



January 28 - February 1, 2019 • Barcelona



INTUITIVE



BRKCRT-3075

The CCIE in a Software-Defined World

Jeff McLaughlin, Enterprise Technical Marketing,
CCIE #14023 (R/S, Security)

Cisco *live!*

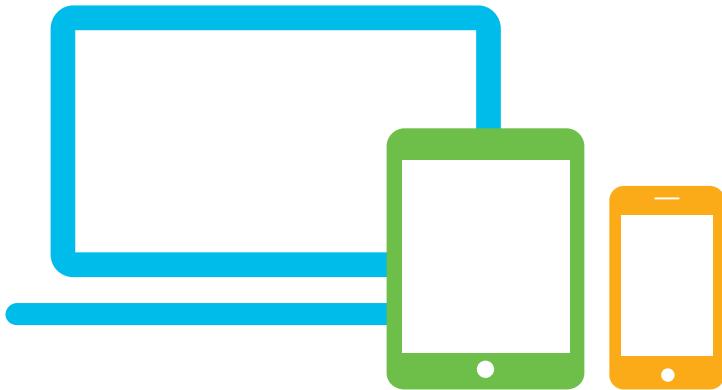


INTUITIVE

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Your Host



Principal Technical Marketing Engineer, Enterprise

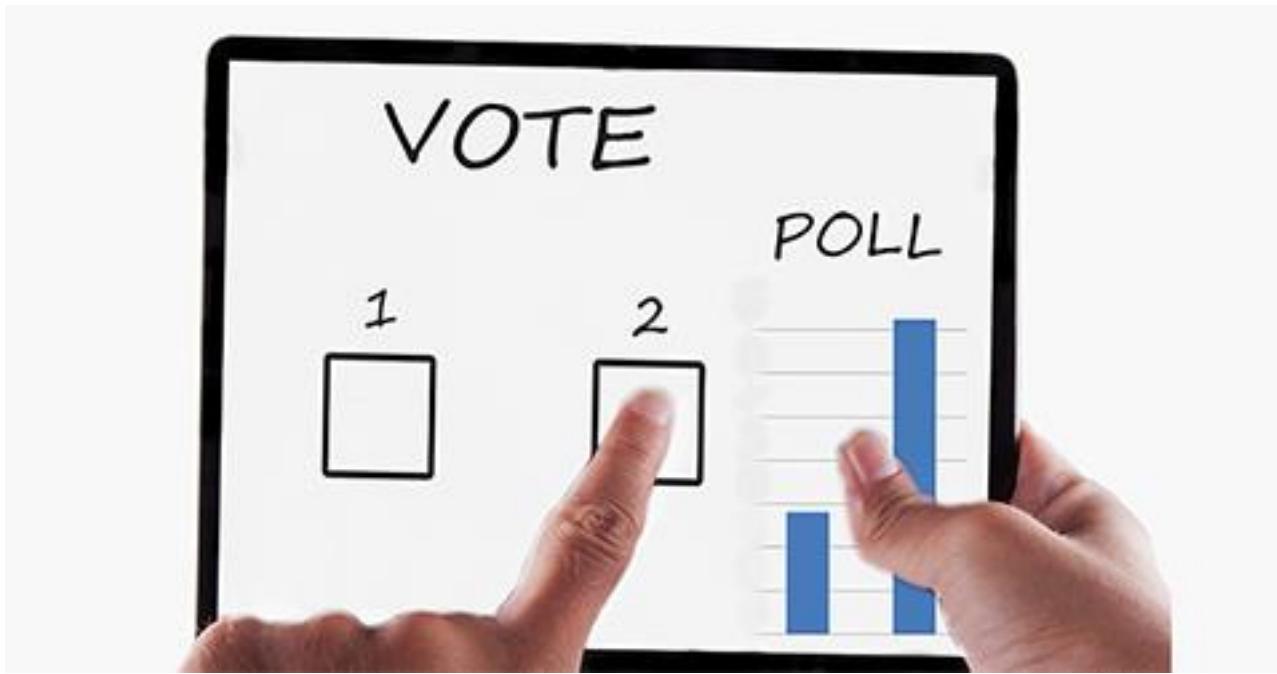
- We guide Cisco engineering on what to build
- We explain to people what engineering builds
- Focused on programmability and automation

Past Lives

- Director of IT network architecture for Juniper
- Routing Protocols engineer in High-Touch TAC
- Gold partner SE and post-sales deployment engineer

Certification Program

- CCIE in R/S and Security; JNCIE in Service Provider (expired)
- Subject Matter Expert for CCIE program





Is the CCIE Still Worth It? - CBT Nuggets

<https://www.cbtnuggets.com> › Blog home › Everything CBTN ▾

Aug 24, 2018 - Is the CCIE Still Worth It? This question about whether the CCIE is **worth it** has been swirling for years with no clear answer. CCIE commands a high salary, but so do many certs. ...
Whether CCIE is **worth it** or not comes down to whether it's **worth it** to you.

What is your opinion in CCIE vs SDN? Is CCIE still worth it to ...

[https://www.quora.com/What-is-your-opinion-in-CCIE-vs-SDN-Is-CCIE-still-worth-it... ▾](https://www.quora.com/What-is-your-opinion-in-CCIE-vs-SDN-Is-CCIE-still-worth-it...)

Nov 29, 2016 - The answer is no CCIE is no longer **worth it** as it used to be. SDN with Cyber Security skill is the way to go. However CCNP is **still worth it**.

Quitting My CCIE Status. Time to Move On. - EtherealMind

<https://etherealmind.com> › Cisco › CCIE ▾

Mar 14, 2018 - 14th March 2018 By Greg Ferro Filed Under: CCIE. Its been 17 years since ... The foundations of the last decade are **still** there and educational material is widely available. Its very ... My time is **worth** more than the test delivers.

Why the concern?

Networking Industry



**CCIE/CLI
(Old World)**

**SDN/APIs
(New World)**

This...



...replaced by this:



This...



...replaced by this:



Will network engineers...



... be replaced by this?

A screenshot of the Cisco DNA Center web interface. The top navigation bar includes the Cisco logo, the DNA Center logo, and user information for 'admin'. Below the header, a banner reads 'DNA Center' and 'Design, Automate and Assure your Network'. The main content area is divided into sections: 'Applications' containing 'Design', 'Policy', and 'Provision' buttons; 'Tools' containing 'Discovery', 'Device Inventory', 'Topology', 'Network Plug and Play', 'Network Hierarchy', and 'Network Settings' buttons, with 'Image Management' also visible; and a sidebar for 'Recently Visited' and 'Recently Added' features like 'Network Settings', 'Discovery', and 'Image Management'. A blue speech bubble icon is in the bottom right corner.

The Headlines...



API Is The New CLI For Cisco Systems



Moor Insights and Strategy Contributor ⓘ

Straight talk from Moor Insights & Strategy tech industry analysts

POST WRITTEN BY

Will Townsend

Will Townsend is a Moor Insights & Strategy senior analyst covering wireless telecommunications and enterprise networking





Does SDN Mean IT Will Be Able To Get Rid of Network People?

Network pros need SDN training, not CCIE status

Network pros will need to look further than traditional vendor certifications if they want to build and manage SDN and programmable infrastructure.

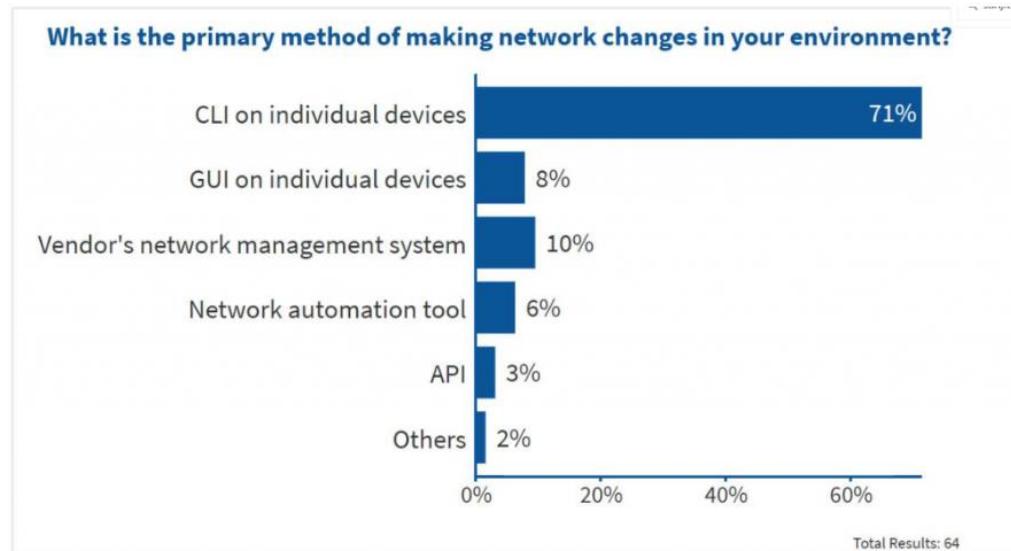
_____ , who is part of the Silicon Valley SDN research vanguard, believes CCIE status is already worthless -- he doesn't even include his own CCIE status on his presentations anymore.

"There are a bunch of certified individuals who don't know how to do crap," said _____ .
"What I want to know when I am hiring is: Can you write code? ... Are you smart?"

07 Oct 2014

Checking in on the Death of the CLI

by Andrew Lerner | January 4, 2018 | Submit a Comment



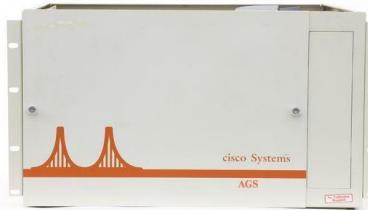
Agenda

- The CCIE: A brief history, and how far we've come
- Are APIs the new CLI?
- What is SDN and why do we need it?
- SD-Access: SDN in the Campus
- The CCIE in an SDN World
- The future of certifications and what you should do

Why the CCIE?

1993

CCIE certification first Introduced



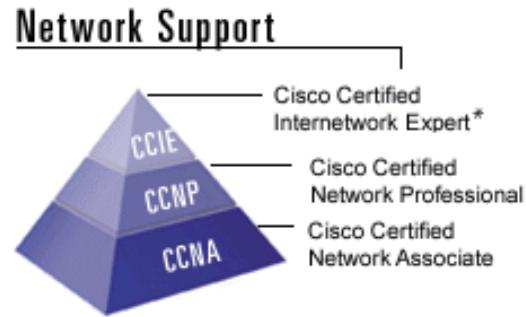
Stuart Biggs, Cisco CCIE 1025

Part of the original blueprint...

- Desktop includes Appletalk, Banyan VINES, [Novell IPX](#), XNS, NetBIOS/NETBEUI/LAN Manager, IEEE 802.3 and 802.5 MAC Layers, and IEEE 802.2 LLC1/LLC2 Layer.
- WAN includes baseband ISDN, Frame Relay, SMDS, X.25 and synchronous point-to-point serial lines.
- Internet includes [TCP/IP](#), [OSI](#) with TP4/CLNS, [DECnet](#) Phase IV and Phase IV+, and SNA/APPC

1998

CCNA and CCNP Introduced



2001 CCIE goes from **two days to one**

Solutions | Products | Ordering | Support | Partners | Training | Corporate
CCIE Program

FAQs

Cisco Systems

Home | What's New | How to Buy | **Login** | Register | Feedback | Search | Map/Help

Overview
Mission
► What's New

Cisco Announces new format for CCIE exams

2004

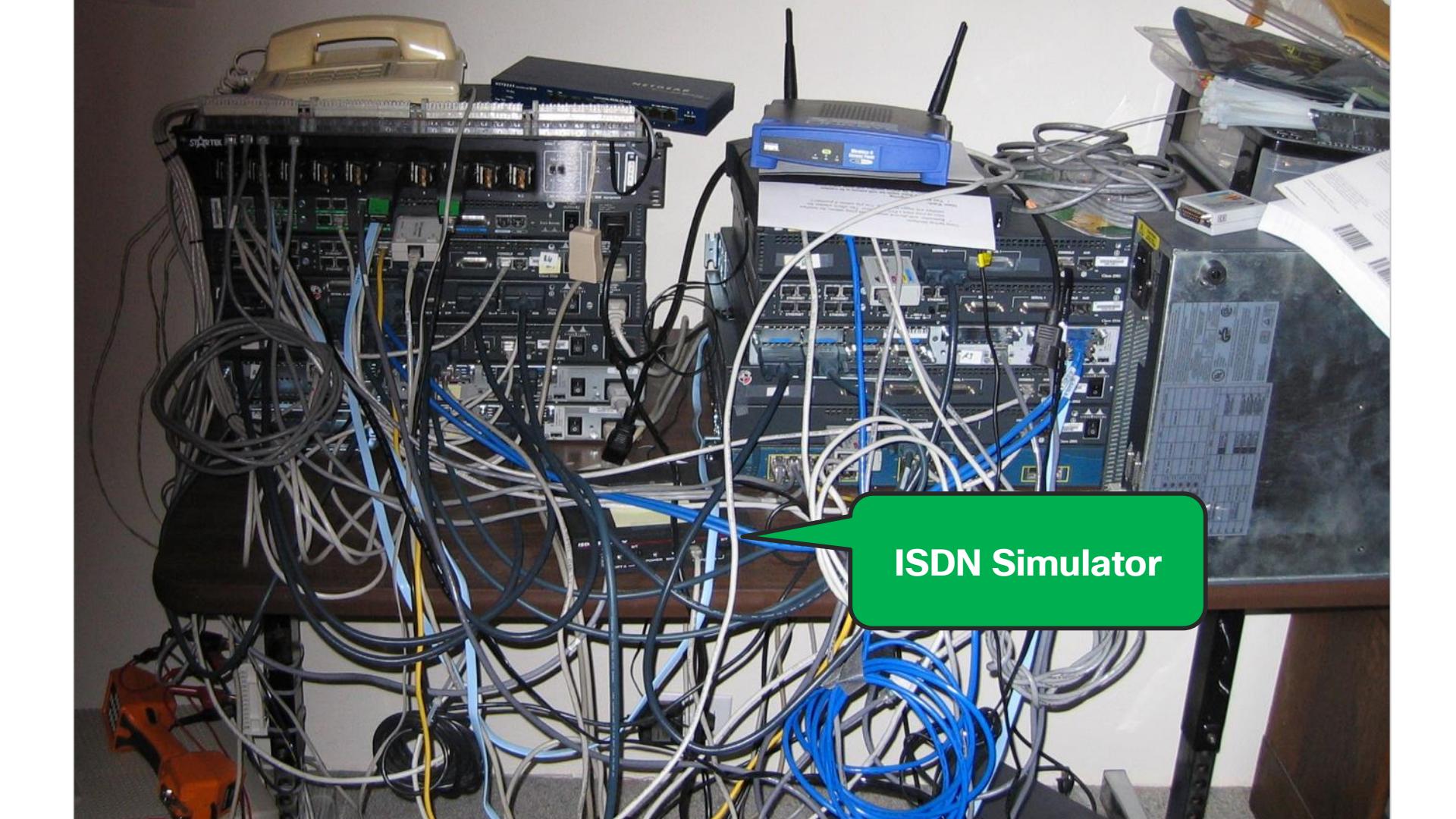
My first CCIE...What was it like?



