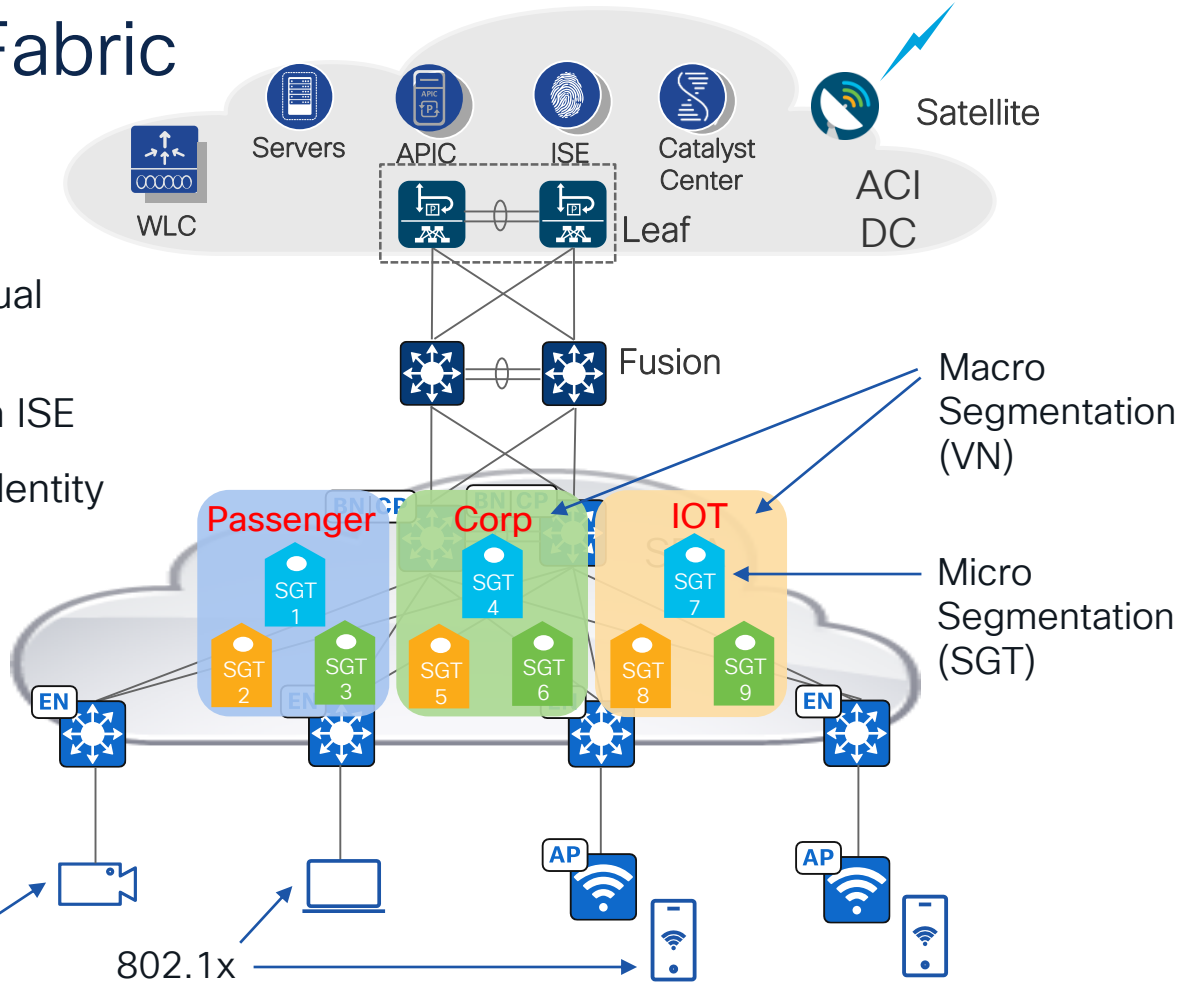
Fabric Enabled Wireless

- No air-pinning to centralized controller
- Wireless client traffic is distributed
- Wired-Wireless communication is directly through Fabric



TrustSec inside Fabric

- Macro segmentation using Virtual Networks (VN)
- Centralized policy authorized in ISE
- Endpoints grouped based on identity
- Micro Segmentation using Security Group Tag (SGT)



Fabric Assurance

Assurance Dashboard

- Health & critical issues summary
- Fabric, device & client health scores
- Wireless trends

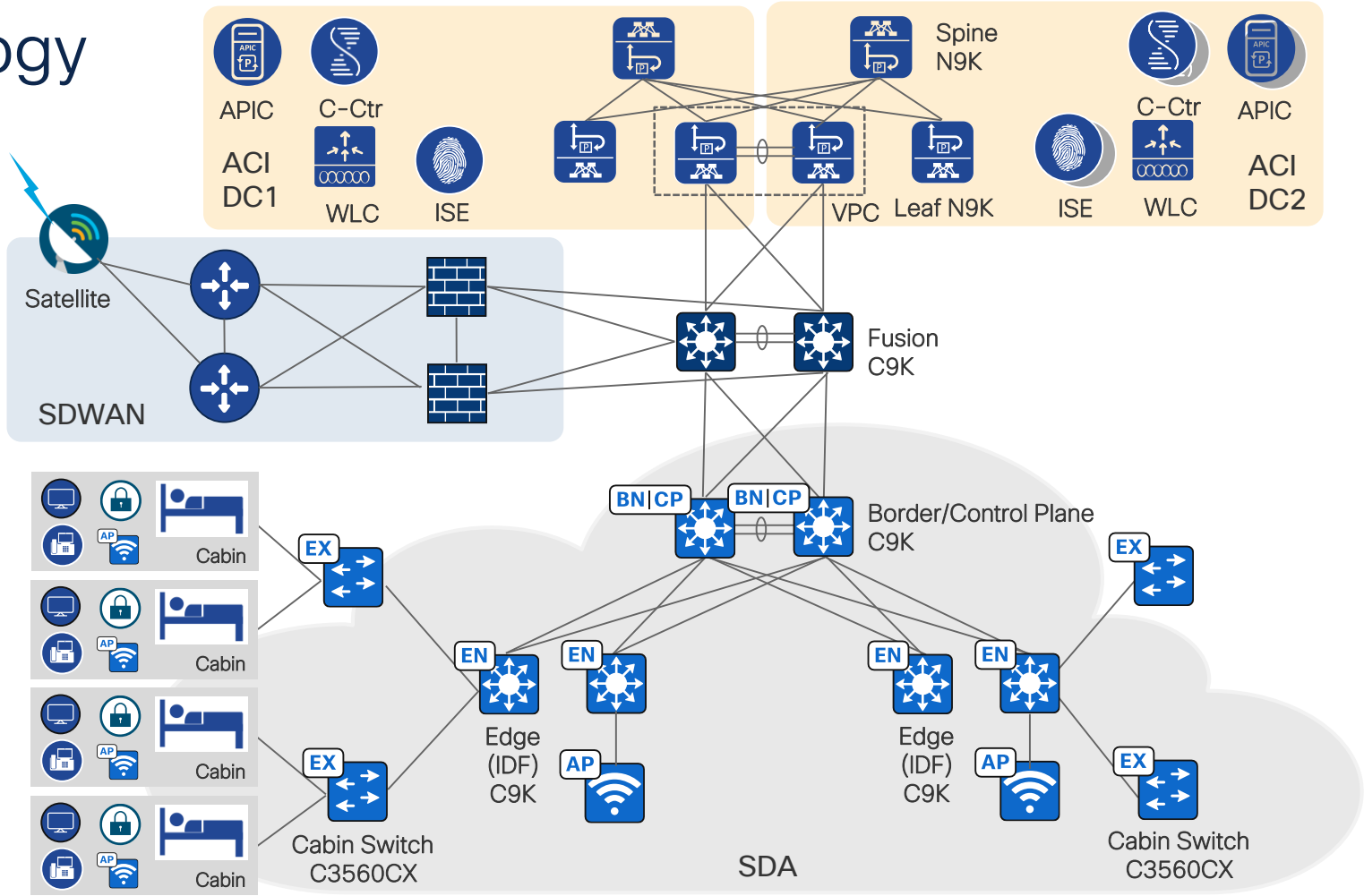
Device & Client 360 Views

- Time travel view
- View connected neighbors & clients
- Universal search for elements in the network

Troubleshooting

- Issues with explanations
- Suggested actions

Topology



Satellite Bandwidth

Challenge:

- Limited Internet bandwidth through Satellite
- Bandwidth priority is given to the paid passengers

Solution: Catalyst Center in Air-Gap Mode

Typical Use Cases

- Department of Defence
- Government

Airgap Implementation Considerations

Supported	Not Supported
Catalyst Center Software Offline Updates	Geo Maps Update
Assurance (Except AI Network Analytics)	License Manager (Devices that do not support SLR/PLR)
Application Policy, Topology, Third Party SDK, Audit Log, Global Search, Home Page, Bonjour, Plug and Play, PSIRTs	AI Network Analytics
SWIM: Manual Image Import, Manual KGV Import, Addons (Manual import required) – SMU, Sub package, APSP, APDP	SWIM Addons – ROMMON; Automated Image Download from cisco.com
SDA (with DHCP server in Airgap)	Integrations outside Airgap
License Manager (SLR/PLR Supported)	Make a Wish

