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#CiscoLive

The bridge to possible

Troubleshooting 5G Architectures

Ravi Narahari, Sr. Technical Leader, Darth Vader’s Mentor

BRKSPG-2040

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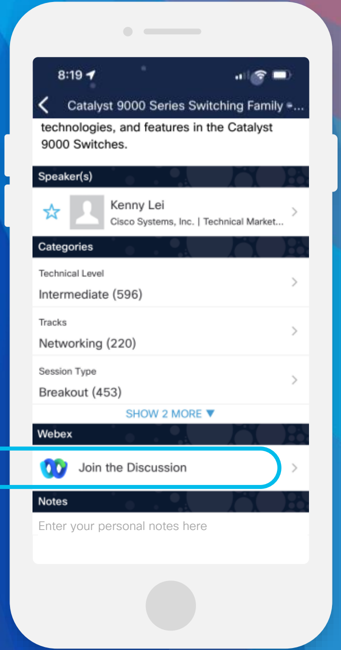

8:19

Catalyst 9000 Series Switching Family ...

technologies, and features in the Catalyst 9000 Switches.

Speaker(s)

Kenny Lei
Cisco Systems, Inc. | Technical Market...

Categories

Technical Level
Intermediate (596)

Tracks
Networking (220)

Session Type
Breakout (453)

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Webex

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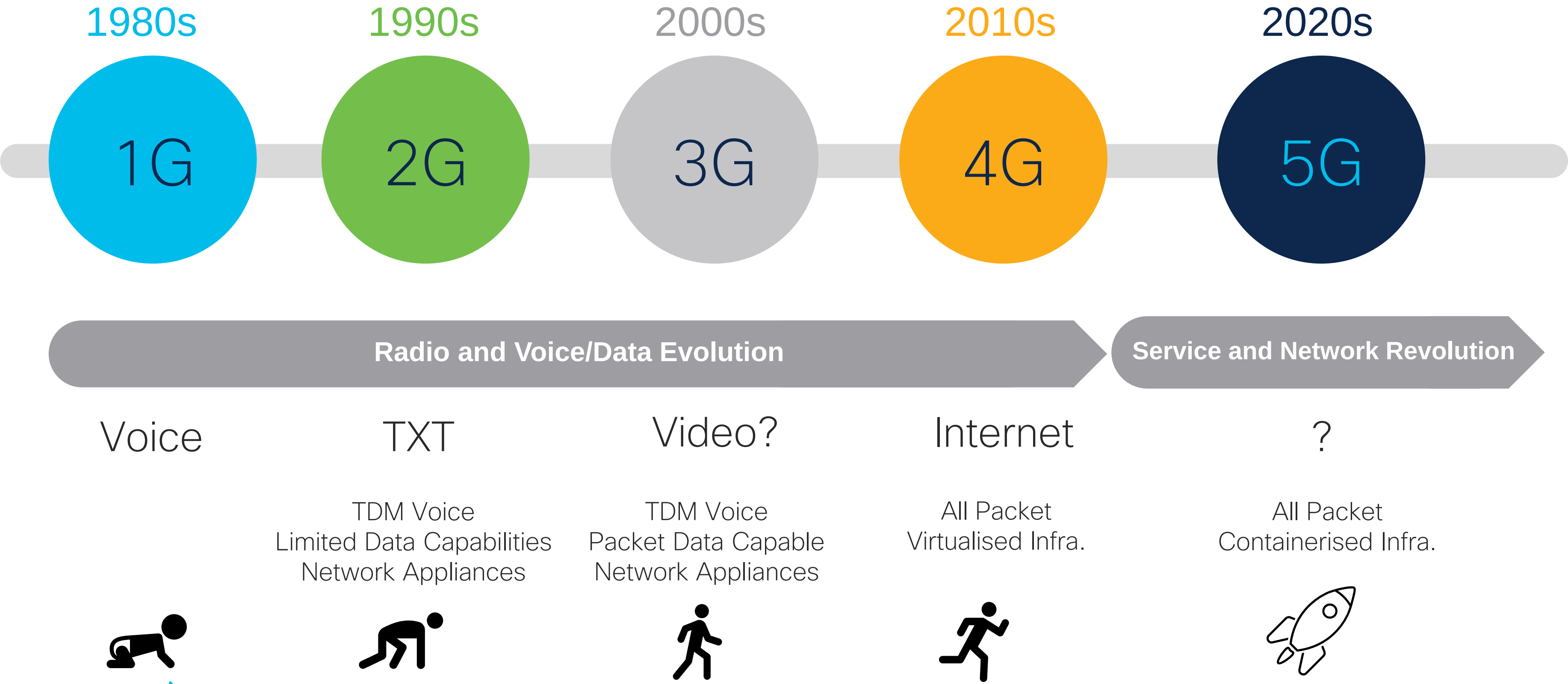
cisco Live!

Agenda

- 5G Technology Summary
- Cloud
- Investigating where is 5G Network Broken
- IP Transport
- Debugging case studies
- Wrap Up

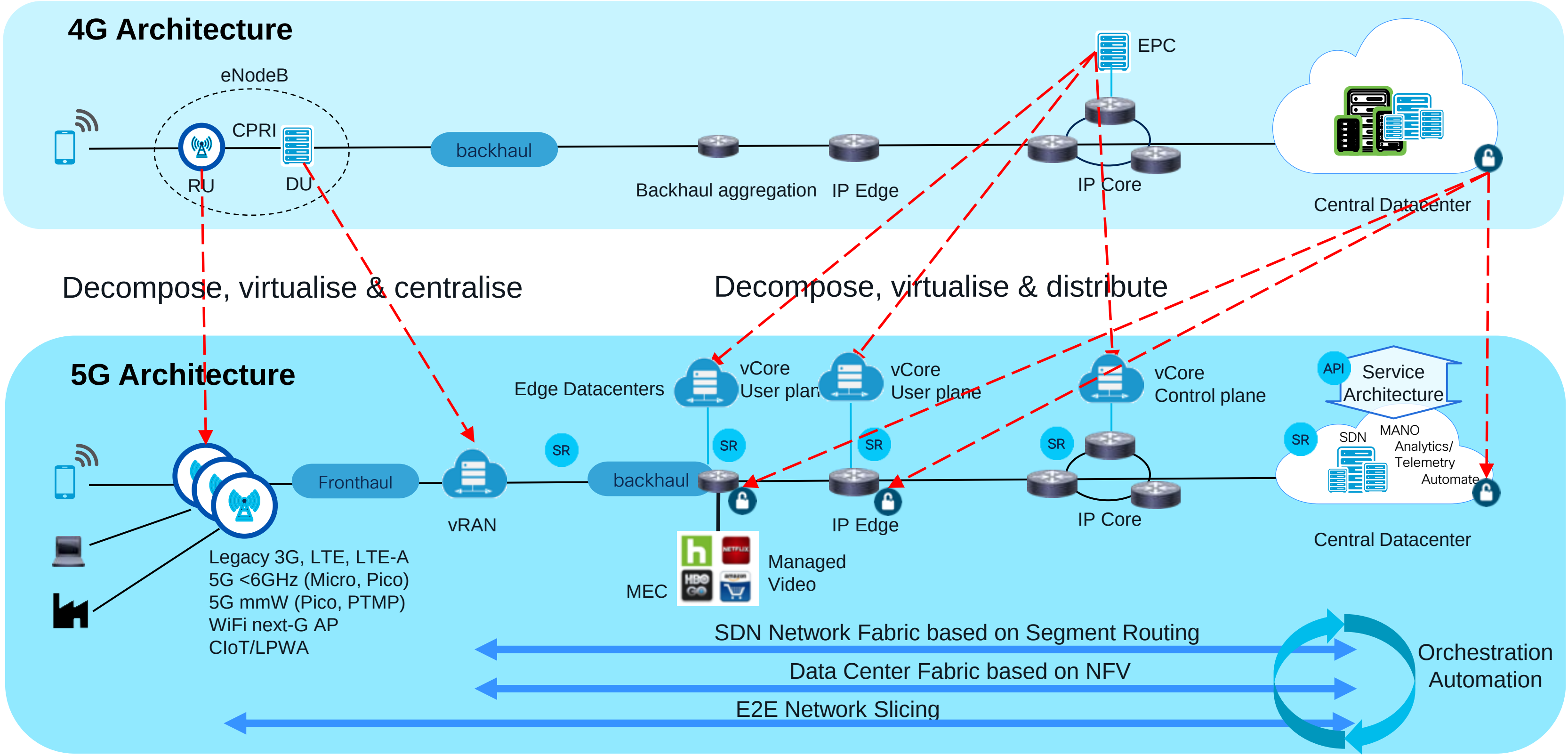
5G Technology Summary

5G is Packet switched. More IP Troubles ?



1980s	1990s	2000s	2010s	2020s
1G	2G	3G	4G	5G
Radio and Voice/Data Evolution				Service and Network Revolution
Voice	TXT	Video?	Internet	?
	TDM Voice Limited Data Capabilities Network Appliances	TDM Voice Packet Data Capable Network Appliances	All Packet Virtualised Infra.	All Packet Containerised Infra.

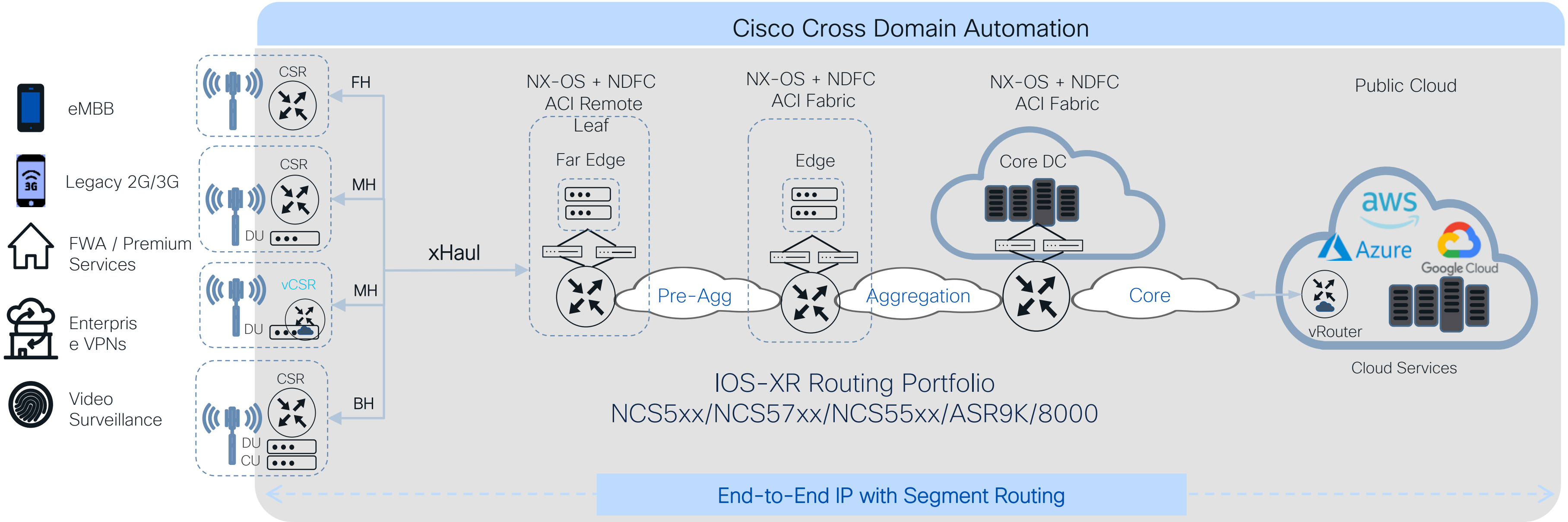
Architecture Evolution



Not all greenfield – Evolution path

- Operators have existing transport networks and services
- 5G services support is/will be added together with existing services
- The architecture needs to support brownfield scenarios
  - Converge of multi-services on common network infrastructure is a key requirement to reduce infrastructure costs and simplify operations
  - There is a need to support legacy interfaces (CPRI) and the industry recognizes such requirement:
    - IEEE specified Radio over Ethernet technology (RoE)
    - ORAN Alliance WG-7 developed the specifications for Fronthaul Gateway Interworking Function
    - Cloud and non cloud architecture

Reference 5G Converged Architecture During Trouble shooting



Cisco Cross Domain Automation

eMBB

Legacy 2G/3G

FWA / Premium Services

Enterprise VPNs

Video Surveillance

CSR

CSR

DU

vCSR

DU

CSR

DU

CU

FH

MH

MH

BH

xHaul

NX-OS + NDFC
ACI Remote Leaf

Far Edge

NX-OS + NDFC
ACI Fabric

Edge

NX-OS + NDFC
ACI Fabric

Core DC

Public Cloud

aws

Azure

Google Cloud

vRouter

Cloud Services

Pre-Agg

Aggregation

Core

IOS-XR Routing Portfolio
NCS5xx/NCS57xx/NCS55xx/ASR9K/8000

End-to-End IP with Segment Routing

Issues may be in any of this eco system

Optimized for Multi-Service Environments
(2G, 3G, 4G, 5G, FWA, Enterprise, Greenfield, Brownfield)

Flexible and programmable architecture

Precise network-based timing and synchronization

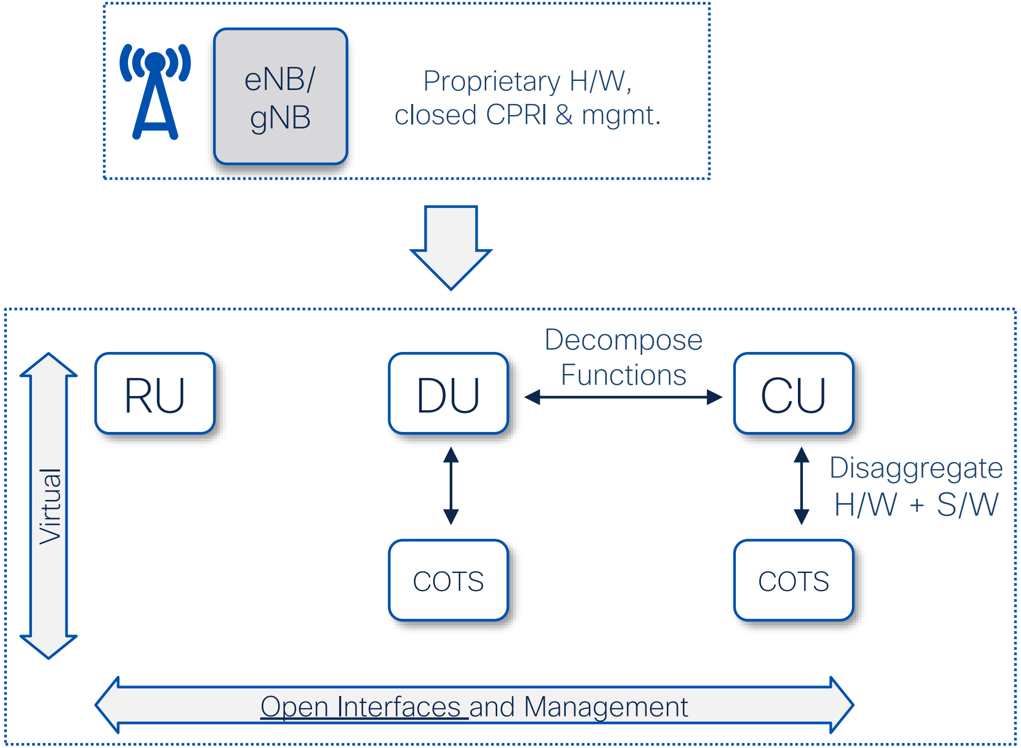
Seamless integration across Transport, DC and Cloud

Consistent QoS and Service Performance

Open, automated, centralized management at scale

Cloud

Open RAN – VNF, Containers – what's Broken ?

