

The Cisco Live! logo, featuring the word "CISCO" in a dark blue, sans-serif font, followed by "Live!" in a dark blue, cursive script font.

CISCO *Live!*

The text "Let's go" in a large, dark blue, sans-serif font, positioned to the left of a bright, multi-colored sunburst graphic that radiates from the right side of the image.

Let's go

#CiscoLiveAPJC



The bridge to possible

1,2,3 Enterprise Campus Wired Design Fundamentals

Back to Basics

Russell Rizbaf - Account Solutions Engineer
@dangerousruss
BRKENS-1501

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Cisco Webex App

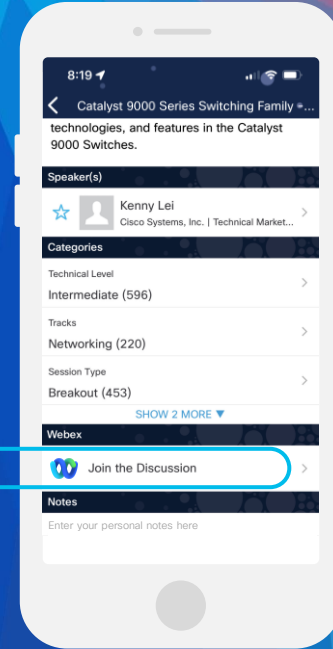
Questions?

Use Cisco Webex App to chat with the speaker after the session

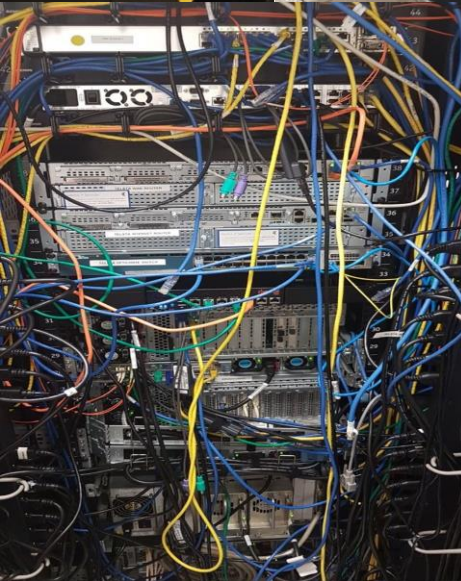
How

- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until December 22, 2023.



<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKENS-1501>



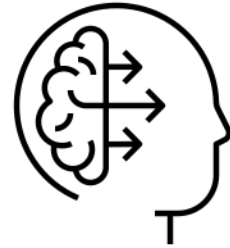
Ethos of the Session



Refresh Basic
Principles



Not a Deep Dive
or CVD

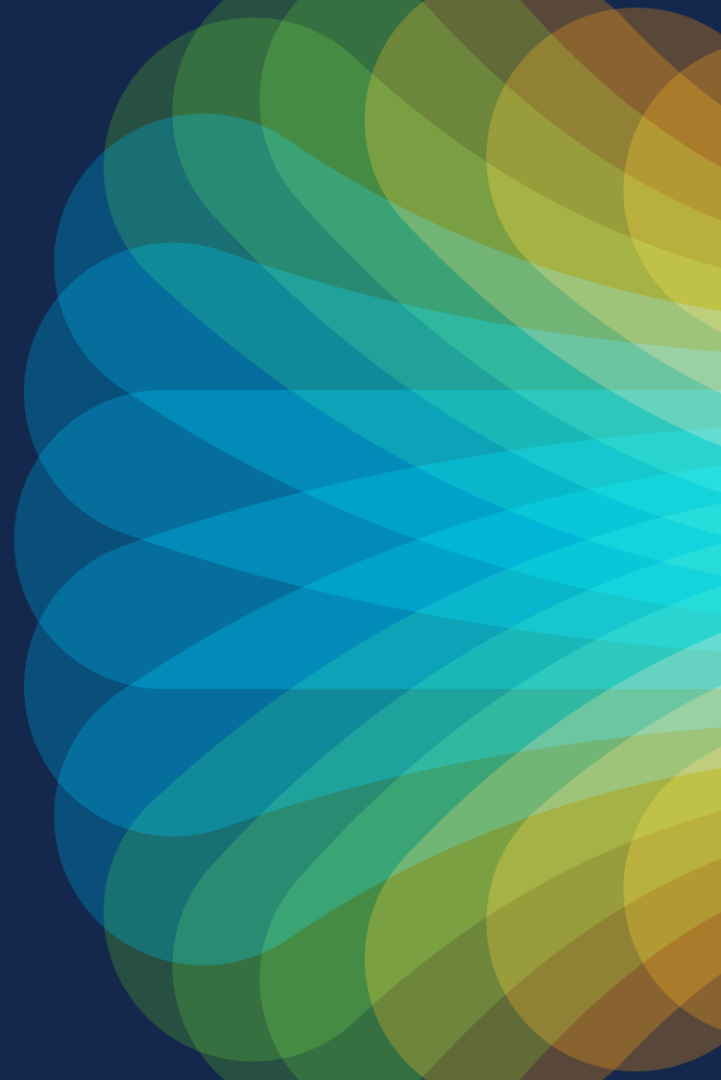


Think about your
own Network

Agenda

- What is a “Campus”?
- 1,2,3, or 4+ Tier Design
- ECMP vs Stackwise
- MPLS vs EVPN vs SD-Access
- Wireless & Security Notes
- Summary and References

What is a “Campus”?





“Field” or “Expanse” or “Plain”

“...the buildings of a college or university, or of a large organisation, and the land that surrounds them”

Cambridge Dictionary

<https://dictionary.cambridge.org/dictionary/english/campus>

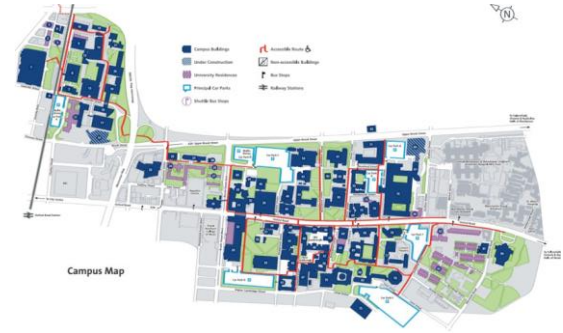
What is a “Campus”?

Common examples are Hospitals & Research Centres, Schools & Universities and Corporations & Offices.

Using this - it's clear a Campus Network is focused on:

- **People** (Users, Vendors, etc.)
- **People's devices** (PCs, Phones, Printers, etc.)
- **Similar geographic area** (LAN, WLAN or MAN, etc.)
- **Access to other domains** (WAN, ISP, DC & Cloud, etc.)

This includes many different network technology areas (Wired, Wireless, Security, QoS, Management, etc.) with a common focus on providing users & devices “access”.



Campus is focused on User Access

Campus = Geography

Buildings are spread out. Multiple floors per building



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www.cisco.com/c/en/us/solutions/cisco-on-cisco/enterprise-networks.html

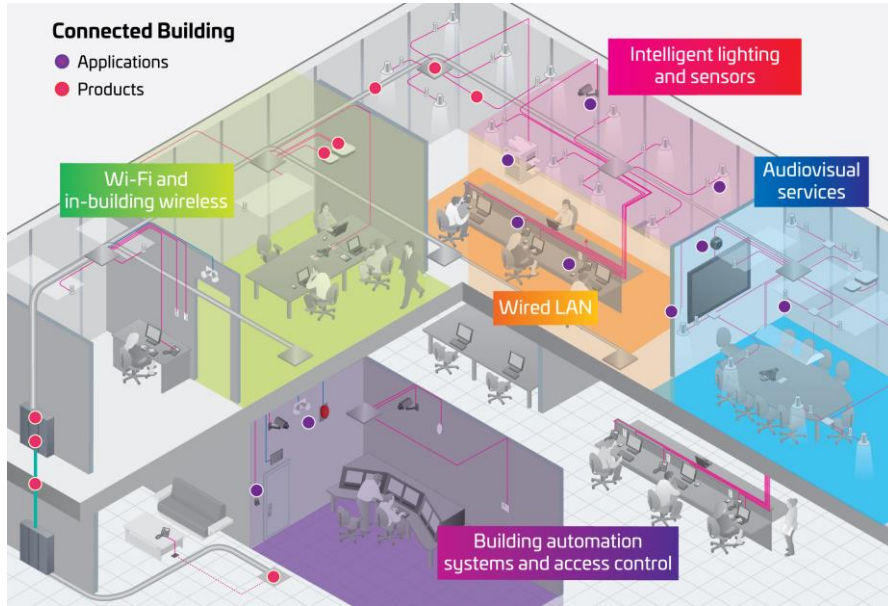
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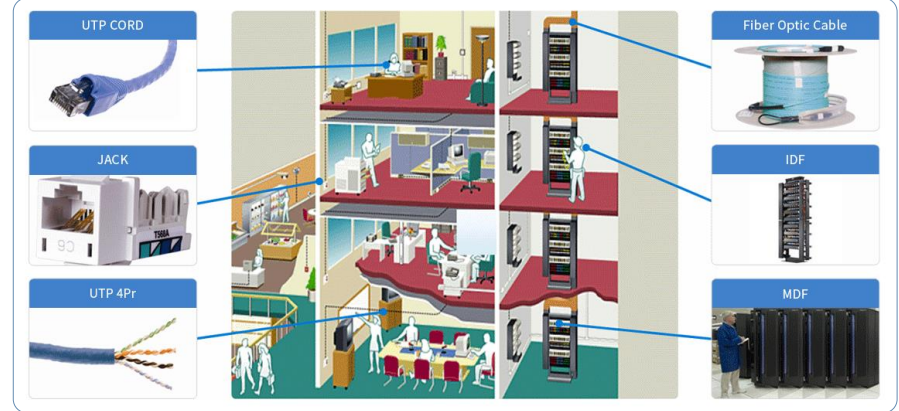
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Campus Networks



MDF = Main Distribution Framework (Core)
IDF = Intermediate Distribution Framework (Distro/Access)



www.cisco.com/c/en/us/solutions/design-zone/networking-design-guides/campus-wired-wireless.html

Campus ≠ Data-Center

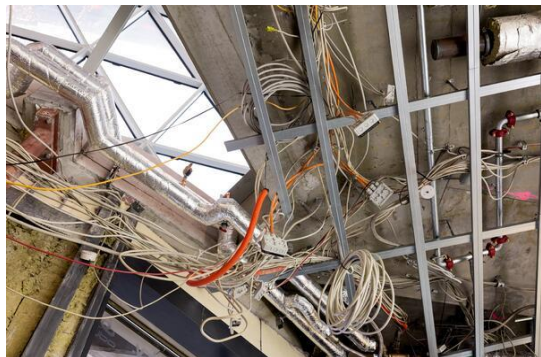
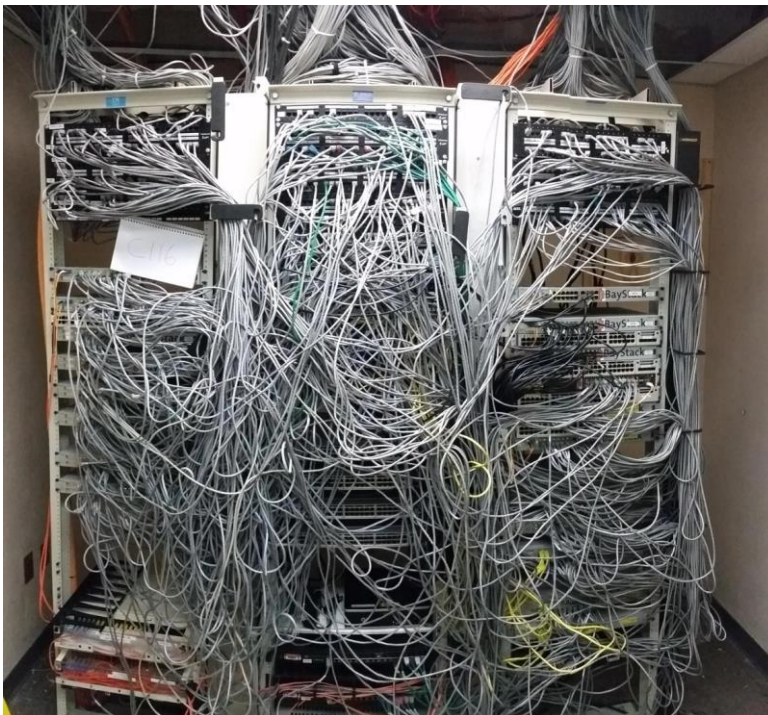
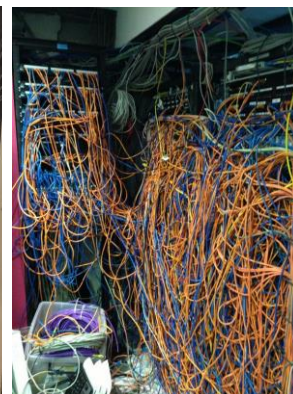
One or few large buildings nearby. Usually a single floor.