Ensure Catalyst Center does not have backdoors to Internet to download online packages automatically, otherwise it would cause upgrade issues

Scale

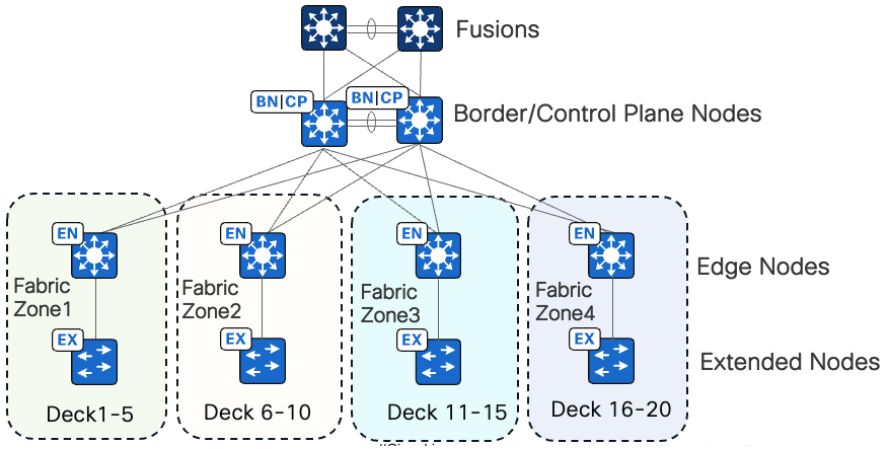
Challenge:

- Supported fabric devices per SDA Fabric site is 1,200 for DN2-HW-APL-XL
- Cruise line required 2000+ Extended Nodes to service all the cabins
- Same IP pools stretching multi-Fabric site was not an option

Solution: Fabric Zone

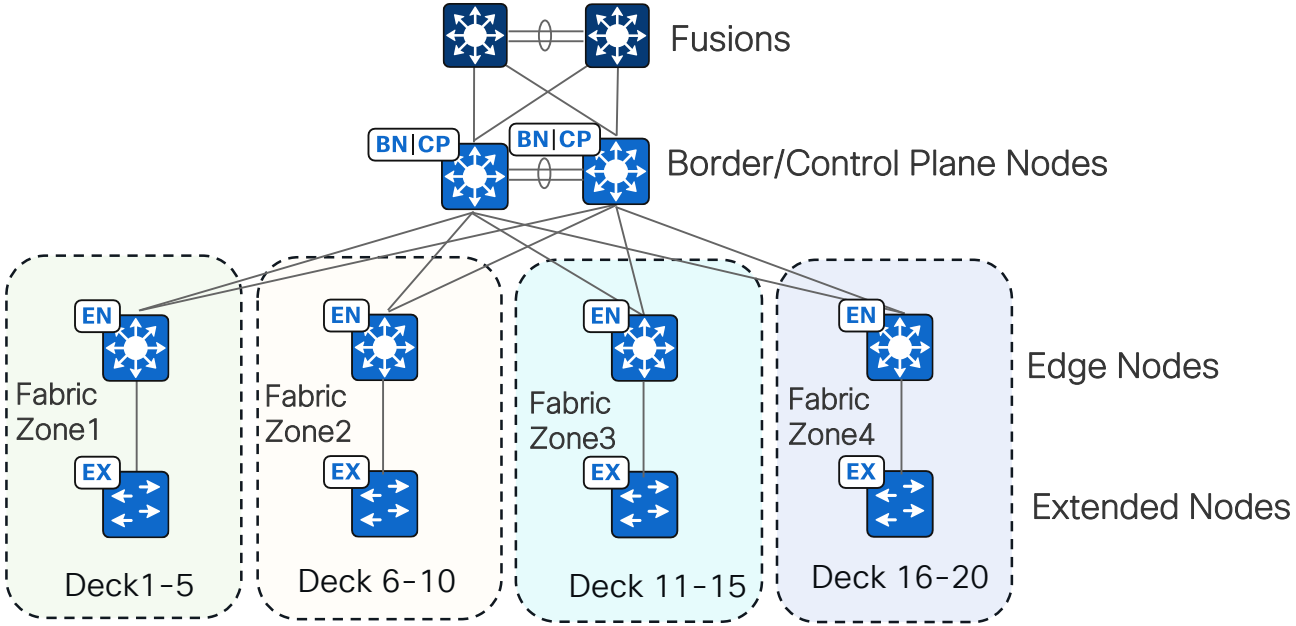
Typical Use Cases

- Manufacturing



Fabric Zones on the Ship

- 4 Zones with 500 Extended Nodes each
- No common changes to all Fabric Zones at the same time
- Onboard 50 Extended Nodes at a time



Review design with Cisco first. Multiple Fabric Site is the preferred choice in other use cases

L2 Connectivity to DC

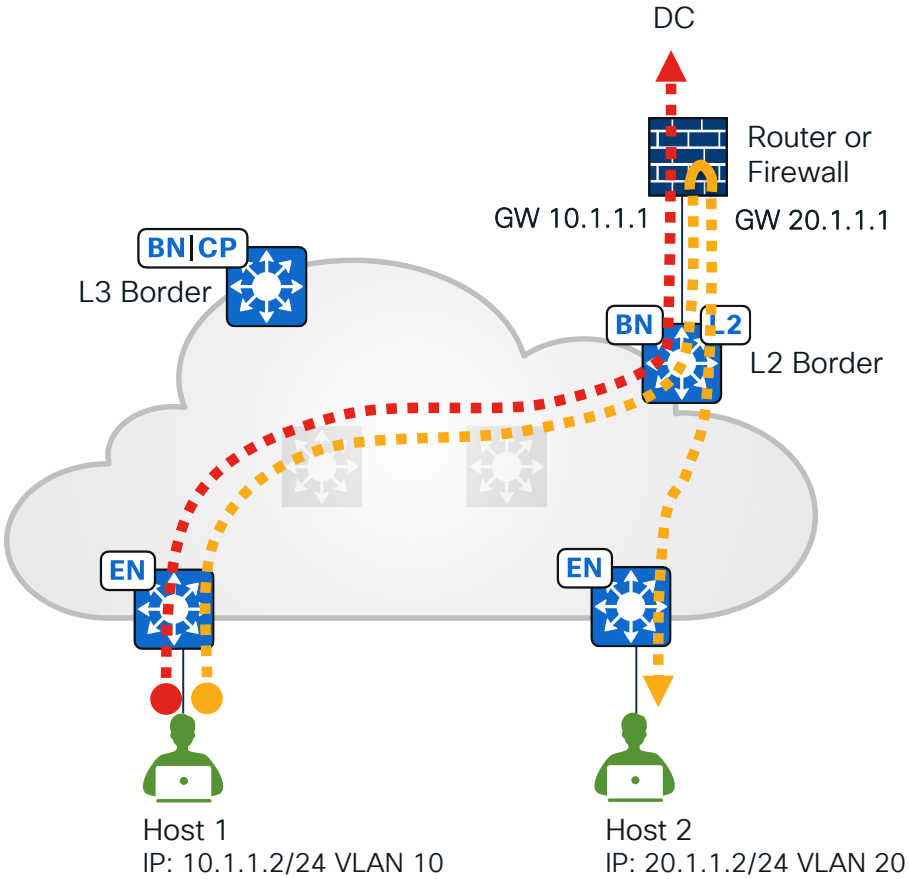
Challenge:

- Certain legacy applications require servers at DC to be on the same L2 segment as the endpoints at the Fabric
- Security requirement for Gateway of a subnet to be outside the Fabric

Solution: Layer 2 Virtual Network

Typical Use Cases

- Manufacturing
- IoT segments
- BMS



Location Redundancy

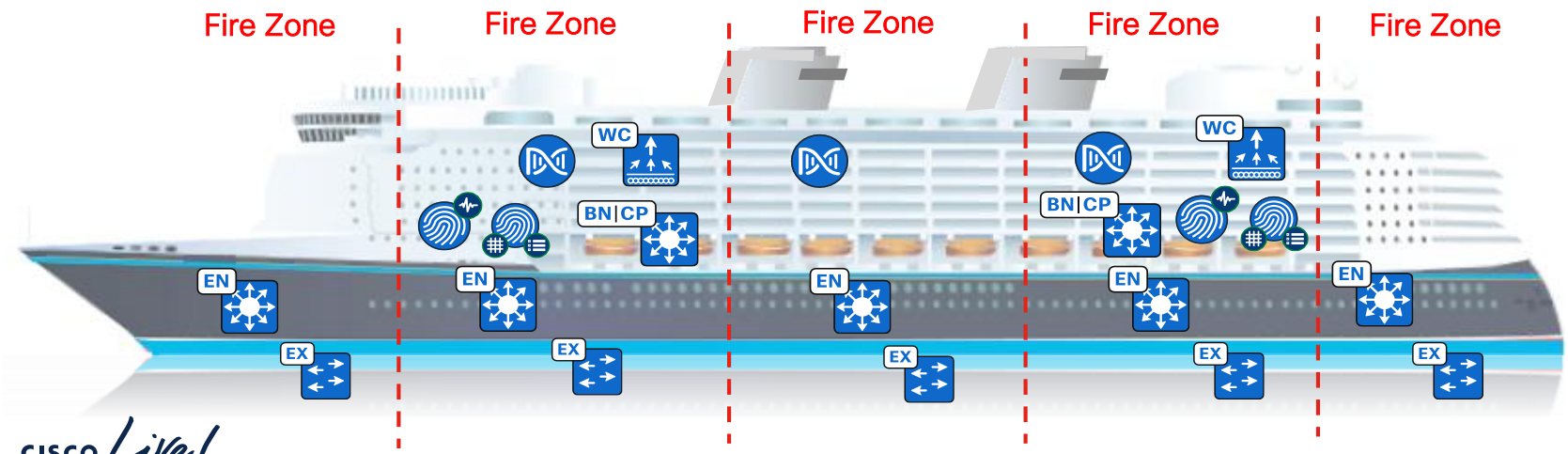
Challenge:

- DCs and critical network devices need to have location redundancy

Solution: Spread them across Fire Zones and locations

Typical Use Cases

- Transportation
- Financial



Ship #2: BGP EVPN Solution

Challenges & Solutions

Automate Fabric Overlay from DC to Campus	Use Nexus Dashboard Fabric Controller (NDFC)
Reduce Fabric Fault Domain	Multisite VXLAN BGP EVPN
L2 Connectivity to Servers	Layer 2 overlay tunnels
Survivability for Critical Services	Spread network devices across fire zones

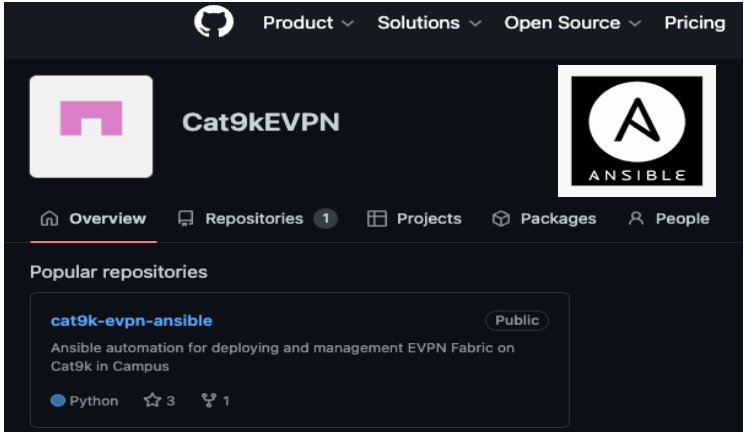
Fabric Automation

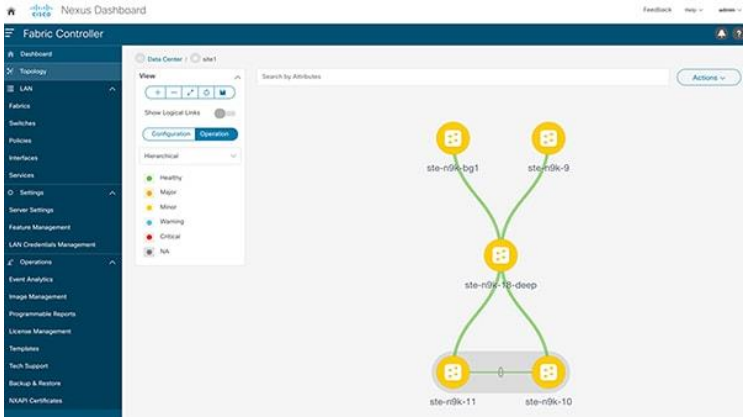
Challenge:

- Need automation for Nexus and Catalyst switches with BGP EVPN deployment with a single pane of glass

Solution:

- NDFC with built in python & CLI policies for configuration generation
- Cat 9000 programmability





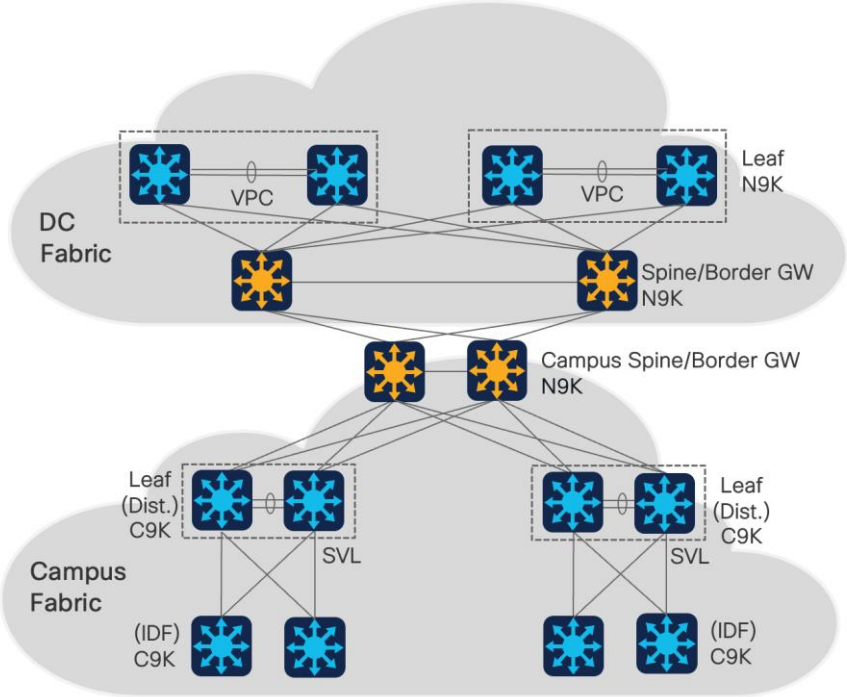
Multisite

Challenge:

- Single fabric fault domain from DC to campus is not scalable

Solution:

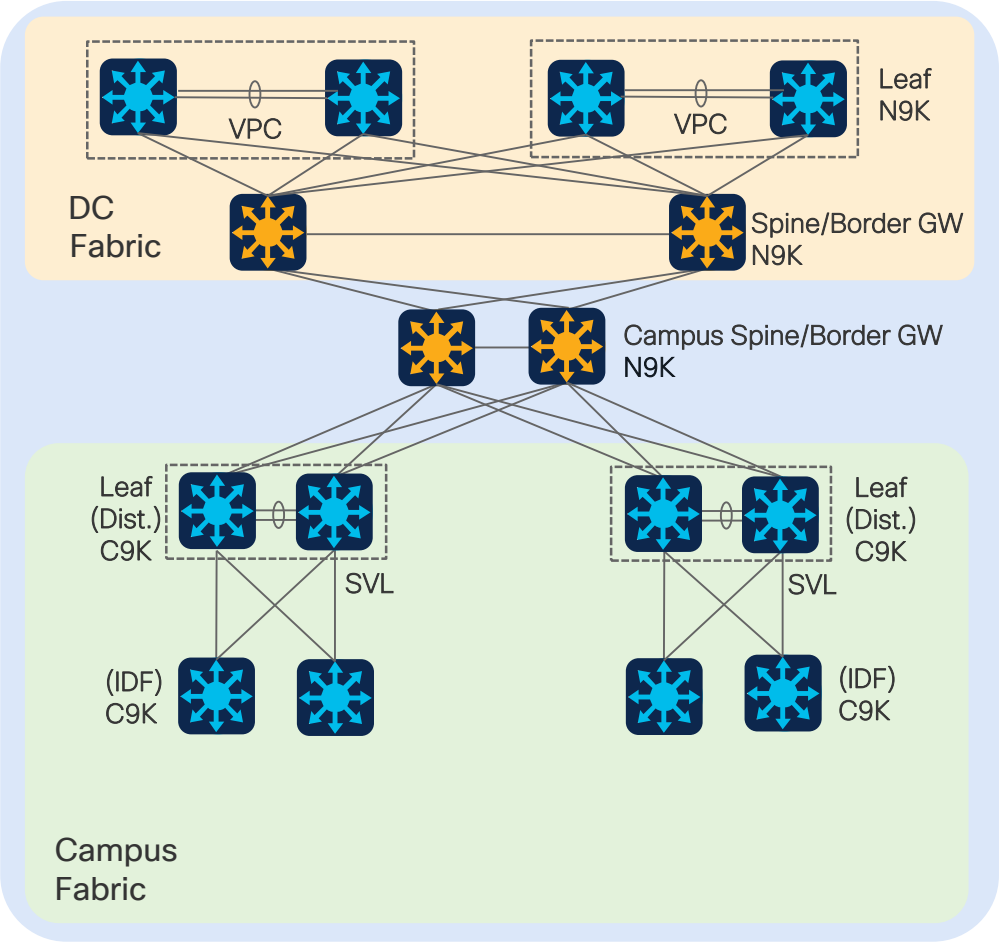
- Implement DC site and Campus site
- Back-to-back multi-site anycast BGW