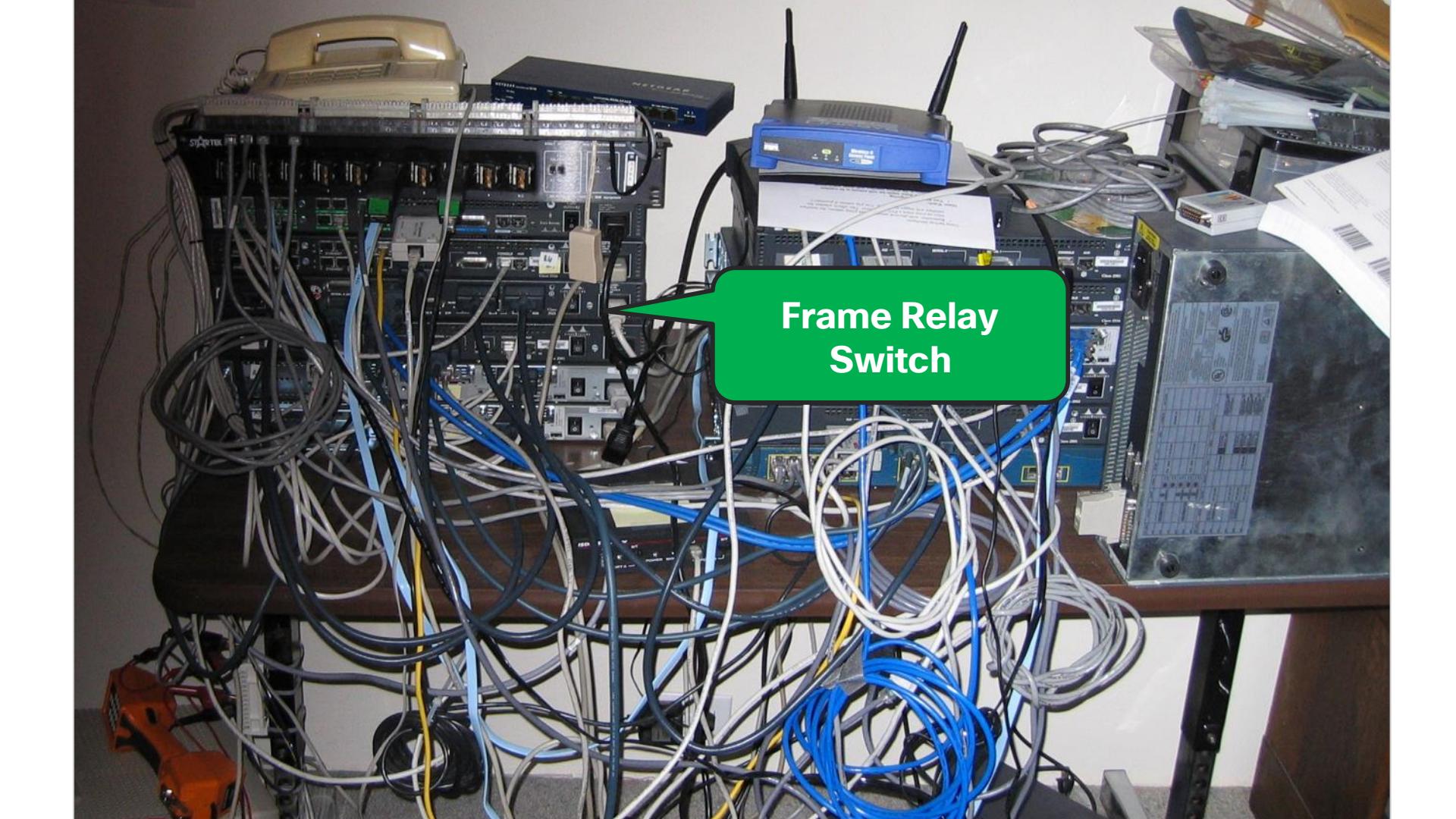




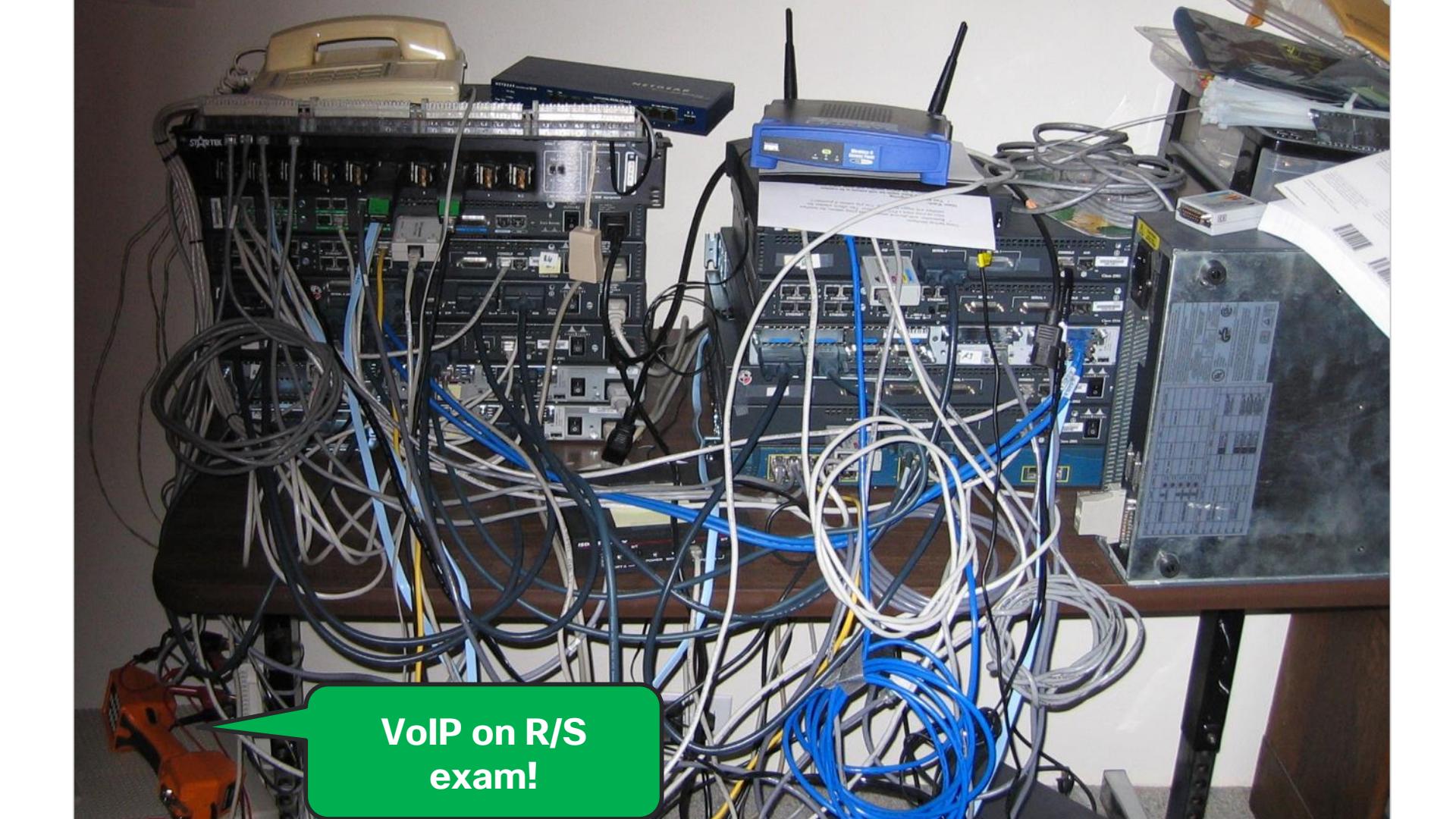
Token Ring MAU



ISDN Simulator



Frame Relay
Switch



**VoIP on R/S
exam!**

CCIE Exam

Multiprotocol



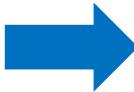
IP

Multi-WAN



Ethernet/MPLS

Two Day



One Day

Are APIs the new CLI?

What is an API?

API = Application Programming Interface



Designed for programmers to access *through code*

CLI = Command-Line Interface



Designed for network engineers to access *directly on device*

For example, a REST API...



Consider some of the things you can do with an app like **Webex Teams**...

Create a space

Start a group conversation in this space.

Catalyst 9k Programmability

Add people by name or email (optional)

Create



Webex Teams

Cisco live!



Add a user to a room

X People (2) ⋮

fabrimac X



fabrimac@cisco.com
Active on 5/19/17



Webex Teams

Cisco *live!*



Read a message



Krishna Chaitanya Kotha 3:13 PM

Does anyone have some sample code for an on-box Python script?



Webex Teams



API's allow you to do same things with a **script** instead of by clicking..

Create a space

Start a group conversation in this space.

Catalyst 9K Programmability

Add people by name or email (optional)

Create

People (1)

fabrimac

fabrimac@cisco.com Active 2 hours ago

Krishna Chaitanya Kotha 3:13 PM
Does anyone have some sample code for an on-box Python script?

Create a space

```
0 def create_room(room_name, token):
1
2     requests.packages.urllib3.disable_warnings(InsecureRequestWarning)
3
4     headers = {'Authorization': 'Bearer ' + token,
5                'Content-Type': 'application/json'}
6     body = json.dumps({'title': room_name})
7
8     resp = requests.post('https://api.ciscospark.com/v1/rooms',
9                           verify=False, headers=headers, data=body)
10
11     print resp
```

Add a user to a space

```
def add_user_to_room(room_id, user, token):
    """
    Adds a user to a room.
    """

    requests.packages.urllib3.disable_warnings(InsecureRequestWarning)

    headers = {'Authorization': 'Bearer ' + token,
               'Content-Type': 'application/json'}
    body = json.dumps({'roomId': room_id, 'personId': user})

    resp = requests.post('https://api.ciscospark.com/v1/memberships',
                         verify=False, headers=headers, data=body)
    print resp
```

Read a message

```
def list_messages(room_id, token):
    """
    Lists messages for a room.
    """

    requests.packages.urllib3.disable_warnings(InsecureRequestWarning)

    headers = {'Authorization': 'Bearer ' + token,
               'Content-Type': 'application/json'}
    resp = requests.get('https://api.ciscospark.com/v1/messages?roomId={}'.format(room_id),
                        verify=False, headers=headers)
    return resp.text
```

APIs expose the following to coders:

- ↳ Actions (Create a space, read a message)
- ↳ Data (Name of the space, text of the message)



REST API calls use **HTTP methods** like GET, PUT and POST.

Create a Room

 Test Mode 

Creates a room. The authenticated user is automatically added as a member of the room. See the Memberships API to learn how to add more people to the room.

POST <https://api.ciscospark.com/v1/rooms>

```
resp = requests.post('https://api.ciscospark.com/v1/rooms',
verify=False,headers=headers,data=body)
```

Two types of API



Northbound: Exposed from controller to scripts

Controller



Southbound: Exposed from devices

Network Device

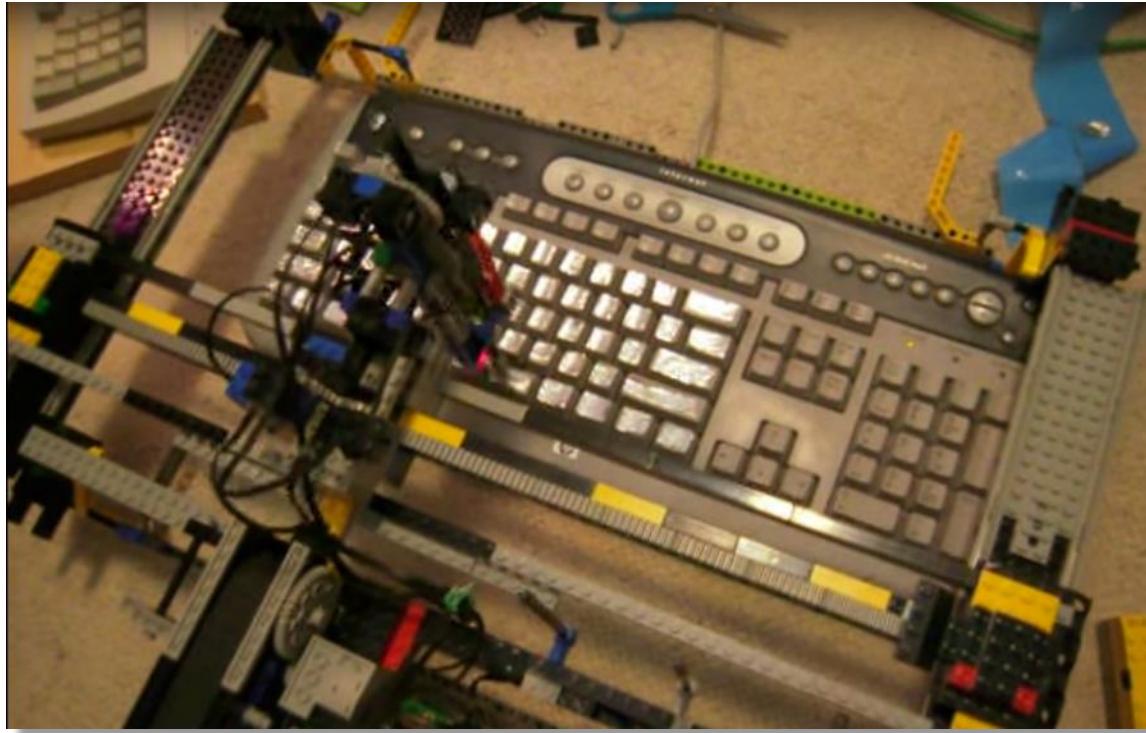
Let's look at **Southbound APIs
(And save controllers for later...)**



Human-Oriented Interface



Machine-Oriented Interface



Machines using human-oriented interfaces can be highly **inefficient!**

Beginning in release 16.3, Cisco has introduced YANG data models, and NETCONF/RESTCONF capabilities into IOS XE.

CLI

```
router bgp 100
bgp log-neighbor-changes
neighbor 13.13.13.1 remote-as 100
neighbor 13.13.13.1 update-source Loopback10
neighbor 14.14.14.1 remote-as 100
neighbor 14.14.14.1 update-source Loopback11
neighbor 15.15.15.1 remote-as 100
neighbor 101.1.1.1 remote-as 4200123003
neighbor 172.26.244.141 remote-as 100
!
iox
ip forward-protocol nd
ip http server
ip http secure-server
!
ip route 10.10.1.0 255.255.255.0 Loopback12
ip route 13.13.13.0 255.255.255.0 172.26.244.141
ip route 14.14.14.0 255.255.255.0 172.26.244.141
ip route 15.15.15.0 255.255.255.0 172.26.244.141
ip route 16.16.16.0 255.255.255.0 172.26.244.141
ip route 21.21.21.0 255.255.255.0 Loopback12
ip route 100.101.102.0 255.255.255.0 Loopback12
ip route 123.22.11.0 255.255.255.0 Loopback12
ip route vrf Mgmt-vrf 0.0.0.0 0.0.0.0 172.26.244.1
ip tacacs source-interface GigabitEthernet1/0/24
ip ssh server algorithm encryption aes128-ctr aes192-ctr aes256-ctr
ip ssh client algorithm encryption aes128-ctr aes192-ctr aes256-ctr
```



Human Oriented Interface

YANG Models

```
list interface {
    key "name";
    unique "type location";

    leaf name {
        type string;
        reference
            "RFC 2863: The Interfaces Group MIB - ifName";
    }

    leaf description {
        type string;
    }

    ...
    container statistics {
        config false;
        leaf discontinuity-time {
            type yang:date-and-time;
        }

        leaf in-octets {
            type yang:counter64;
            reference
                "RFC 2863: The Interfaces Group MIB - ifHCInOctets";
        }
    }
}
```



Machine Oriented Interface

Structured vs Unstructured Data

Un-structured

John Smith 42 14155551212



What is this?

- His age?
- The year he graduated college?
- Meaning of life, the universe & everything?

Structured

Name: John Smith
Age: 42
Phone: +1-415-555-1212



Keys



Values

Hierarchical Structured Data (XML-like)

The diagram illustrates hierarchical structured data using curly braces {} to group elements. On the left, labels 'First User' and 'Second User' are aligned with their respective brace groups. The 'First User' group contains XML-like code for a user named John Smith, aged 42, with a phone number. The 'Second User' group contains XML-like code for a user named Sarah Kim, aged 27, with a phone number.

```
<user1>
  <name>John Smith</name>
  <age>42</age>
  <phone>+1-415-555-1212</phone>
</user1>

<user2>
  <name>Sarah Kim</name>
  <age>27</age>
  <phone>+1-718-555-1212</phone>
</user2>
```

ΙΠΠΟΝΙΚΩΔΕΤΩΚΑΛΛΙΟΥ
ΠΑΤΡΙΚΑΙΔΟΣΛΗΝΕΧΟΝΤΙ
ΜΕΓΑΛΗΝΚΑΙΔΥΝΑΜΙΝΑΠΟ
ΠΛΟΥΤΟΥΚΑΙΓΕΝΟΥΣΕΝΕ
ΤΡΙΤΕΚΟΝΔΑΥΛΟΝΟΥΧΥΠ
ΟΡΓΗΣΗΔΙΑΦΟΡΑΣΤΙΝΟΣ
ΠΡΟΔΗΘΕΙΣΑΛΛΕΠΙΓΕΛΛ
ΤΙΣΥΝΘΕΜΕΝΟΣΠΡΟΣΤΟΥΣ
ΕΤΑΙΡΟΥΣΠΕΡΙΒΟΝΤΟΥΔΕ
ΤΗΣΑΣΕΛΓΕΙΑΣΕΝΤΗΠΟΛΕΙ
ΓΕΝΟΜΕΝΗΣΚΑΙΣΥΝΑΓΑ
ΝΑΚΤΟΥΝΤΩΝΩΣΠΕΡΕΙΚ
ΟΣΑΠΑΝΤΩΝΑΜΗΜΕΡΑ
ΠΑΡΗΝΟΔΛΚΙΒΙΔΗΣΕΠΗ
ΤΗΝΟΙΚΙΑΝΤΟΥΙΠΠΟΝΙΚΟΥ
ΚΑΙΤΗΝΟΥΡΑΝΚΟΦΑΣΕΙС
ΗΛΘΕΠΡΟΣΑΥΤΟΝΚΑΙΘΕΙС
· ΤΟΙΜΑΤΩΝΠΑΡΕΔΙΔΟΥΤΩ
ΣΩΜΑΜΑΣΤΙΓΟΥΝΚΑΙΚΟ
ΛΑΖΕΙΝΚΕΛΑΓΥΩΝΔΑΕ



Ancient unstructured data

COULDYOUREADITIFWEWROTELIKETHISWIT
HNOPUNCTUATIONITISHARDTOFIGUREOUT
WHEREONEWORDORSENTENCEBEGINSORE
NDSANDITISNOTEASYTOSEPARATEOUTALL
THEELEMENTSOFTHETEXTTHANKGOODNES
SSOMEONECAMEUPWITHABETTERWAY

Note inconsistent “key” format!

```
switch1# sh int e1/10
Ethernet1/10 is up
  Hardware: 1000/10000 Ethernet, address: 0005.73d0.9331 (bia 0005.73d0.9331)
  Description: To UCS-11
  MTU 1500 bytes, BW 1000000 Kbit, DLY 10 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Switchport monitor is off
  EtherType is 0x8100
  Last link flapped 8week(s) 2day(s)
  Last clearing of "show interface" counters 1d02h
  30 seconds input rate 944 bits/sec, 118 bytes/sec, 0 packets/sec
  30 seconds output rate 3110376 bits/sec, 388797 bytes/sec, 5221 packets/sec
```

CLI = Unstructured Data

What we need:

Standard, structured way to represent configuration and operational data.

```
<ipv4 xmlns="http://openconfig.net/yang/interfaces/ip">
  <addresses>
    <address>
      <ip>172.26.194.212</ip>
      <config>
        <ip>172.26.194.212</ip>
        <prefix-length>24</prefix-length>
      </config>
    </address>
  </addresses>
</ipv4>
```

XML vs JSON



```
<interfaces xmlns:=" [...] yang:ietf-interfaces">
  <interface>

    <name>eth0</name>
    <type>ethernetCsmacd</type>
    <location>0</location>
    <enabled>true</enabled>
    <if-index>2</if-index>

  </interface>
</interfaces>
```

NETCONF/RESTCONF



```
{
  "ietf-interfaces:interfaces": {
    "interface": [
      {
        "name": "eth0",
        "type": "ethernetCsmacd",
        "location": "0",
        "enabled": true,
        "if-index": 2
      }
    ]
  }
}
```

RESTCONF



Sends

```
<interface>Gigabit 1/0</interface>
<ifaddr>10.0.0.1/24</ifaddr>
```



Error!