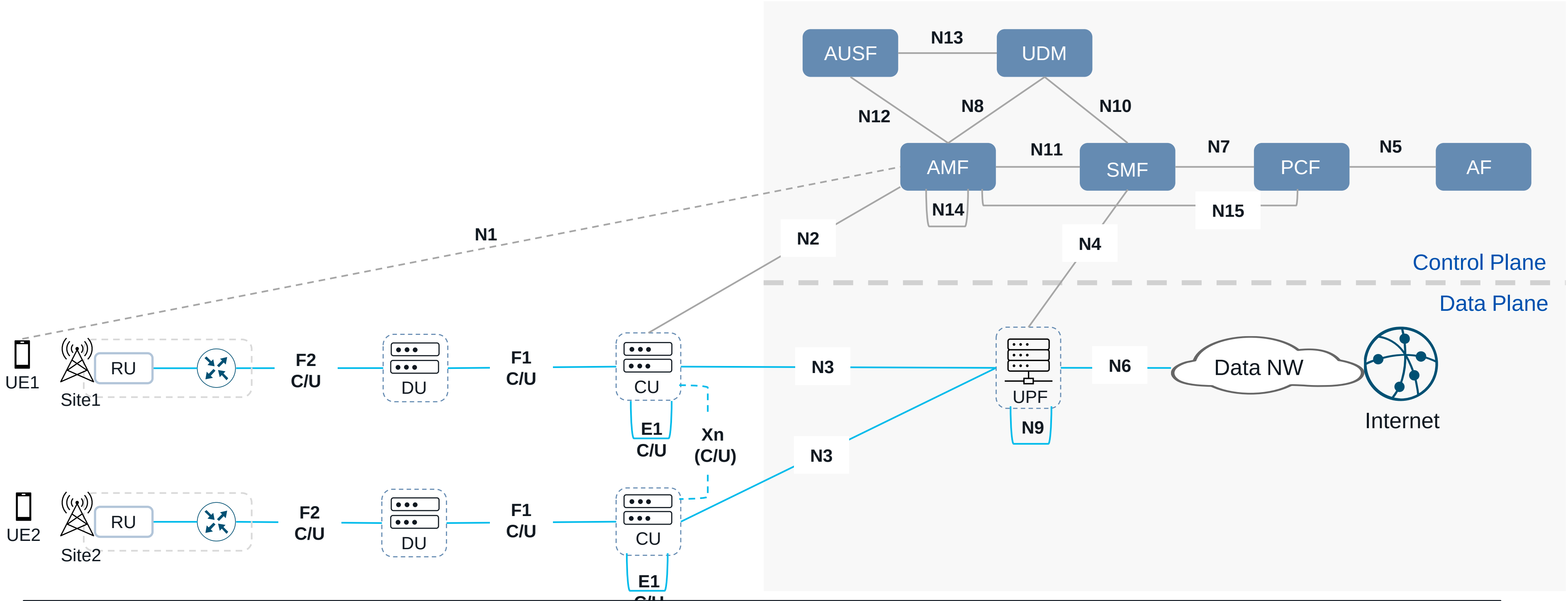


- Open interfaces with vendor diversity
- Disaggregated software, cloud-based models

RU: Radio Unit
DU: Distributed Unit
CU: Centralized Unit

COTS: Commercial Off-The-Shelf
(support challenges)

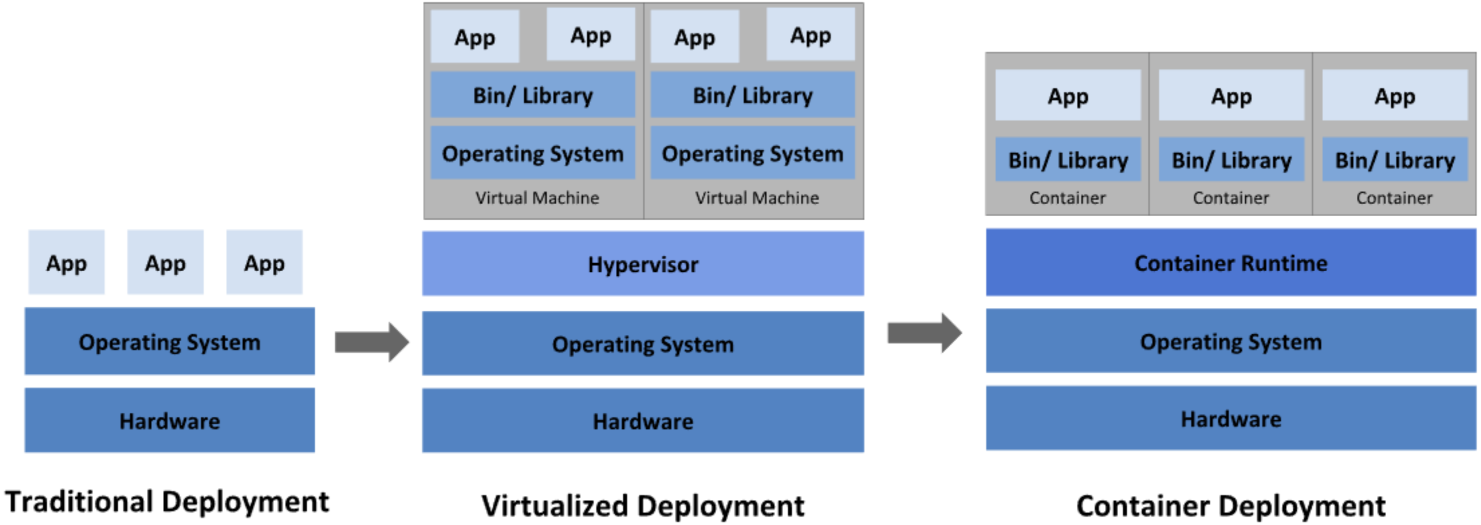
Start at RAN and then 5G Core Interfaces if Problem not Obvious



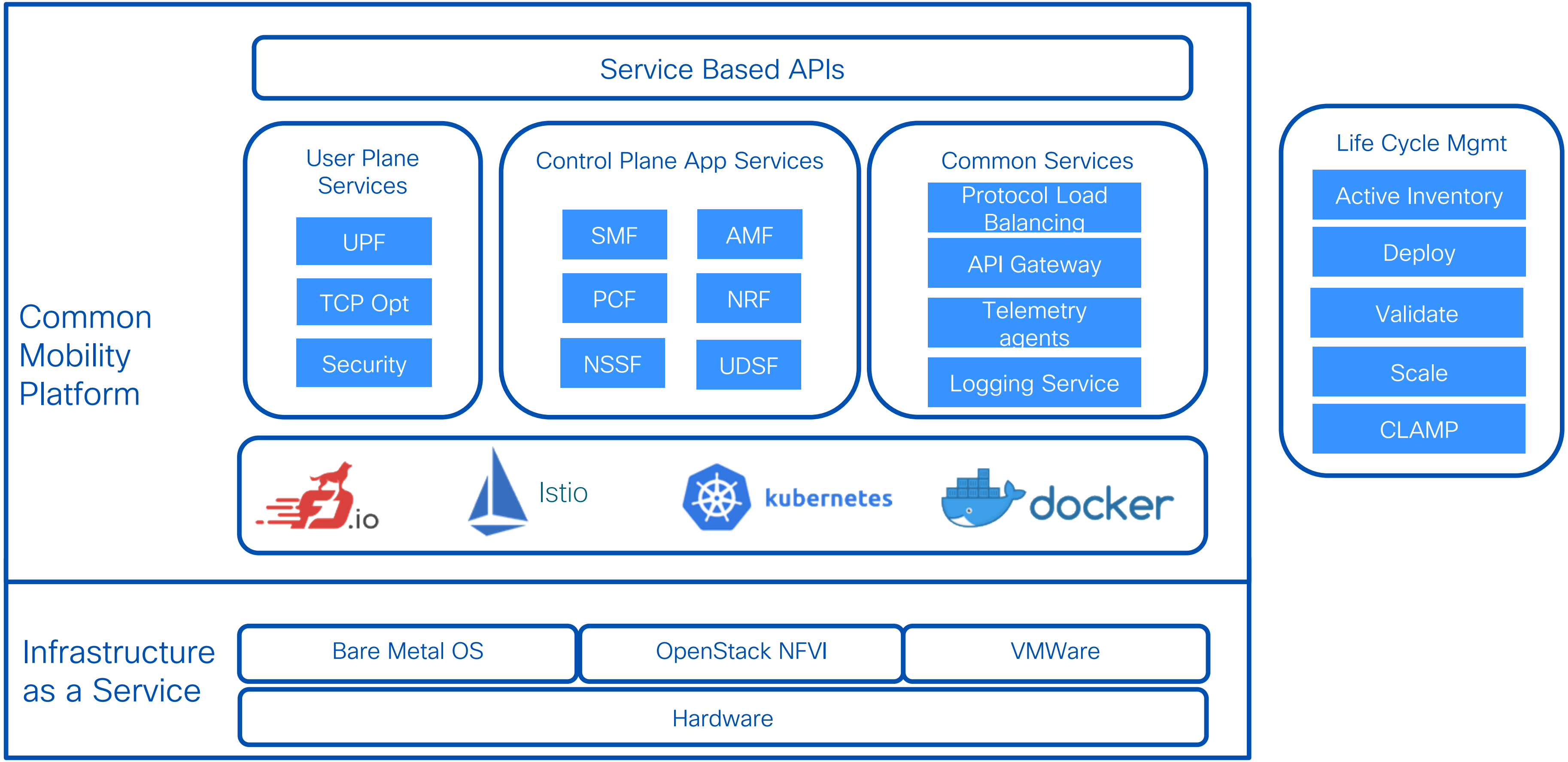
Start from left to right, RU to DU etc..

Kubernetes Overview

Traditional -> Virtual Machine -> Container as time goes by...



Cisco Cloud Native Architecture for Mobile Core



Service Based APIs

Common Mobility Platform

User Plane Services
- UPF
- TCP Opt
- Security

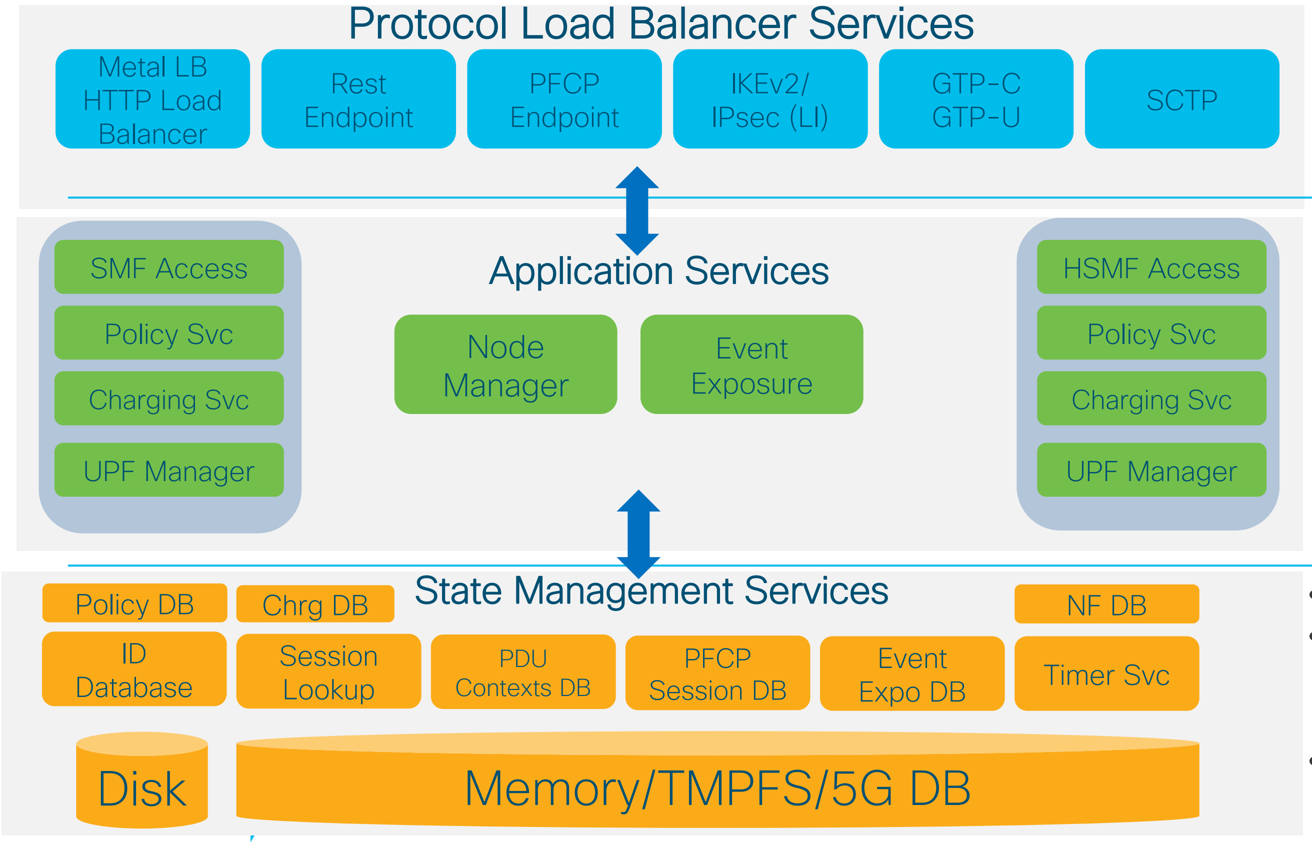
Control Plane App Services
- SMF
- AMF
- PCF
- NRF
- NSSF
- UDSF

Common Services
- Protocol Load Balancing
- API Gateway
- Telemetry agents
- Logging Service

Life Cycle Mgmt
- Active Inventory
- Deploy
- Validate
- Scale
- CLAMP

Infrastructure as a Service
- Bare Metal OS
- OpenStack NFVI
- VMWare
- Hardware

Cloud Native Application Architecture / Micro Services



- Dynamic Discovery of application containers
- Protocol proxy and/or termination, e.g., Diameter, GTP, HTTP2

- Core application/business logic
- Varying degrees of Microservice granularity
- Native scale out and upgrade
- Stateless services

- State separation layer
- Supports different data storage technologies – in memory caches to full fledge DBs
- Scale out technologies

CEE pod list (Cisco Specific)

- ”Common Execution Environment” combines all the applications and services that are used by all network functions (such as logging, alerting, collecting of statistics etc.)
- Output on right is derived from command
  “kubectl get pods -n cee-global -o wide”
- Pods marked with “*” in the node column run on all nodes (shortened here for visibility)

```
NAME
READY   NODE
alert-logger-74446c8fd6-9krdt        1/1
oam-2
alertmanager-0                        1/1
oam-2
alertmanager-1                        1/1
oam-3
alertmanager-2                        1/1
oam-1
```

Verify Status – NSSF, AMF

```
root@198:~/conf# kubectl get pods -n nssf -o wide

NAME                                                              READY     STATUS
RESTARTS   AGE       IP              NODE
activemq-0                                                        1/1
Running   0          3d       10.42.0.73      worker2

root@198:~/conf# kubectl get pods -n amf -o wide
NAME                                                        READY     STATUS
RESTARTS   AGE       IP              NODE
amf-amf-documentation-documentation-5fbb577548-srddh        1/1       Running   0
2d        10.43.128.120   worker6
amf-amf-pats-executor-6bf4d7bc4d-gncfb                      1/1       Running   0
2d        10.33.0.59      worker1
amf-amf-pats-repo-ff988f847-7nd2b                           1/1       Running   0
```