Multisite

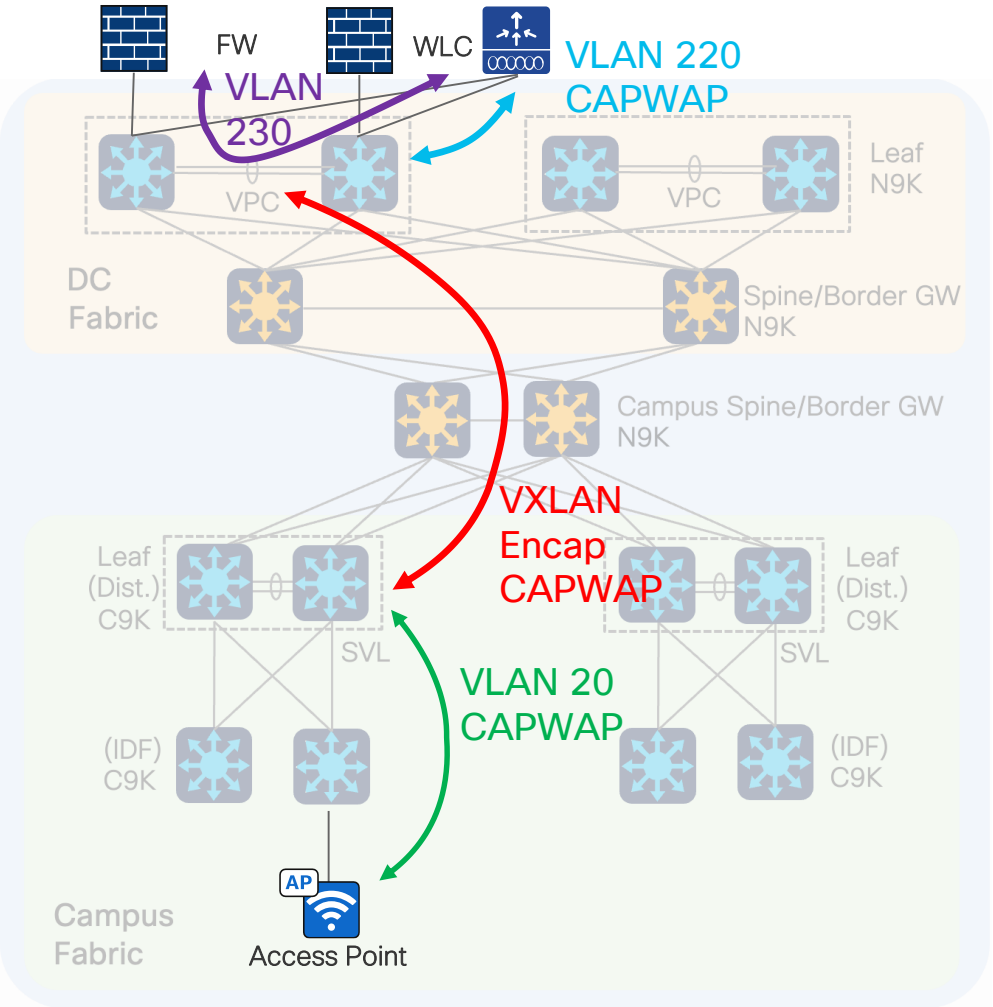
- Separate replication domains for BUM (Broadcast, Unknown Unicast, and Multicast) traffic
- Granular control on cross-site L2 and L3 communication
- Better overall scalability
- Smaller fault domain

	Micro segmentation across campus and DC is not supported



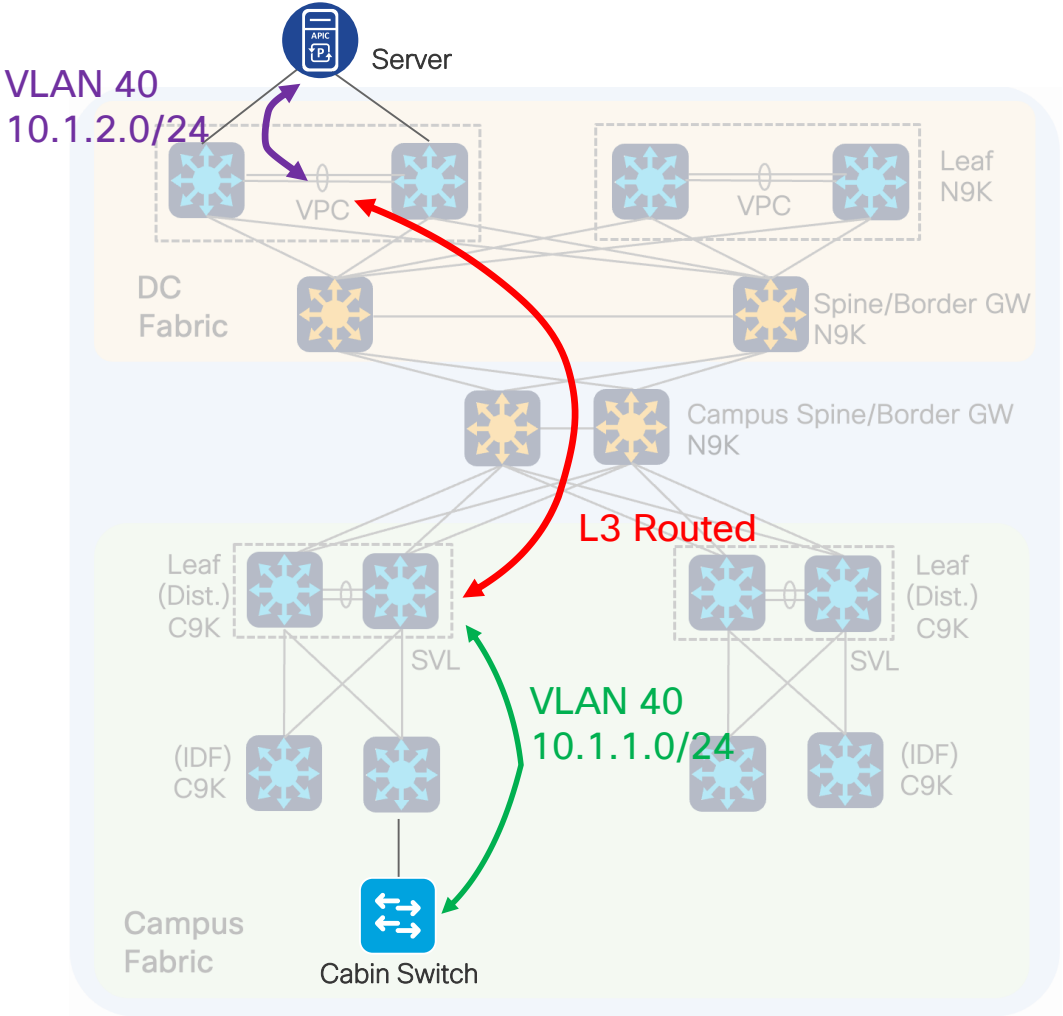
Wireless Inter-Site Traffic

- CAPWAP from Access Point reaches Leaf over VLAN 20
- CAPWAP encapsulated in VXLAN reaches DC Leaf
- CAPWAP traffic from service Leaf sent to WLC over VLAN 220 as CAPWAP
- Traffic sent as Ethernet from WLC to FW over VLAN 230