Expecting:

```
<interface>
<name>Gigabit 1/0</name>
<address>10.0.0.1/24</address>
</interface>
```

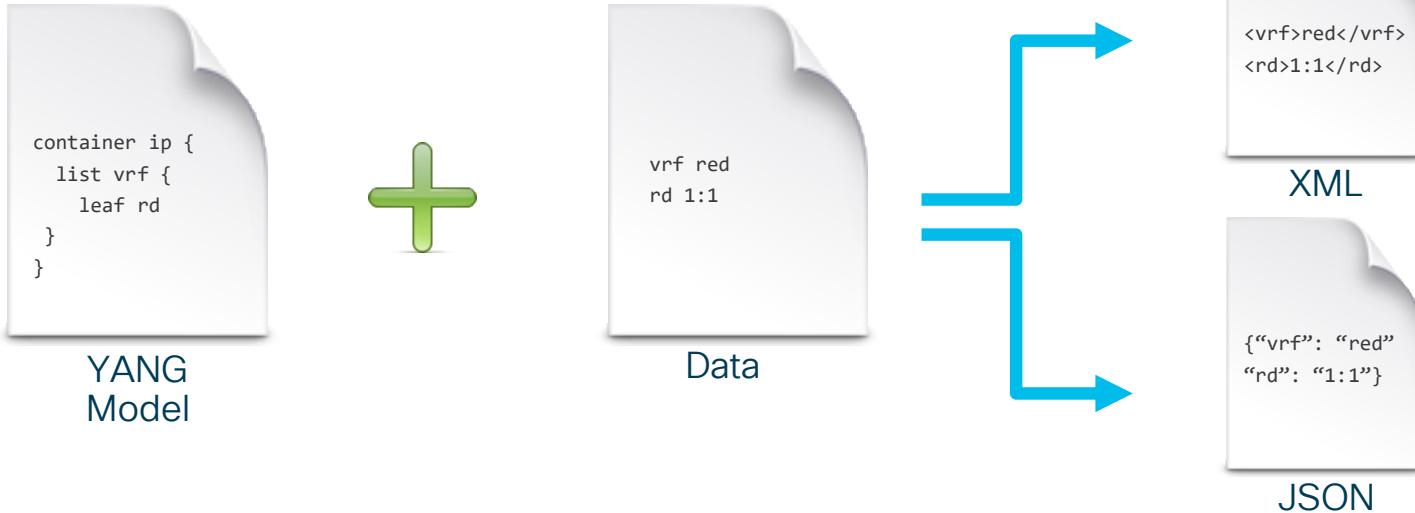
YANG Data Models



YANG models do not contain data or XML.

YANG models are like templates used to generate consistent XML.

YANG Data Models



YANG models can be used as a template for generating structured data in many different formats.

YANG Configuration Model Example*

```
container ip {  
    list vrf {  
        description  
            "Configure an IP VPN Routing/Forwarding  
            instance";  
  
        leaf name {  
            type string;  
        }  
  
        leaf rd {  
            description  
                "Specify Route Distinguisher";  
            type rd-type;  
        }  
    }  
}  
* Note: YANG model simplified for clarity
```

YANG

```
<ip>  
  <vrf>  
    <name>vrf_red</name>  
    <rd>65000:1</rd>  
  </vrf>  
  <vrf>  
    <name>vrf_green</name>  
    <rd>65000:2</rd>  
  </vrf>  
</ip>
```

XML

```
ip vrf vrf_red  
  rd 65001:1  
!  
ip vrf vrf_green  
  rd 65001:2  
!
```

CLI

So why is this:

```
<ip>
  <vrf>
    <name>vrf_red</name>
    <rd>65000:1</rd>
  </vrf>
  <vrf>
    <name>vrf_green</name>
    <rd>65000:2</rd>
  </vrf>
</ip>
```



...better than this?

```
ip vrf vrf_red
  rd 65001:1
!
ip vrf vrf_green
  rd 65001:2
!
```



CLI

```
ip vrf vrf_red
  rd 65001:1
!
ip vrf vrf_green
  rd 65001:2
!
```

- Good for human consumption
- Unstructured from a machine perspective



YANG-structured data

```
<ip>
  <vrf>
    <name>vrf_red</name>
    <rd>65000:1</rd>
  </vrf>
  <vrf>
    <name>vrf_green</name>
    <rd>65000:2</rd>
  </vrf>
</ip>
```

- Designed for machine consumption
- Directly convertible to/from Python dicts!

Where are YANG models?



Models installed on device automatically with IOS XE.



Also can be downloaded from GitHub.

<https://github.com/YangModels/yang/tree/master/vendor/cisco>

The screenshot shows the GitHub repository page for 'YangModels/yang'. The repository has 113 stars and 138 forks. The code tab is selected, showing files like MIBS, README.md, and various YANG models for Cisco devices. The repository was last updated on Nov 28, 2016.

| File | Description | Last Updated |
|------------------------------|---|--------------|
| MIBS | Cisco IOS XE 16.3.2 Release Yang Models | 2 months ago |
| README.md | Cisco IOS XE 16.3.2 Release Yang Models | a month ago |
| cat3k-netconf-capability.xml | Cisco IOS XE 16.3.2 Release Yang Models | 2 months ago |
| check-models.sh | Cisco IOS XE 16.3.2 Release Yang Models | 2 months ago |
| cisco-acl-oper.yang | Cisco IOS XE 16.3.2 Release Yang Models | 2 months ago |
| cisco-bfd-state.yang | Cisco IOS XE 16.3.2 Release Yang Models | 2 months ago |

Who defines the YANG models?

Vendors

- Only work on specific vendor devices
- Greater feature coverage
- Can be OS-unique (IOS-XE, XR, etc.)



Standards Bodies

- Multi-vendor support
- More limited feature coverage
- Allow vendor-specific extensions



Actually an "industry forum"

Important Point!

Cisco's data models and IETF/OpenConfig data models are just two ways of doing the same thing.

```
<interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces"> ← IETF-defined model
  <interface>
    <name>GigabitEthernet 1/0/24</name>
    <description>Configured by NETCONF!</description>
  </interface>
</interfaces>
```

Both of these do exactly the same thing!

```
<native xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-native"> ← Cisco-defined “native” model
  <interface>
    <GigabitEthernet>
      <name>1/0/24</name>
      <description>Configured by NETCONF!</description>
    </GigabitEthernet>
  </interface>
</native>
```

Important Point!

Cisco's data models and IETF/OpenConfig data models are just two ways of doing the same thing.

```
<interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces"> ← IETF-defined model
  <interface>
    <name>GigabitEthernet 1/0/24</name>
    <description>Configured by NETCONF!</description>
  </interface>
</interfaces>
```

```
switch# show run interface g1/0/24
interface GigabitEthernet 1/0/24
  description Configured by NETCONF!
```

```
<native xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-native"> ← Cisco-defined “native” model
  <interface>
    <GigabitEthernet>
      <name>1/0/24</name>
      <description>Configured by NETCONF!</description>
    </GigabitEthernet>
  </interface>
</native>
```

NETCONF



SSH

RESTCONF



HTTP/S

XML

XML/JSON



So will this replace CLI?

```
<ip>
  <vrf>
    <name>vrf_red</name>
    <rd>65000:1</rd>
  </vrf>
  <vrf>
    <name>vrf_green</name>
    <rd>65000:2</rd>
  </vrf>
</ip>
```

```
ip vrf vrf_red
  rd 65001:1
!
ip vrf vrf_green
  rd 65001:2
!
```

Note Well:

- ↳ Same parameters being passed
- ↳ Almost identical syntax

Assume the most dramatic scenario:

In 2019, NETCONF/RESTCONF **completely replaces** CLI...

Everything you learnt for your CCIE would still be totally relevant.

How would you build a script if you didn't know what you were automating?

Assume the most realistic scenario:

In 2019, CLI continues to be the **primary means** of configuration/operation for most networks...

Everything you learnt for your CCIE would still be totally relevant.

How would you build a script if you didn't know what you were automating?

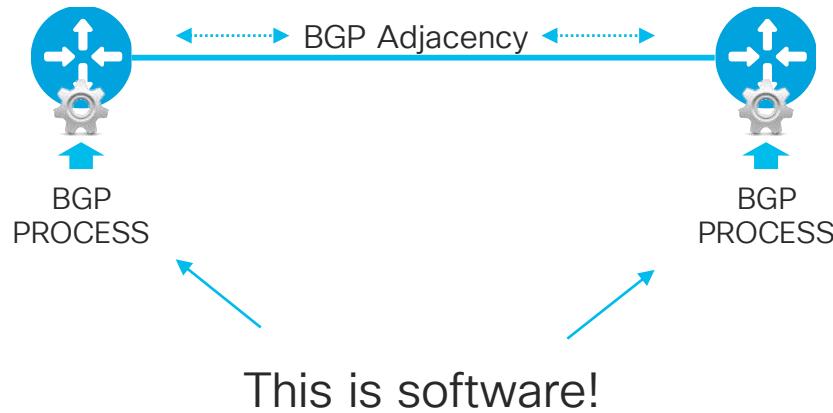
So what should I do?

- ↳ Study *basic* scripting
- ↳ Study device APIs (YANG/NC/RC)
- ↳ Add this tool to your toolbox

Is SDN the new CLI?

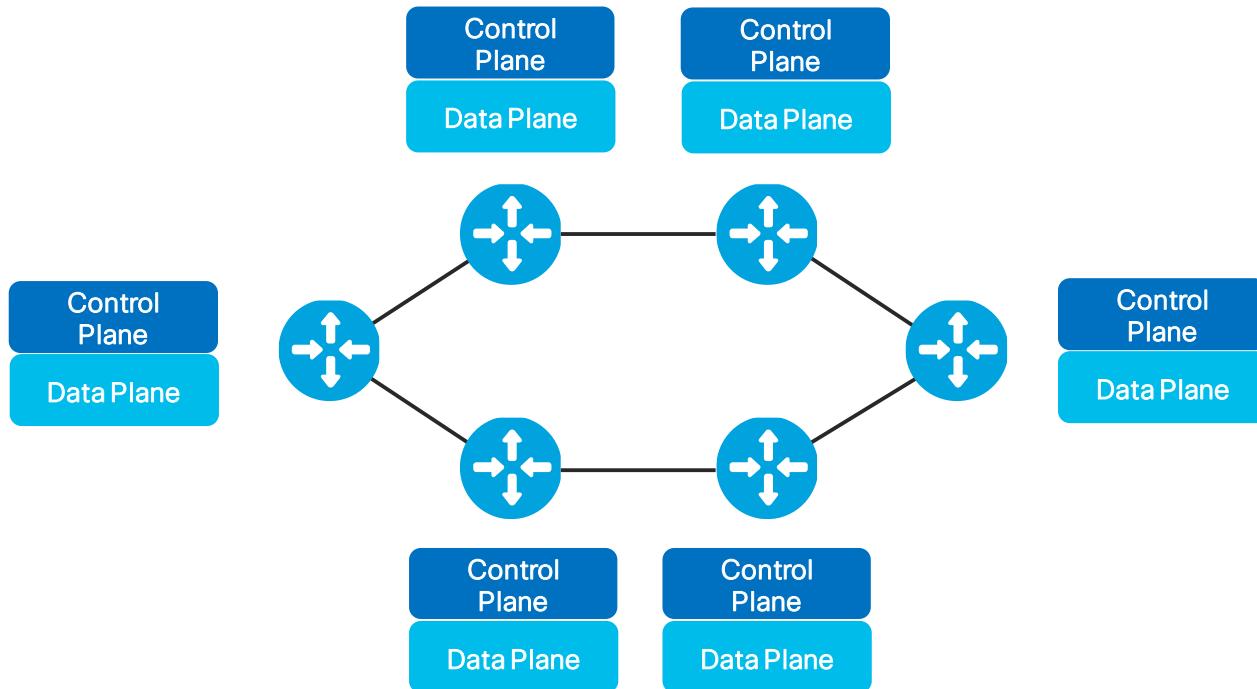
What is Software-Defined Networking?

Hint: Before the "SDN" hype, networks were software-defined!