Ensure to look for status Pending

```
master1:~$ kubectl get pod -A -o wide | grep -i pending
```

Session Establishment between SMF & UPF

```
[local]POD7-UP# show sx peers <truncated output>

Wednesday April 24 16:30:18 EDT 2019

+---Node Type:    -€ - CPLANE       (-) - UPLANE
|
|+--Peer Mode:    (-) - Active       (-) - Standby
|
||+-Association   (-) - Idle         (-) - Initiated
||| State:        (-) - Associated   (-) - Releasing
|||               (-) - Released
Recovery         |    Current    Max       Peer
vvvvv  v       Group Name               Node ID                Peer ID       Timestamp
v   Sessions  Sessions    State
----- ---- -------------------- ------------------------------ ---------- -------------
------ ---- --------- --------- ---------
CAAND 5    ingress              198.18.134.13                    33554434   2019-04-
24:15:57:10 1    0         0         ACTIVE


Total Peers:    1

[local]POD7-UP#
```

Interface Specific Error codes

- smf-rest-ep logs for smf-ims : | Interface n11 | Count Error Code Transaction Log | 175 404 N11N1N2MessageTransferReq(19) Received N1N2 response error - status code: 404 | 54 403 N11N1N2MessageTransferReq(19) Received N1N2 response error - status code: 403 | 5 404 N11EbiAssignmentReq(22) Received Assign Ebi Response error - status code: 404
- Interface n10 | Count Error Code Transaction Log | 1843 404 N10UnsubscribeForNotificationReq(222) Received Unsubscribe-to-Notification response error - status code: 404 | 895 404 N10SubscriptionFetchReq(36) Received sm subscription response error - status code: 404 | 288 404 N10DeregistrationRequest(45) Received deregistration response error - status code: 404 | 6 500 N10DeregistrationRequest(45) Received deregistration response error - status code: 500 | 6 500 N10RegistrationRequest(33) Received registration response error - status code: 500
- Interface n40 | Count Error Code Transaction Log | 289 404 N40ChargingDataReq(63) Received Charging Data Response error - response status code: 404 | 221 410 N40ChargingDataReq(63) Received Charging Data Response error - response status code: 410
- Interface n7 | Count Error Code Transaction Log | 5 404 N7SmPolicyDeleteReq(54) Received sm policy control delete error - response status code: 404 |

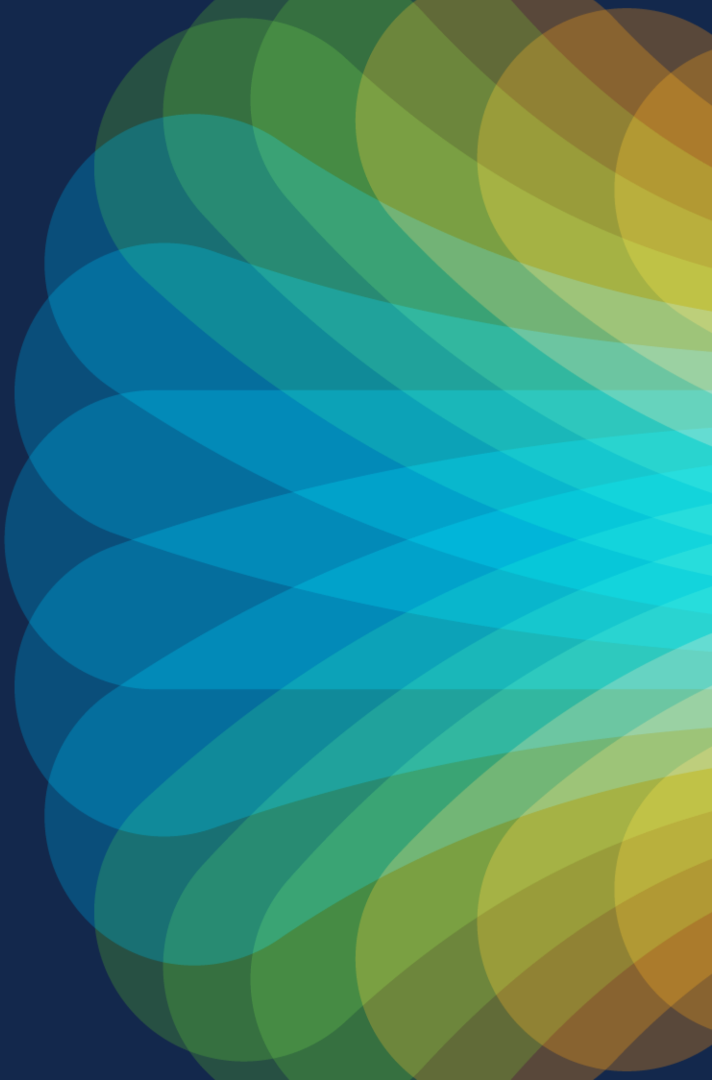
SMF – IMS Logs

- 4445 Error Message : Session not found
- 4318 [ERROR] [smf-service.smf-app.messageprocessor] Timer EventId = [0], Timer Type = [UnknownTimer]
- 1702 Error Message : 403 : Key not found in indexing
- 1702 [ERROR] [MasterBlueprint.go:426] [infra.transaction.core] Error deleting session [DatastoreDelete] 403 : Key not found in indexing
- 1665 [ERROR] [SessionTimer.go:157] [smf-service.smf-app.gen] RemoveTimer: Unable to Delete timer type [11] but has valid handle
- 1289 [ERROR] [smf-service.smf-app.udm] UDM Subscription Fetch Failure | 1289 [ERROR] [smf-service.smf-app.sgw] UDM Subscription Fetch Failure

Kubernetes - Check all the namespace created

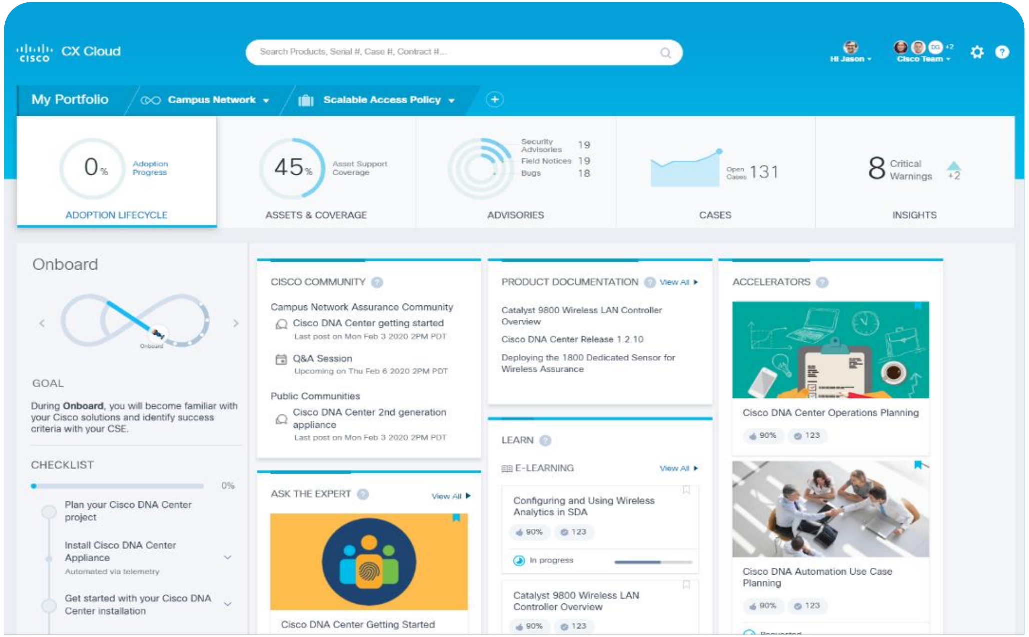
-
  ```
  root@198:~# kubectl get ns
  NAME STATUS AGE
  amf Active 3d
  base Active 203d
  cnee Active 3d
  default Active 206d
  helm Active 105d
  kube-public Active 206d
  kube-system Active 206d
  nrf Active 3d
  nssf Active 3d
  pcf Active 3d
  smf Active 3d
  ```

Where is 5G Network Broken ?



Approach to Troubleshooting – Blame Game

- First thing to know is what is broken
- Logically look for issues as a stack – Mobile or IP
- HW and SW defects
- Line of sight
- Radio
- Mobile core
- IP Transport



Onboard

GOAL

During **Onboard**, you will become familiar with your Cisco solutions and identify success criteria with your CSE.

CHECKLIST 0%

- Plan your Cisco DNA Center project
- Install Cisco DNA Center Appliance
  Automated via telemetry
- Get started with your Cisco DNA Center installation

CISCO COMMUNITY

Campus Network Assurance Community

Cisco DNA Center getting started
Last post on Mon Feb 3 2020 2PM PDT

Q&A Session
Upcoming on Thu Feb 6 2020 2PM PDT

Public Communities

Cisco DNA Center 2nd generation appliance
Last post on Mon Feb 3 2020 2PM PDT

PRODUCT DOCUMENTATION

Catalyst 9800 Wireless LAN Controller Overview

Cisco DNA Center Release 1.2.10

Deploying the 1800 Dedicated Sensor for Wireless Assurance

ACCELERATORS

Cisco DNA Center Operations Planning

Cisco DNA Automation Use Case Planning

ASK THE EXPERT

Cisco DNA Center Getting Started

LEARN

E-LEARNING

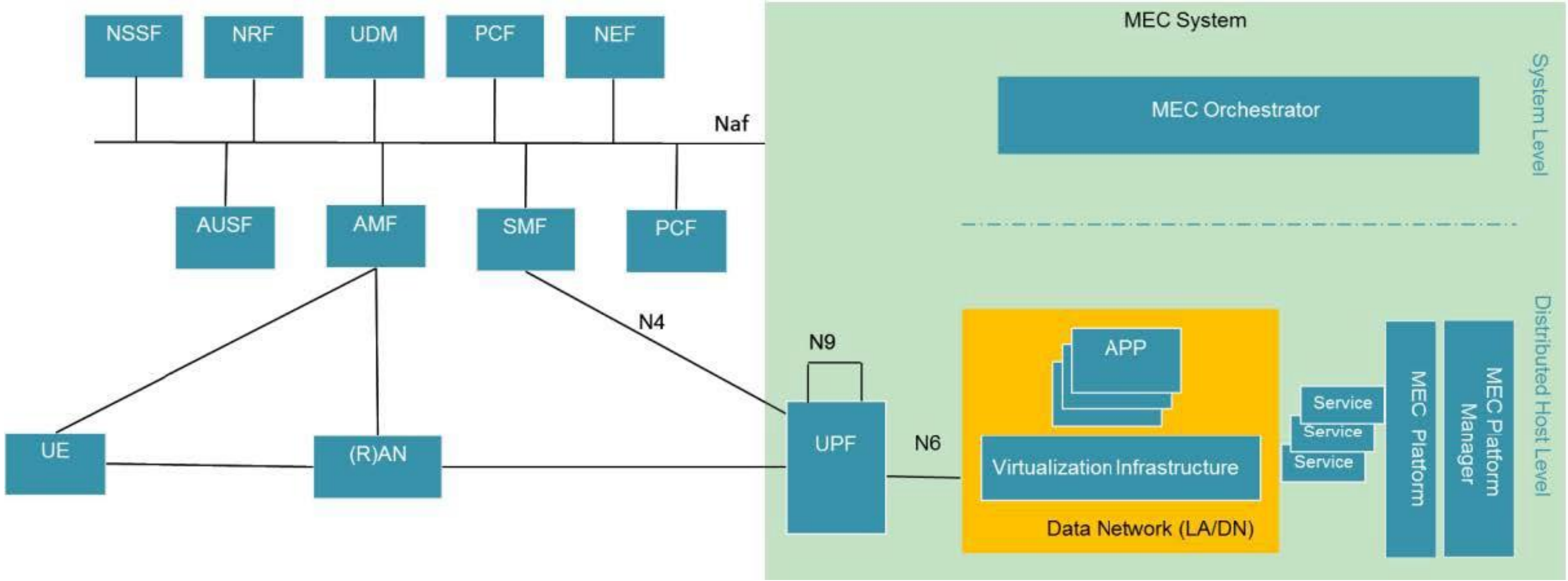
Configuring and Using Wireless Analytics in SDA

Catalyst 9800 Wireless LAN Controller Overview

Approach to Troubleshooting – Ask the questions

- UE – 5G SoC ? – Handset / Device 5G capability
- NSA , SA ? – 4G CP and 5G UP
- Inline CUPS
- Apps – PAS, PCF
- Through put issues
- Data leak
- NR side / Xhual / 5G Core

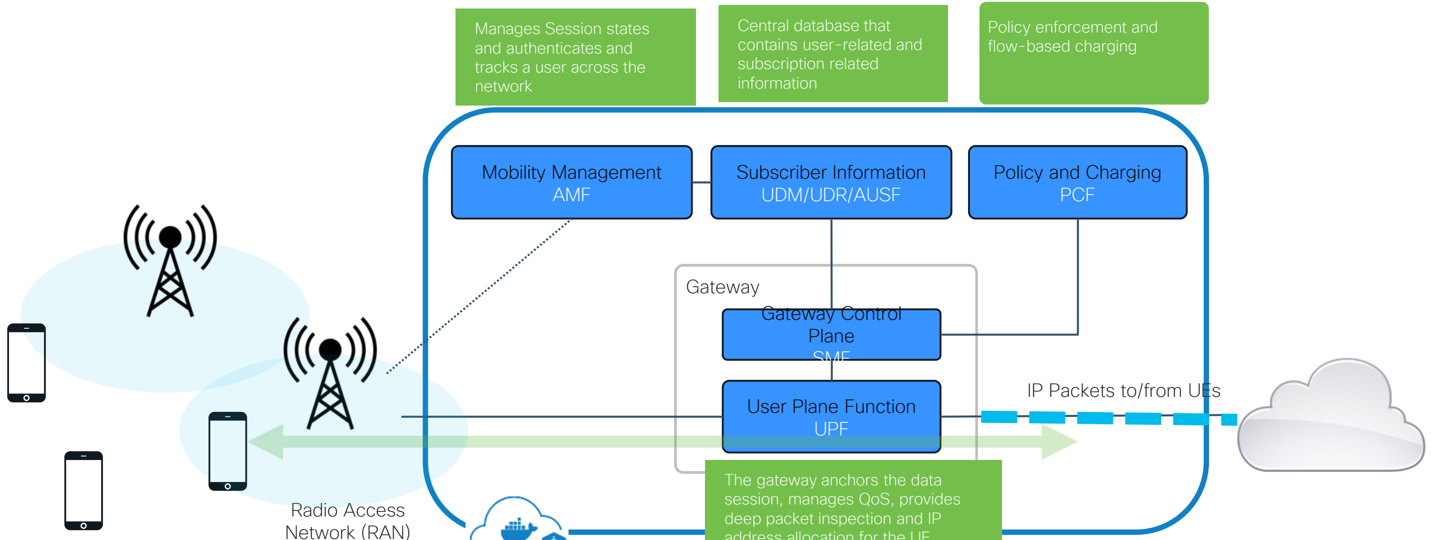
MEC in 5G – Content, Latency, Thruput ?