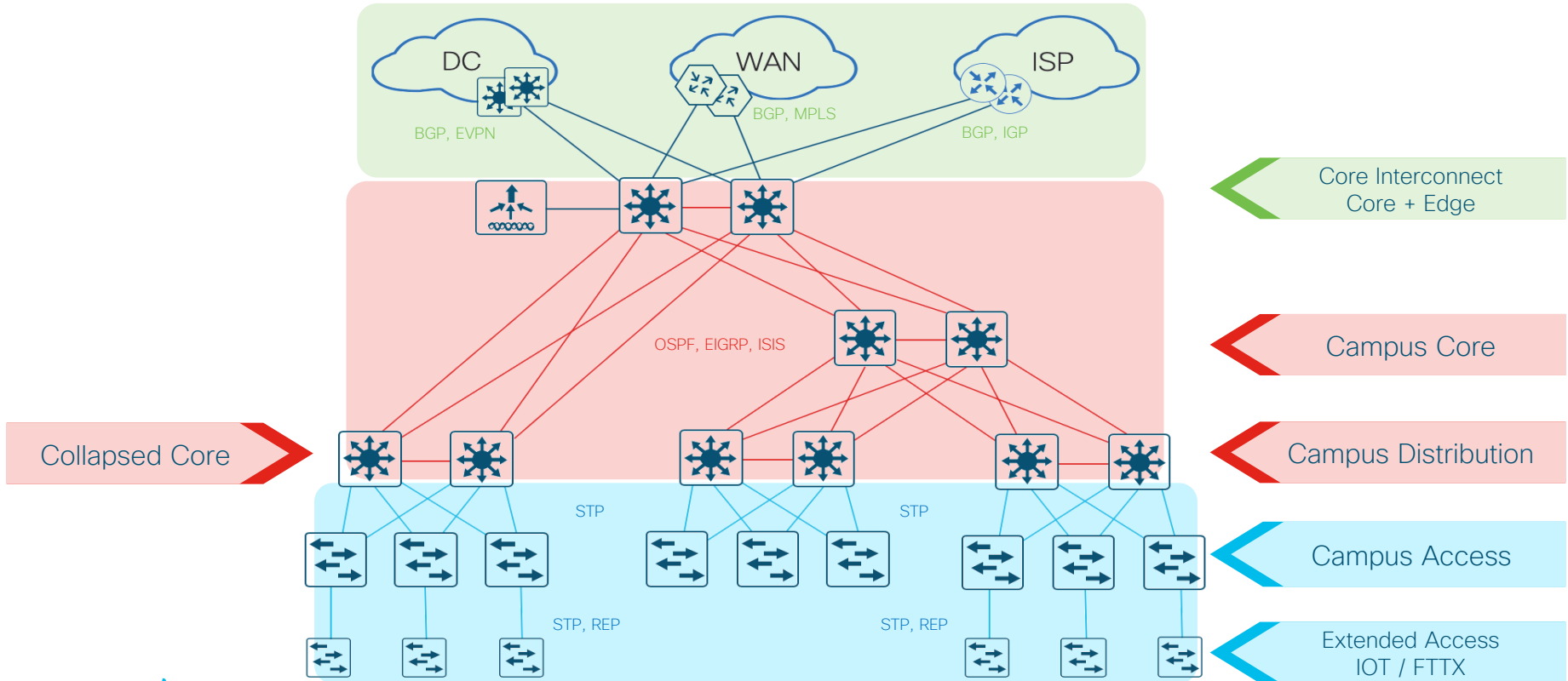
www.cisco.com/c/en/us/solutions/cisco-on-cisco/enterprise-networks.html



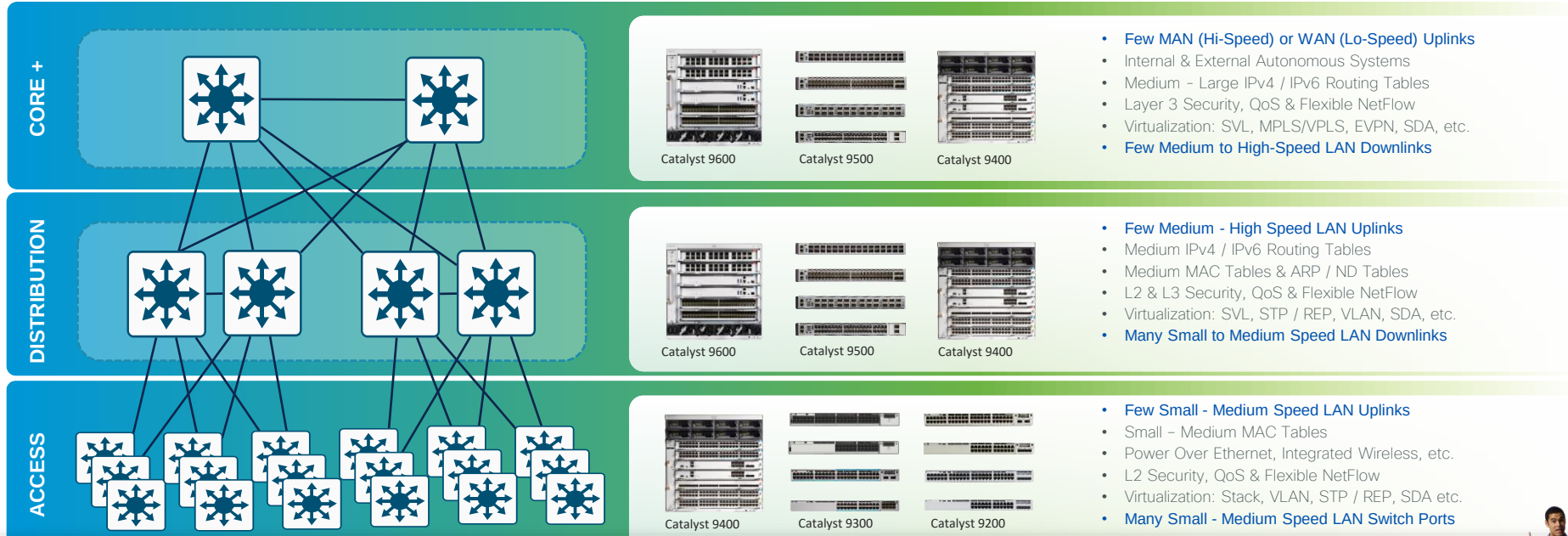
Campus Networks – Real Life



Campus PINs & Topology



Campus Multi-Layer Model



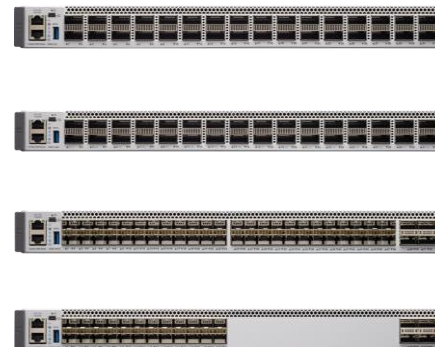
Always 3 “Logical” Layers

- Each layer serves a specific set of functions
- Each layer has a specific set of requirements

If you collapse layers -
your multi-layer device
needs to support
all “logical” functions



Modular vs. Fixed Platforms



Modular

PROs

- More Flexible
- Longer Life-Cycle
- Higher Port Density
- More Power/Cooling
- Redundant Processors

CONs

- More Complex
- BW limit by Chassis
- Slow(er) Dev & Test
- Lower MTBF
- Higher COGs

Fixed

PROs

- Less Complex
- Swap Chassis for BW
- Faster Dev & Test
- Higher MTBF
- Lower COGs

CONs

- Less Flexible
- Shorter Life-Cycle
- Lower Port Density
- Less Power/Cooling
- Single Processor



Copper vs. Fiber Media

www.cisco.com/c/en/us/products/interfaces-modules/transceiver-modules/

Category 5, 6 & 7

Unshielded (UTP)

Shielded (STP)

RJ45 (Access to Endpoints)



Cat6A
(Offset Wires)

Cat5E
(Flush Wires)



Cheap, Short Distance
Slow Speed



OM3, OM4 & OM5

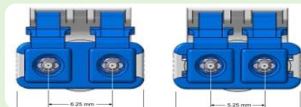
Multi-Mode (MMF)

Single-Mode (SMF)

Wave-Division
Multiplex (WDM)

SFP (Access & Distribution)

QSFP (Core & Edge)

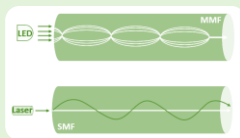


SFP-LC
LC Duplex

mSFP
Mini LC Duplex



MMF



MPO12
12 Fibers

MPO24
24 Fibers



\$\$\$\$ but Faster and
Longer Distance



Campus Networks - Reference Slides

L2/L3 Unicast Technologies

IPv4 Unicast

- MP-BGP, VPNv4
- Internet (v4), NAT, PBR
- MPLS-VPN, VRF-Lite
- IPv4 SSO, NSF/NSR, GIR

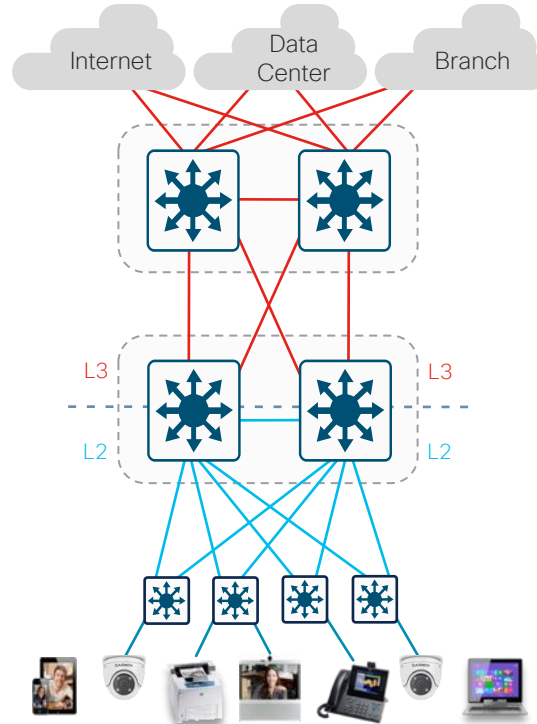
Core

- EIGRP, OSPFv2, ISIS, RIP
- SVI, HSRP/VRRP
- ARP, DHCP Relay
- IPDT/SISF, DAI
- BFD, Echo
- IPv4 SSO, NSF/NSR, GIR

Distribution

- PVST, MST, REP/RENN
- 802.1Q, DTP
- VLANs, VTP
- DHCP Snooping
- MAC Learning
- L2 SSO

Access



IPv6 Unicast

- MP-BGP, VPNv6
- Internet2 (v6), NAT64, PBR
- MPLS-VPN, VRF-Lite
- IPv6 SSO, NSF/NSR, GIR