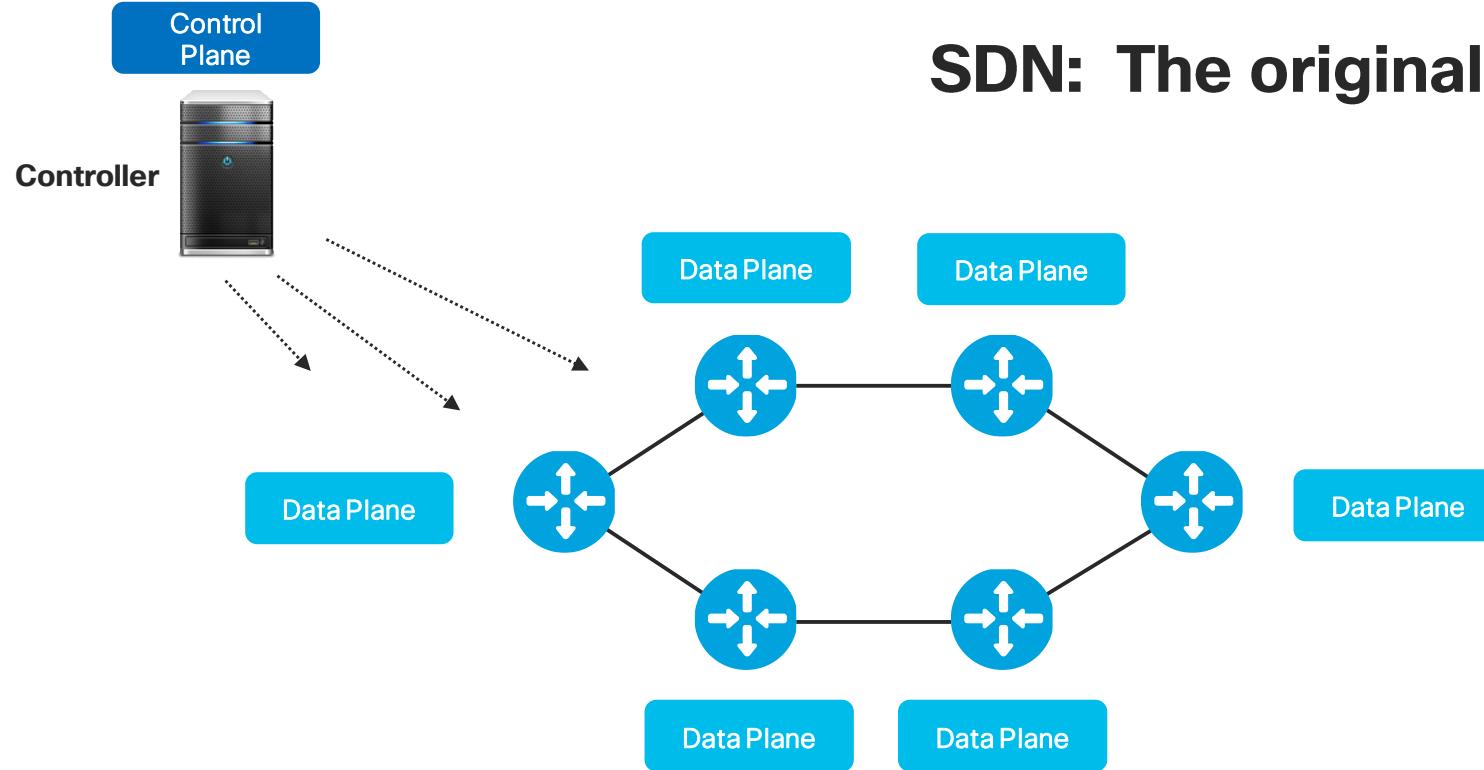


The original intent of SDN: Separate control from data plane

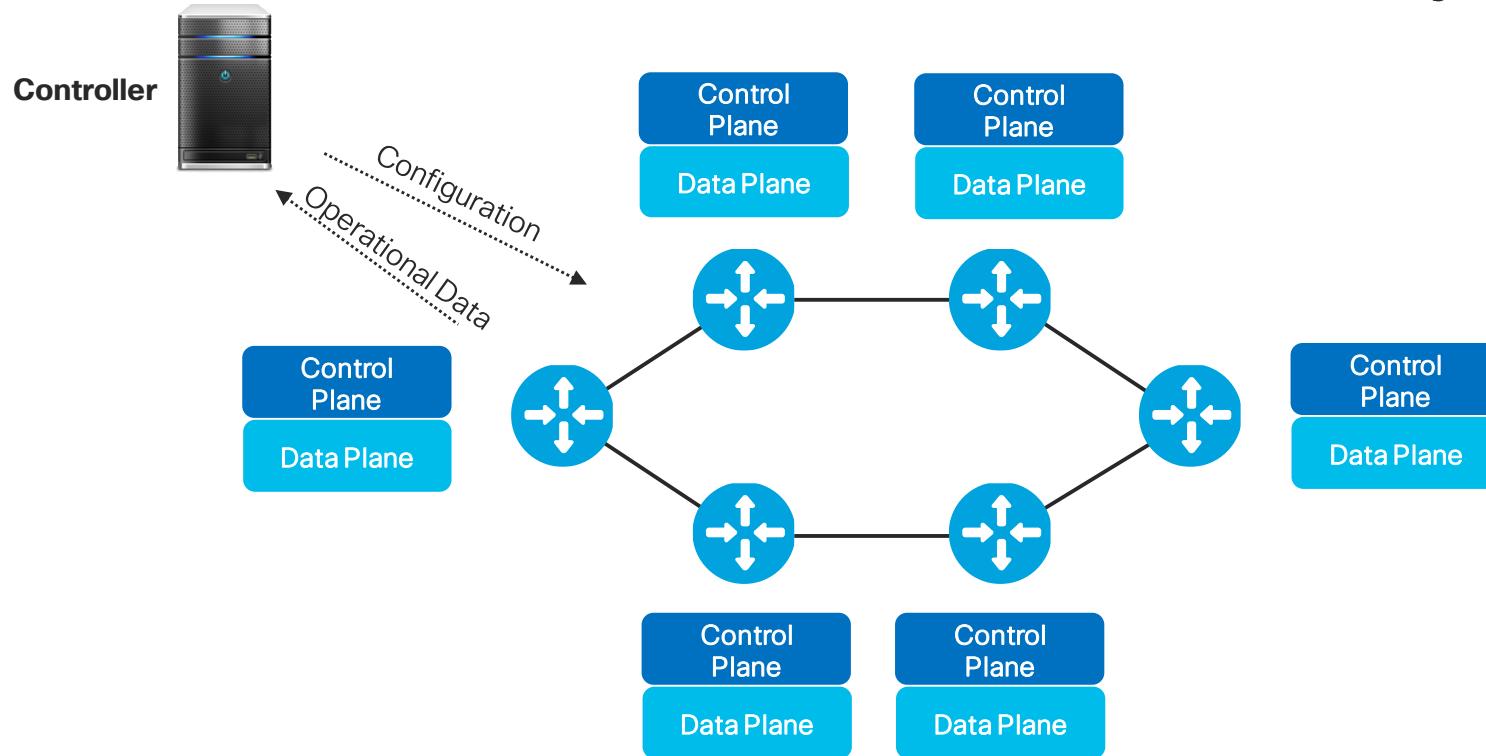
Traditional Networking...



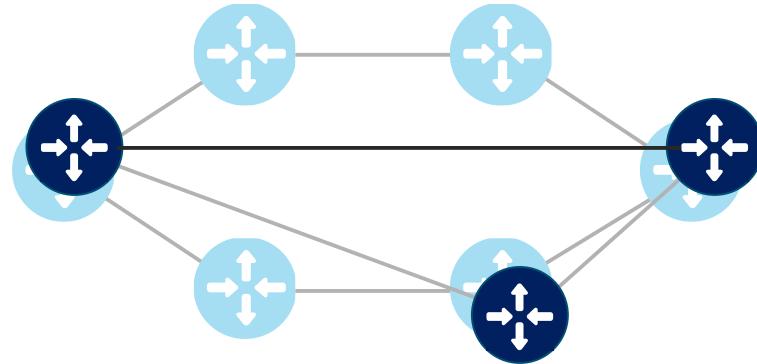
SDN: The original idea...



SDN: What it really is today...



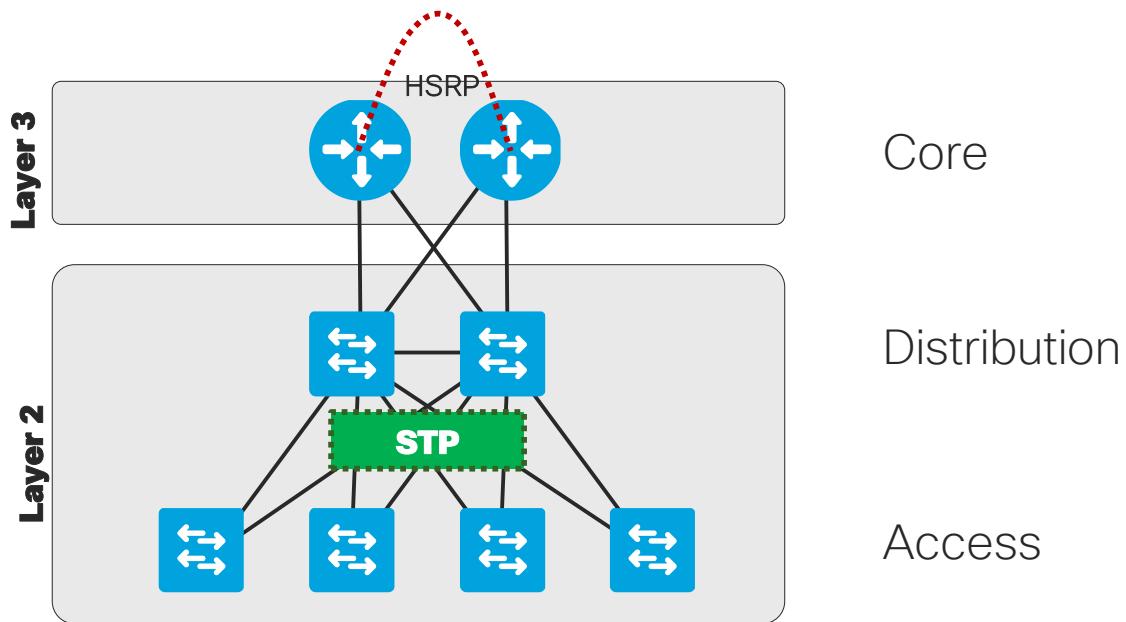
SDN now includes overlay networks (more on that later)



SDN in the campus

Traditional Campus Networks

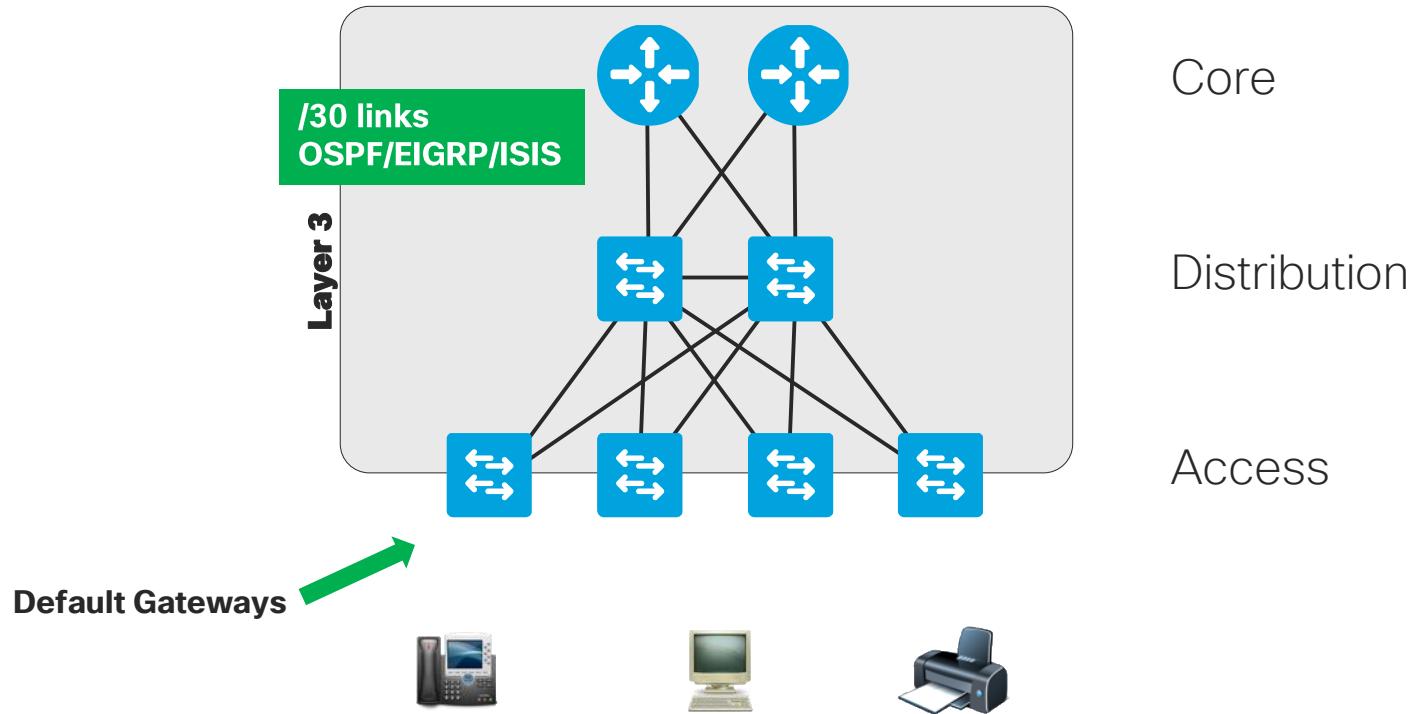
Default Gateways ➔



Traditional Network Challenges

- Slow Convergence with Link Failures
- Inefficient use of bandwidth
- Sub-Optimal Routing Paths
- Attempts to Solve:
 - Spanning Tree Improvements: RSTP, MSTP, etc.
 - Box Aggregation: VSS, Stackwise, etc.