5G nodes are CNFs!

- Some MEC nodes will be cloud-native as well
- Edge DC platform will have to accommodate both VNFs and CNFs

5G Core Issues – Think of APIs, Kubernetes ? – end points, tls not matching, version mismatch



Manages Session states and authenticates and tracks a user across the network

Central database that contains user-related and subscription related information

Policy enforcement and flow-based charging

The gateway anchors the data session, manages QoS, provides deep packet inspection and IP address allocation for the UE. The gateway is split into a control plane and user plane function. Enabling the User plane to be deployed remotely from the control plane

User Equipment (UE)

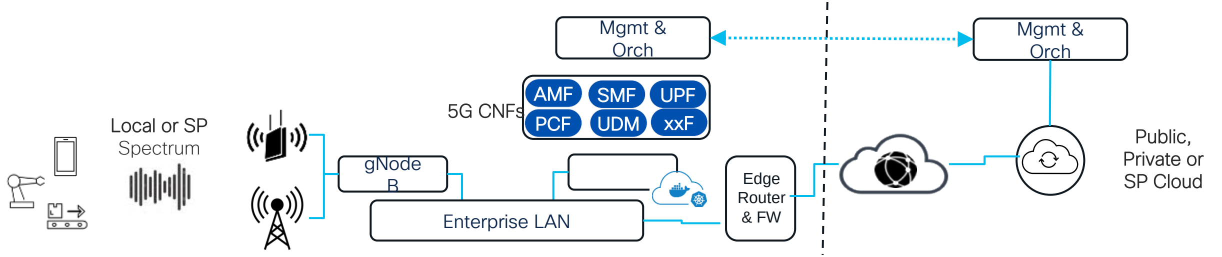
UPF	User Plane Function
SMF	Session Management Function
AMF	Access & Mobility Function
AUSF	Authentication Server Function
UDM	User Data Management
UDR	User Data Repository
PCF	Policy Control Function

Infrastructure

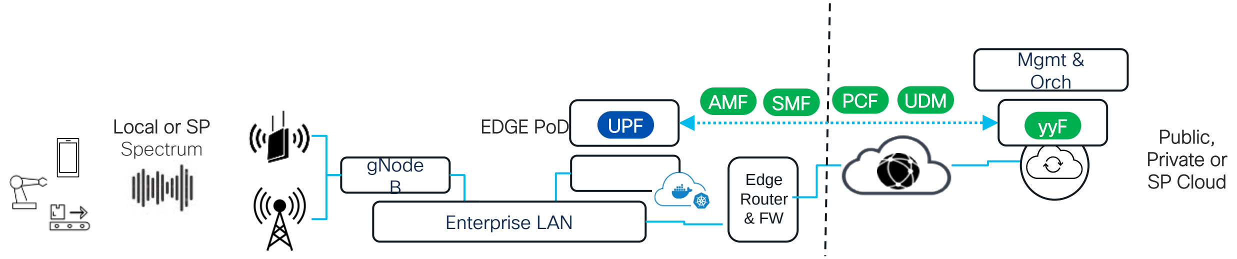
- Resources – Apps- VM based vs Kubernetes allocation --
- Kubernetes – automation – match with App infrastructure – synergy
- Look for issues – Topic
- Accessibility – VM vs Kubernetes – 100s of logs

5G Private Networks – troubleshoot from left to right

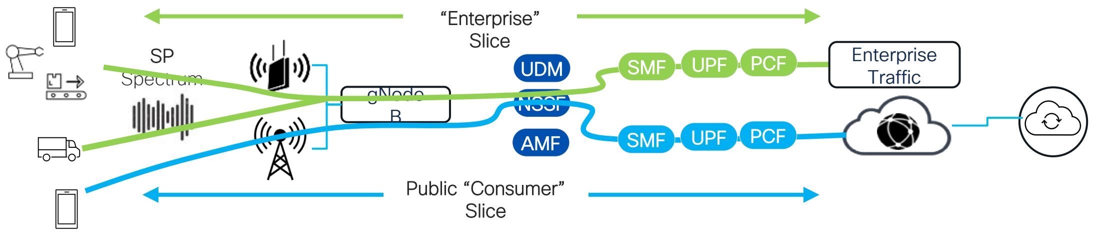
Full Private Deployment



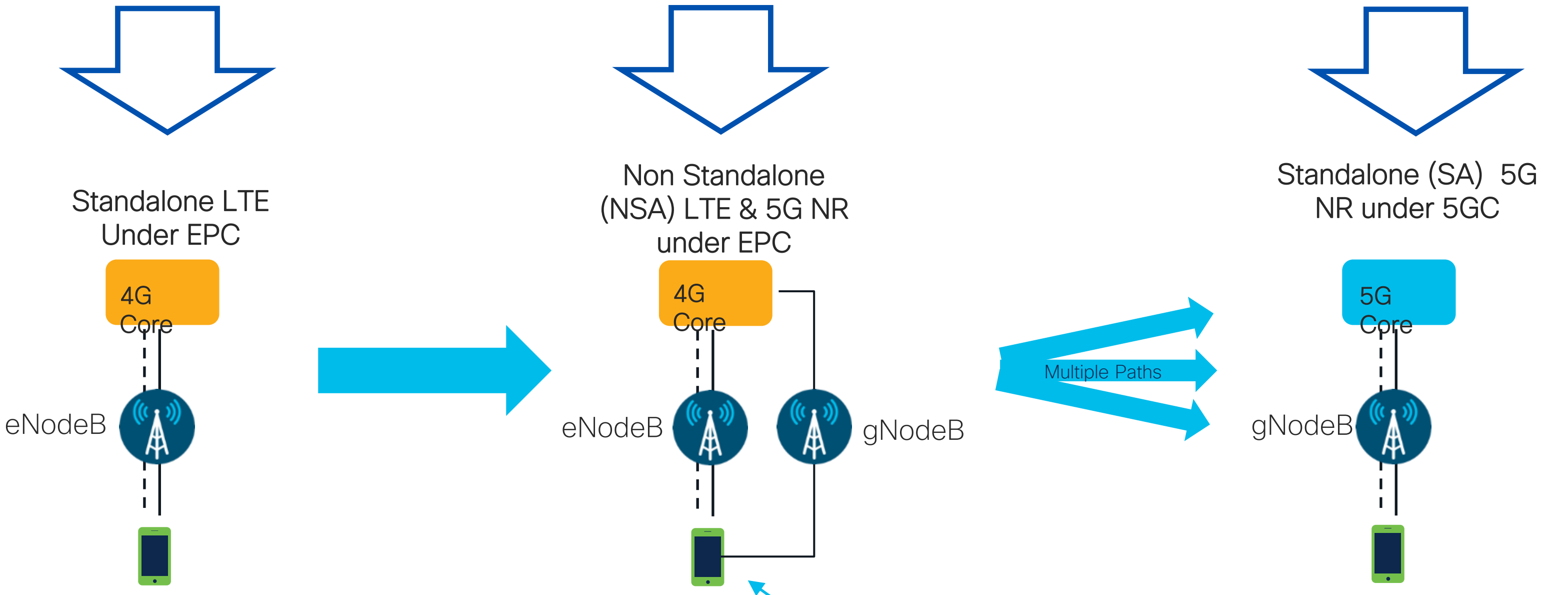
Hybrid Cloud Private Deployment



Macros Slice Deployment



5G SA and 5G NSA Components to look for issues – NSA is for eMBB, SA is for uLL,IOT



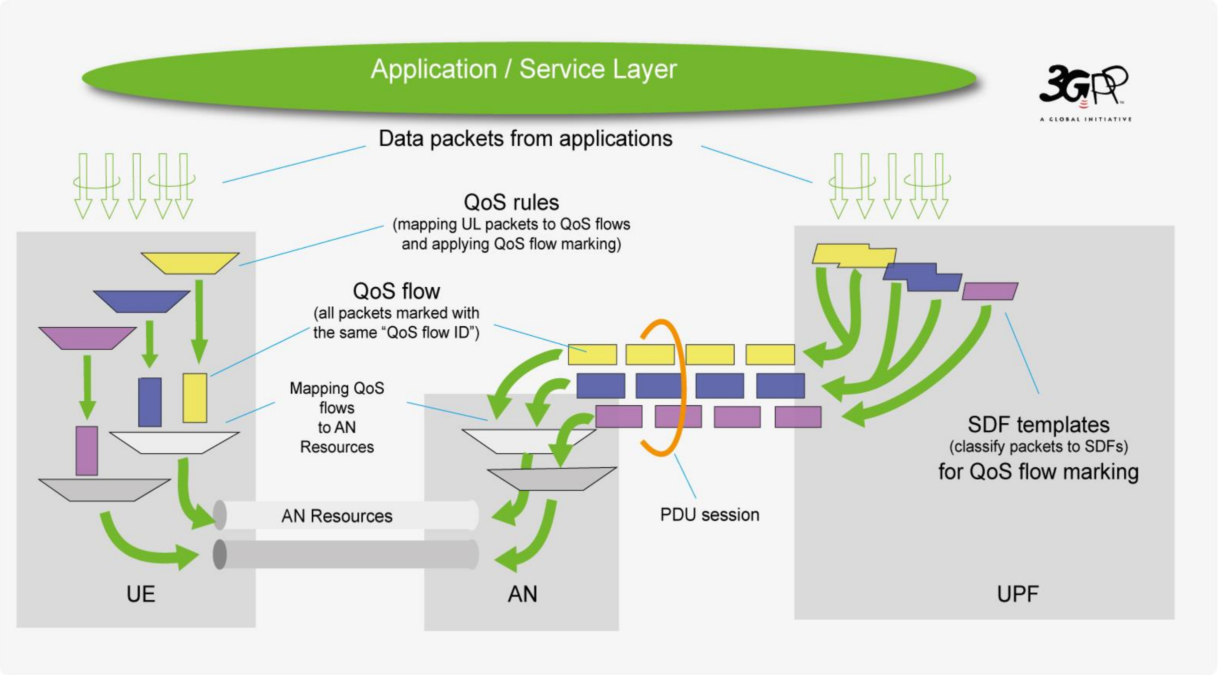
GSMA Option 1

GSMA Option 3

GSMA Option 2

Device must support 4G and 5G radio in NSA mode. 4G used to "attach" and bring up bearer. REQUIRES both 4G and 5G spectrum/radios

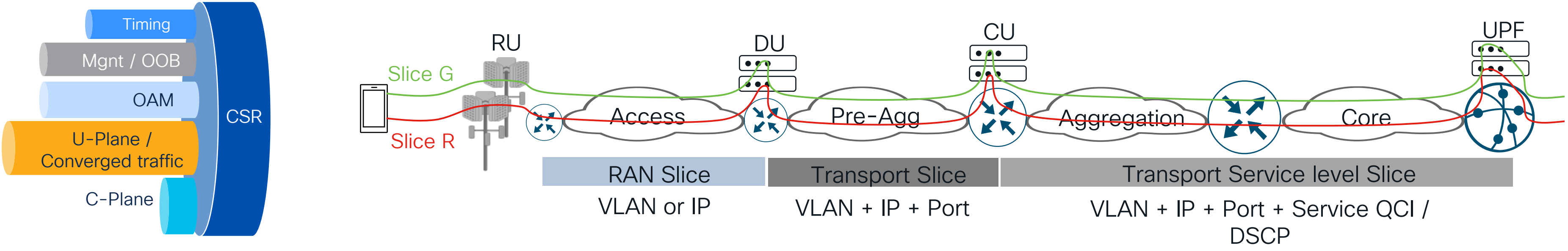
QoS Framework



Application / Service Layer
3GPP
A GLOBAL INITIATIVE
Data packets from applications
QoS rules
(mapping UL packets to QoS flows and applying QoS flow marking)
QoS flow
(all packets marked with the same "QoS flow ID")
Mapping QoS flows to AN Resources
AN Resources
PDU session
SDF templates
(classify packets to SDFs)
for QoS flow marking
UE
AN
UPF

- Flow based QoS, instead of bearer based

Service Classification and Protection



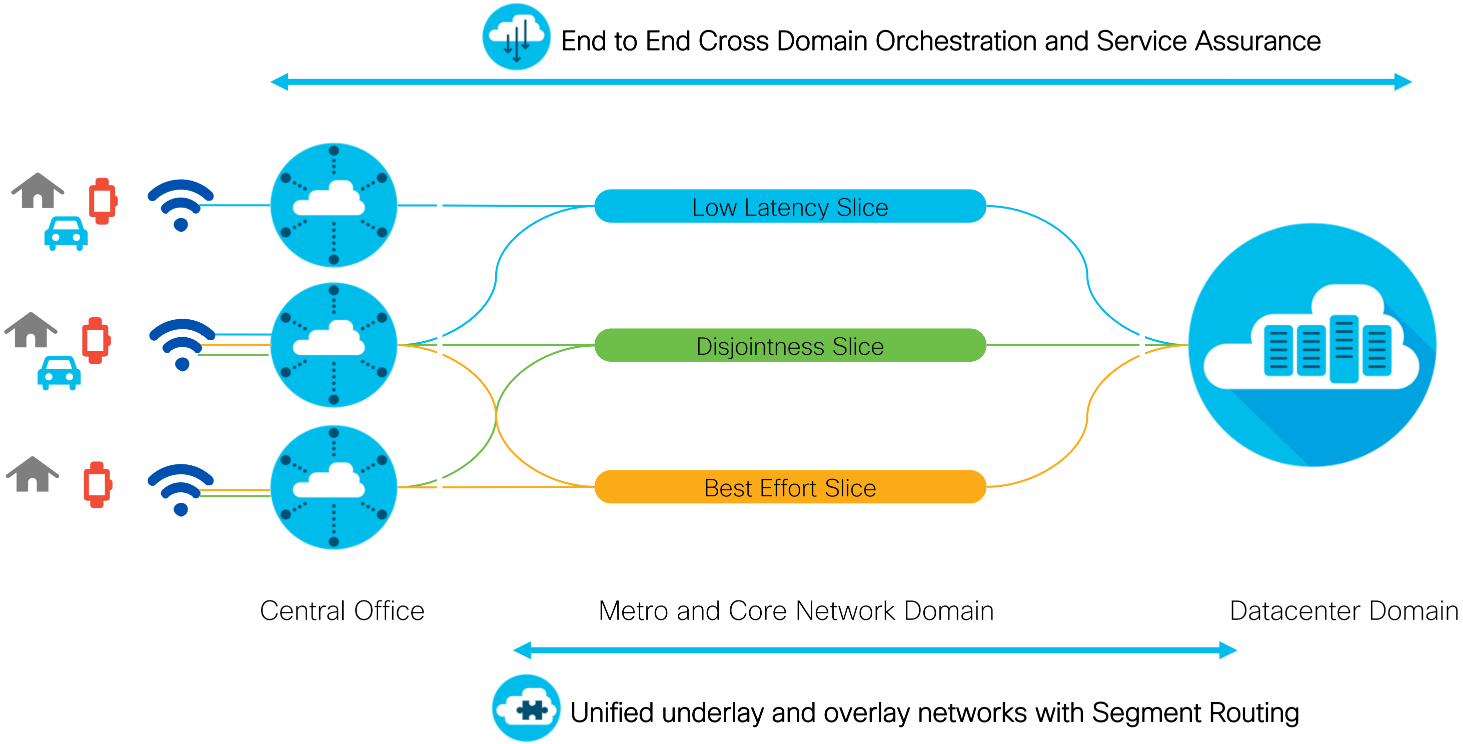
Service Classification and Quality of Service

- CU plane traffic requirements preserved ?
- Ensuring Timing service always received best latency and jitter ?
- Protecting against traffic bursts and spikes ?
- Guarantee quality of service to all other traffics ?