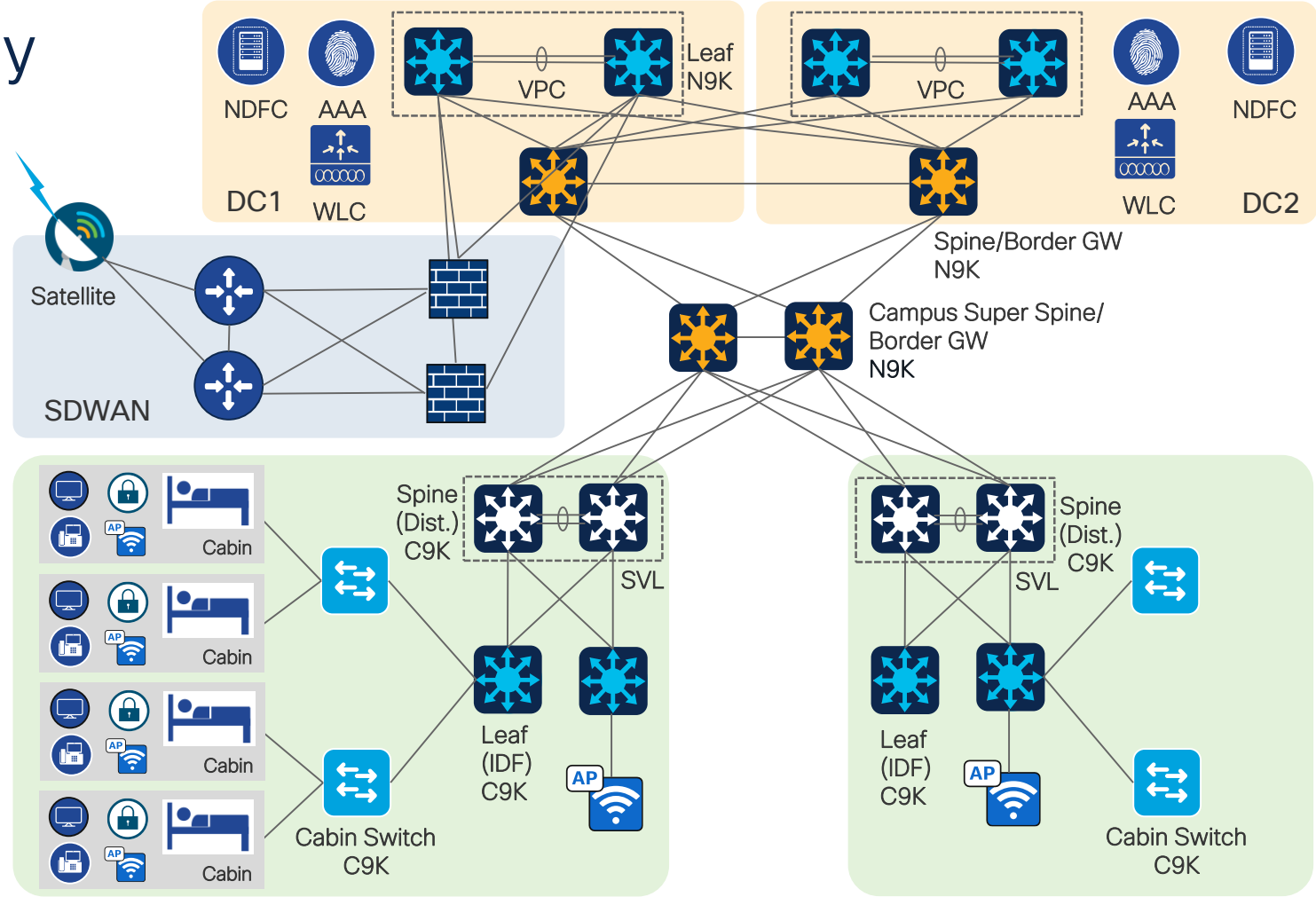


L3 Inter-Site Traffic

- Anycast Gateway required for each subnet
- Anycast Gateway for server resides in DC
- Anycast Gateway for IDF resides in Campus
- Traffic routed between different VLANs/subnets with the same L3 VNI



Topology


NDFC
AAA
WLC
DC1
VPC
Leaf
N9K
VPC
AAA
NDFC
WLC
DC2
Spine/Border GW
N9K
Satellite
SDWAN
Campus Super Spine/
Border GW
N9K
Cabin
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Cabin
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Spine
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C9K
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Cabin Switch
C9K
Spine
(Dist.)
C9K
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(IDF)
C9K
AP
Cabin Switch
C9K

L2 Connectivity to DC

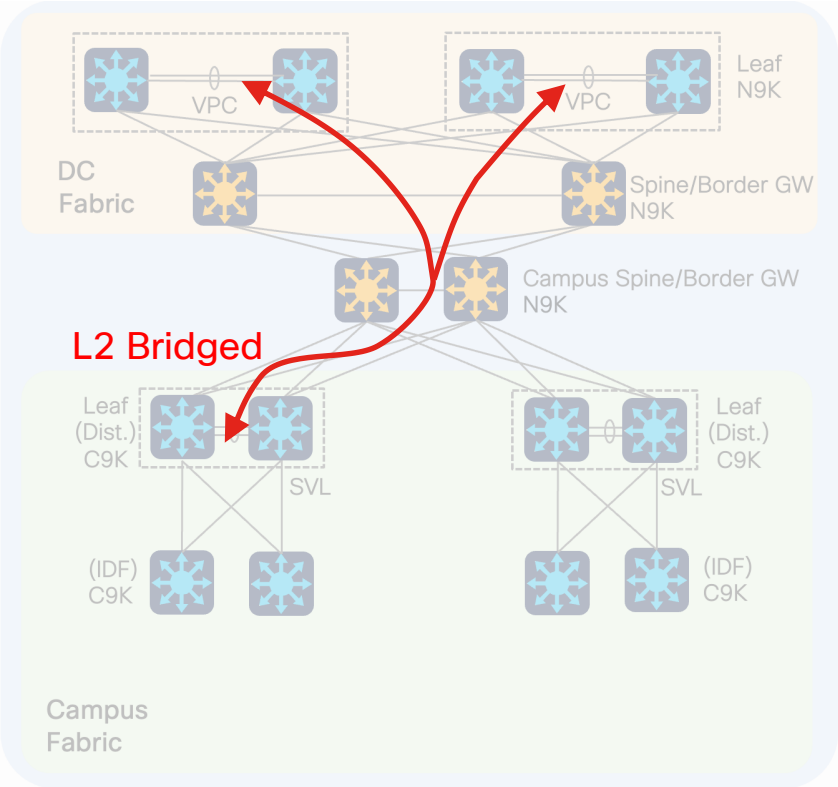
Challenge:

- Certain legacy applications require endpoints at the Campus to be on the same L2 segment as servers at DC

Solution: Layer 2 Overlay Tunnels

Typical Use Cases

- Manufacturing
- IoT



Location Redundancy

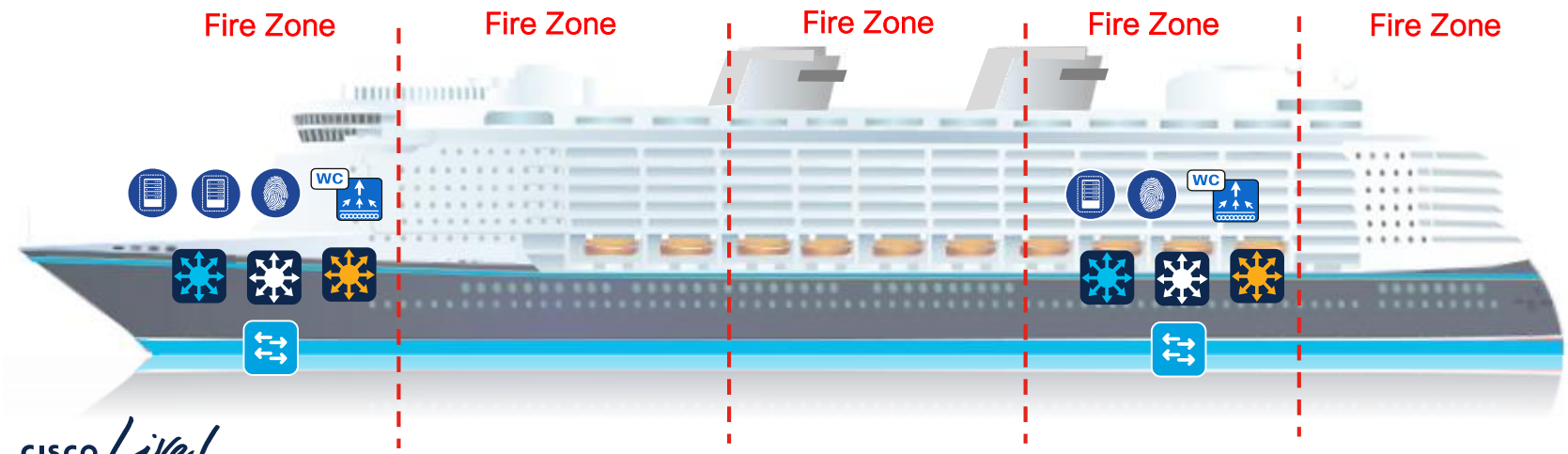
Challenge:

- DCs and critical network devices need to have location redundancy

Solution: Spread them across Fire Zones and locations

Typical Use Cases

- Transportation
- Financial

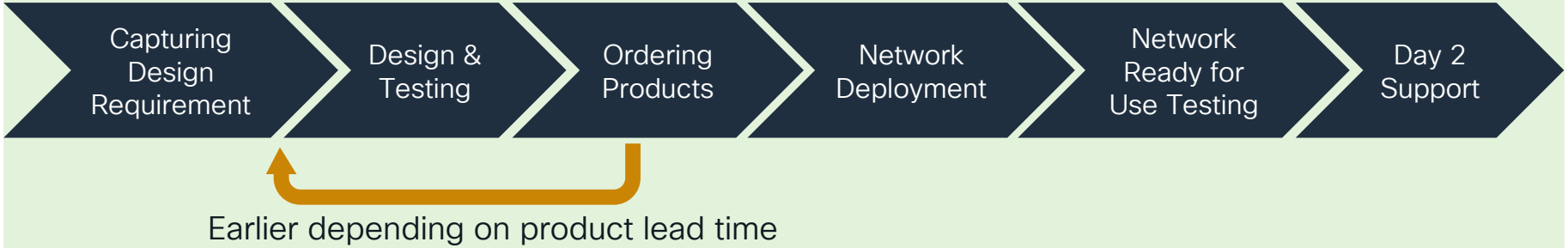


Plan, Design, Implementation, and Support Best Practices

Plan

Project Planning

- Plan according to contractually binding ship sail date
- Set major milestones



- Engage all involved parties relevant to deployment phases
- Track progress and take actions as needed