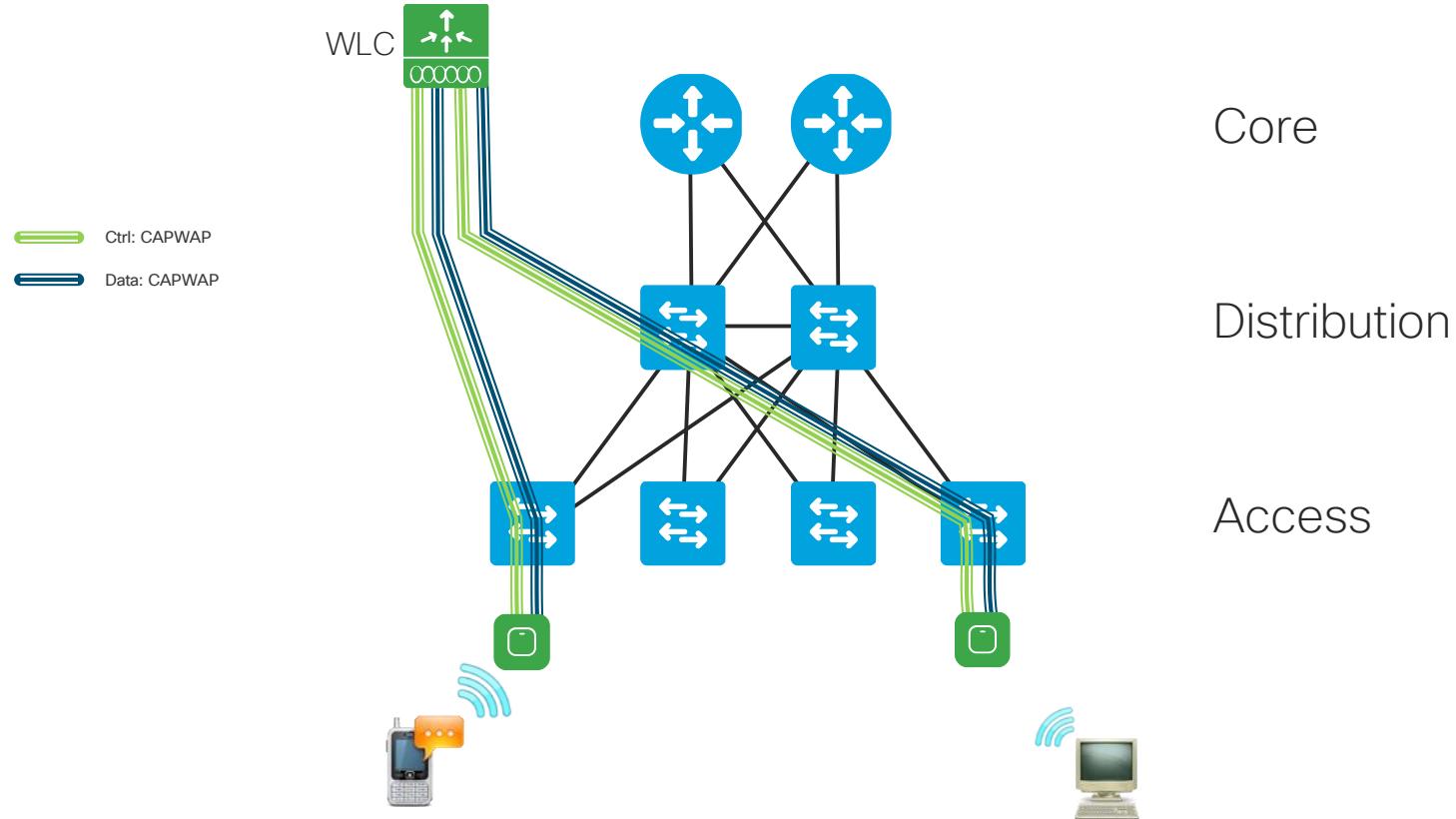
Layer 3 Routed Network



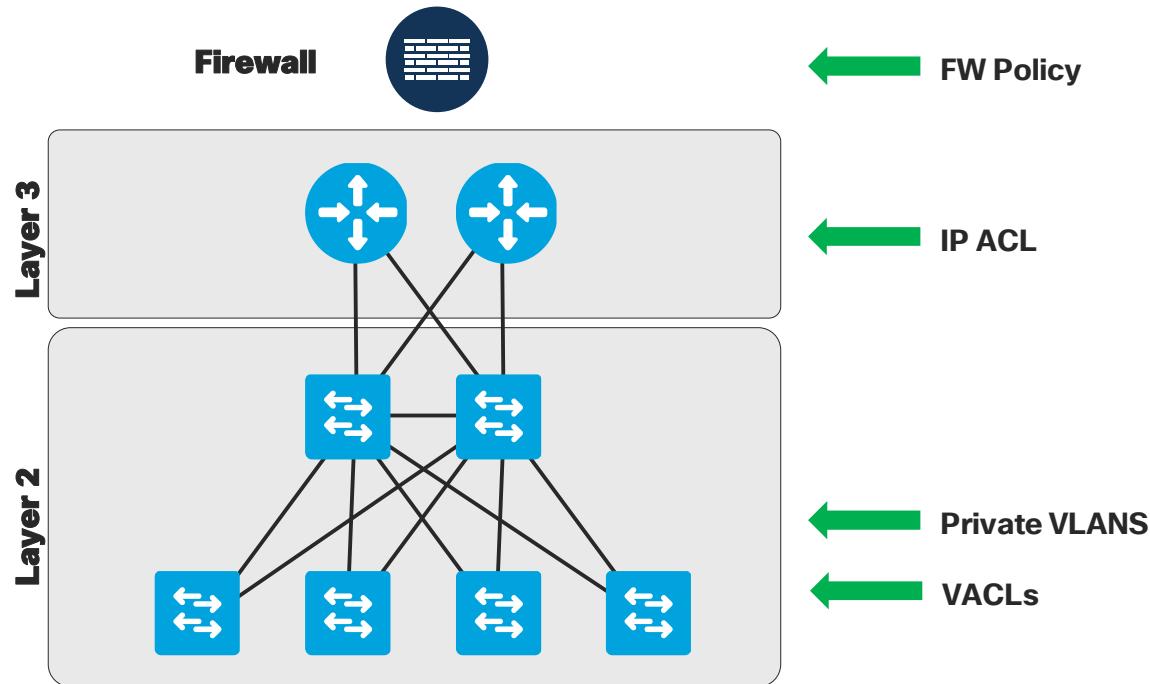
Layer 3 Routed Network Challenges

- Unable to stretch VLANs
- Default gateway redundancy
- Device Mobility

Wireless



Security



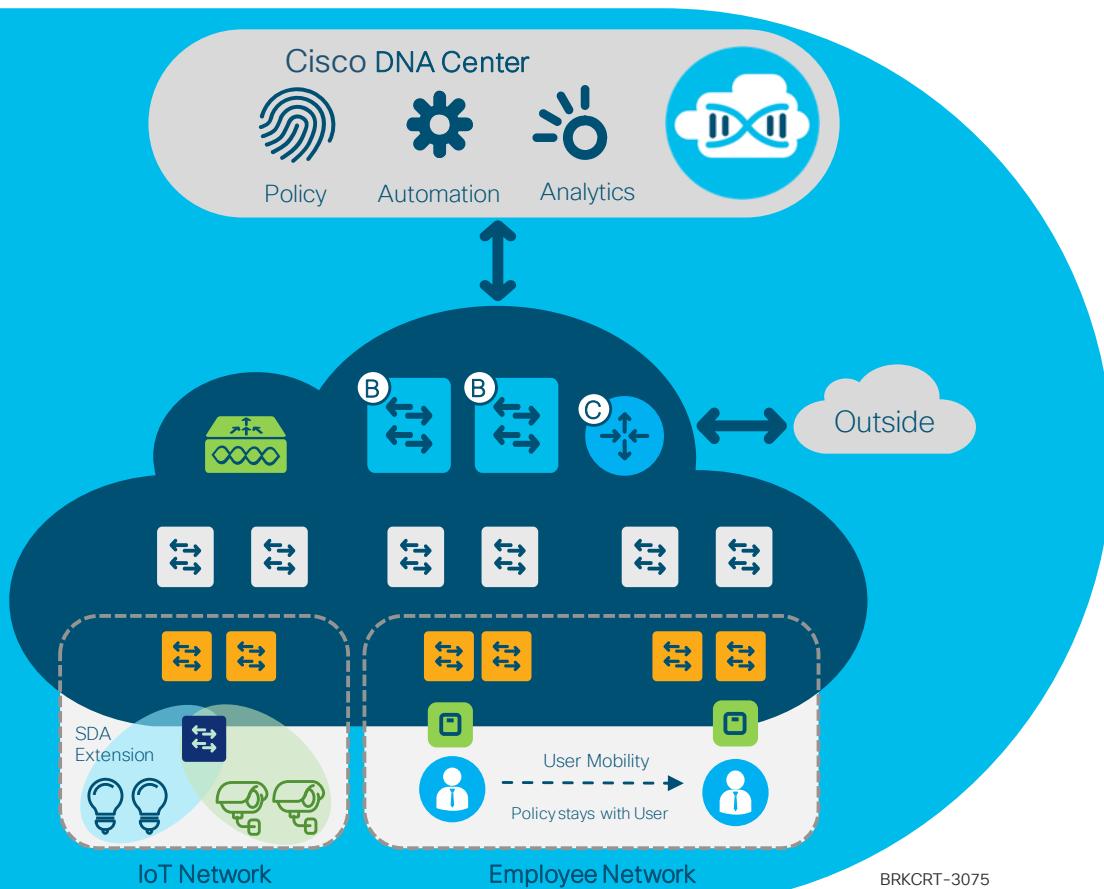
Problems with Traditional Security

- IP-based: What if user moves location?
- Complex to Manage
 - Thousands of ACEs in some cases
 - Hard to audit old ones
- Difficult to do micro-segmentation
- Only one level of hierarchy

Software-Defined Access



Cisco DNA & SD-Access



Automated Network Fabric

Single Fabric for Wired & Wireless
with simple Automation



Identity-Based Policy & Segmentation

Decouples Security & QoS
from VLAN and IP Address



Insights & Telemetry

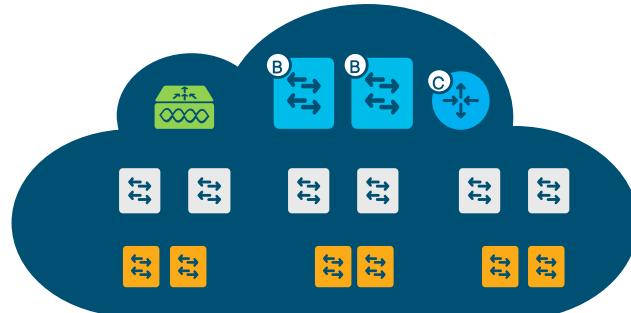
Analytics and Insights into
User and Application behavior



SD-Access

Campus Fabric - Key Components

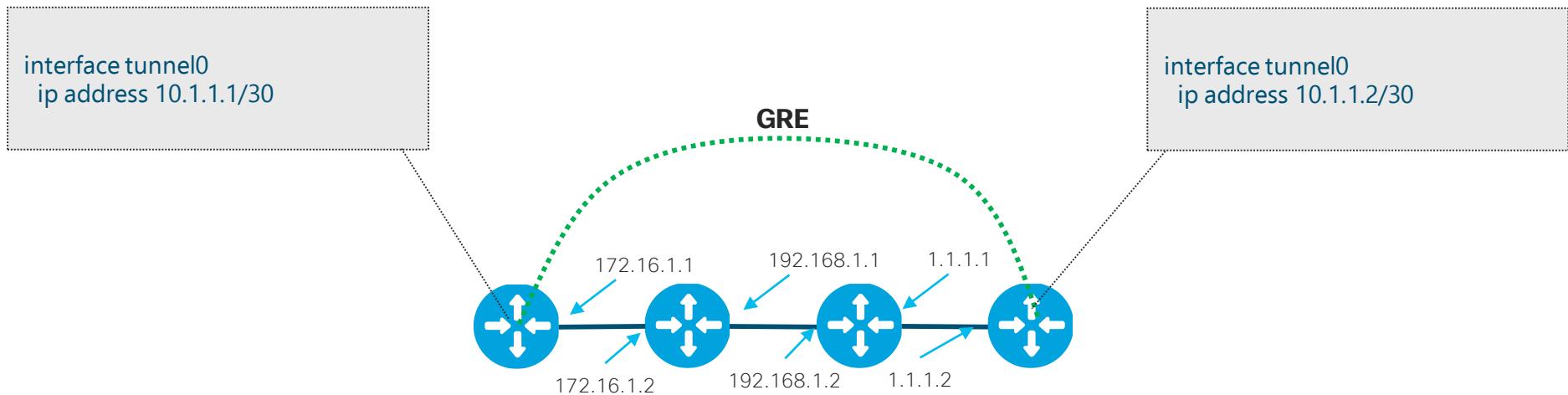
1. Control-Plane based on LISP
2. Data-Plane based on VXLAN
3. Policy-Plane based on SGT



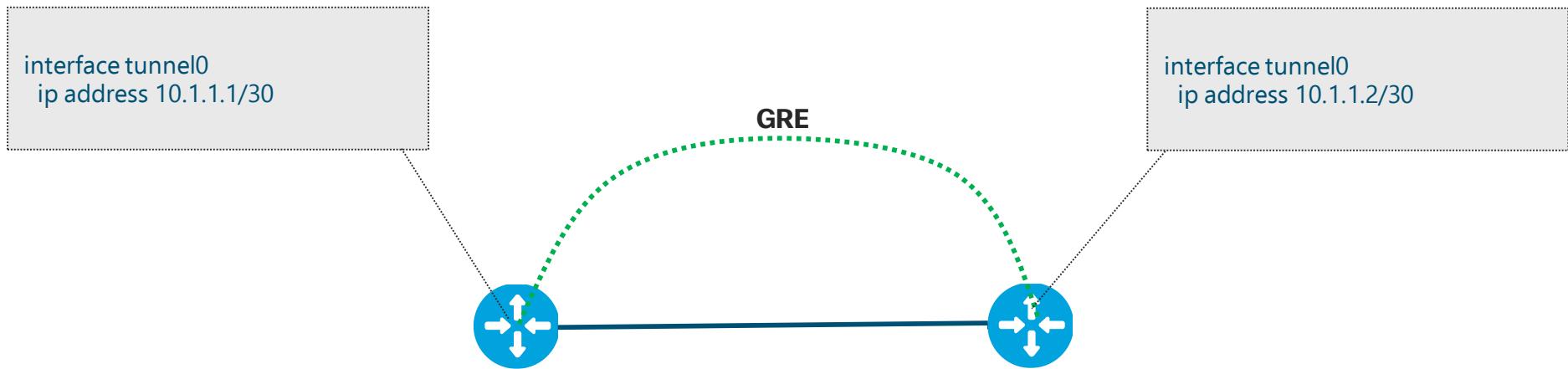
Key Features

- L2 + L3 Overlay -vs- L2 or L3 Only
- Host Mobility with Anycast Gateway
- Adds VRF + SGT into Data-Plane
- Virtual Tunnel Endpoints (Automatic)
- NO Topology Limitations (Basic IP)