Service convergence and Routing

- Allowing traffic convergence ?
- Do we have Resiliency and Redundancy
- Fast Convergence with TI-LFA tested and working ?
- Traffic steering for flexible workload deployment validated ?

5G Network Slicing – Recall QoS ID



End to End Cross Domain Orchestration and Service Assurance

Central Office

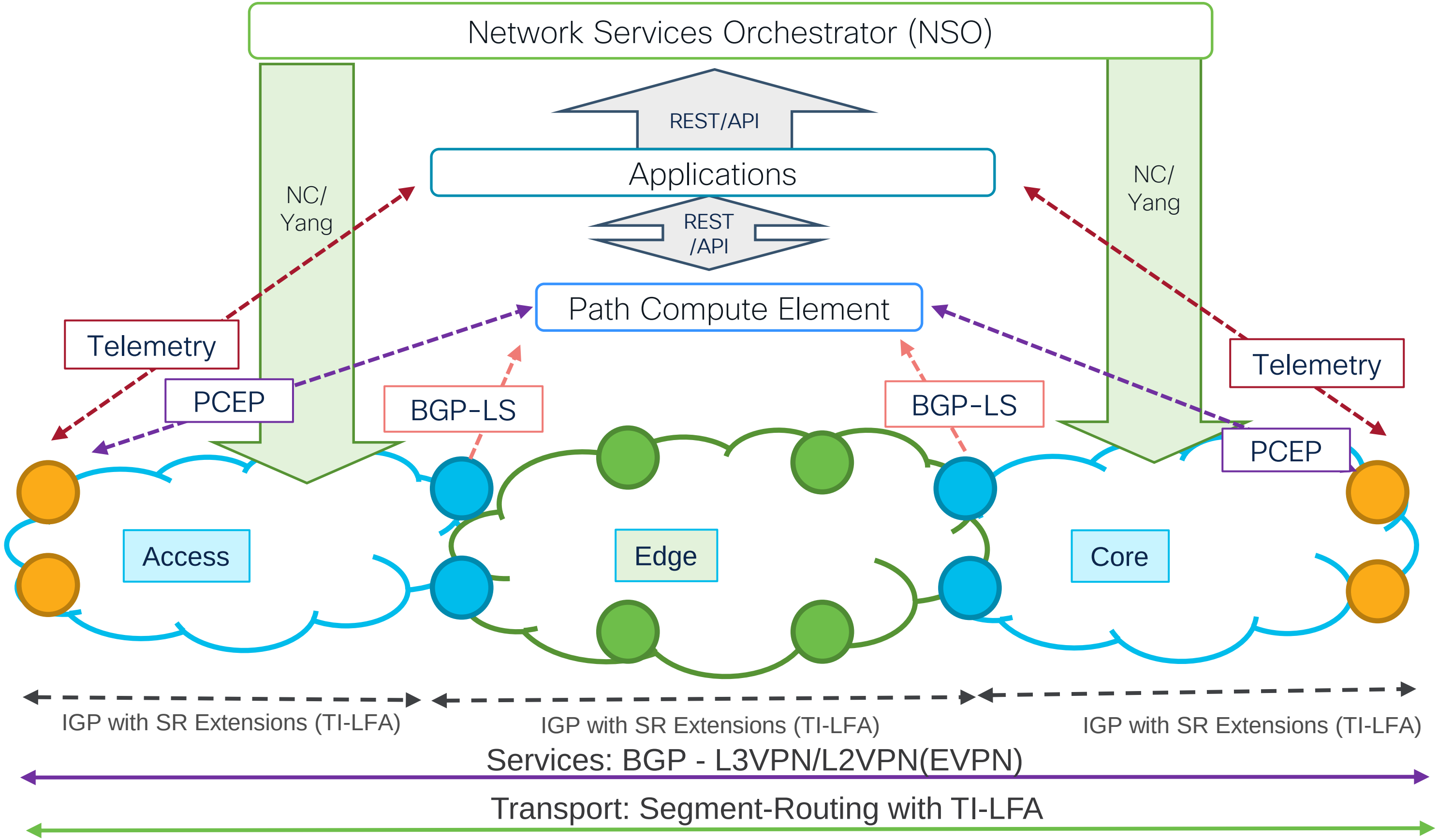
Metro and Core Network Domain

Datacenter Domain

Unified underlay and overlay networks with Segment Routing

IP Transport Segment Routing

Network issues as a Programed Fabric


Network Services Orchestrator (NSO)
REST/API
Applications
REST
/API
Path Compute Element
NC/
Yang
NC/
Yang
Telemetry
PCEP
BGP-LS
BGP-LS
Telemetry
PCEP
Access
Edge
Core
IGP with SR Extensions (TI-LFA)
IGP with SR Extensions (TI-LFA)
IGP with SR Extensions (TI-LFA)
Services: BGP - L3VPN/L2VPN(EVPN)
Transport: Segment-Routing with TI-LFA

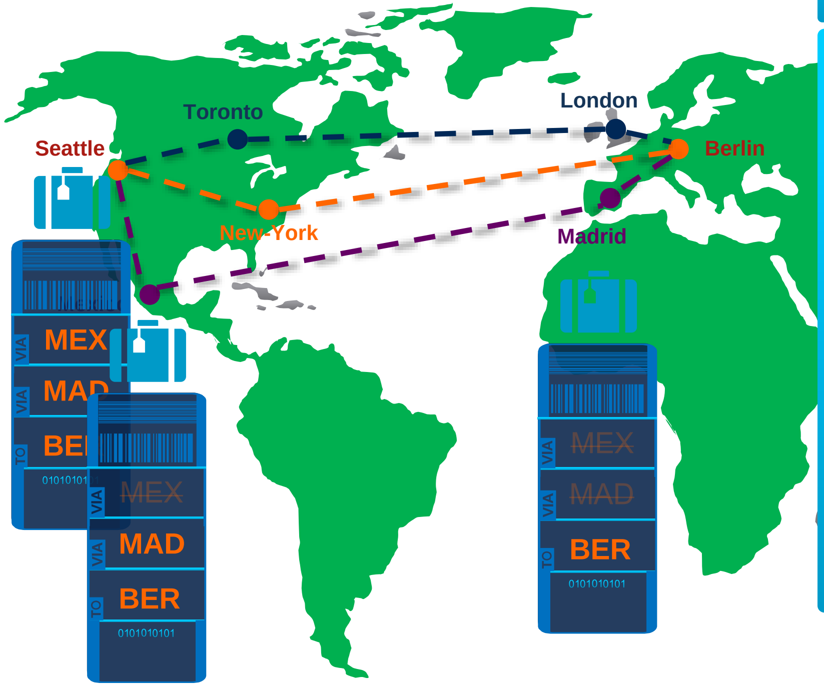
- App. Driven N/W and Usecases
- Automation
- Data Collection & Analytics
- Device and Services Onboarding
- EVPN Based Services
- Controller Based Forwarding
- Segment Routing Transport

Segment Routing – Any source routing issues ?

Evolve MPLS with Segment Routing

Segment Routing

Mission – Route the luggage to Berlin via Mexico and Madrid



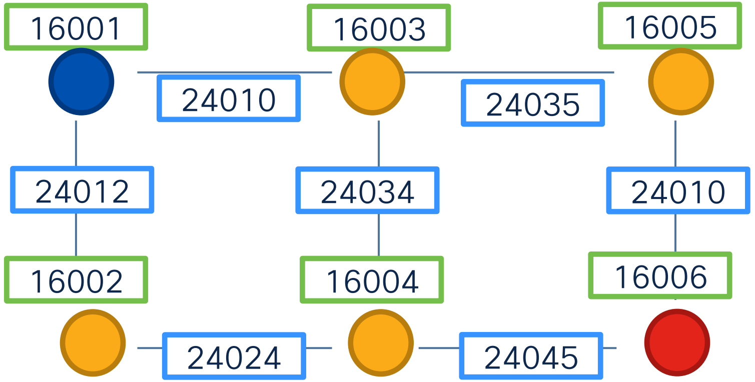
1. A unique and global luggage tag is attached to the luggage with the list of stops to the final destination

2. At each stop, the luggage is simply routed to the next hop listed on the luggage tag

RESULT: **Path can be controlled Simple and scalable**

Segment Routing – Technology Overview

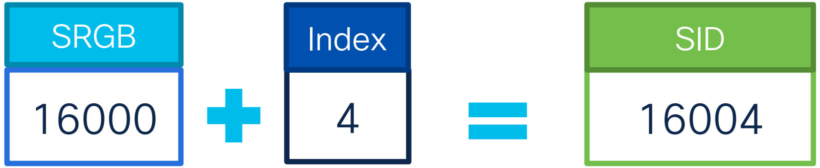
Prefix SID (Node SID)	Adjacency SID
Globally Significant	Locally Significant Unidirectional



Segment = **Instructions** such as
"go to node N using the shortest path"

Segment ID Construct

- Configured under IGP Routing Protocol
- Requires: Enabling SR & Configuring Prefix-SID
  - Configure “Absolute Value” or “Index”
- Optional: Configure SR-Global-Block (SRGB).
  - Default 16000 – 23999 (higher in newer versions)
- SRGB & Index advertised using IGP



- Result: No LDP Needed for label distribution

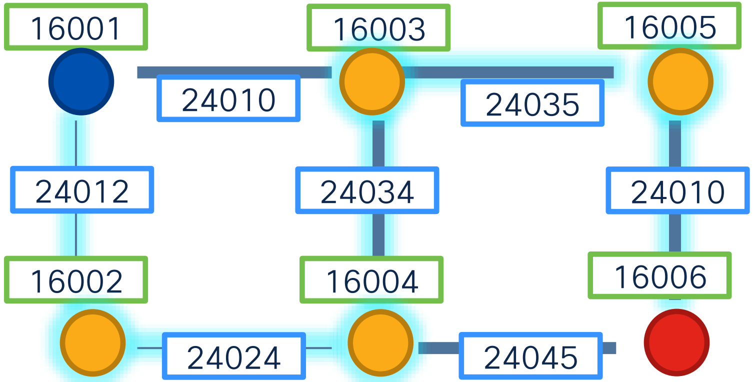
SRTE

Segment Routing – Programming The Path

Go To "RED"

RED = SID-List:
24012
24024
16003
16005
16006

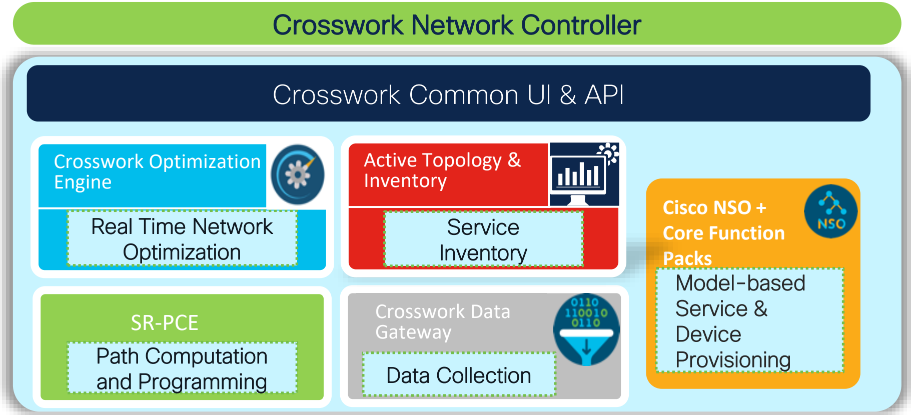
24012; INT="x"



Reached "RED"

Crosswork Network Controller

Lifeline to troubleshoot


Crosswork Network Controller

Crosswork Common UI & API

Crosswork Optimization Engine

Real Time Network Optimization

Active Topology & Inventory

Service Inventory

Cisco NSO + Core Function Packs

Model-based Service & Device Provisioning

SR-PCE

Path Computation and Programming

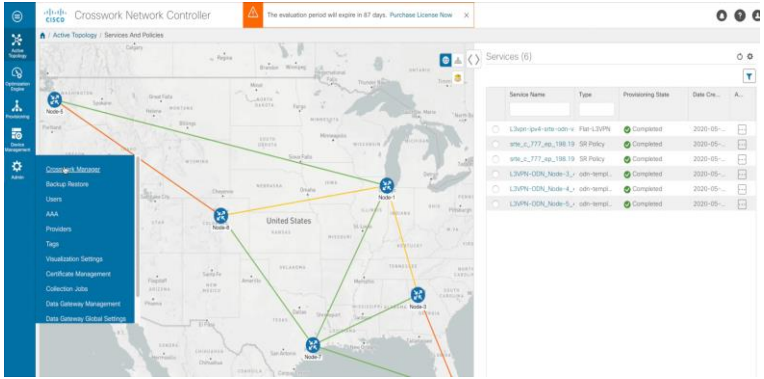
Crosswork Data Gateway

Data Collection

Use Cases

- Service Provisioning for L3VPN and L2VPN
- Service-Oriented Transport Provisioning (SR-TE)
- Topology & Inventory
- Bandwidth Optimization
- Real time network optimization to meet SLA

Multivendor
Multi-domain
Physical and Virtual


Crosswork Network Controller

The evaluation period will expire in 87 days. Purchase License Now

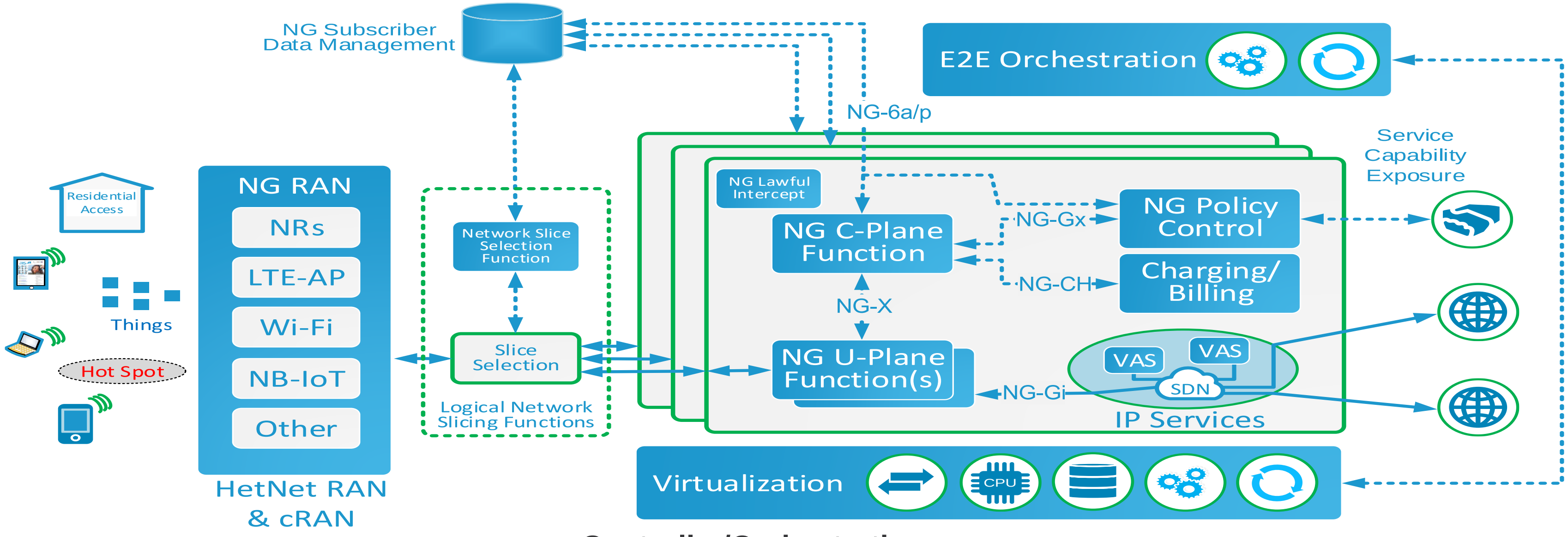
Active Topology / Services And Policies

Services (6)