Core

- EIGRPv6, OSPFv3, ISISv6, RIPng
- SVI, HSRPv6/VRRPv6
- NDP, DHCPv6 Relay
- SISF (v4/v6), RA Guard
- BFDv6, Echo
- IPv6 SSO, NSF/NSR, GIR

Distribution

- PVST, MST, REP/RENN
- 802.1Q, DTP
- VLANs, VTP
- DHCPv6 Snooping
- MAC Learning
- L2 SSO

Access

Campus Networks - Reference Slides

L2/L3 Multicast Technologies

IPv4 Multicast

- PIM-SM, SSM and Bidir
- AutoRP, BSR RP, MSDP
- MVPN, Multicast VRF-Lite
- Multicast load splitting
- IPv4 multicast HA

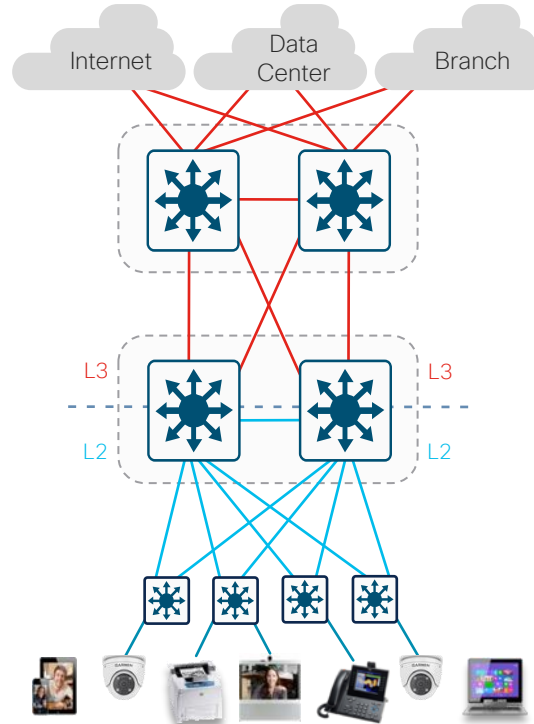
Core

- Dual-stack IPv4 / IPv6
- PIM-SM, SSM and Bidir
- IGMPv2,v3 snooping
- Stub multicast routing
- PIM BFD
- IPv4 multicast HA

Distribution

- IGMP v1,v2,v3 snooping
- IPv4 multicast QoS & ACL
- IGMP v1,v2 filtering

Access



IPv6 Multicast

- PIM-SM and SSM
- IPv6 BSR RP
- IPv6 embedded RP
- IPv6 multicast HA

Core

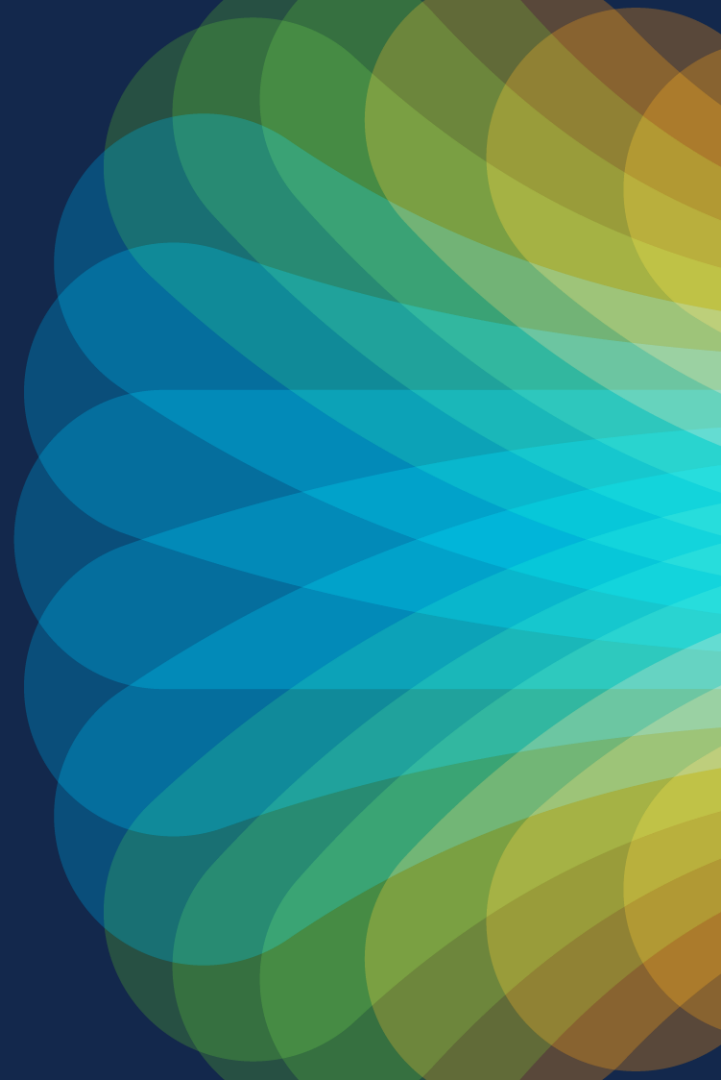
- Dual-stack IPv4 / IPv6
- PIM-SM and SSM
- MLDv1,v2 snooping
- HW register and RPF
- HSRP-aware PIM
- IPv6 multicast HA

Distribution

- MLD v1,v2 snooping
- IPv6 multicast QoS & ACL
- MLD v1,v2 filtering

Access

1,2,3, or 4+ Tier Design



Campus Baseline

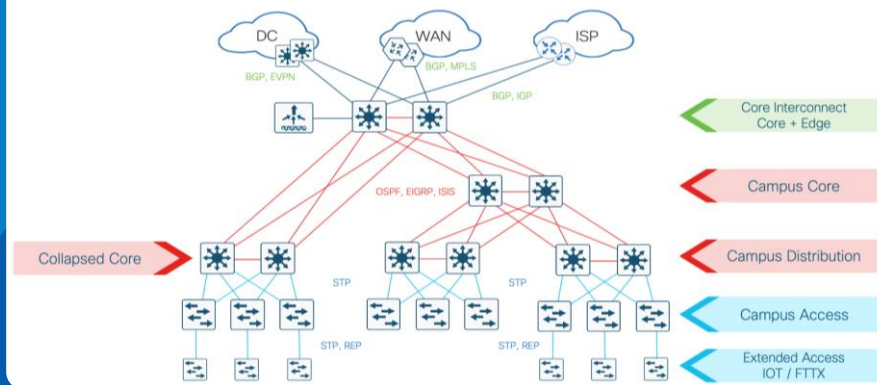
Core & Edge

Campus Core (Baseline)

Campus Core Interconnect

Campus Core + WAN Edge

Campus PIN & Topology



Campus Core (Baseline)

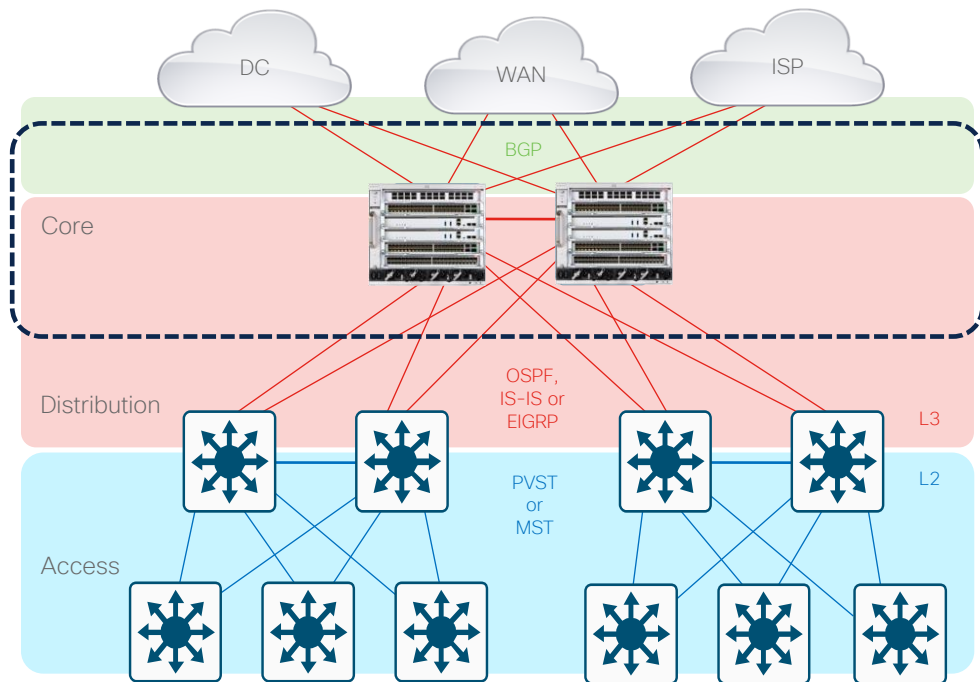
Primary Job: Connect Dist. to Interconnect/Edge and Dist to Dist

- Aka: [MDE](#), [BDE](#)
- Common in Medium & Large Campus

How: A simple, high-bandwidth, L3 transport between other network layers

Typical Deployment:

- Common in Medium & Large Campus
- L3 routed (both north & south)
- North: BGP or IGP (ABR), PIM + MSDP
- South: OSPF, IS-IS or EIGRP, PIM
- Minimal L3 Features, Limited ACLs, QoS Netflow etc



Campus Core Interconnect

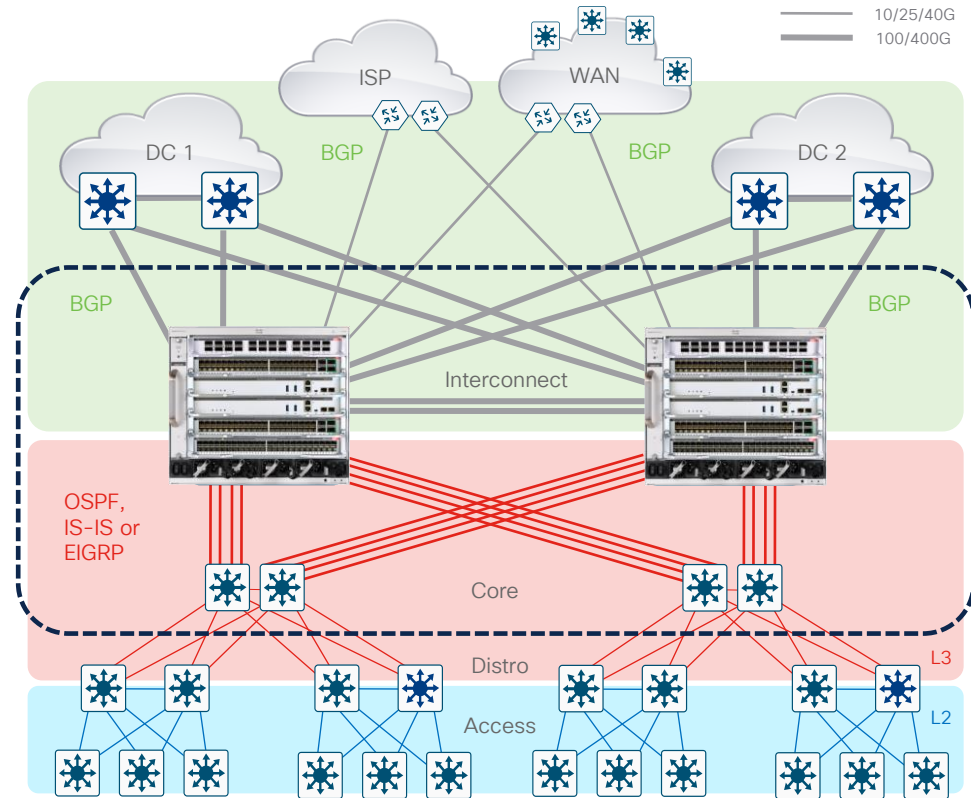
Primary Job: Extension of the core. Connect up multiple cores on campus

How: Distribute the bandwidth and density multiple Core layers

- Similar attributes & requirements as Core PIN

Typical Deployment:

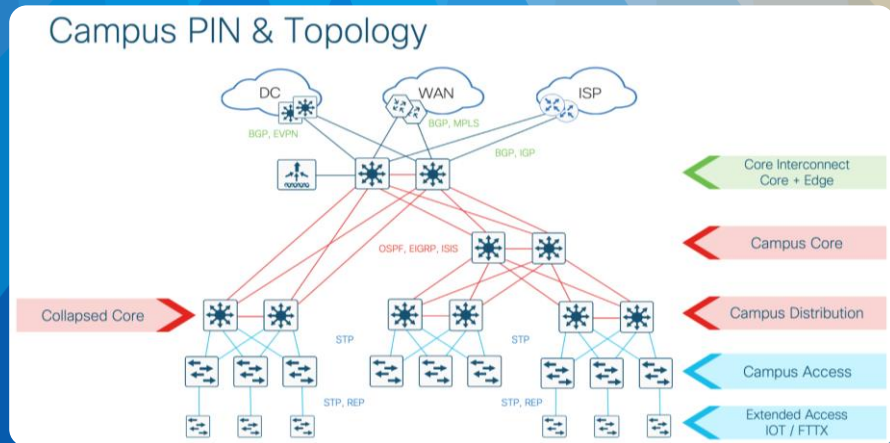
- L3 routed (both north & south)
- North: BGP or IGP (ABR), PIM + MSDP
- South: OSPF, IS-IS or EIGRP, PIM
- Some ACLs, QoS Netflow etc
- Maybe MPLS, VRF-Lite
- Higher L3 forwarding Scale



Distribution

Collapsed Core

Campus Distro + Ext. Access



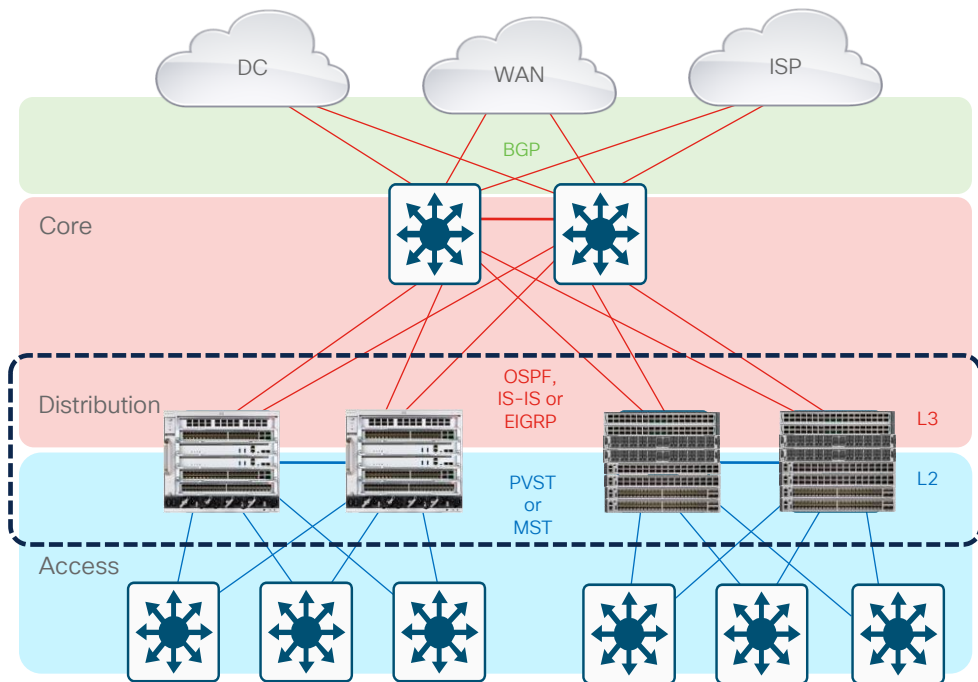
Campus Distribution (Baseline)

Primary Job: Connect up multiple Access layers to the Core...DISTRIBUTE downstream

How: Provides both L3 and L2 features to upper and lower tiers

Typical Deployment:

- SVIs, HSRP/VRRP live here
- VLANs
- Trunking (802.1Q) to Access
- More V/ACLs,
- QoS Classifications and Marking
- Capable switching at both L2 and L3



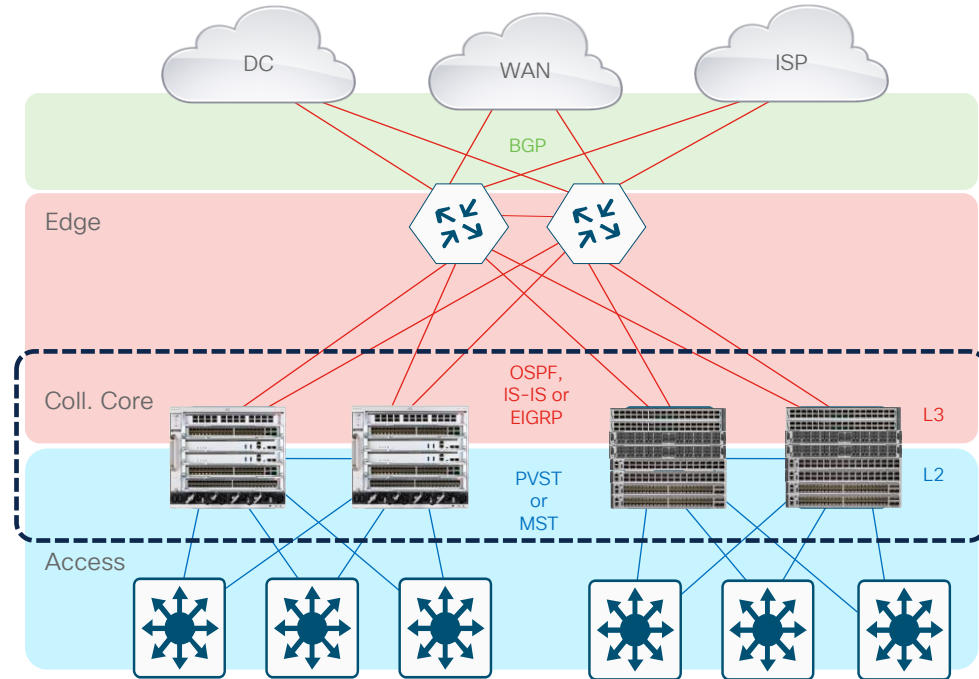
Campus Collapsed Core

Primary Job: Glue between Access and WAN/Edge layer

How: High port density, high L3 and L2 feature scale all collapsing Core and Dist into one tier

Typical Deployment:

- Smaller locations/lower port density
- SVIs, HSRP/VRRP live here
- VLANs
- Trunking (802.1Q) to Access
- More V/ACLs,
- QoS Classifications and Marking
- Highly performant switching at both L2 and L3



Campus Baseline

Access

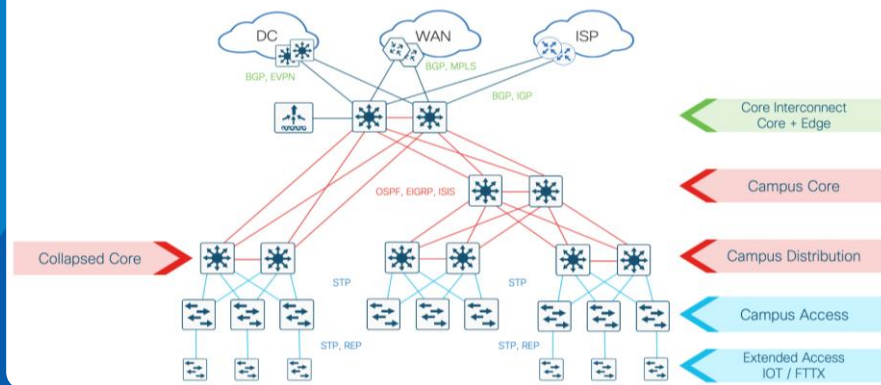
Campus Access (Baseline)

Routed Access

Extended Access

(for IOT & FTTX)

Campus PIN & Topology



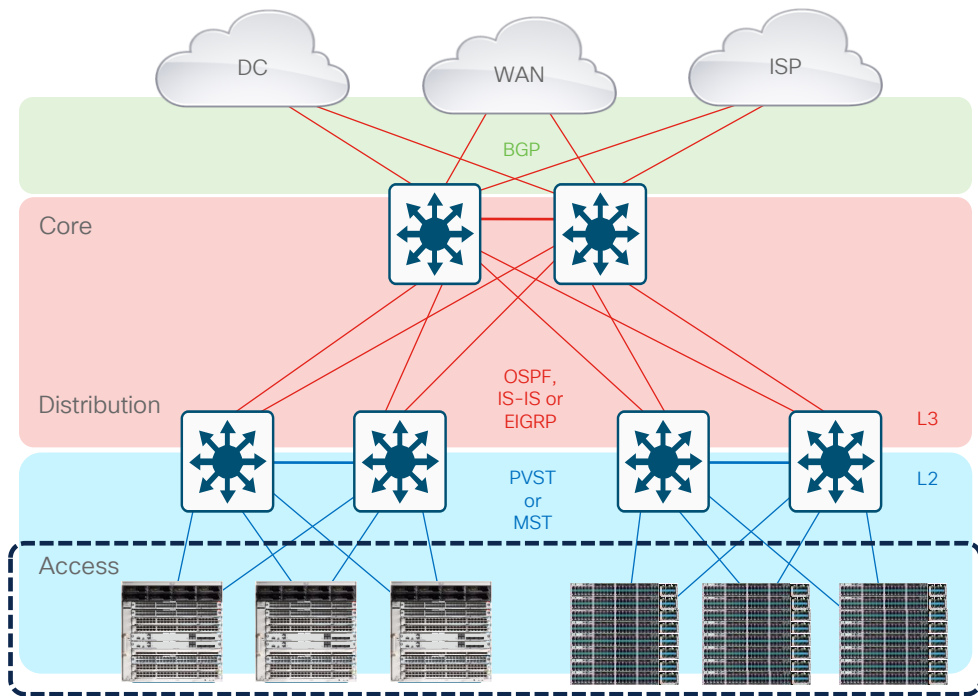
Campus Access (Baseline)

Primary Job: Focused on connecting users, devices and Extended Access to DIST

How: High port density, with L2 feature scale all

Typical Deployment:

- North: VLANs, 802.1Q STP etc
- South AAA, STP, Portfast, [REP](#)
- QoS Classifications and Marking
- [Low/Medium Feature Scale](#)



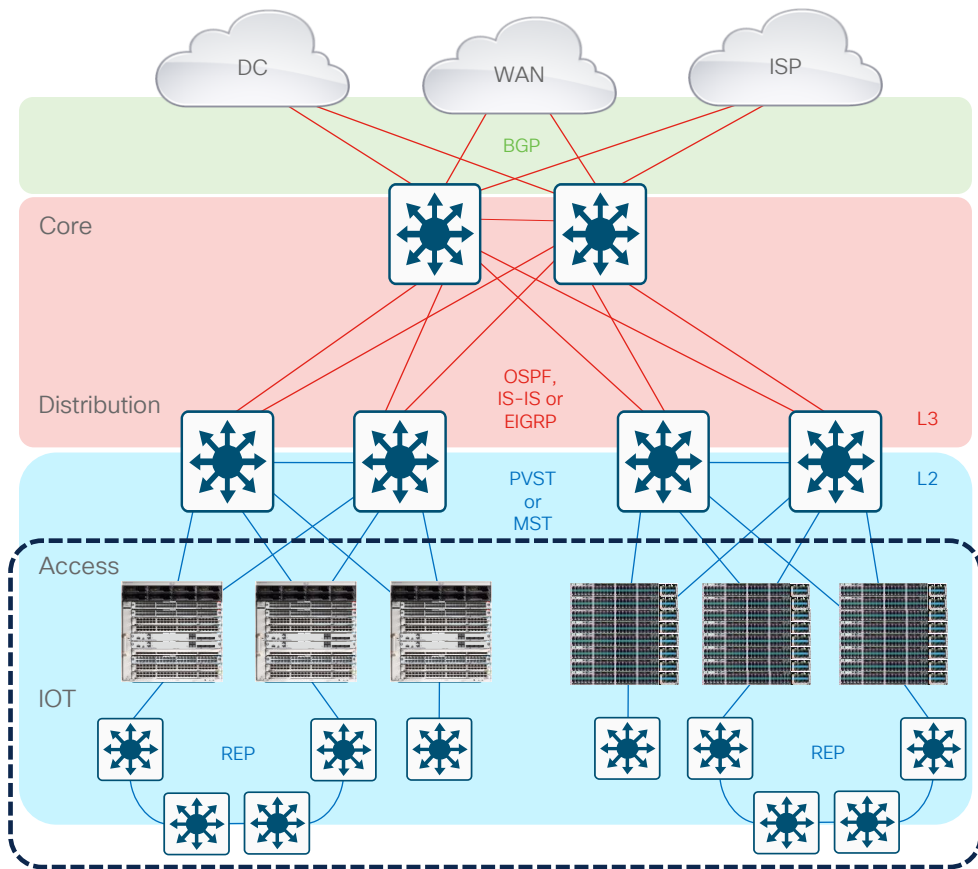
Extended Access (IOT / FTTX)

Primary Job: Extended Access is to extend the Access tier of switching.