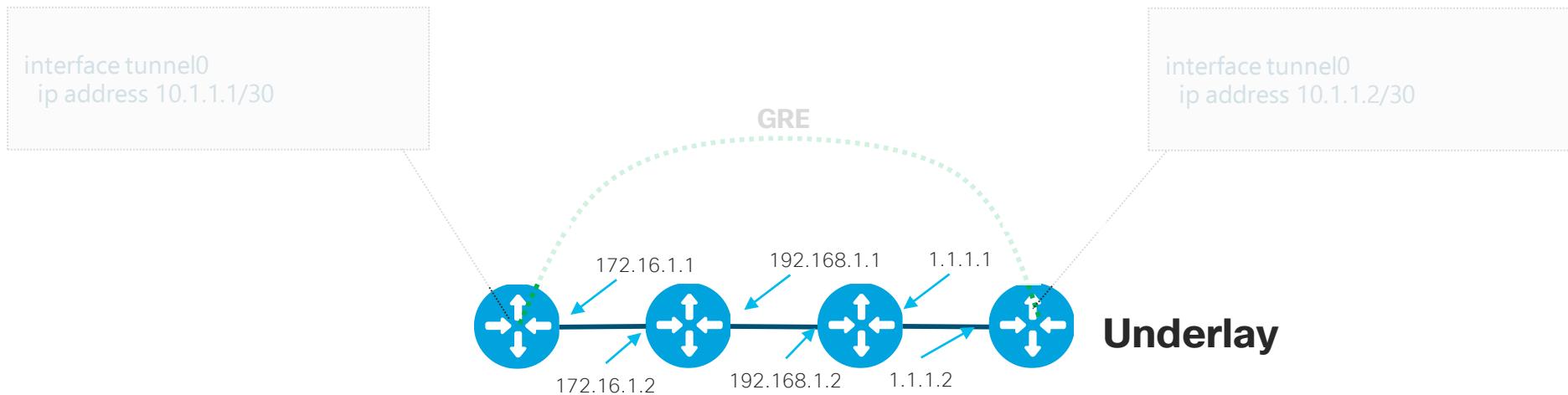
Overlays and Underlays



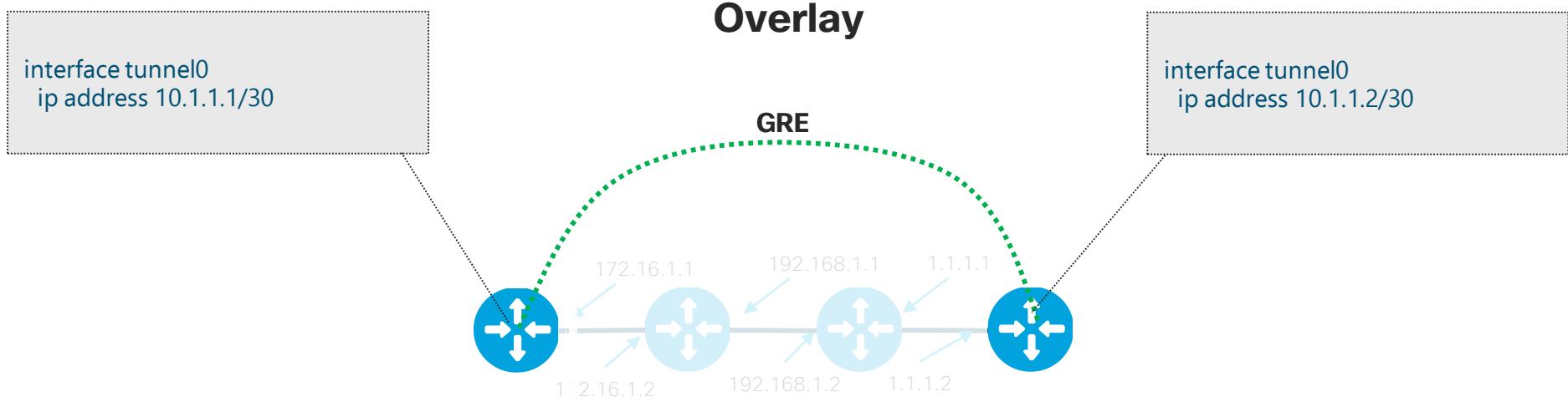
Overlays and Underlays



Overlays and Underlays



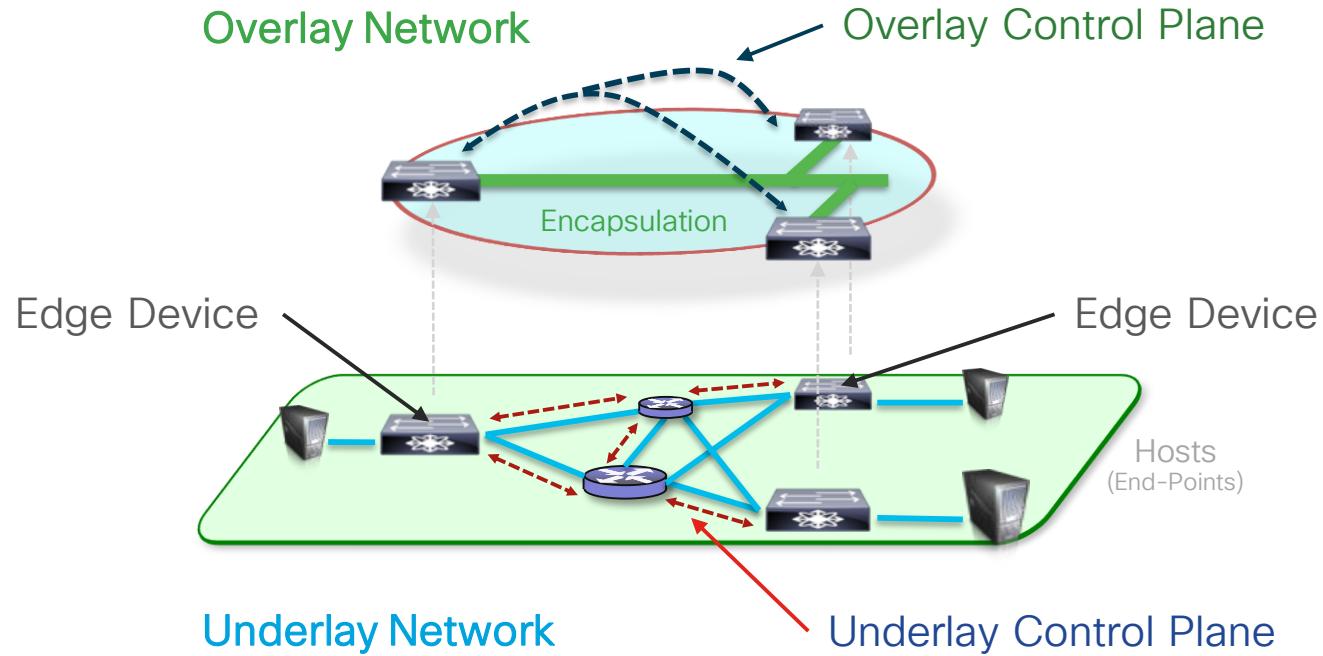
Overlays and Underlays

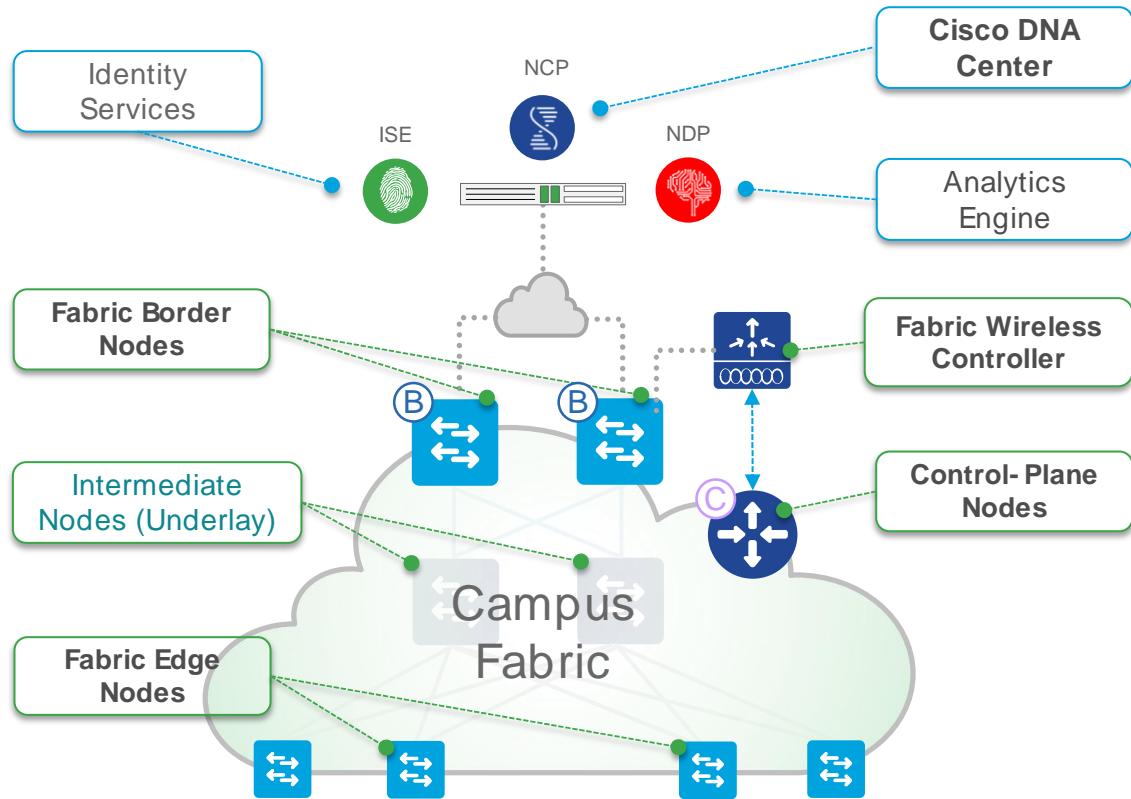




SD-Access

Fabric Terminology





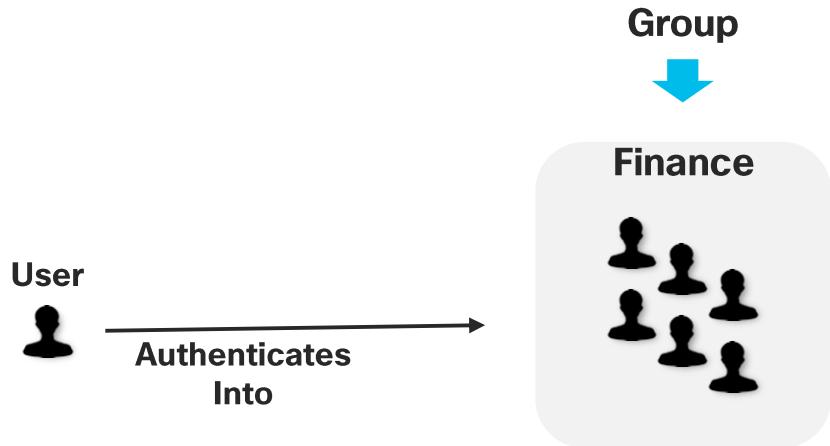
- **Cisco DNA Center** – Enterprise SDN Controller provides GUI management and abstraction via Apps that share context
- **Identity Services** – External ID System(s) (e.g. ISE) are leveraged for dynamic Endpoint to Group mapping and Policy definition
- **Analytics Engine** – External Data Collector(s) (e.g. NDP) are leveraged to analyze Endpoint to App flows and monitor fabric status
- **Control-Plane Nodes** – Map System that manages Endpoint to Device relationships
- **Fabric Border Nodes** – A Fabric device (e.g. Core) that connects External L3 network(s) to the SDA Fabric
- **Fabric Edge Nodes** – A Fabric device (e.g. Access or Distribution) that connects Wired Endpoints to the SDA Fabric
- **Fabric Wireless Controller** – A Fabric device (WLC) that connects Wireless Endpoints to the SDA Fabric



Cisco DNA-Center

Application used by the Administrator to manage and operate the Network

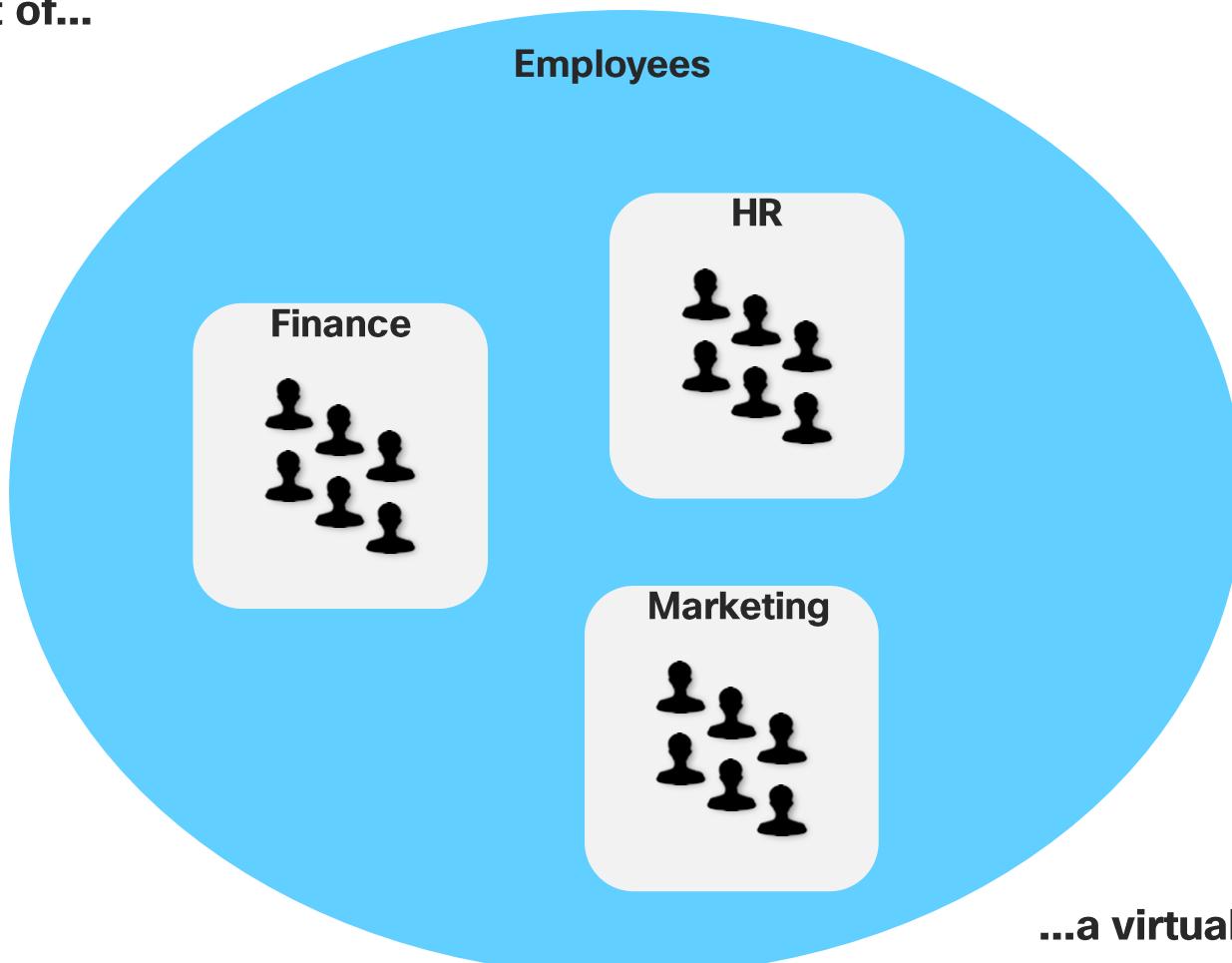
Policy and Segmentation

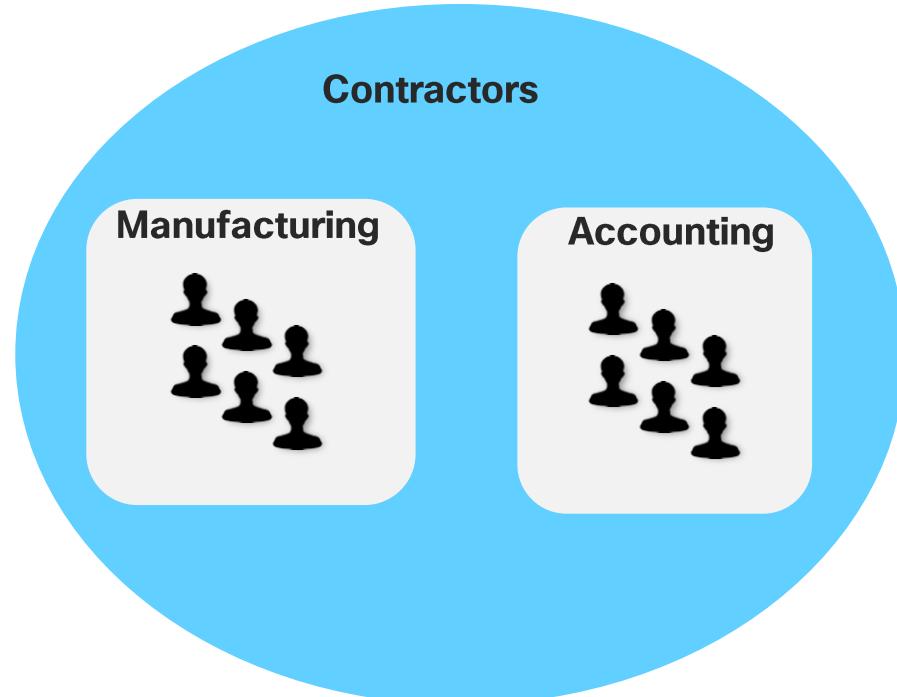
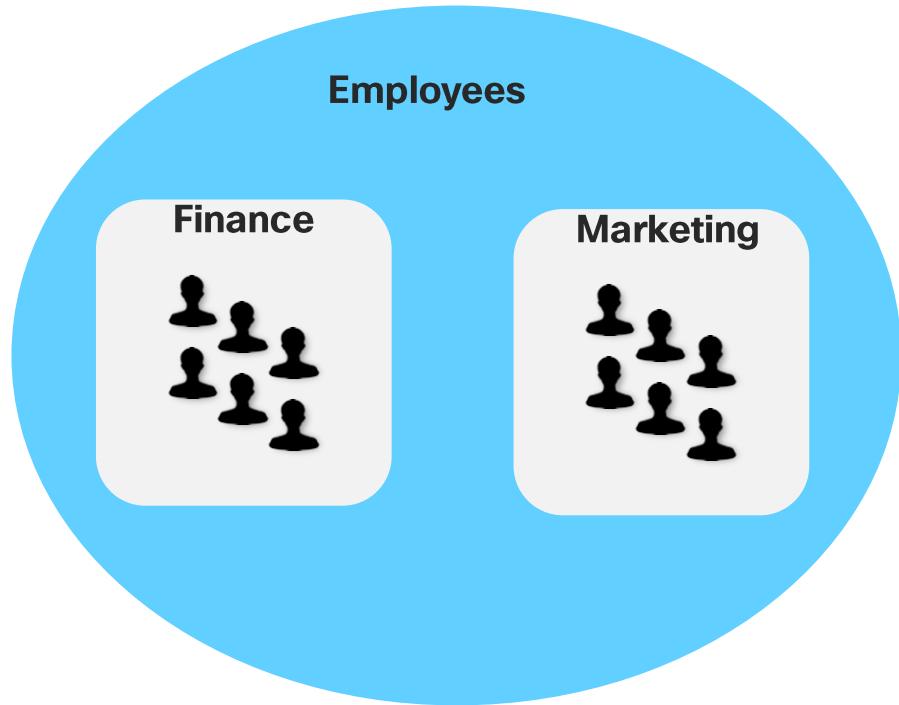


How?

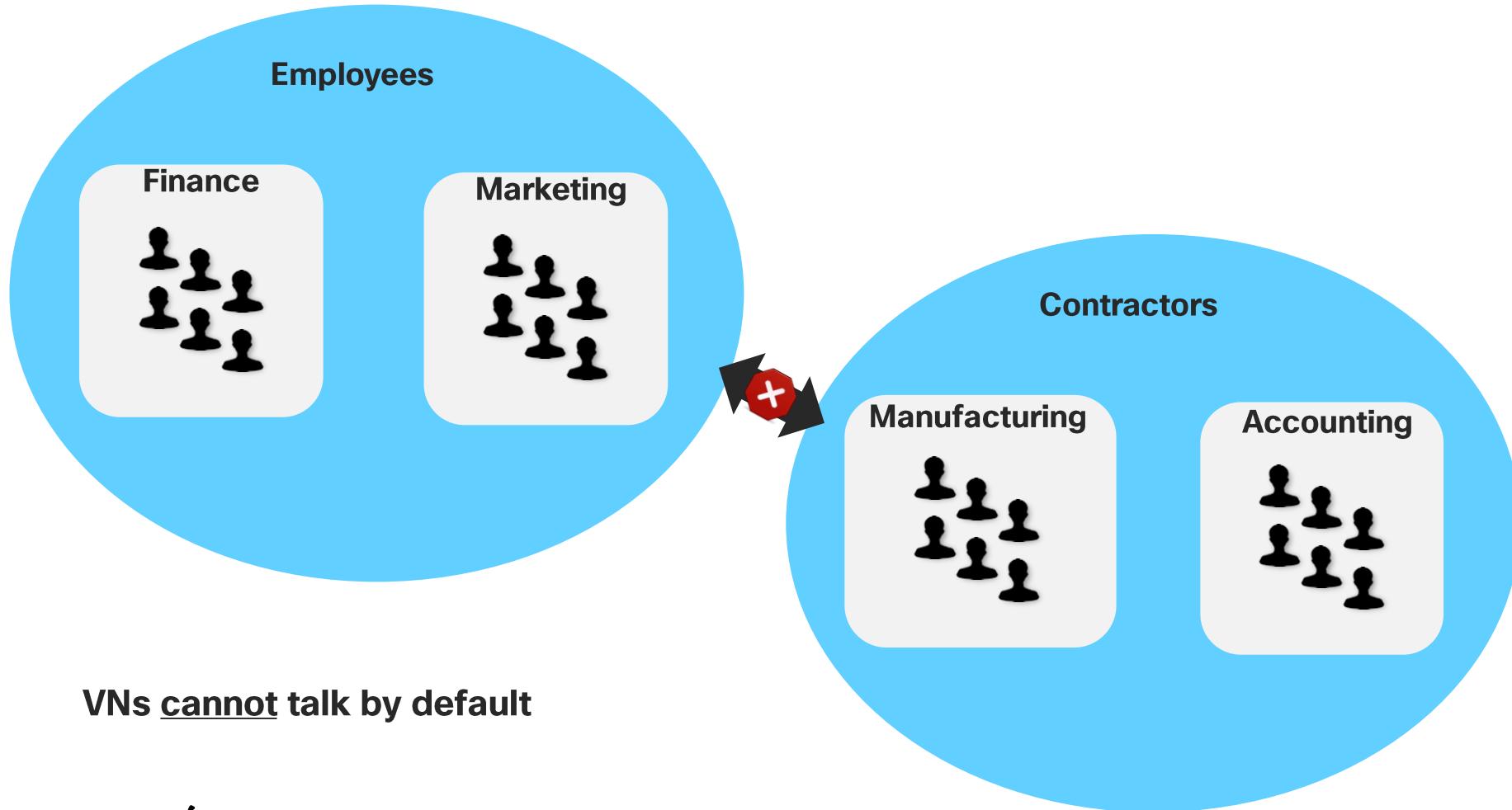
Good: Static Port assignment
Better: Profiling, MAB
Best: 802.1x

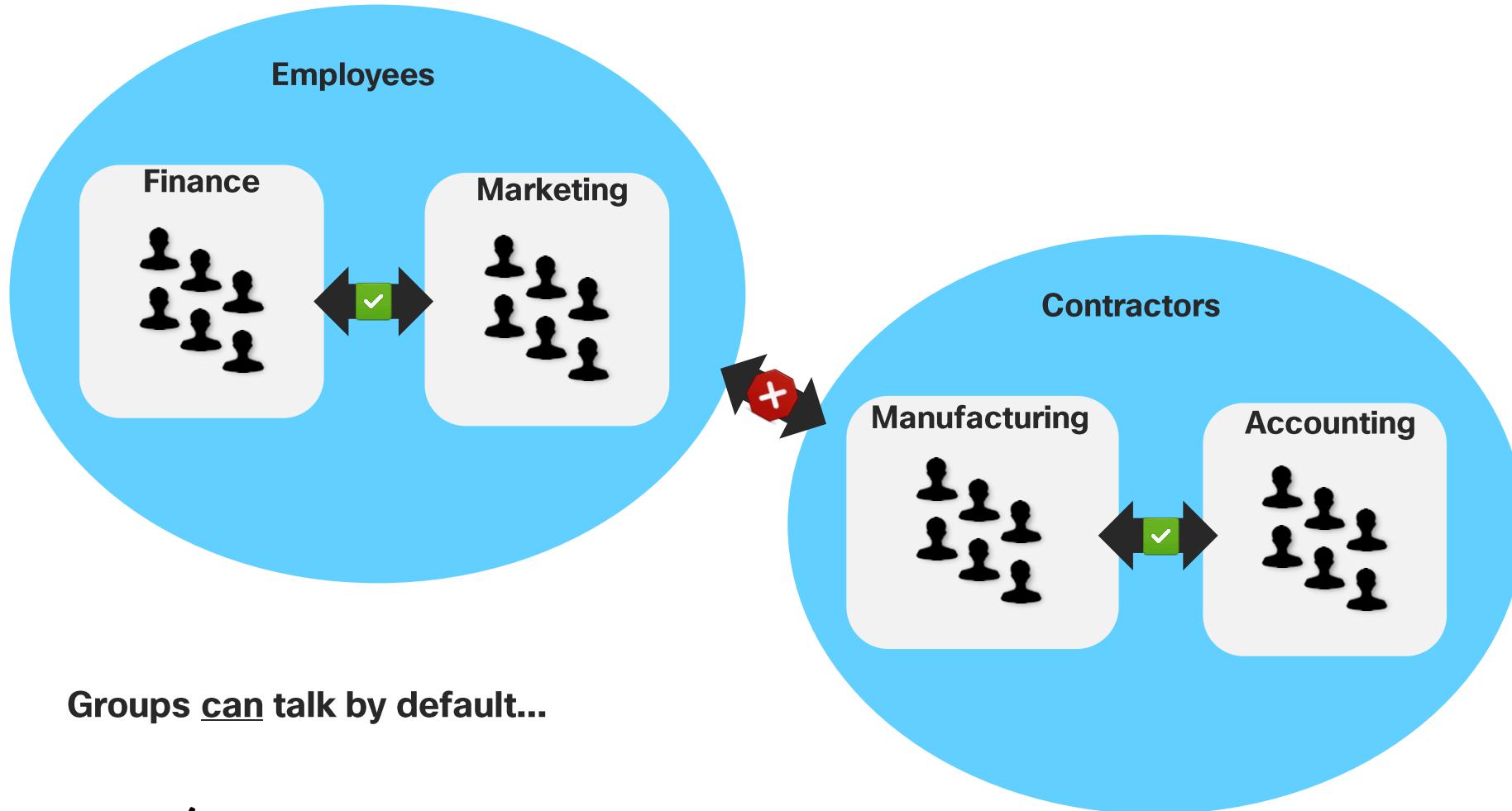
That group is a part of...