	Service Name	Type	Provisioning State	Date Cre...	A...
○	L3vpn-ipv4-srte-odn-v	Flat-L3VPN	Completed	2020-05-...	⋯
○	srte_c_777_ep_198.19	SR Policy	Completed	2020-05-...	⋯
○	srte_c_777_ep_198.19	SR Policy	Completed	2020-05-...	⋯
○	L3VPN-ODN_Node-3_	odn-templ...	Completed	2020-05-...	⋯
○	L3VPN-ODN_Node-4_	odn-templ...	Completed	2020-05-...	⋯
○	L3VPN-ODN_Node-5_	odn-templ...	Completed	2020-05-...	⋯

Extended for Network Slicing

Segment Routing Underlay and EVPN Overlay



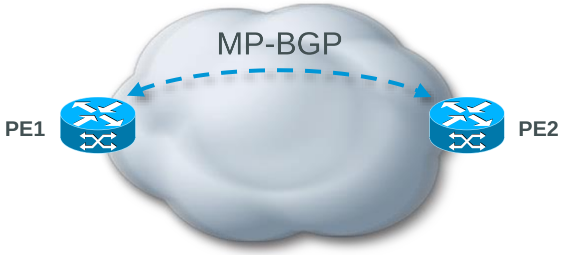
Controller/Orchestration

Services: BGP - L3VPN/L2VPN(EVPN)

Transport: Segment-Routing

MPLS Control and Forwarding Operation with Segment Routing

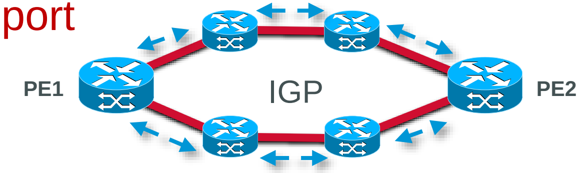
Services



IPv4 | IPv6 | IPv4 VPN | IPv6 VPN | VPWS | VPLS

No changes to control or forwarding plane

Packet Transport



LDP | RSVP | Static | BGP | IS-IS | OSPF

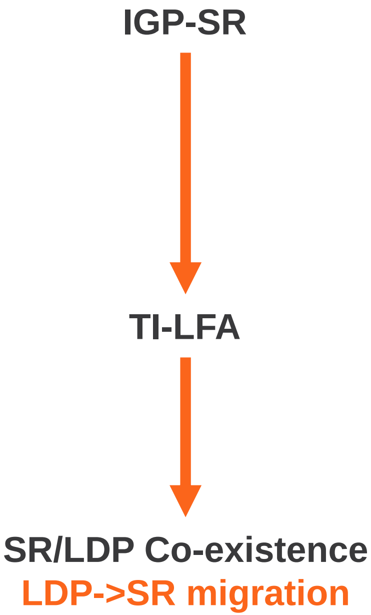
MPLS Forwarding

IGP or BGP label distribution for IPv4 and IPv6. Forwarding plane remains the same

IGP-SR/TI-LFA/SR-LDP Configuration issues

```
router isis 1
 address-family ipv4 unicast
  metric-style wide
  segment-routing mpls
 !
 interface Loopback0
  address-family ipv4 unicast
   prefix-sid index 1
```

```
router ospf 1
 router-id 1.1.1.1
 segment-routing mpls
 segment-routing forwarding mpls
 area 0
  interface Loopback0
   passive enable
   prefix-sid index 1
```



IGP-SR

TI-LFA

SR/LDP Co-existence

LDP->SR migration

```
router isis 1
 interface GigabitEthernet0/0/0/2
  address-family ipv4 unicast
   fast-reroute per-prefix
   fast-reroute per-prefix ti-lfa
```

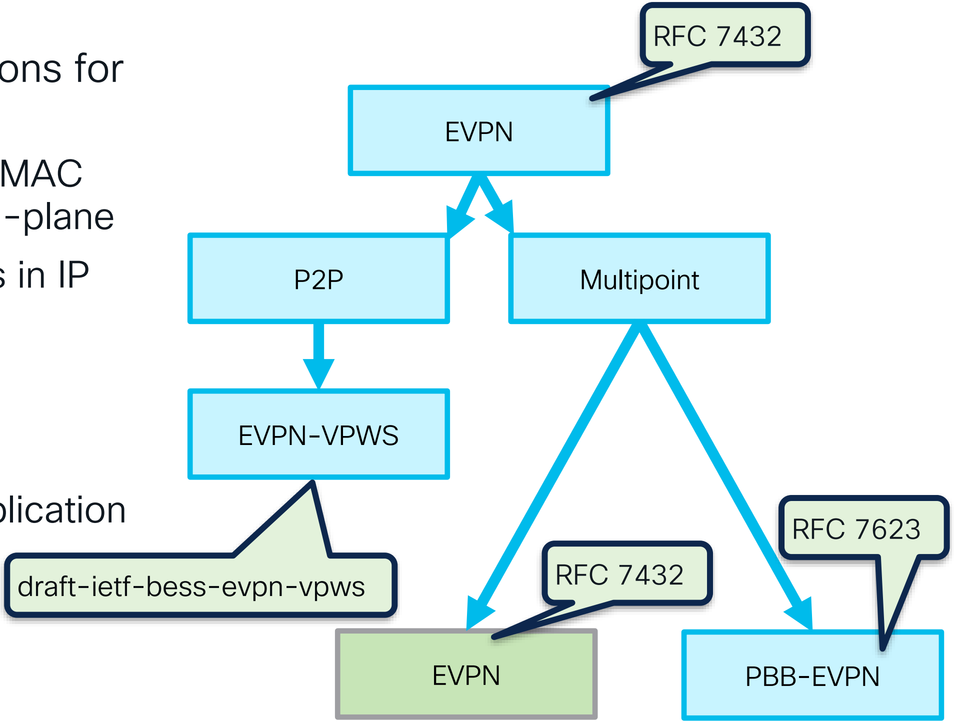
```
router ospf 1
 fast-reroute per-prefix
 fast-reroute per-prefix ti-lfa
```

```
router isis 1
 address-family ipv4 unicast
  segment-routing mpls sr-prefer
```

```
router ospf 1
 segment-routing mpls
 segment-routing sr-prefer
```

What is EVPN

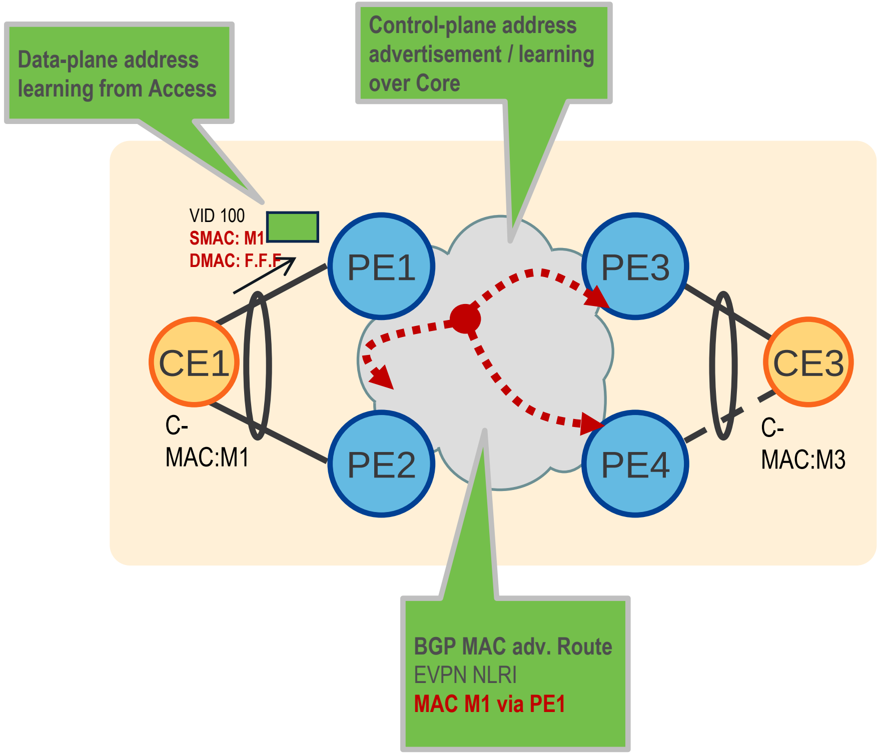
- EVPN family introduces next generation solutions for Ethernet services
  - BGP control-plane for Ethernet Segment and MAC distribution learning over MPLS or VXLAN data-plane
  - Same principles and operational experience as in IP VPNs
- No use of Pseudo wires
  - Uses MP2P tunnels for unicast
  - Multi-destination frame delivery via ingress replication (via MP2P tunnels) or LSM
- Multi-vendor solutions



Ethernet VPN

Highlights

- Next generation solution for Ethernet multipoint (E-LAN) services
- PEs run Multi-Protocol BGP to advertise & learn Customer MAC addresses (C-MACs) over Core
  - Same operational principles of L3VPN
- Learning on PE Access Circuits via data-plane transparent learning
- No pseudowire full-mesh required
  - Unicast: use MP2P tunnels
  - Multicast: use ingress replication over MP2P tunnels or use LSM
- Standardized at IETF – RFC 7432



Data-plane address learning from Access

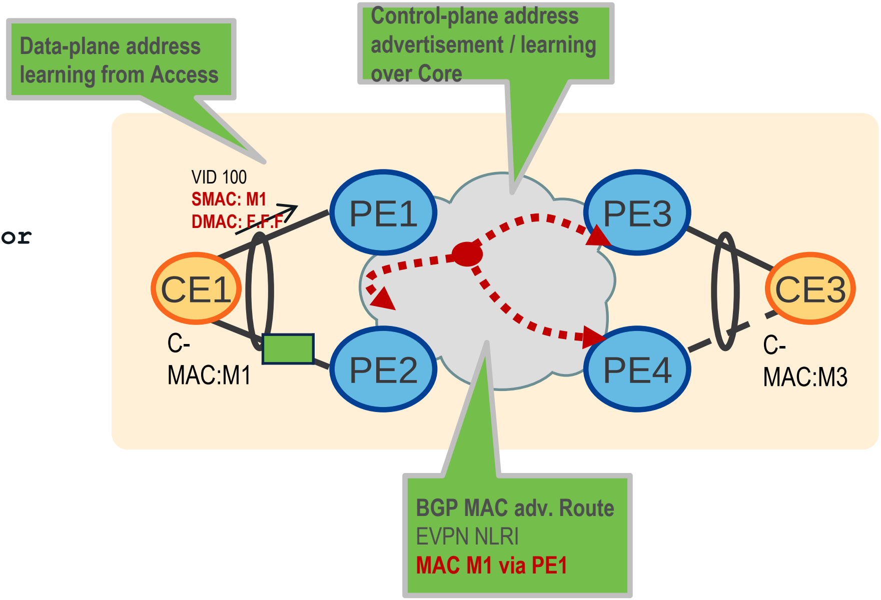
Control-plane address advertisement / learning over Core

BGP MAC adv. Route
EVPN NLRI
MAC M1 via PE1

BGP Ethernet VPN

Verification

```
RP/0/RSP0/CPU0:router# show evpn evi vpn-id 2001 neighbor

 Neighbor IP  vpn-id

-----------         --------

20.20.20.20 2001

30.30.30.30 2001

Verify the BGP L2VPN EVPN summary.

RP/0/RSP0/CPU0:router# show bgp l2vpn evpn summary

 ...

Neighbor Spk AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down St/PfxRcd

20.20.20.20 0 200 216739 229871 200781341 0 0 3d00h 348032

30.30.30.30 0 200 6462962 4208831 200781341 10 0 2d22h 35750
```



Data-plane address learning from Access

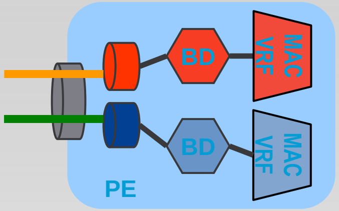
Control-plane address advertisement / learning over Core

BGP MAC adv. Route
EVPN NLRI
MAC M1 via PE1

EVPN – Components

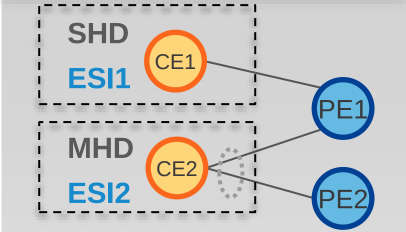
L2 and L3 in the same instance!

EVPN Instance (EVI)



- EVI spans all PEs participating in an EVPN
- MAC-VRF: A VRF table for MACs on a PE
- Encompass one or more bridge-domains, depending on service interface type
  - Port-based
  - VLAN-based (shown above)
  - VLAN-bundling
  - VLAN aware bundling (NEW)

Ethernet Segment



- Represents a ‘site’ connected to one or more PEs
- Uniquely identified by a 10-byte global Ethernet Segment Identifier (ESI)
- Could be a single device or an entire network
  - Single-Homed Device (SHD)
  - Multi-Homed Device (MHD)
  - Single-Homed Network (SHN)
  - Multi-Homed Network (MHN)

BGP Routes

Route Types
[1] Ethernet Auto-Discovery (AD) Route
[2] MAC Advertisement **Route**
[3] Inclusive Multicast Route
[4] Ethernet Segment Route
(5) IP Prefix Advertisement Route

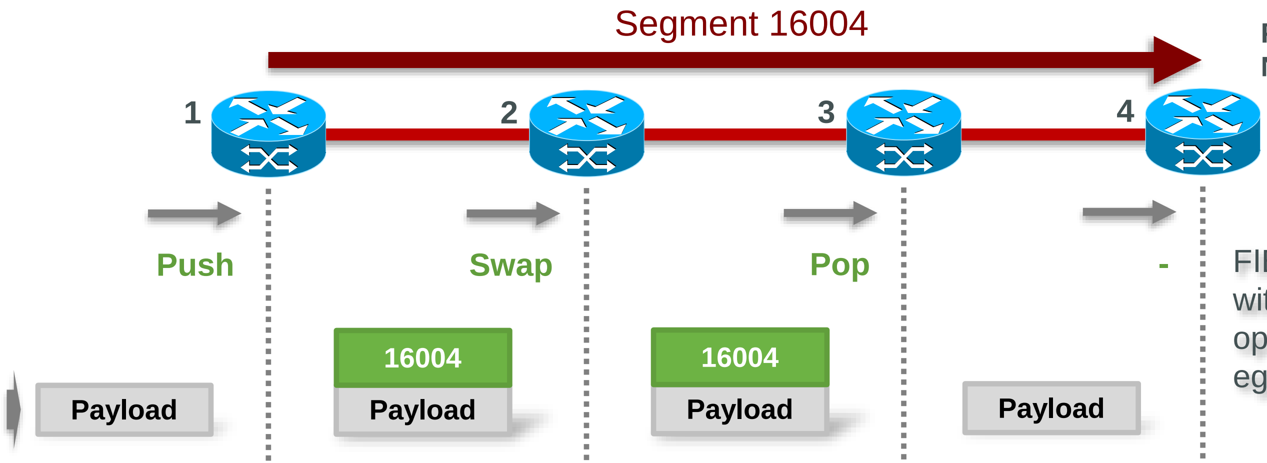
- EVPN and PBB-EVPN define a single new BGP NLRI used to carry all EVPN routes
- NLRI has a new SAFI (70)
- Routes serve control plane purposes, including:
  - MAC / IP address reachability
  - MAC mass withdrawal
  - Split-Horizon label adv.
  - Aliasing
  - Multicast endpoint discovery
  - Redundancy group discovery
  - Designated forwarder election