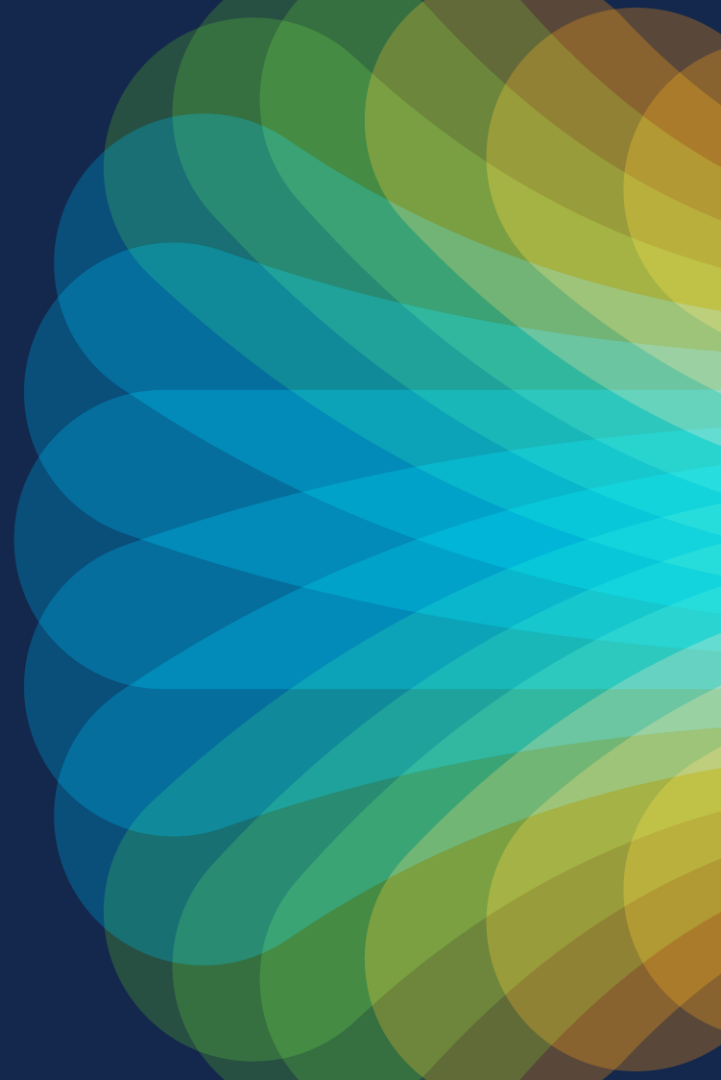
How: Using familiar uplink media, but some times running REP to create Loop architectures

Typical Deployment:

- North: VLANs, 802.1Q STP etc
- South AAA, STP, Portfast, REP
- QoS Classifications and Marking
- IoT Security
- “Medium+” Feature Scale



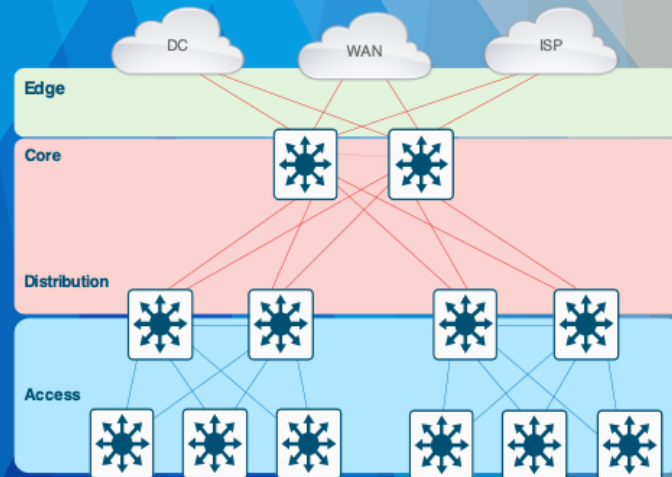
ECMP vs Stackwise



Campus Baseline

Campus Architecture

Equal Cost Multi-Path
Virtual Switches (StackWise)

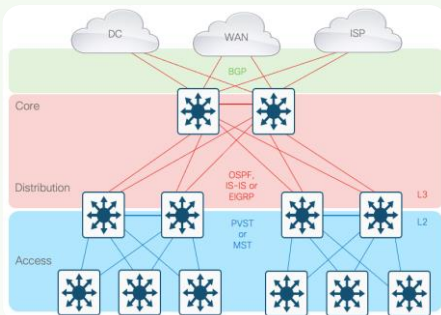


Campus Architectures

Control-Plane & Data-Plane Redundancy

1

ECMP (L2/L3 Paths)

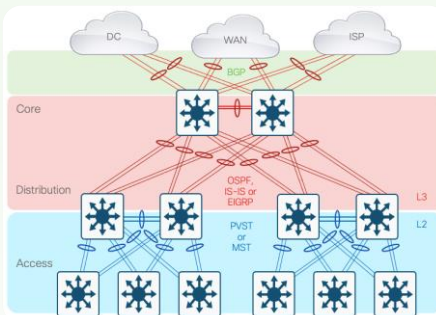


- Complex Topology
- More Nodes, Less Cables
- More Neighbours (+ Tuning)
- Protocol Load-Balancing (ECMP)
- Node-level Redundancy

More Neighbours = Requires Protocol Tuning

2

EtherChannel (L2/L3 LAG)

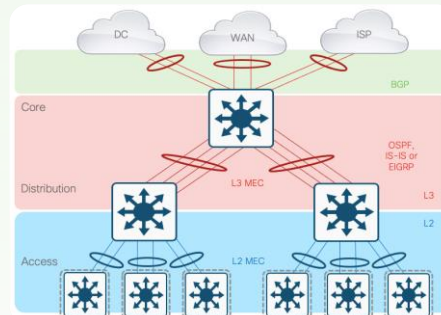


- Complex Topology
- Same Nodes, More Cables (2-8)
- Same Neighbours (+ Tuning)
- EtherChannel Load-Balancing
- Node & Link-level Redundancy

More Neighbours = Requires Protocol Tuning

3

StackWise (L2/L3 MEC)



- Simple Topology
- Same Cables, Less Nodes
- Less Neighbours (No Tuning)
- Multi-chassis EtherChannel (MEC)
- Layer-level Redundancy

Fewer Neighbours = No Protocol Tuning

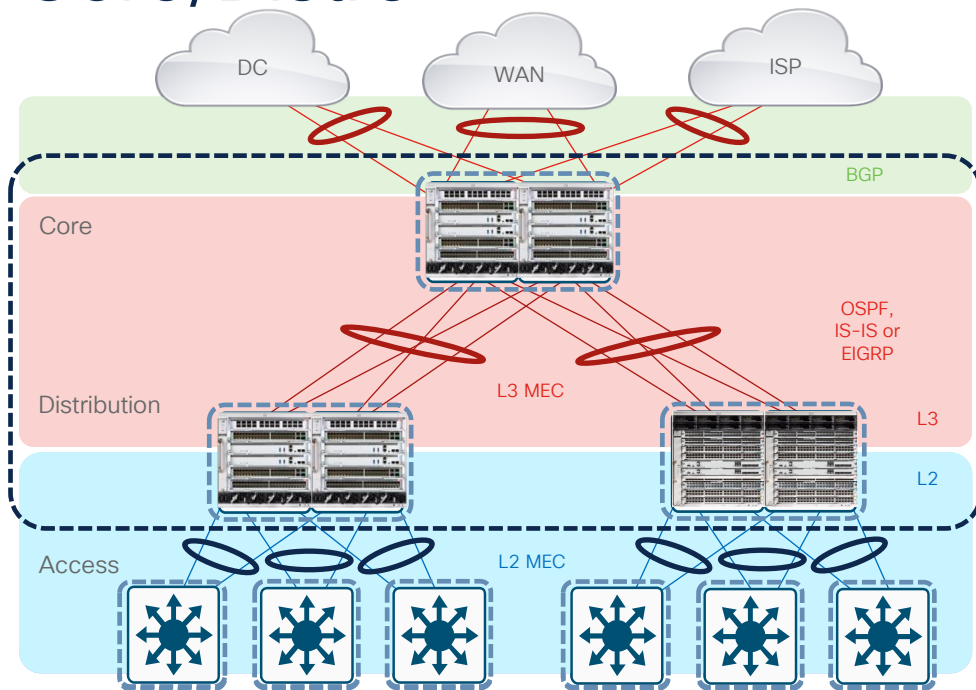
StackWise Virtual (SVL) Core/Distro

Primary Job: Combines Core and/or Dist into single virtual switch(es). Simplify the Core/Dist/Both

How: Same L2&3 Protocols are all delivered North and South, just a single virtual box.

Typical Deployment:

- Uses Multi-Chassis EtherChannel (MEC)
- Active/Active Data-Plane (both forwarding)
- Active/Passive Control-Plane
- Need performant hardware with good Feature Scale



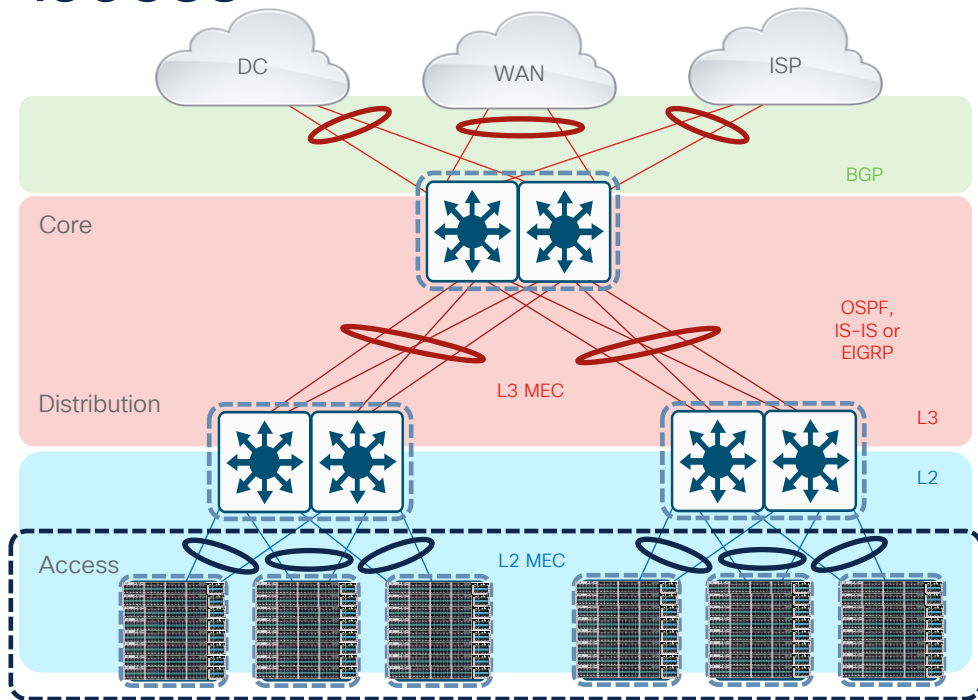
StackWise (not Virtual) Access

Primary Job: Combines multiple switches to form single switch, creating high port density