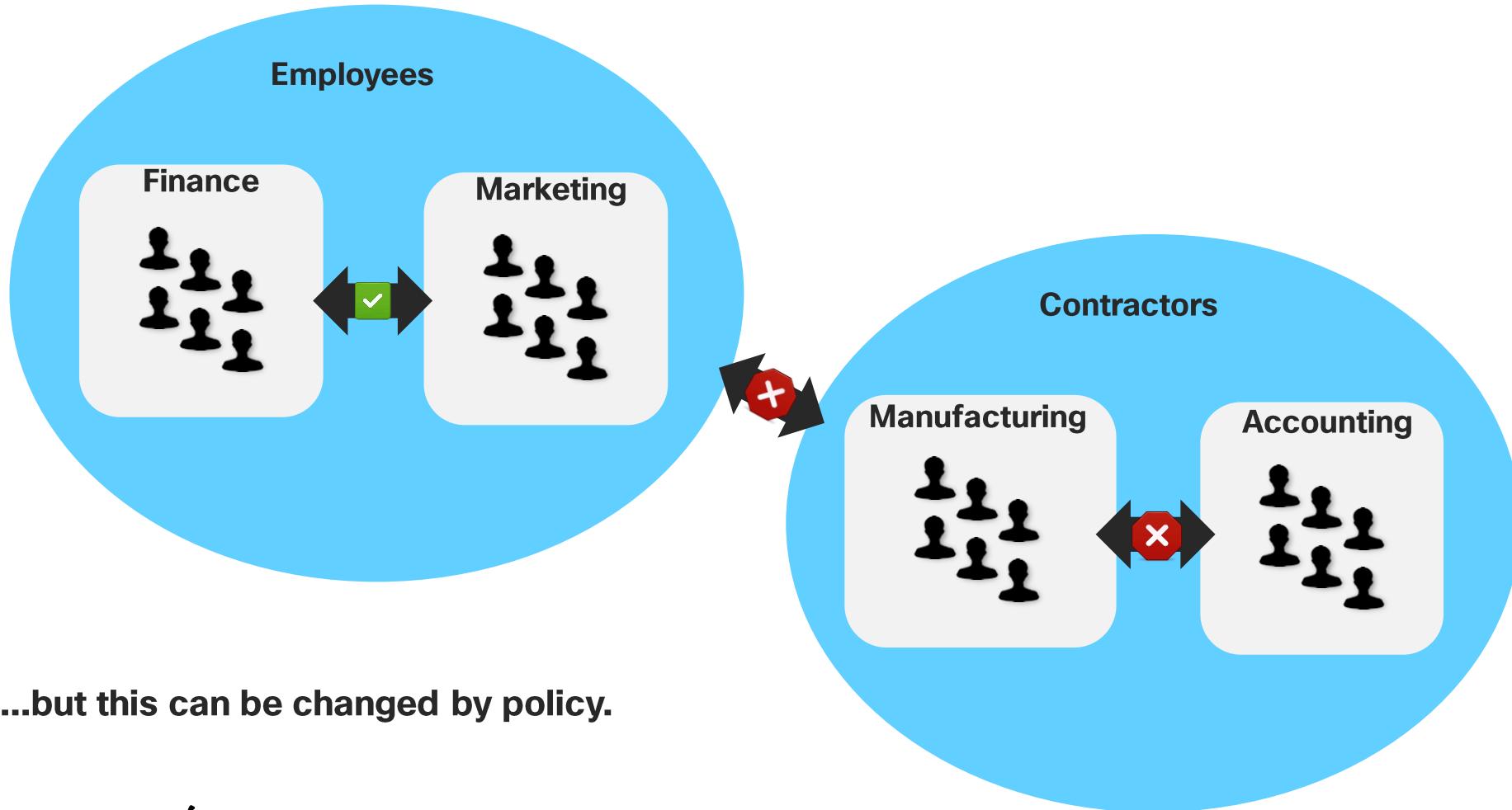




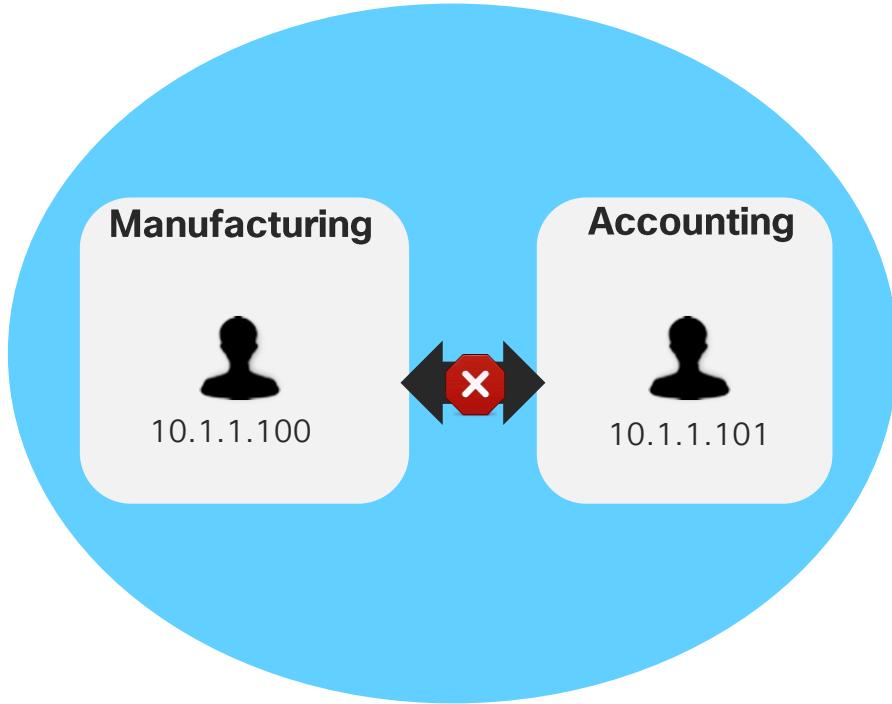
We can have multiple VNs



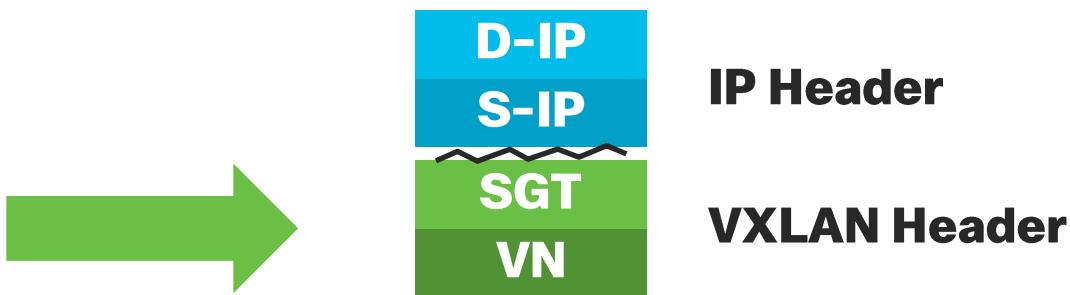


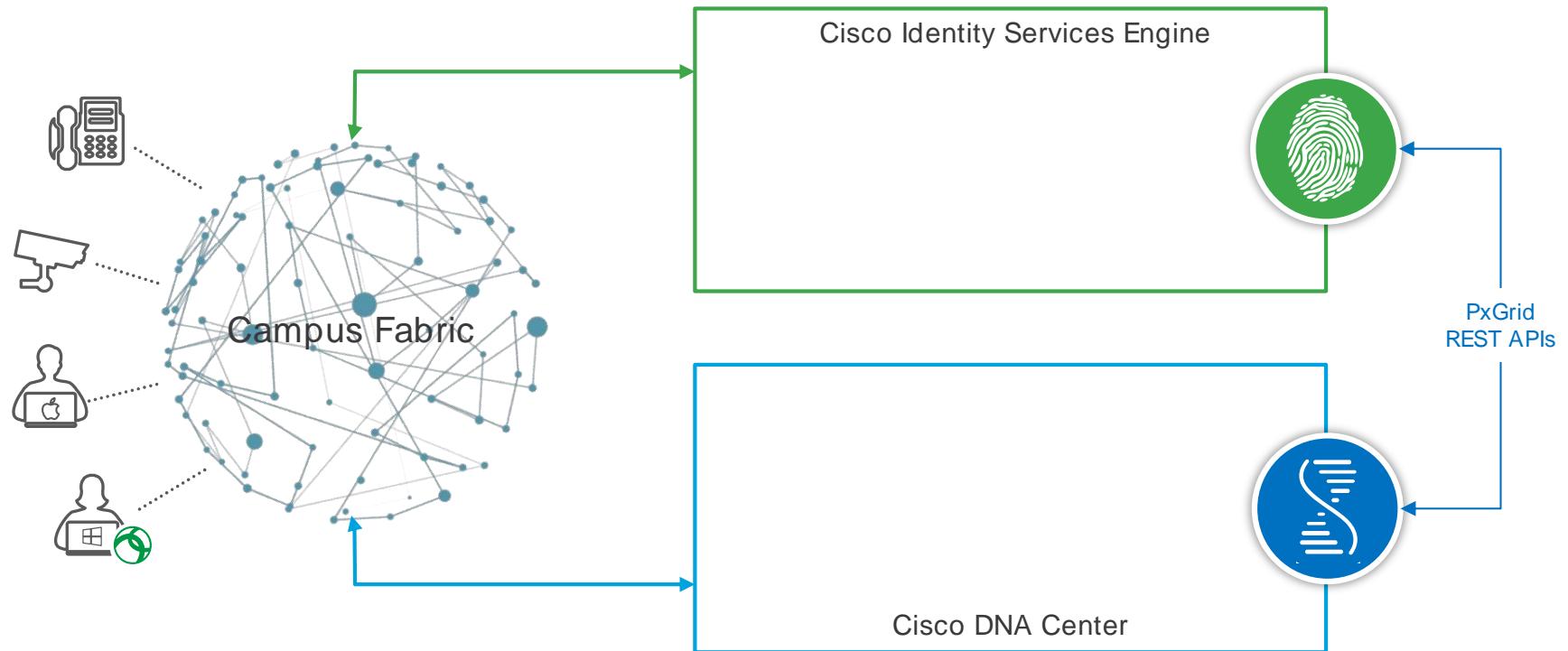


Even users in the **same subnet** can be prevented from communicating.



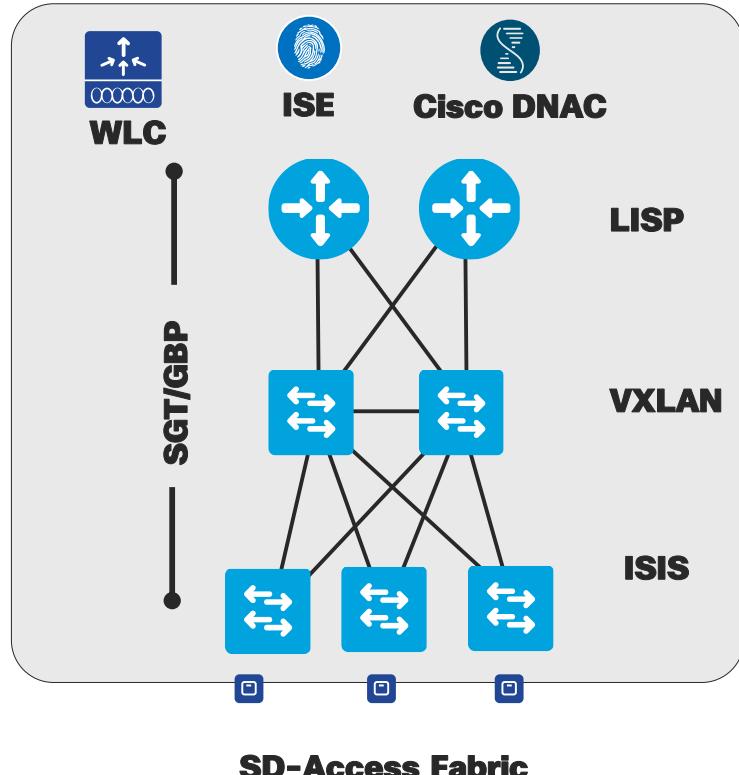
Policy is tied to VN and group, not IP address...



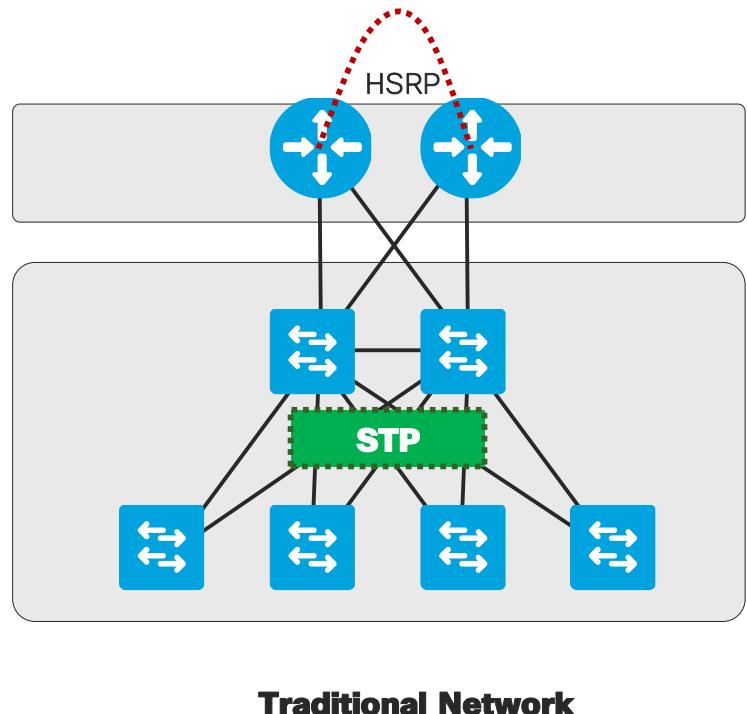


So what about the CCIE?

Is this less complicated...



...than this??



SD-Access, ACI, and other SDN techniques still rely on fundamental networking protocols and routing techniques.