BGP Route Attributes

Extended Communities
ESI MPLS Label
ES-Import
MAC Mobility
Default Gateway
Router’s MAC

- New BGP extended communities defined
- Expand information carried in BGP routes, including:
  - MAC address moves
  - C-MAC flush notification
  - Redundancy mode
  - MAC / IP bindings of a GW
  - Split-horizon label encoding

MPLS Data Plane Operations – push label

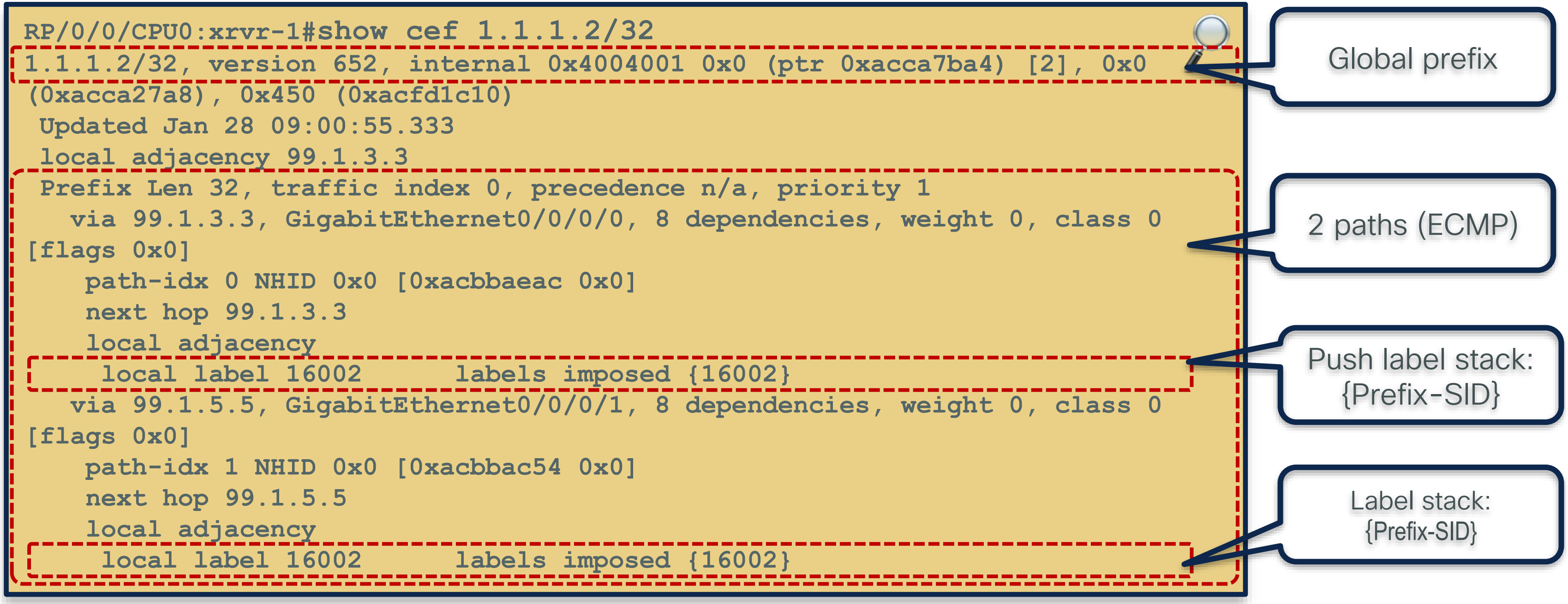


Prefix-SID 16004
NP-flag=0, E-flag=0

FIB entry remote prefix P
with prefix-SID N
operation : push N
egress interface : oif spt(N)

```
RP/0/0/CPU0:Node1#show cef 1.1.1.4/32
1.1.1.4/32, version 277, internal 0x4004001 0x0 (ptr 0xacce39a4) [1], 0x0 (0xaccde760), 0x450 (0xacd8b8)
 local adjacency 10.0.0.2
 Prefix Len 32, traffic index 0, precedence n/a, priority 1
   via 99.1.2.2, GigabitEthernet0/0/0/0, 5 dependencies, weight 0, class 0 [flags 0x0]
    path-idx 0 NHID 0x0 [0xacbb3bf0 0x0]
    next hop 99.1.2.2
    local adjacency
     local label 16004      labels imposed {16004}
```

Verifying IP Forwarding (global table)



```
RP/0/0/CPU0:xrvr-1#show cef 1.1.1.2/32
1.1.1.2/32, version 652, internal 0x4004001 0x0 (ptr 0xacca7ba4) [2], 0x0
(0xacca27a8), 0x450 (0xacfd1c10)
 Updated Jan 28 09:00:55.333
 local adjacency 99.1.3.3
 Prefix Len 32, traffic index 0, precedence n/a, priority 1
   via 99.1.3.3, GigabitEthernet0/0/0/0, 8 dependencies, weight 0, class 0
[flags 0x0]
    path-idx 0 NHID 0x0 [0xacbbaeac 0x0]
    next hop 99.1.3.3
    local adjacency
     local label 16002      labels imposed {16002}
   via 99.1.5.5, GigabitEthernet0/0/0/1, 8 dependencies, weight 0, class 0
[flags 0x0]
    path-idx 1 NHID 0x0 [0xacbbac54 0x0]
    next hop 99.1.5.5
    local adjacency
     local label 16002      labels imposed {16002}
```

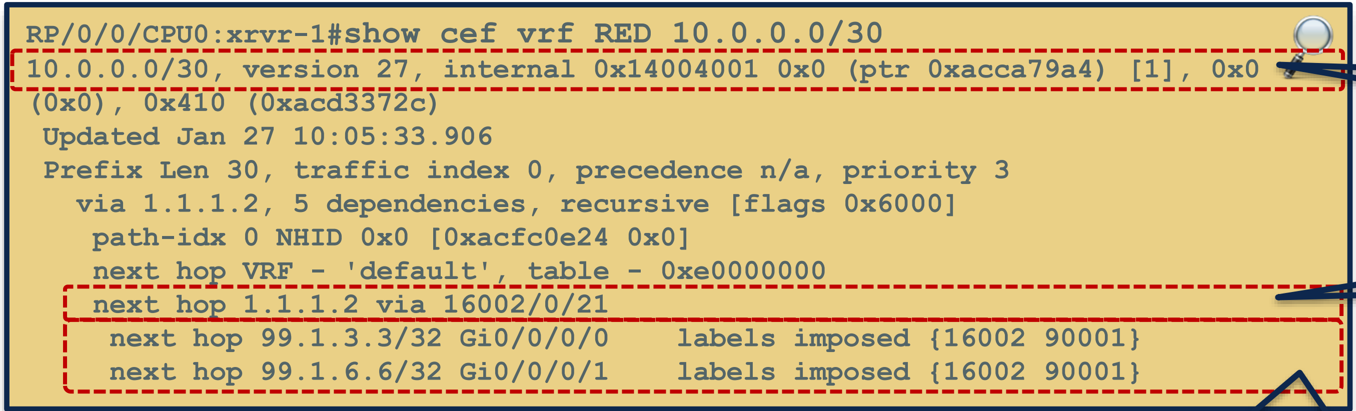
Global prefix

2 paths (ECMP)

Push label stack:
{Prefix-SID}

Label stack:
{Prefix-SID}

Verifying IP Forwarding (VRF RED)



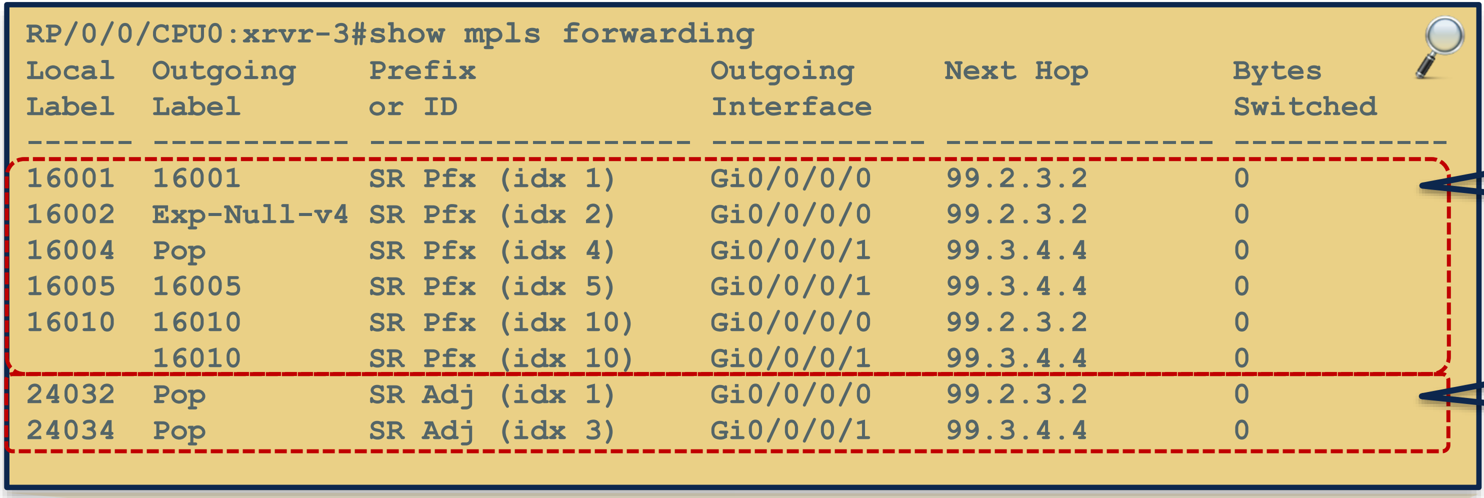
```
RP/0/0/CPU0:xrvr-1#show cef vrf RED 10.0.0.0/30
10.0.0.0/30, version 27, internal 0x14004001 0x0 (ptr 0xacca79a4) [1], 0x0
(0x0), 0x410 (0xacd3372c)
 Updated Jan 27 10:05:33.906
 Prefix Len 30, traffic index 0, precedence n/a, priority 3
   via 1.1.1.2, 5 dependencies, recursive [flags 0x6000]
    path-idx 0 NHID 0x0 [0xacfc0e24 0x0]
    next hop VRF - 'default', table - 0xe0000000
    next hop 1.1.1.2 via 16002/0/21
     next hop 99.1.3.3/32 Gi0/0/0/0    labels imposed {16002 90001}
     next hop 99.1.6.6/32 Gi0/0/0/1    labels imposed {16002 90001}
```

VPN prefix (VRF RED)

BGP nexthop, egress PE

2 paths (ECMP)
Push label stack:
{Prefix-SID to egress PE, BGP VPN label}

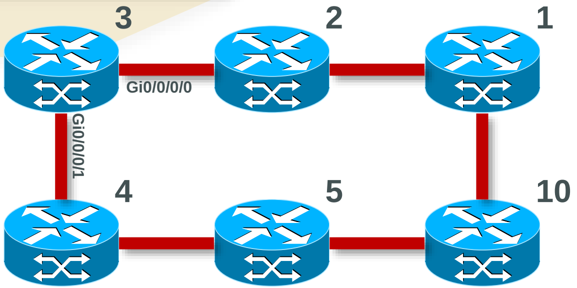
Verifying MPLS Forwarding



```
RP/0/0/CPU0:xrvr-3#show mpls forwarding
Local  Outgoing    Prefix             Outgoing     Next Hop        Bytes
Label  Label       or ID              Interface                    Switched
------ ----------- ------------------ ------------ --------------- ------------
16001  16001       SR Pfx (idx 1)     Gi0/0/0/0    99.2.3.2        0
16002  Exp-Null-v4 SR Pfx (idx 2)     Gi0/0/0/0    99.2.3.2        0
16004  Pop         SR Pfx (idx 4)     Gi0/0/0/1    99.3.4.4        0
16005  16005       SR Pfx (idx 5)     Gi0/0/0/1    99.3.4.4        0
16010  16010       SR Pfx (idx 10)    Gi0/0/0/0    99.2.3.2        0
       16010       SR Pfx (idx 10)    Gi0/0/0/1    99.3.4.4        0
24032  Pop         SR Adj (idx 1)     Gi0/0/0/0    99.2.3.2        0
24034  Pop         SR Adj (idx 3)     Gi0/0/0/1    99.3.4.4        0
```

prefix-SIDs of remote nodes

adjacency-SIDs



Node *n* advertises prefix-SID 16000+*n*

Verifying MPLS Forwarding

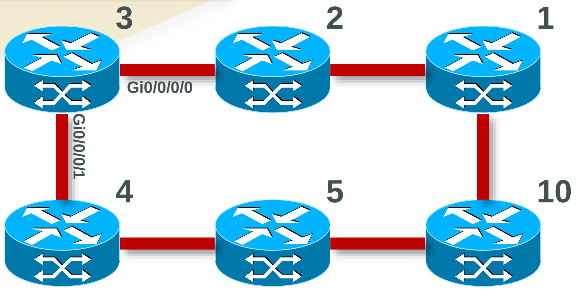
```
RP/0/0/CPU0:xrvr-3#show mpls forwarding
Local  Outgoing    Prefix             Outgoing     Next Hop        Bytes
Label  Label       or ID              Interface                    Switched
------ ----------- ------------------ ------------ --------------- ------------
16001  16001       SR Pfx (idx 1)     Gi0/0/0/0    99.2.3.2        0
16002  Exp-Null-v4 SR Pfx (idx 2)     Gi0/0/0/0    99.2.3.2        0
16004  Pop         SR Pfx (idx 4)     Gi0/0/0/1    99.3.4.4        0
16005  16005       SR Pfx (idx 5)     Gi0/0/0/1    99.3.4.4        0
16010  16010       SR Pfx (idx 10)    Gi0/0/0/0    99.2.3.2        0
       16010       SR Pfx (idx 10)    Gi0/0/0/1    99.3.4.4        0
24032  Pop         SR Adj (idx 1)     Gi0/0/0/0    99.2.3.2        0
24034  Pop         SR Adj (idx 3)     Gi0/0/0/1    99.3.4.4        0
```