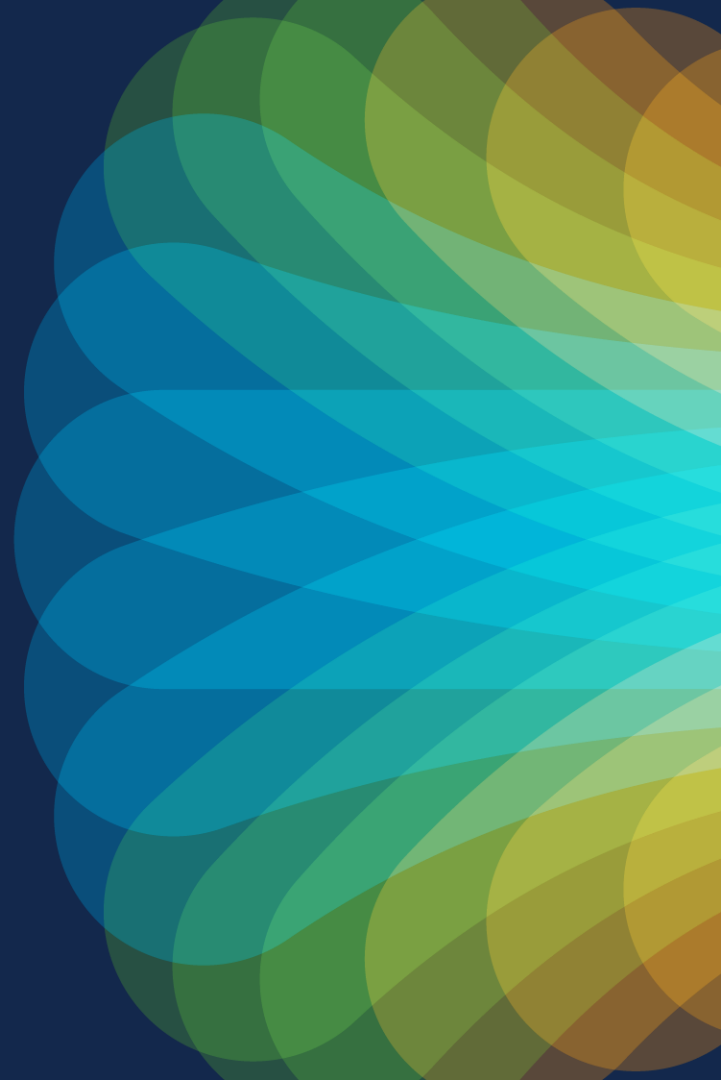
How: Stacking cables in the back modules, they synchronise and form a single control plane; ie 1 switch

Typical Deployment:

- Patched together in a ring with special cable kits
- Goes through an election process to decide active
- Can mix model types to suit port requirement
- Low end hardware support