Management: ISE, Cisco DNAC

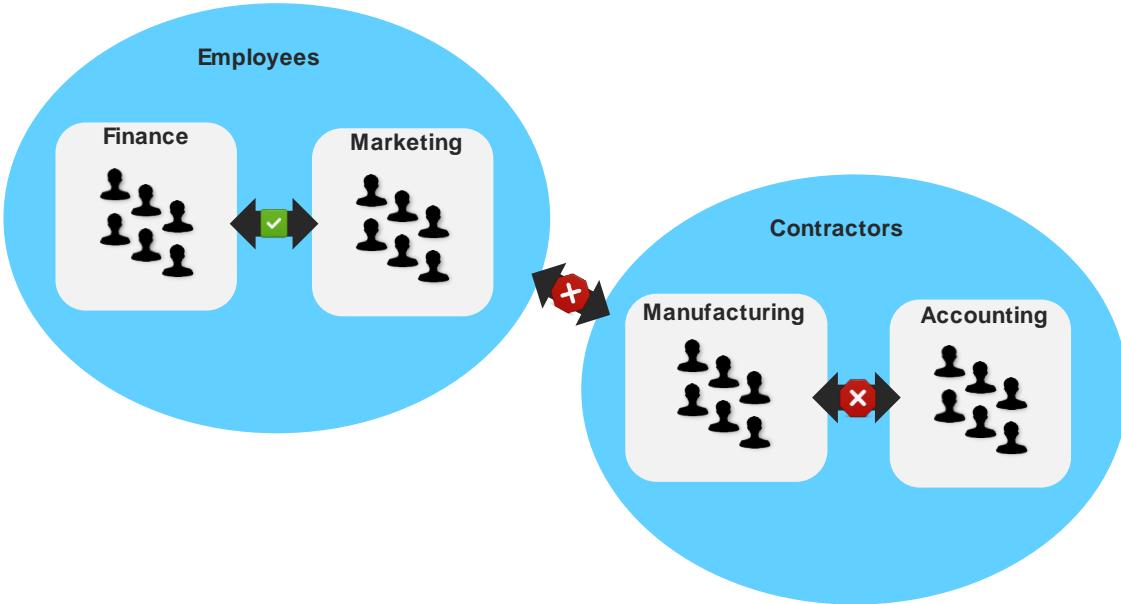
Policy Plane: VN/SGT

Control Plane: LISP

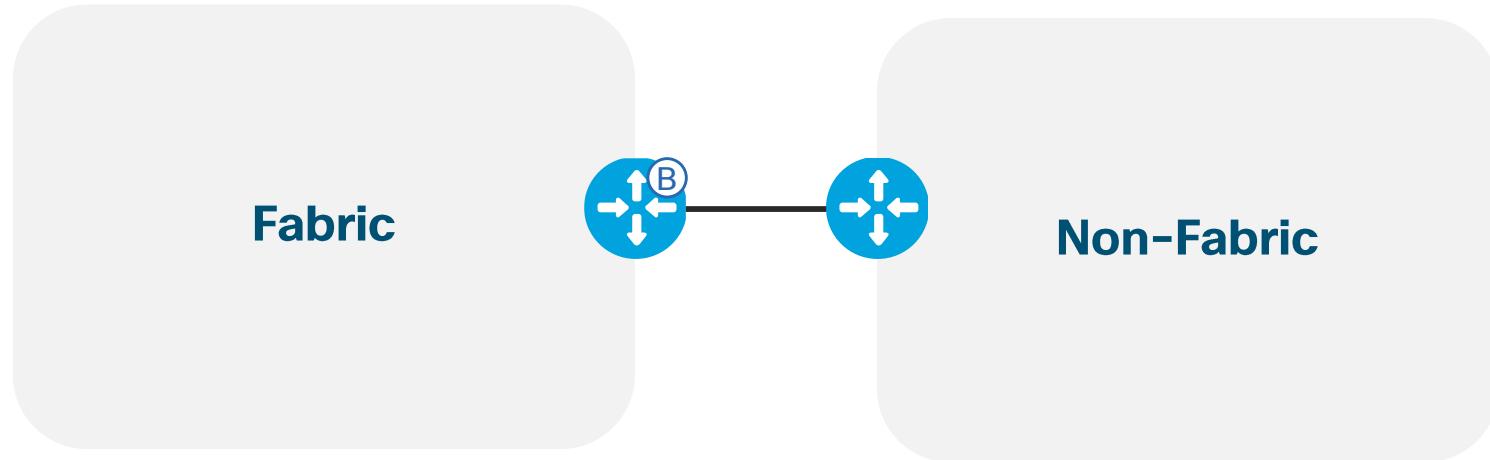
Routing Protocols: ISIS, BGP

IP, VXLAN

Ethernet



Complex policy constructs need skilled engineers to design.



Border hand-off and fusion routers require protocol expertise

The CCIE in an SDN world

**What we do is the same...
How we do it is different.**



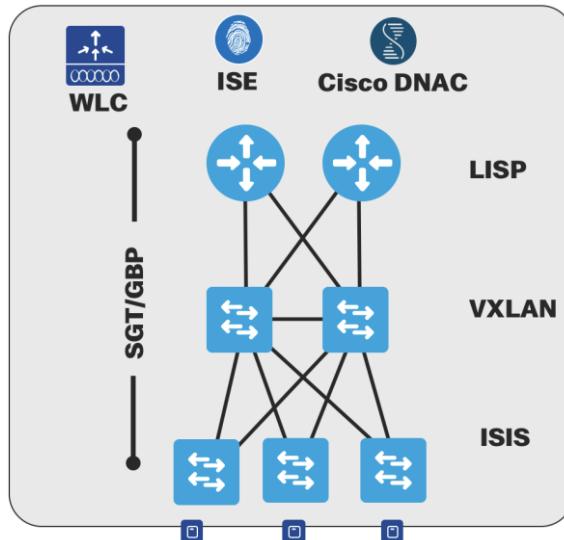


Complexity moving from box-level...



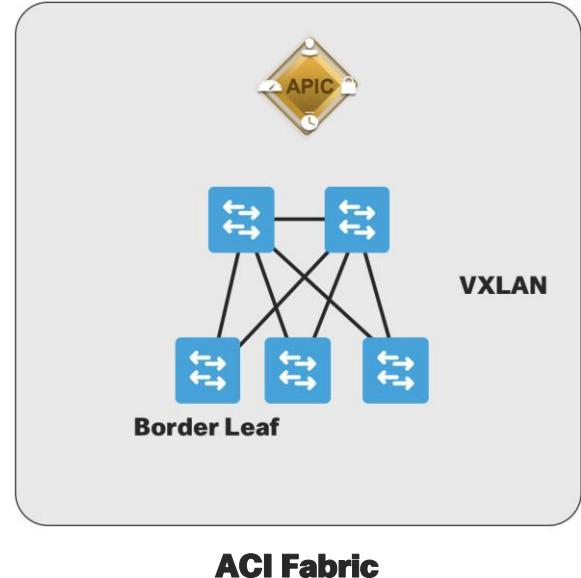
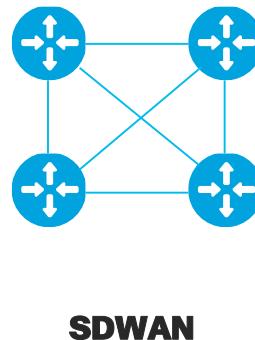
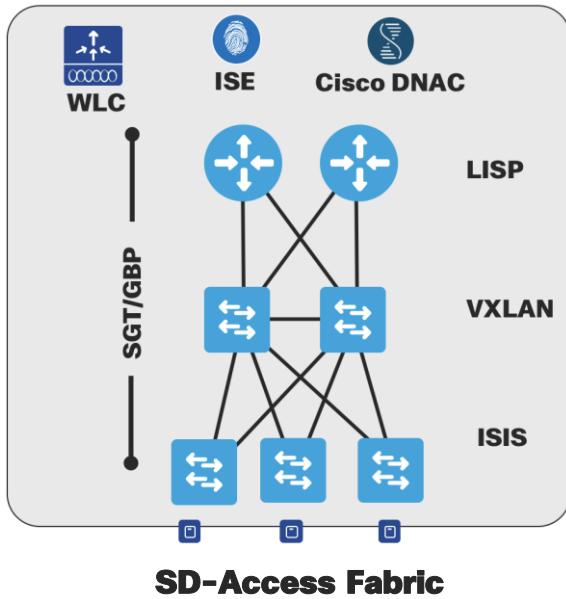
How do I configure BGP?
How do I configure NBAR?
How do I redistribute and tag routes?

...to solution level.



How do I design policy?
How do I connect fabric to non-fabric?

...to solution level.



How do I connect different domains/technologies?

The CCIE has survived automation systems before...

CCIE Security



FMC

CCIE Collaboration



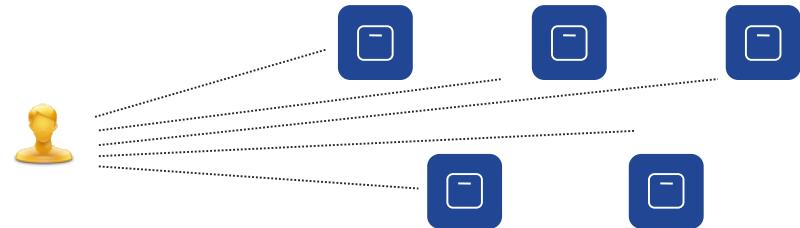
CUCM

CCIE Data Center

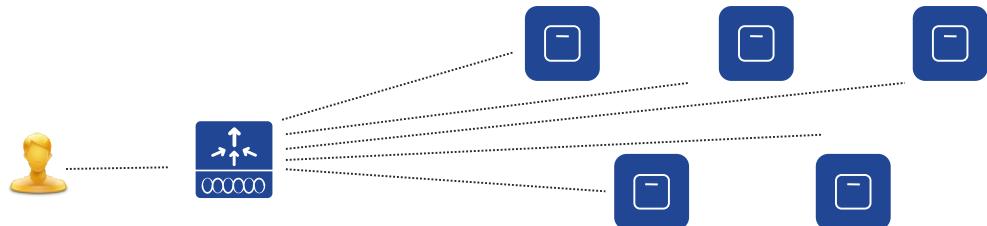


ACI

**We used to configure
wireless APs individually...**



**But now configure them
through a controller.**



Certification program futures

CCIE Evolving Technologies 1.1 Blueprint

This domain, worth 10 percent overall, ensures that all CCIE/CCDE candidates have a clear understanding of important cloud, network programmability, and IoT concepts.

A.1 Cloud

- A.1.b Describe cloud infrastructure and operations
- A.1.b.i Compute virtualization (containers and virtual machines)
- A.1.b.ii Connectivity (virtual switches, SD-WAN and SD-Access)
- A.1.b.iii Virtualization functions (NFVi, VNF, and L4/L1)
- A.1.b.iv Automation and orchestration tools (cloud center, Cisco DNA-center, and Kubernetes)

CCIE Evolving Technologies 1.1 Blueprint

This domain, worth 10 percent overall, ensures that all CCIE/CCDE candidates have a clear understanding of important cloud, network programmability, and IoT concepts.

A.2 Network Programmability

- A.2.a Describe architectural and operational considerations for a programmable network
 - A.2.a.i Data models and structures (YANG, JSON and XML)
 - A.2.a.ii Device programmability (gRPC, NETCONF and RESTCONF)
 - A.2.a.iii Controller based network design (policy driven configuration and northbound/southbound APIs)
 - A.2.a.iv Configuration management tools (agent and agent-less) and version control systems (Git and SVN)

How will the lab change?

Protocols will still be king

- ↳ APIs and SDN still require knowledge of core networking protocols
- ↳ Good luck troubleshooting SDN without understanding protocols

Warning: Personal (not official) thoughts

Expect new controllers (Cisco DNAC) on exam

- ↳ Just like ACI with data center, the exam will still be hard
- ↳ The CCIE program is conservative, so they'll do it when they're ready

Warning: Personal (not official) thoughts

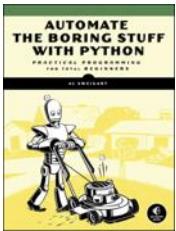
Expect some APIs or scripting on exam

- ↳ All this means is doing the same thing in a different way
- ↳ This is not a programming exam, so it won't be 100% API

Warning: Personal (not official) thoughts

What to do next?

Learn basic scripting



Automate the Boring Stuff with Python, Al Sweigart

Great introduction to Python focused on automation. (Not specifically network automation.) Covers Python 3.0 only. Assumes zero knowledge. Read Excel docs, generate PDFs, etc. Highly recommended.



Real Python. <http://realpython.com>

Three-part course. Begins with basics assuming no knowledge. Covers Python 2.7 and 3.0. Parts II and III focus on web development with Python. Covers flask, Django, jinja2 templates. Many resources on the web site for free.

Study APIs

<http://developer.cisco.com>

Get started with what DevNet has to offer



Learning Tracks



Video course



Sandbox

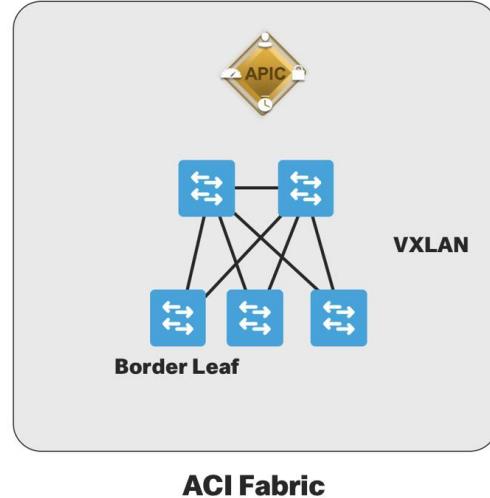
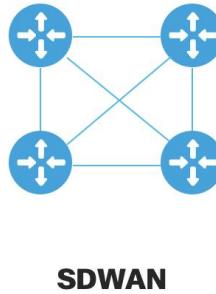
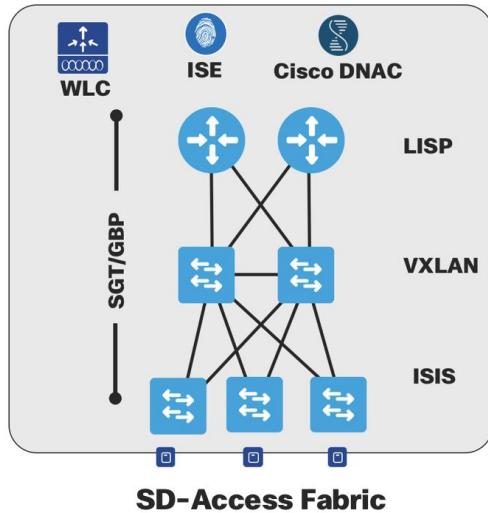


Code Exchange



Ecosystem Exchange

Develop solutions-level thinking



EN Booksprints

<http://cs.co/cat9000book>

<http://cs.co/sdabook>

<http://cs.co/programmabilitybook>

<http://cs.co/wirelessbook>

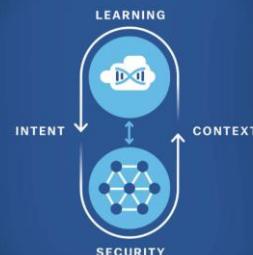
<http://cs.co/assurancebook>

Cisco Catalyst 9000
A New Era of Networking



cisco

Cisco Software-Defined Access
Enabling Intent-based Networking



IOS XE Programmability
Automating Device Lifecycle Management



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Cisco Enterprise Wireless
Intuitive Wi-Fi Starts Here

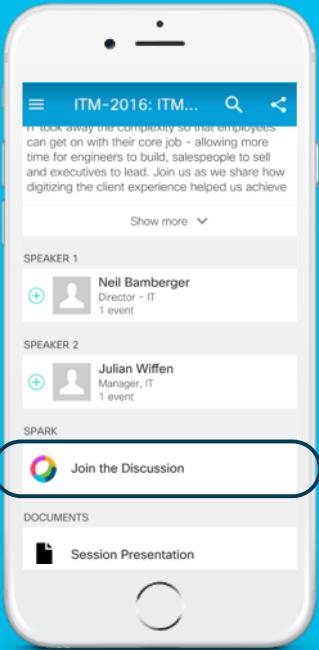


cisco

Cisco DNA Assurance
Unlocking the Power of Data



cisco



Cisco Webex Teams



Questions?

Use Cisco Webex Teams (formerly Cisco Spark) to chat with the speaker after the session

How

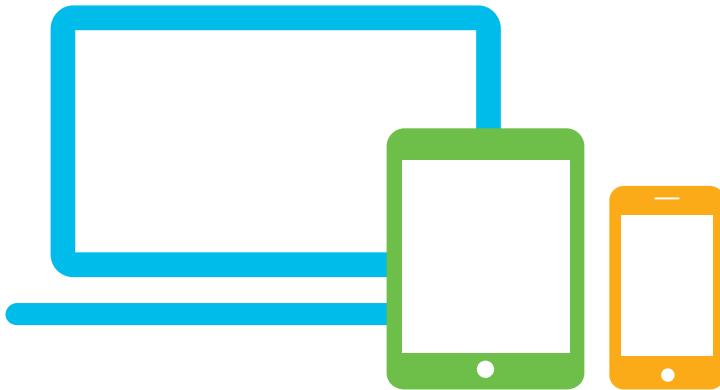
- 1 Find this session in the Cisco Events Mobile App
- 2 Click “Join the Discussion”
- 3 Install Webex Teams or go directly to the team space
- 4 Enter messages/questions in the team space

cs.co/ciscolivebot#BRKCRT-3075

Complete your online session survey

- Please complete your Online Session Survey after each session
- Complete 4 Session Surveys & the Overall Conference Survey (available from Thursday) to receive your Cisco Live T-shirt
- All surveys can be completed via the Cisco Events Mobile App or the Communication Stations

Don't forget: Cisco Live sessions will be available for viewing on demand after the event at [ciscolive.cisco.com](https://cisco.com/ciscolive)



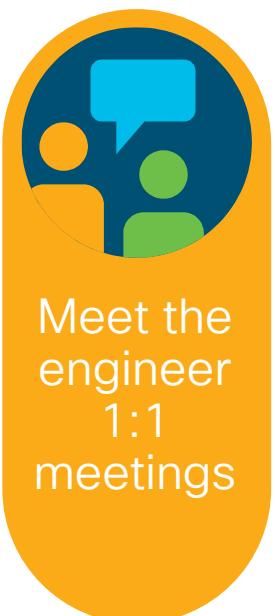
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Thank you

Cisco *live!*



INTUITIVE



INTUITIVE