Plan

Capture Design Requirement

- Current operation model
- Priorities and approaches to meet them
- Traffic Flow: Campus – DC - Internet
- Application requirement

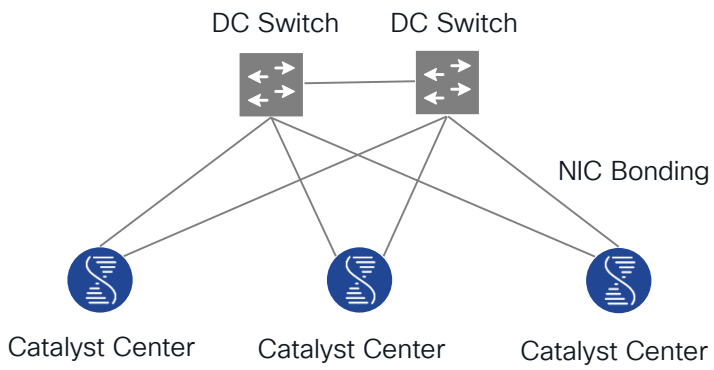
Security Policies

- Define security policies based on business requirement
- Macro and micro segmentation
- Group Based Policies
- Endpoint authentication and authorization
- Further developed in Design and fine-tuned in lab and onsite

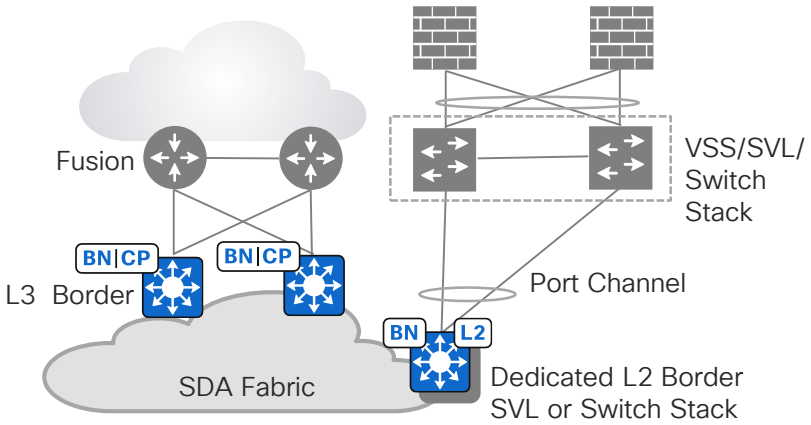
Design

Redundancy

- Link, controller and hardware redundancy
- Put critical roles on dedicated devices
- Routing if possible, bridging only if you have to



Catalyst Center 3-Node Cluster HA

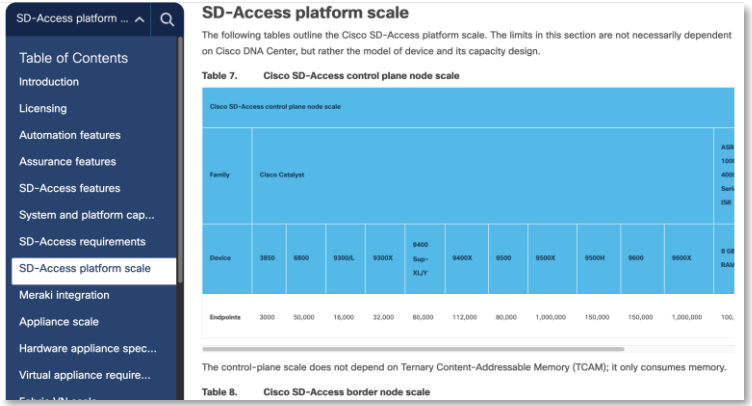


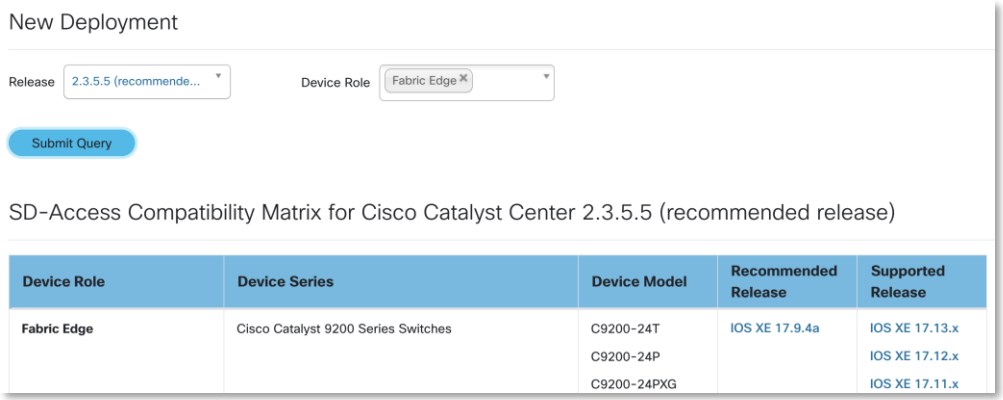
SDA L2 Border

Design

Sale & Feature Support

- Consider platform & controller scales
- Older hardware affects Fabric wide feature support
- Use recommended controller & device software versions
- Standardize network site hierarchy, scalable IP address schemes & device naming

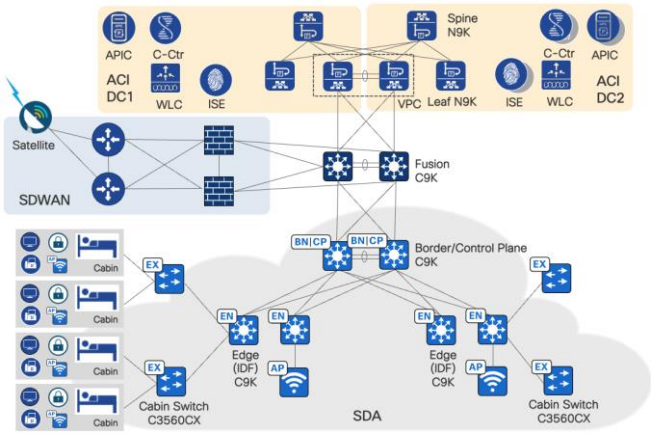


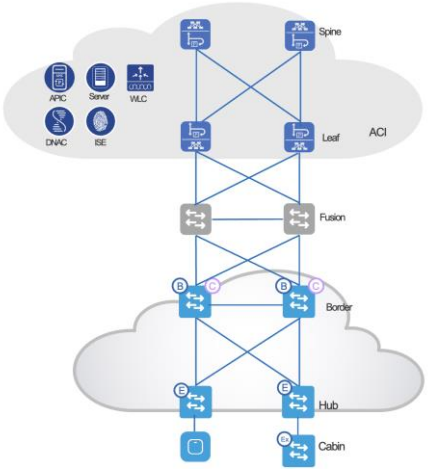


Design

Lab Environment

- Set up a scaled down proof of concept (POC) lab if feasible
- The lab assists in developing implementation procedures
- Software version and hardware certification
- Ongoing lab testing prior to implementing new features to production network



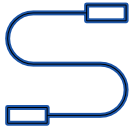


Deployment

Coordination

- Consider international shipyard construction constrains
- Address issues with shipyard construction timely:
  - Cabling
  - Unaccountable APs and Cabin switches
- Conduct post implementation WiFi RF survey before ships are in service

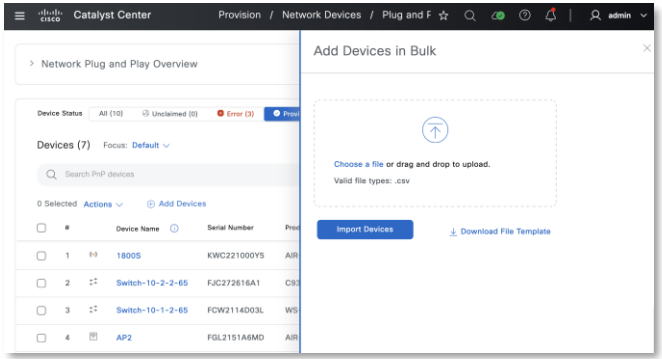





Deployment

SDA Automation

- 100s of APs and cabin switches can be connected by shipyard construction at different times
- Automate AP onboarding using a CSV template
- Large numbers of Extended Node onboarding can be automated using templates



Serial Number	Model	AP Name	Site	RF Profile
FJC253786GH	C9115AXE-B	AP-9-2-9016	Global/ADVENTURE/FABRIC_ZONE_03/DECK_09	PASSENGER
FJC253716MV	C9115AXE-B	AP-9-2-9018	Global/ADVENTURE/FABRIC_ZONE_03/DECK_09	CREW