Remote prefix-SID

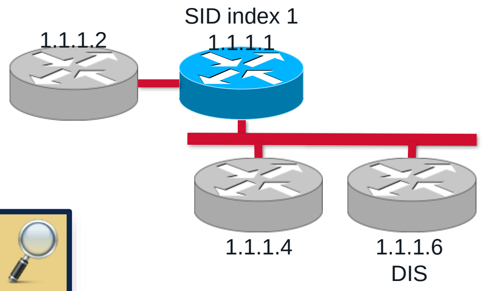
Neighbor prefix-SID Explicit-Null

Neighbor prefix-SID PHP on

Remote prefix-SIDs ECMP



Node *n* advertises prefix-SID 16000+*n*



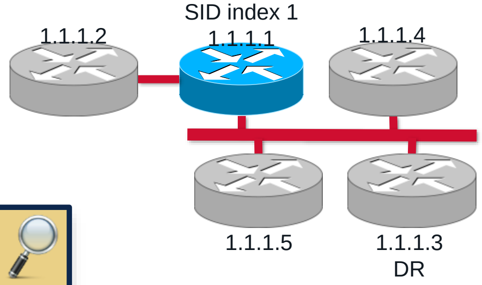
Verifying IS-IS Database

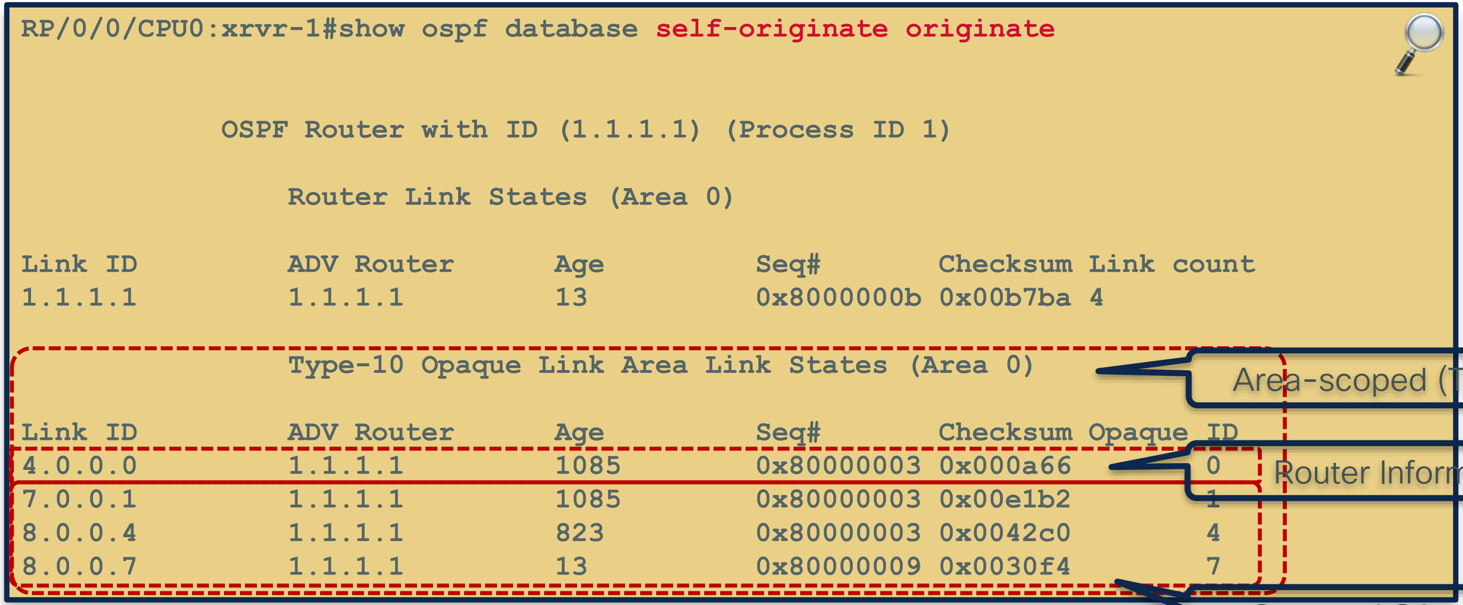
```
RP/0/0/CPU0:xrvr-1#show isis database verbose xrvr-1

IS-IS 1 (Level-2) Link State Database
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
xrvr-1.00-00     * 0x00000073   0x4eba         1161              0/0/0
  Area Address: 49.0001
  NLPID:        0xcc
  NLPID:        0x8e
  MT:           Standard (IPv4 Unicast)
  MT:           IPv6 Unicast                                      0/0/0
  Hostname:     xrvr-1
  IP Address:   1.1.1.1
  IPv6 Address: 2001::1:1:1:1
  Router Cap:   1.1.1.1, D:0, S:0
    Segment Routing: I:1 V:1, SRGB Base: 16000 Range: 8000

<...>
```

Two topologies: IPv4 and IPv6

Single SRGB for both IPv4 and IPv6
I:1 IPv4; V:1 IPv6
Label range 16,000 – 23,999

Verifying OSPF Database





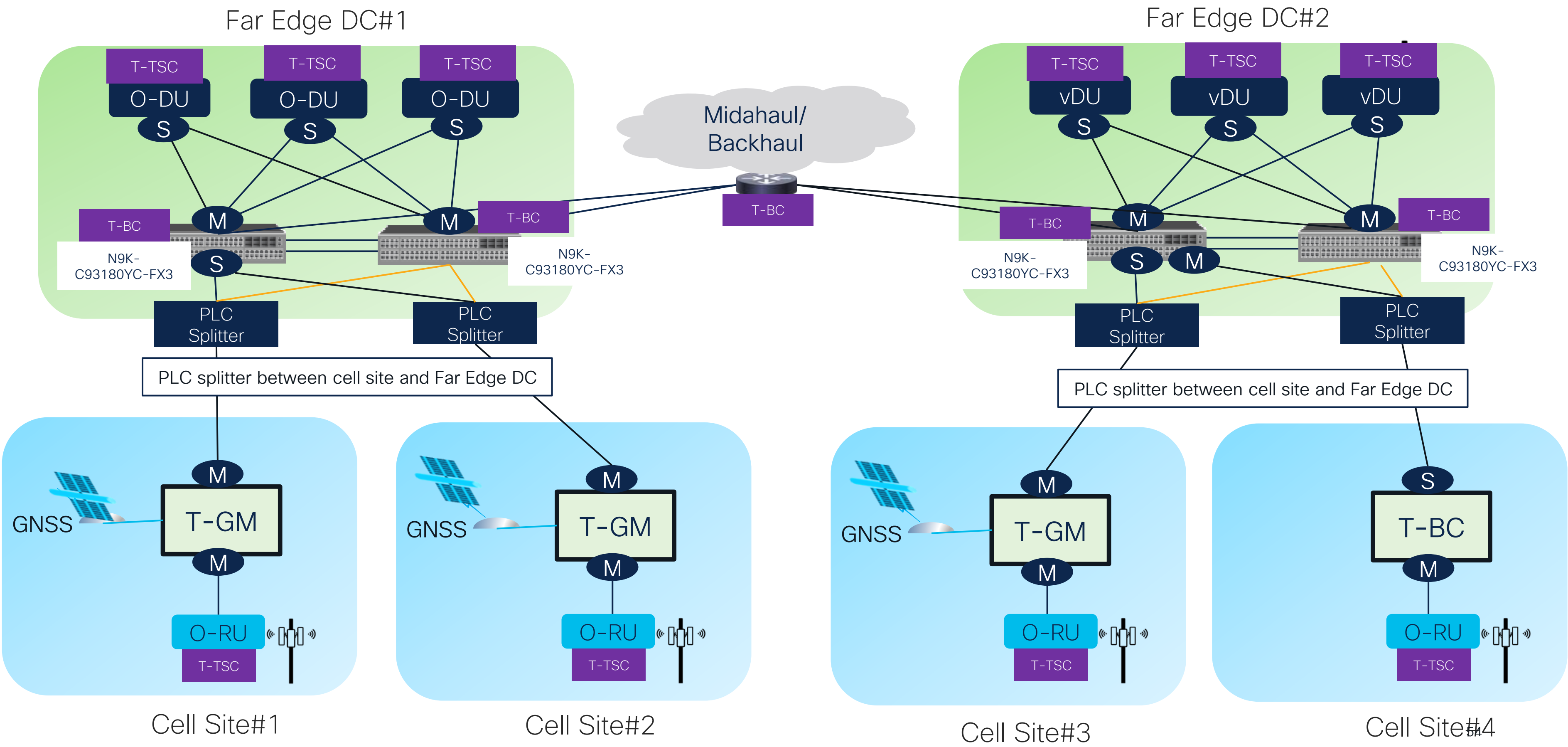
```
RP/0/0/CPU0:xrvr-1#show ospf database self-originate originate


            OSPF Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age          Seq#       Checksum Link count
1.1.1.1         1.1.1.1         13           0x8000000b 0x00b7ba 4

                Type-10 Opaque Link Area Link States (Area 0)

Link ID         ADV Router      Age          Seq#       Checksum Opaque ID
4.0.0.0         1.1.1.1         1085         0x80000003 0x000a66        0
7.0.0.1         1.1.1.1         1085         0x80000003 0x00e1b2        1
8.0.0.4         1.1.1.1         823          0x80000003 0x0042c0        4
8.0.0.7         1.1.1.1         13           0x80000009 0x0030f4        7
```

Area-scoped (Type10) Opaque LSAs

Router Information Opaque LSA

Opaque LSAs for Segment Routing

Issues with ACI Leaf delivering clock to O-DUs and O-RUs



Debugging Case studies

RCAs

- **MPLS L3 connectivity to some cell sites when a core network link broke down-** Service was restored after issuing clear mpls ldp neighbor*.
- **NCS-5508 -config SR policy on NSO print error –** Policy Config issue
- **Fallback from SR-Policy to Native SR after RPFO – Defect**
- **Micro Services -** abnormal Micro-service memory usage - The Workaround to restart the rest-ep was already applied, and the container-memory-usage was cleared.
- **Throughput issue in 5G -** Suspecting issue is due to QOS Data & Control plane Buffer exhaust - Qos buffer enhancement with different buffer options
- **ACI | Stale Route found in ACI |** Route do not exist in ACI but is seen receiving from ACI from external site - defect - Issue got resolved after upgrading Border Leaf to version

RCAs

- **5G AMF - Three pods in pending state -** Issue recovered after restart of kubectl, no issues on kubernetes settings
- **5G SA // AMF De-registration call flow - registration-request fails –** Stop sending Http2 go away
- **UDM peer is not getting selected properly as per the static configuration** - restart of the rest-ep endpoint that display the problem
- **G SA : Call Drop - SMF Not Initiating Dedicated Bearer During EPSFB -** Defect
- **Bad 5G site UE speed is around 80Mbps and good site is around 800Mbps –** IP Transport issue

Summary

Key Takeaways

- Troubleshooting 5G involves
- NR
- Mobile Core
- PDU
- Cloud
- IP Routing
- Apps
- Cisco support

Cisco Private 5G Learning Map

Start

June 4 | 2:00 pm
TECSPG-2432
New Adventures in Wireless: The Journey of WiFi6 and Private 5G Networks for the Enterprise

June 5, | 8:00 am
BRKSEC-2085
Architecting Enterprise Security in a Wi-Fi plus Private 5G World

June 5 | 8:30 am
BRKSPG-2042
Architecting Private 5G for resiliency, security, and enterprise network convergence

June 5 | 10:30 am
BRKSPM-1006
The 5G System as a Spectrum Management Solution

June 5 | 11:00 am
BRKENS-2950
Is your Enterprise Network Ready for P5G

June 5 | 11:30 am
PSOSPG-1002
Leading Your Digital Transformation with Cisco Private 5G Network Offer

June 6 | 3:00 pm
BRKEWN-2030
WiFi6 and Private 5G for the Enterprise – a 'Better Together' Journey

June 7 | 2:30 pm
PSOGEN-1033
Unlock business outcomes from connectivity with a Private 5G solution

June 7 | 4:00 pm
BRKSPG-3004
Monolithic or Polylithic packet cores? The case for specialized use-case-based mobile packet cores

June 8 | 09:30 am
BRKSPG-2044
5G Use Cases Flight Line of the Future and Smart Warehouse

June 8 | 01:00 pm
IBOSPG-2007
Getting Started with Private 5G

June 8 | 1:00 pm
BRKGEN-2001
Cisco P5G - A Robust and Secure Architecture

Finish

Cisco 5G Learning Map

Start

June 4 | 9:00 am

TECIOT-2584

Designing IoT Wireless Networks

June 5, | 8:30 am

BRKNWT-2203

Automation-first Approach to Network Infrastructure Modernization for 5G & Beyond

June 5 | 1:00 pm

BRKSPG-2063

Design, Deploy and Manage Transport Slicing using SDN Controller and Assurance

June 5 | 1:00 pm

BRKARC-2094

Hiking the Band Canyon with 5G: New Use Cases, New Business Outcomes

June 5 | 2:30 pm

BRKSPG-1002

Don’t Just Connect, Grow your IoT Business with Cisco IoT Cellular Connectivity Management

June 5 | 3:00 pm

BRKIOT-1126

Connecting Moving Assets with Cisco IoT Solutions

June 6 | 10:30 am

BRKSPG-2315

Cloud-Ready Converged SDN Transport

June 6 | 1:00 pm

BRKSPG-2401

Cisco Secure Edge Protection – Protecting the 5G Edge against DDoS Attacks

June 6 | 2:30 pm

IBOSPM-2030

5G Transport Design Considerations Combining Onsite and Cloud-Based Deployments

June 6 | 4:00 pm

BRKSPM-2027

Holistic Security in 5G Deployments

June 7 | 10:30 am

BRKSPG-2133

Evolution of the Transport Network Architecture in the Context of 5G and Open RAN

June 8 | 8:30 am

BRKSPG-3050

Synchronizing 5G Mobile Networks

Cisco 5G Learning Map

June 8 | 9:30 am

IBOSPG-2006

DISH Wireless, World’s first 5G
Network with a Hybrid Cloud

June 8 | 10:30 am

BRKNWT-2301

DevNetOps Automation Approach to
Network Infrastructure Modernization for 5G
and Beyond

June 8, | 11:00 am

BRKSPG-2040

Troubleshooting 5G Architectures

June 8 | 1:00 pm

BRKMER-2001

Postcards from the 5G Edge: Meraki
Cellular Gateways

Finish

Fill out your session surveys!

Attendees who fill out a minimum of four session surveys and the overall event survey will get **Cisco Live-branded socks** (while supplies last)!

Attendees will also earn 100 points in the **Cisco Live Game** for every survey completed.

These points help you get on the leaderboard and increase your chances of winning daily and grand prizes

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- Book your one-on-one Meet the Engineer 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

The bridge to possible

Thank you

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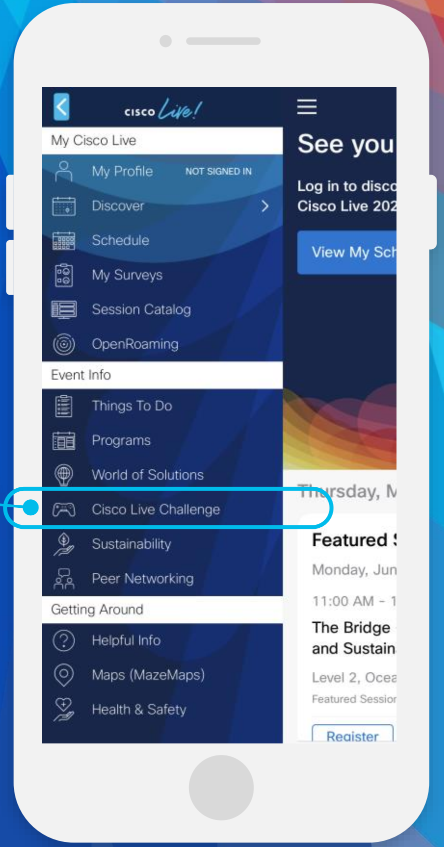
2. Click on 'Cisco Live Challenge’ in the side menu.
3. Click on View Your Badges at the top.
4. Click the + at the bottom of the screen and scan the QR code:



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Let's go

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