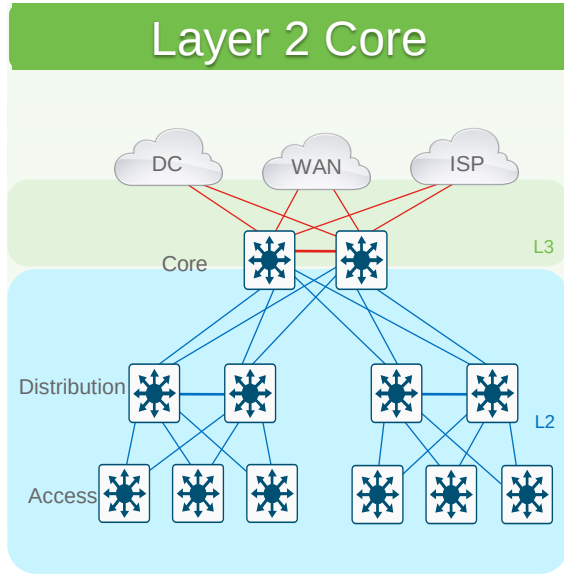


MPLS vs EVPN vs SD-Access

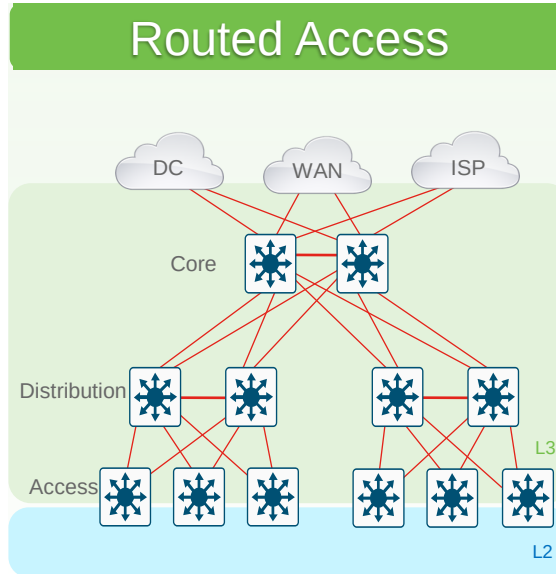


Layer 2 Demarcation

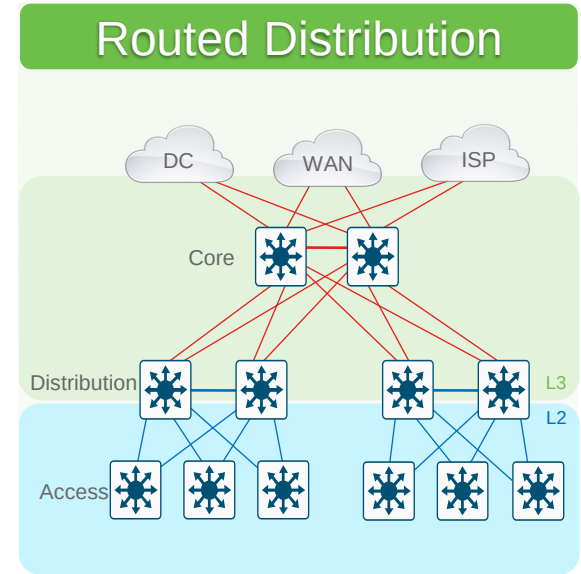
Understanding the history



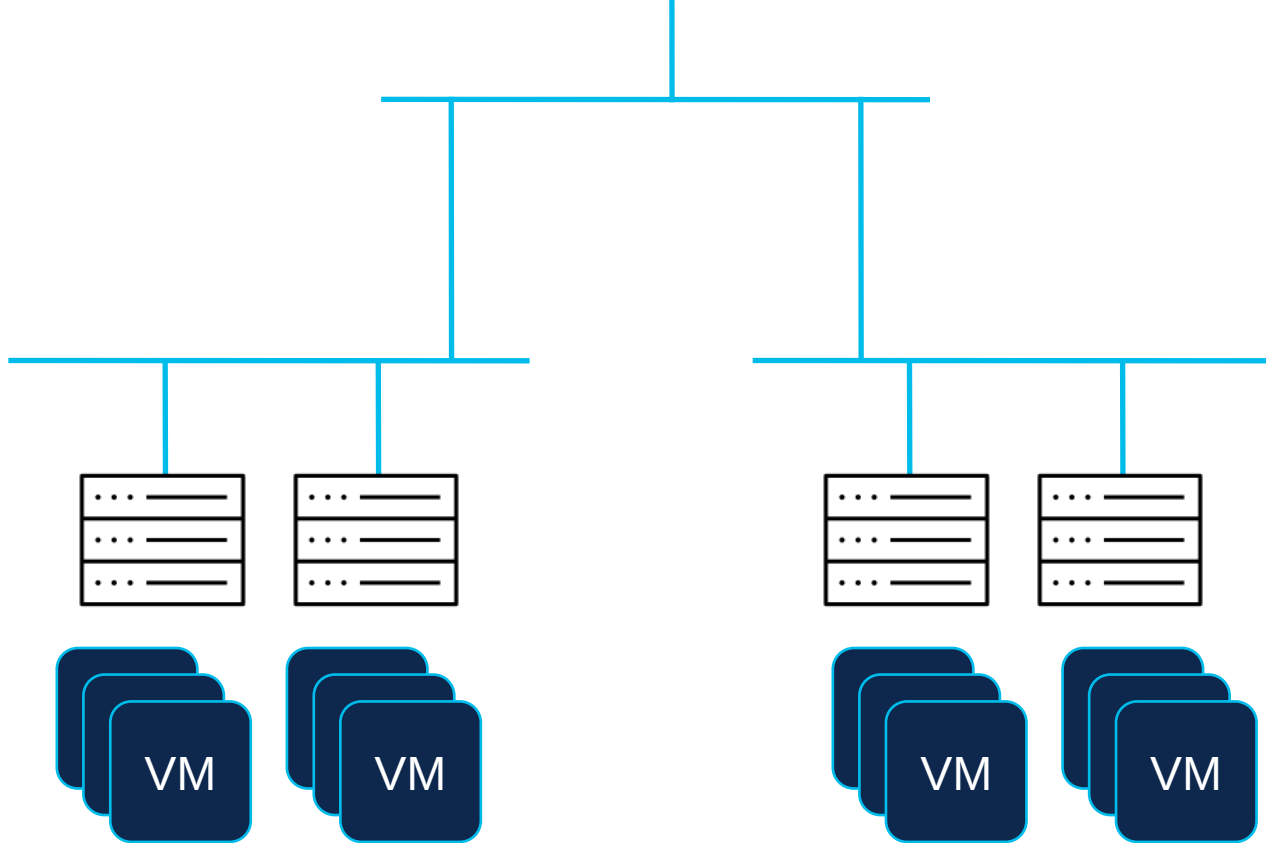
Large L2 Domains

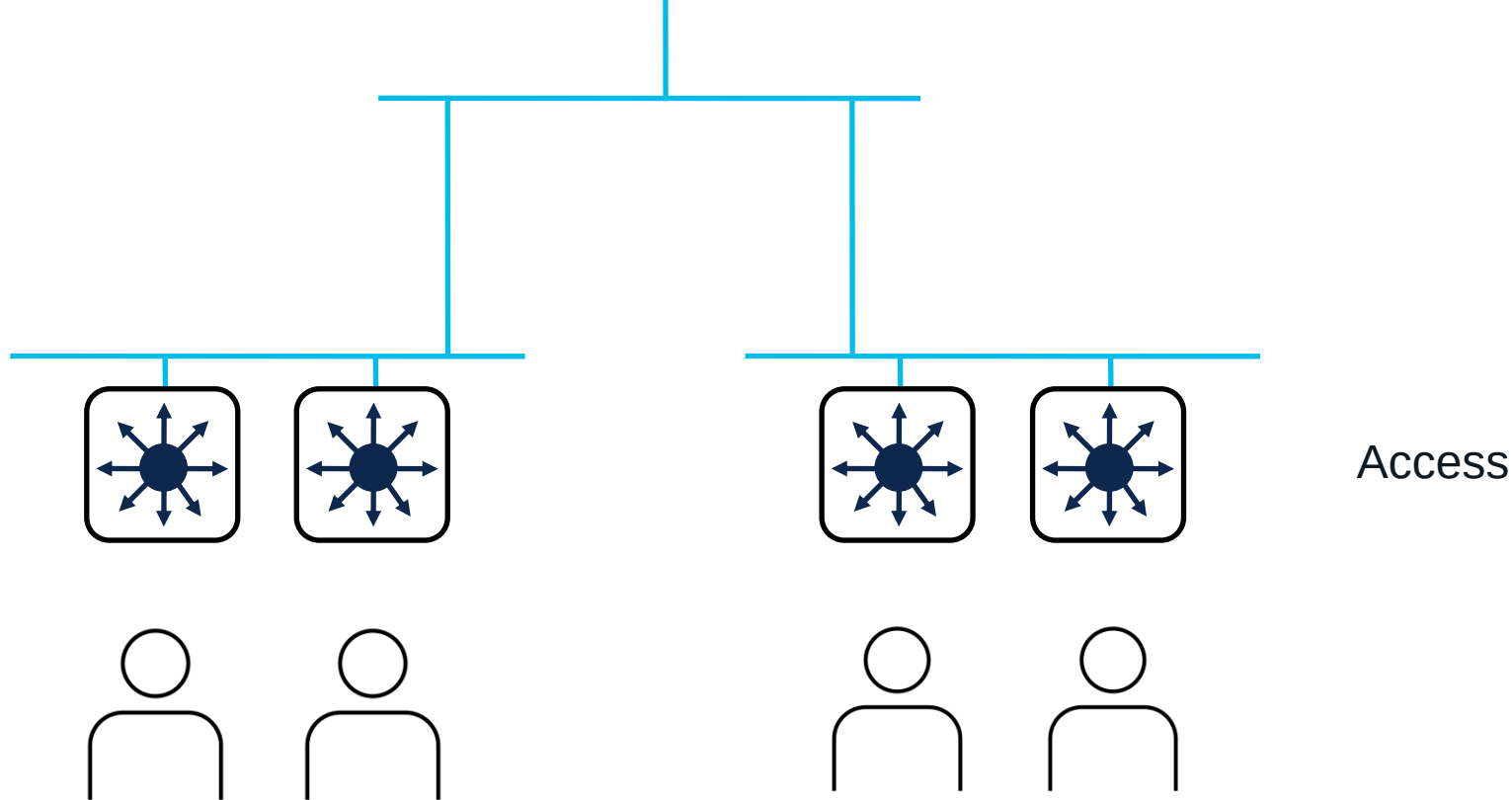


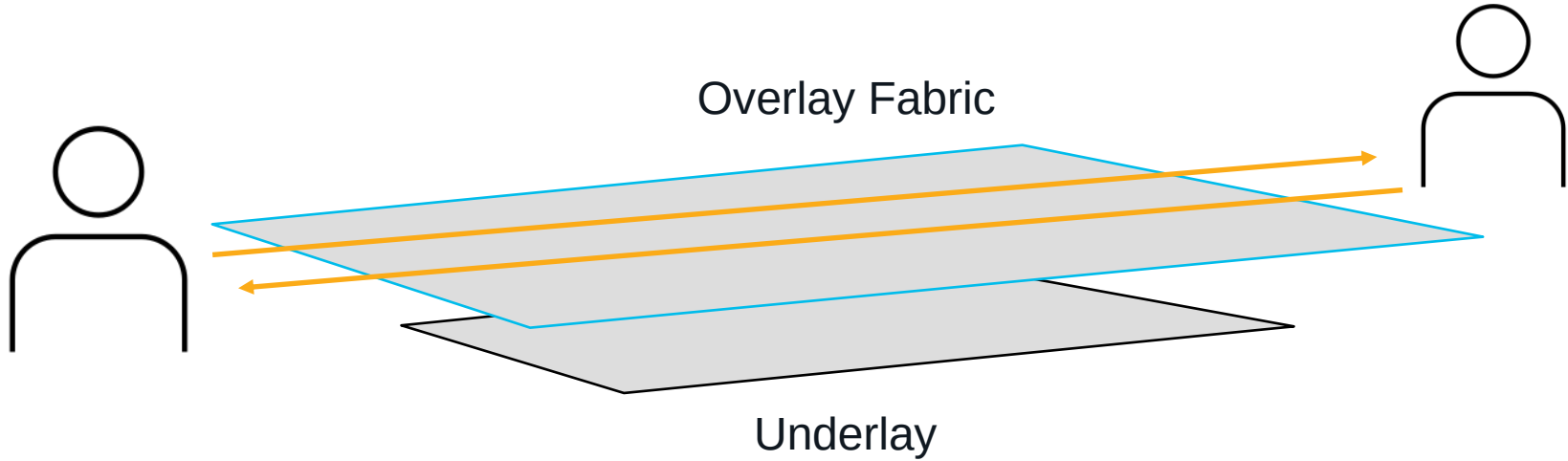
Confined VLANs



Balanced





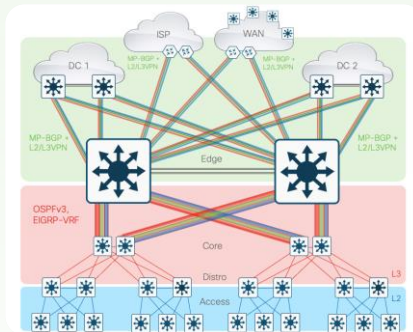


Campus Solutions & Designs

Providing additional services (beyond basic PINs)

1

MPLS (L2/L3VPN)

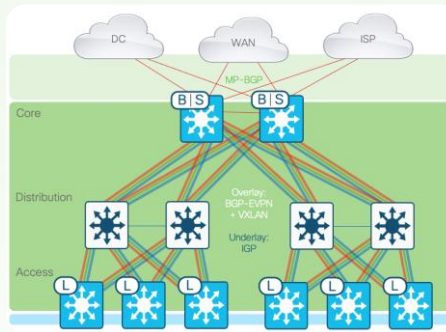


- L3 Underlay + L2/L3 VPN Overlay
- Virtual Private Networks
- L3 VRF-based Segmentation
- WAN/Edge + VPN Services

MPLS/VPLS, LDP, SR, MP-BGP, PIC
MVPN, LSM, Extranet, MSR
SSO, NSF/NSR, ECMP, GIR
VPN-FNF, Uniform/Pipe QoS, PBR, IPACL

2

EVPN (L2/L3VNI)

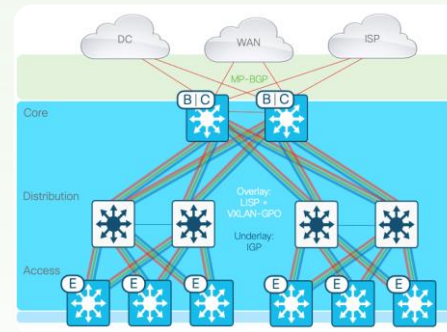


- L3 Underlay + L2/L3 VNI Overlay
- Virtual Network Instances
- L2/L3 VNI-based Segments
- Common WAN/LAN Services

MP-BGP/EVPN, VXLAN, VRF-Lite
L2 TRM, L3 TRM, L2 BUM
SSO, NSF/NSR, ECMP, GIR
Fabric-FNF, Uniform QoS, IPACL/OGACL

3

SDA (L2/L3VNI + SGT)



- L3 Underlay + L2/L3 VNI Overlay
- VNIs + Scalable Group Tagging
- L2/L3 VNI + SGT Segments
- LAN Services + [Group-Based Policy](#)

LISP, VXLAN, MP-BGP, VRF-Lite
LISP HER, Native, L2 BUM
SSO, NSF/NSR, ECMP, GIR
Fabric-FNF, App QoS, SGACL

MPLS

Multi Protocol
Label Switching

EVP

N
Ethernet Virtual
Private Network

SDA

Software Defined
Access

EVPN

Ethernet Virtual
Private Network

SDA

Software Defined
Access

Scalability



Flexibility



User Mobility



Less Resource Intensive



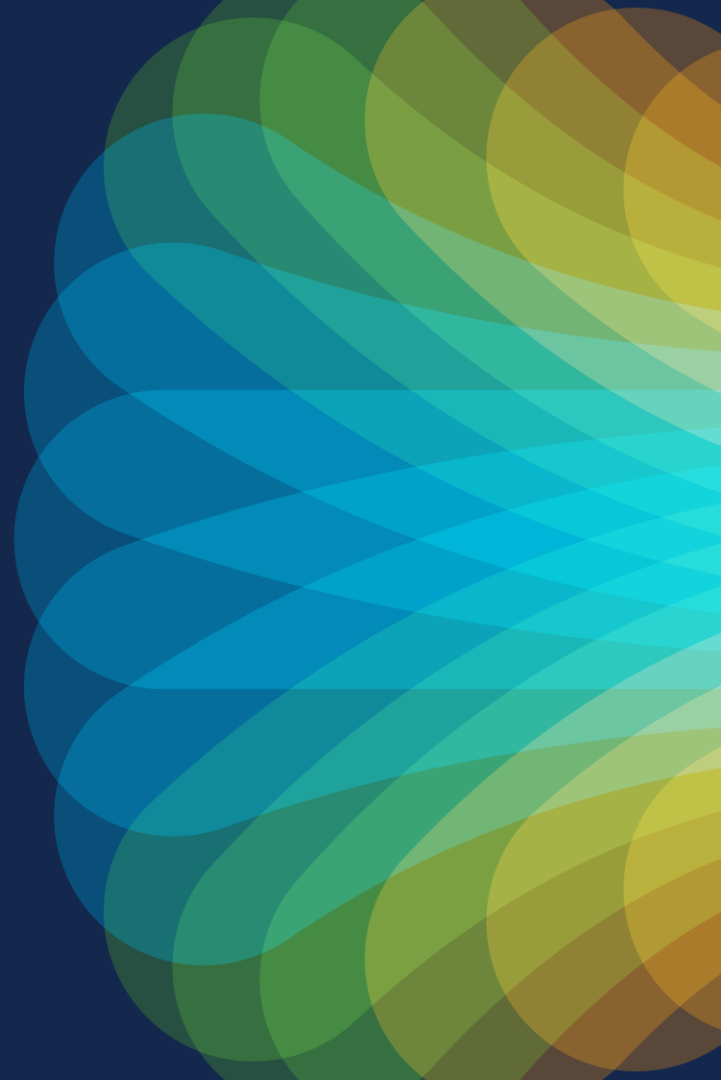
More Granular Security



Includes Wireless



Wireless & Security Notes



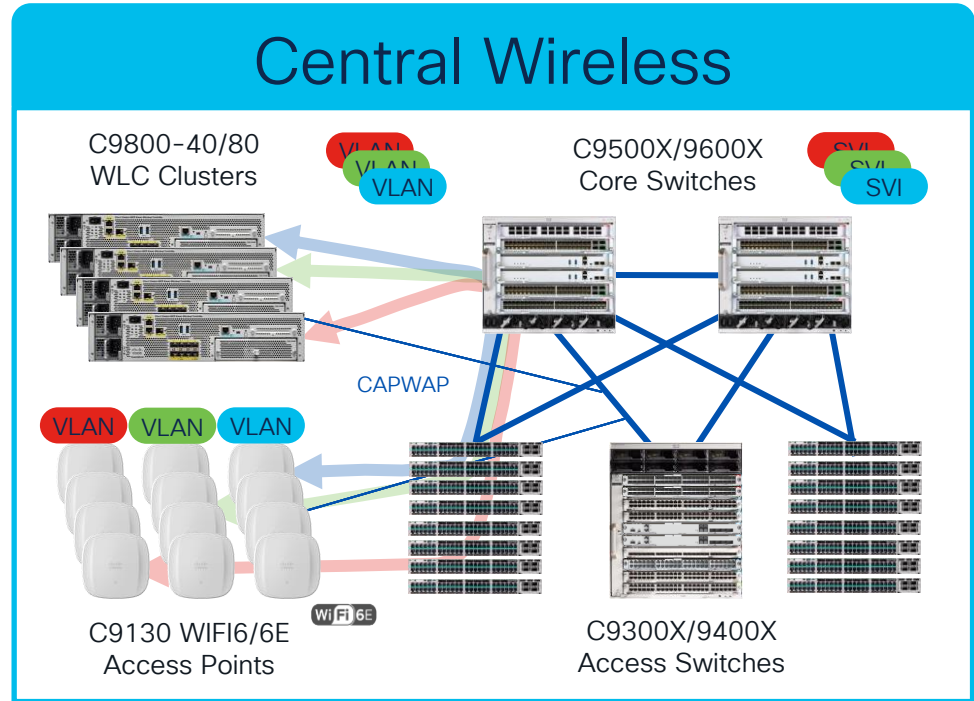
Wireless LAN

Primary Job: Connects APs centrally to 1 or more WLCs. Removes the need for WLCs at each site.