Extended Node Onboarding

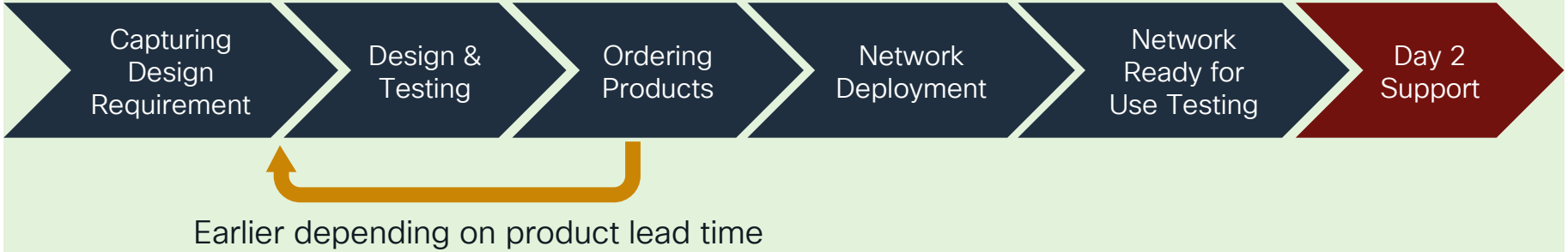
- Configure an EEM script in a template
- Push the template into upstream Edge switches by provisioning
- The Edge creates a port-channel and trunk when it sees a C3560CX as its CDP neighbor
- The C3560CX is onboarded as an Extended Node automatically
- Once all the C3560CX are onboarded, remove the EEM script from the Edge

```
event manager applet detect-3560CX authorization bypass
 event neighbor-discovery interface regexp Ethernet.* cdp add
 action 1.0 regexp "(C3560CX)" "$_nd_cdp_platform"
 action 2.0 if $_regexp_result eq "1"
 action 2.1 cli command "enable"
 action 3.0 cli command "show running-config interface $_nd_local_intf_name"
 action 4.0 regexp "(channel-group)" "$_cli_result"
 action 5.0 if $_regexp_result eq "0"
 action 6.0 cli command "enable"
 action 7.0 cli command "config t"
 action 8.0 cli command "default interface $_nd_local_intf_name"
 action 8.1 cli command "int $_nd_local_intf_name"
 action 8.3 cli command "switchport mode trunk"
 action 8.4 syslog msg "3560CX detected, no port-channel present"
 action 8.5 break
 action 8.6 else
 action 8.7 syslog msg "3560CX detected, port-channel present"
 action 9.1 end
 action 9.2 end
```

Post Implementation Support

Day 2 Support

- Design/Implementation team provides support immediately after ship launch
- Transfer network As-Built documents to Day-2 support
- Train Day-2 support team on features and technology
- Changes made to production should be reviewed, approved and implemented during change windows



Sneak Preview: Catalyst Center Orchestrated BGP EVPN

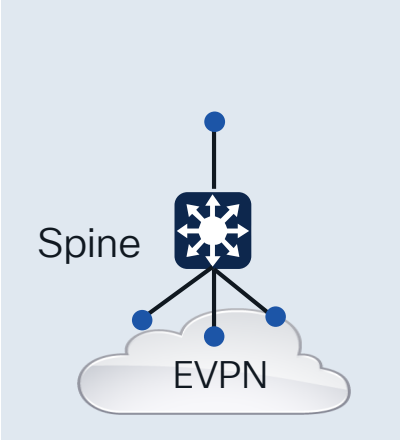
SDA-EVPN Supported Hardware

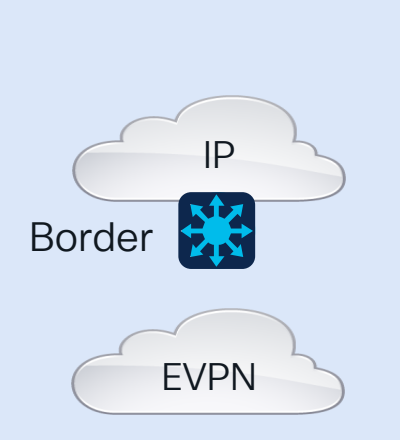
Catalyst Center		
Physical Appliance	Virtual Appliance	Cloud
DN2-HW-APL DN2-HW-APL-L DN2-HW-APL-XL	DN2-SW-APL	Amazon Web Services

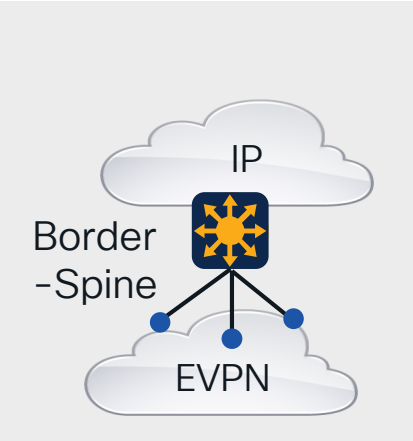
Catalyst Center can support either SDA-LISP or SDA-EVPN. Co-existence of both control-planes on single Catalyst Center is not supported

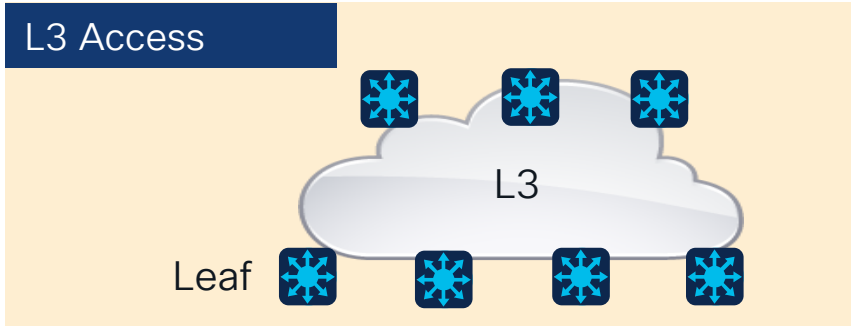
Catalyst Switches (IOS-XE 17.12.x and above)	
Core	Access
Catalyst 9500 Non-High-Performance Catalyst 9500 High-Performance Catalyst 9600 Sup-1	Catalyst 9300L/LM Catalyst 9300/9300B Catalyst 9300-X Catalyst 9400 Sup-1 Catalyst 9400-X Sup-2

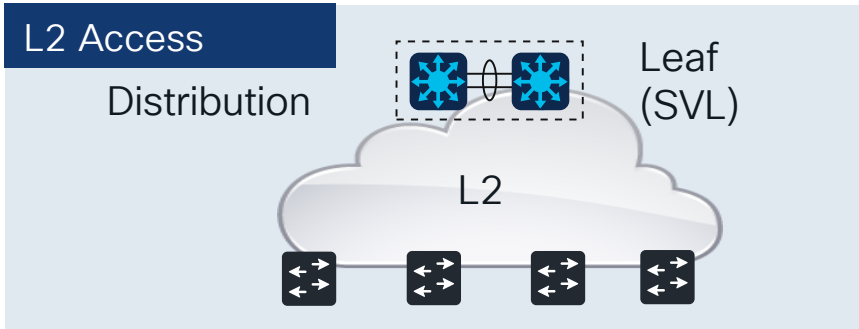
Fabric Roles and Access Modes





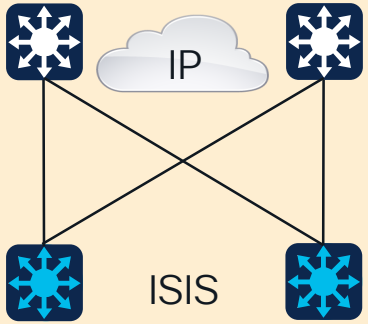




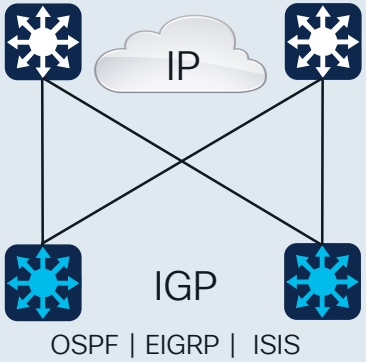


Flexible Underlay Options

LAN Automation



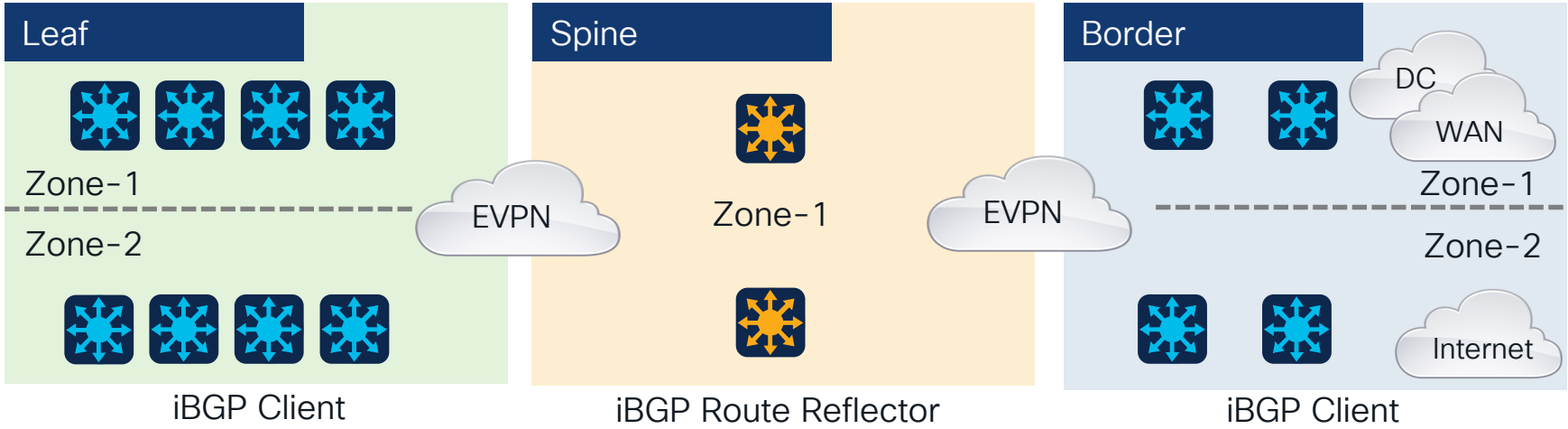
Brownfield



- Network virtualization does not mandate change to existing network
- Customers can build SDA-EVPN Fabric while managing brownfield underlay independently