How: CAPWAP tunnels from AP to WLC

Typical Deployment:

- WLC Patched into Core
- APs at remote sites speak back to centralised WLCs



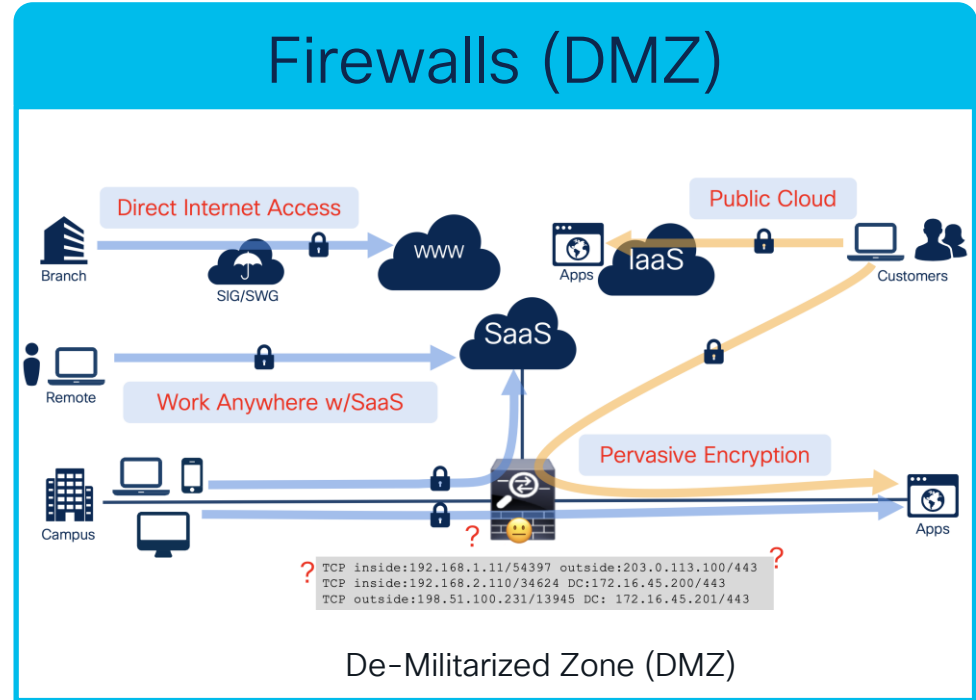
Firewalls & ACLs

Primary Job: Controlling access to different areas of the network.

How: ACL focused approach to accessing different network segments L2-L4 or L4-7

Typical Deployment:

- Firewalls connected to Core
- Protects to/from WWW.
- Protects to/from WAN
- Protects to/from DC
- Can run IGPs BGP
- L2 connections, or have SVIs



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a technical expert!

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to meet, greet, whiteboard & gain
insights about your unique questions
with the best of the best.



Meet the Expert Opening Hours:

Tuesday	3:00pm – 7:00pm
Wednesday	11:15am – 7:00pm
Thursday	9:30am – 4:00pm
Friday	10:30am – 1:30pm

Session Surveys

We would love to know your feedback on this session!

- Complete a minimum of four session surveys and the overall event surveys to claim a Cisco Live T-Shirt

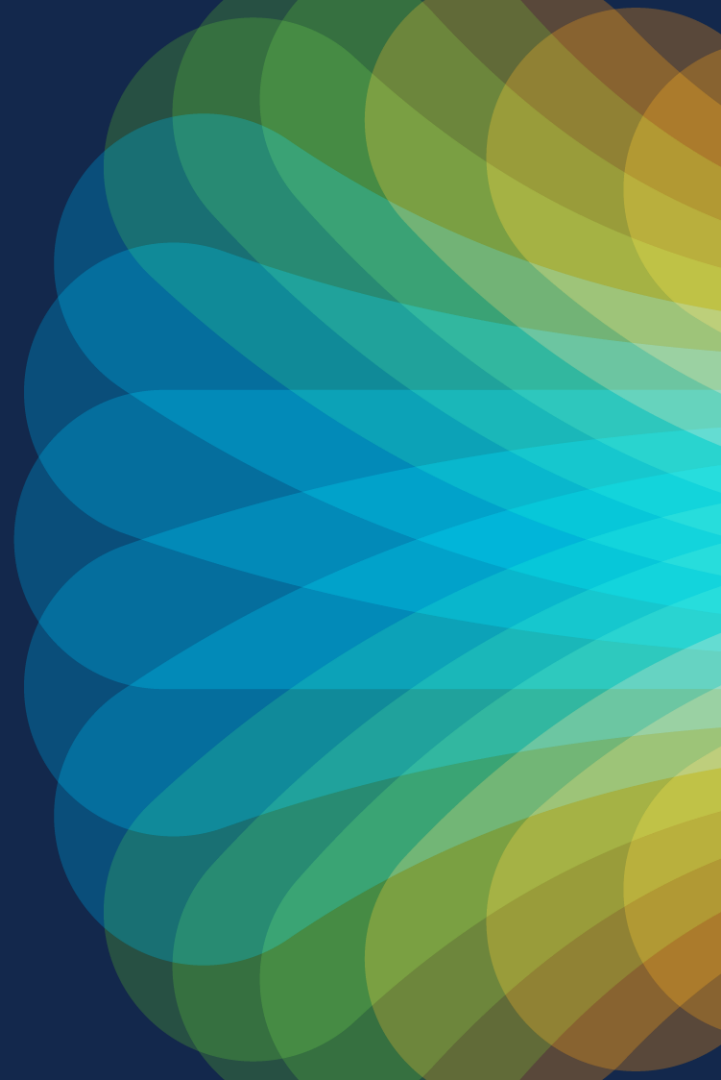


Continue your education

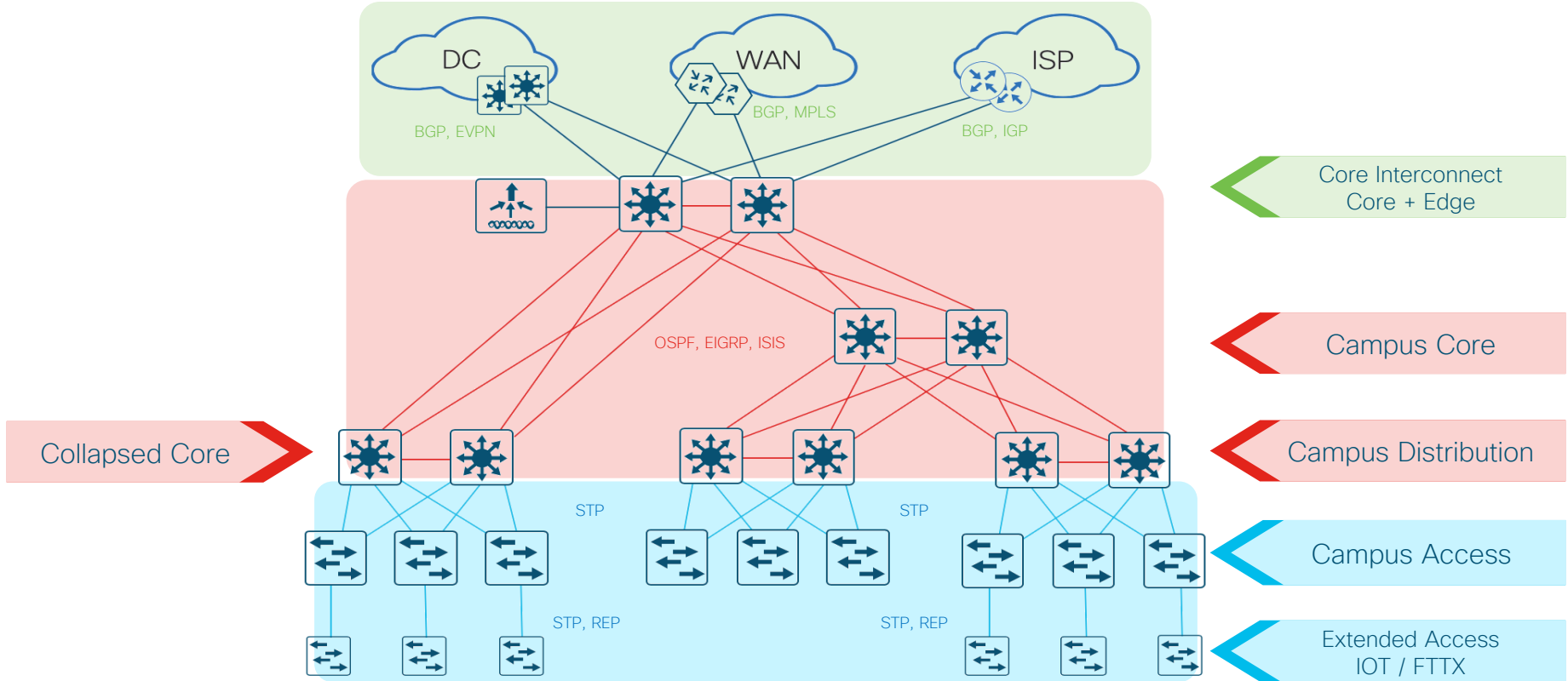


- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Expert meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand

Summary and References



Campus PINs & Topology



Keep Learning!

cisco.com/go/cvd
cs.co/en-cvds

Cisco Validated Design (CVD)

Design Zone - Design Guides
Use our documentation for faster, more reliable, and predictable deployment.
[Watch video \(6:03\)](#)

What is a Cisco Validated Design Guide (CVD)?
Cisco Validated Designs (CVDs) provide the foundation for systems design. They are based on common use cases or engineering system priorities. Each guide incorporates a broad set of technologies, features, and applications to address your needs. Most important, it has been comprehensively tested by Cisco engineers to help ensure a faster, more reliable, and fully predictable deployment.

What a Validated Design Guide provides

- Reliability**
CVDs are extensively tested. You can confidently set performance expectations when you deploy your solution.
- Less risk**
Using a CVD reduces both the risk that products won't work together and the risk that they won't perform as promised.
- Comprehensiveness**
CVDs provide everything from system designs to configuration instructions to a bill of materials (BOM).
- 24-hour support**
Because CVD solutions are guaranteed to work as specified, we offer 24-hour support options for any issues that might arise.

Featured design guides

- SD-Access Design**
Design, provision, apply policy, and provide wired and wireless network assurance with a security.
- SD-Access Deployment**
Automate the deployment of a secure software-defined wired and wireless campus network.
- Data Center Design Playbook**
A comprehensive summary of Cisco UCS Solution CVDs, in one place.

Cisco EN Validated Design and Deployment Guides

What are EN Validated Design & Deployment Guides?

Design Guides
Technical solution design best practices based on common use cases.

Deployment Guides
Practical, technical step-by-step guidance to Design, Deploy & Operate your network.

EN Validated Design & Deployment Guide Solutions

SD-Access	SD-WAN	Security, Policy & Access	Infrastructure
View	View	View	View



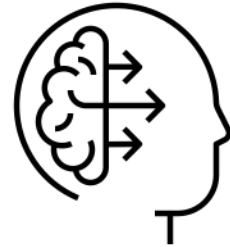
Ethos of the Session



Refresh Basic
Principles



Not a Deep Dive
or CVD



Think about your
own Network



The bridge to possible

Thank you

CISCO *Live!*

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The Cisco Live! logo, featuring the word "CISCO" in a dark blue, sans-serif font, followed by "Live!" in a dark blue, script font.

CISCO *Live!*

The text "Let's go" in a dark blue, sans-serif font, positioned to the left of a bright, multi-colored sunburst graphic that radiates from the right side of the image.

Let's go

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