SDA-EVPN does not support fabric automation on network switches with pre-configured BGP

Control Plane & Fabric Zone



Control Plane

- Underlay IGPs can be used to build iBGP sessions over loopbacks

Fabric Zone

- A device can only be associated to single Fabric Zone
- A Fabric site can have multiple Leaf and Border zones but one Spine zone only

Simplified Addressing

L3VN Address Pool

- Route-Distinguisher
- L3VNI ID
- Core VLAN
- NVE
- Default MDT Group
- Route-Target
- Data MDT Group Range

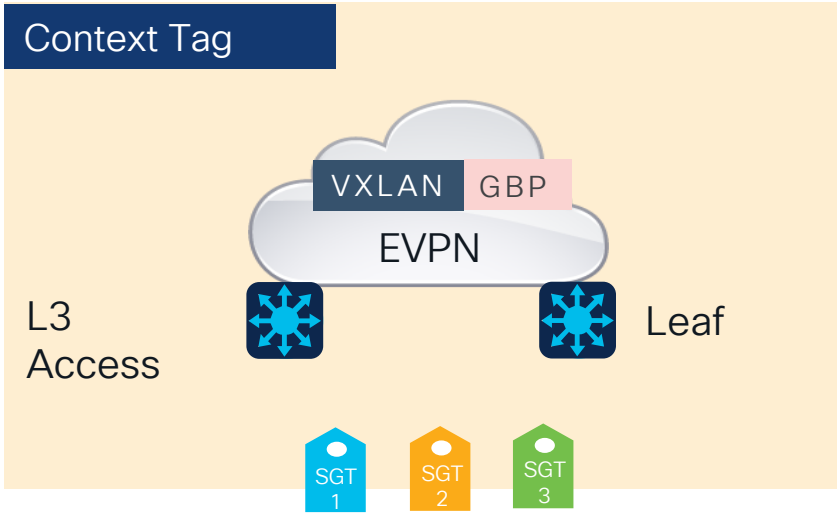
L2VN Address Pool

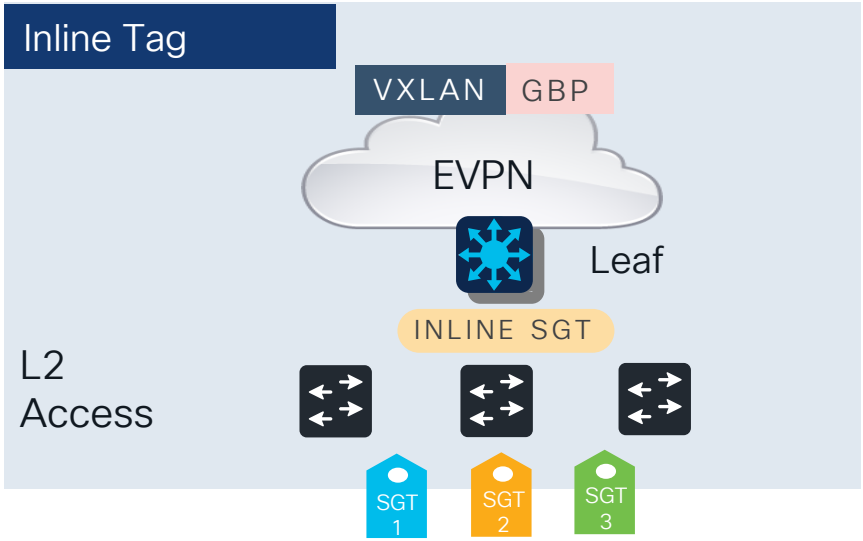
- Route-Target
- EVI Instance ID
- Multicast Replication
- L2VNI ID
- NVE
- Route-Distinguisher

- Fabric Resource Pools auto-generated
- Automation workflows dynamically reserve & release addresses to pools
- Reduces operational complexity

Fabric Resource Pool is a one-time initial fabric site configuration step. It cannot be expanded or modified once fabric site automation is completed

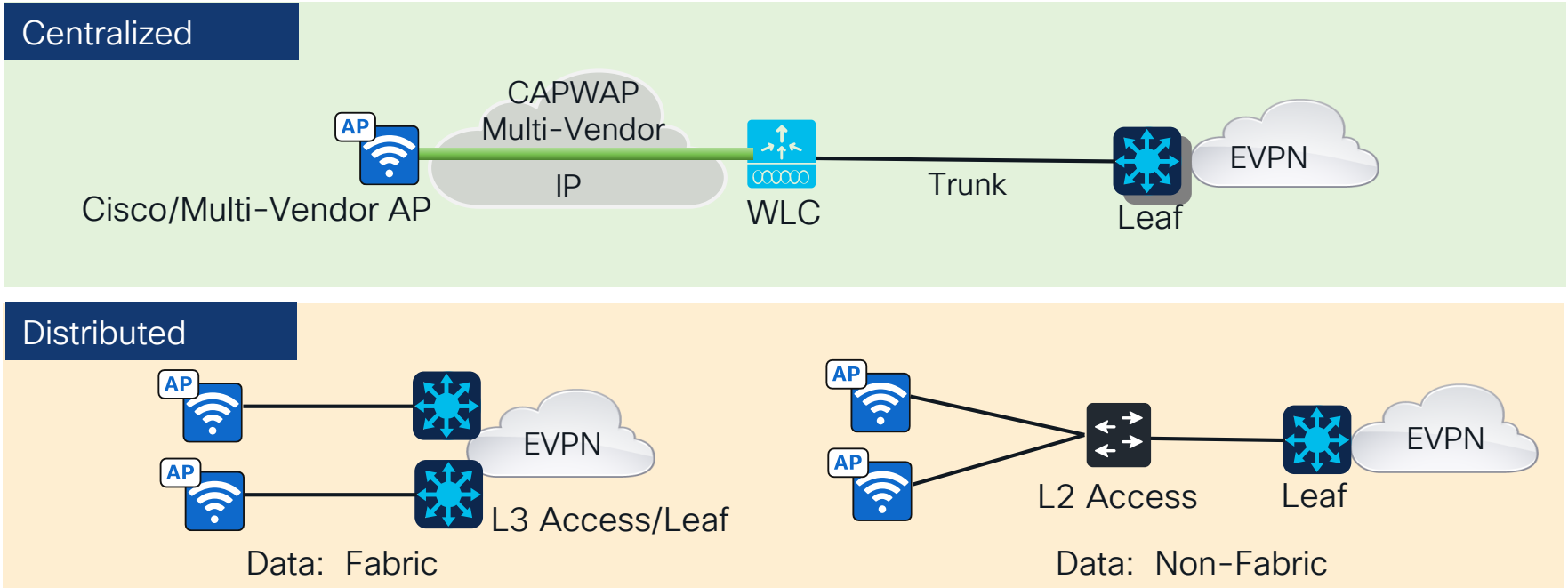
Context Aware Fabric – Micro Segmentation





- VXLAN with Group Based Policy (GBP) extension uses SGT for endpoint contexts
- VXLAN data-plane with GBP extents policy-plane across fabric

Wireless Integration



- Centralized/Distributed wireless integrated with SDA-EVPN overlay
- AP to WLC Control-plane preserved in underlay

SDA-EVPN does not automate wireless network and switch ports connected to WLC & APs

Cisco Campus BGP EVPN Solution Evolution

	Do It Yourself CLI	Programmable Ansible, Terraform	NDFC	SDA-EVPN Catalyst Center
Fabric Configuration	✓ CLI templates	✓ Automated	✓ Automated	✓ Intent-Based
Software Life Cycle Management		✓	✓	✓
Config Compliance			✓	✓
Assurance & Analytics (Endpoint, Policy & Trust)				✓
Zero-Trust Architecture				✓

Enterprise Ready Catalyst 9000 Foundation

How Did the Tale of Two Ships End?

- Network implementation started from around 2022-23
- SD-Access LISP (SDA) & BGP EVPN deployed on two ships from two different cruise lines
- Around ten vessels have been deployed using these two solutions, with more to come
- Both solutions have been very stable

Complete Your Session Evaluations

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Thank you