Transforming Subscriber Services using Cisco Cloud Native BNG

CKN

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MIG
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Agenda

- Shift and Evolution
- cnBNG Architecture
- Resiliency
- Take aways

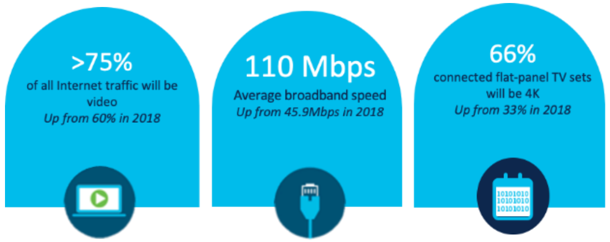
Shift and Evolution

The only thing that doesn’t change is
“*the change*” itself

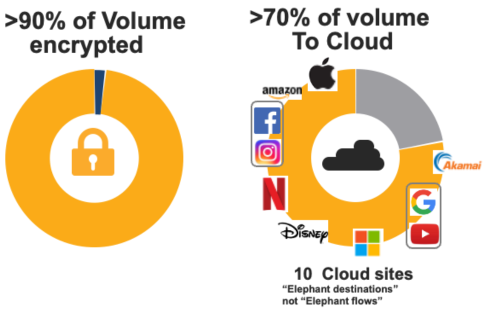
A Broadband “guru” on BNG

Broadband Internet Traffic Trends

High BW

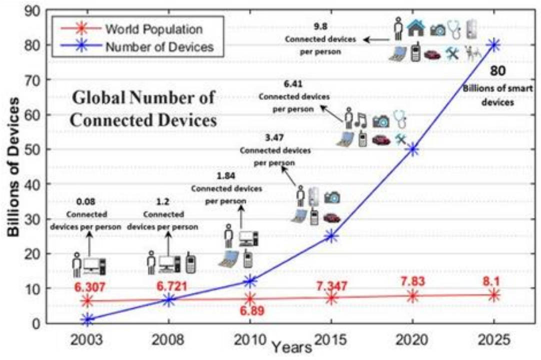


Encrypted



Destination: All-encrypted world
Cloud: Concentrating the Internet

Nomadic



9.8 Connected devices per home

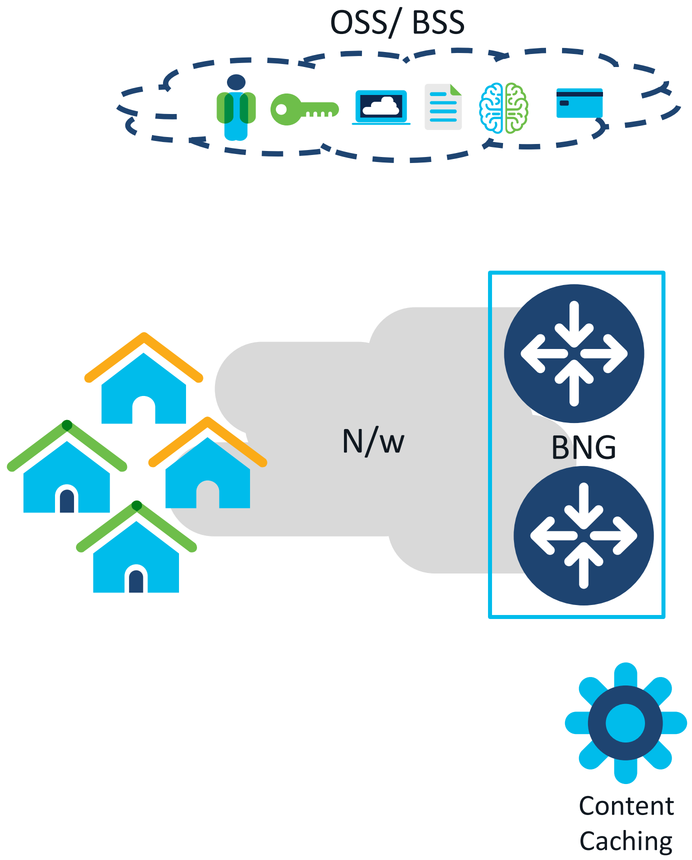
Wireline Broadband Network Challenges

Growth Planning

Faster Time To Market

TCO Reduction

OSS/BSS Integration



Wireline Broadband Offerings Trends

Broadband Service offerings are getting lean and flat

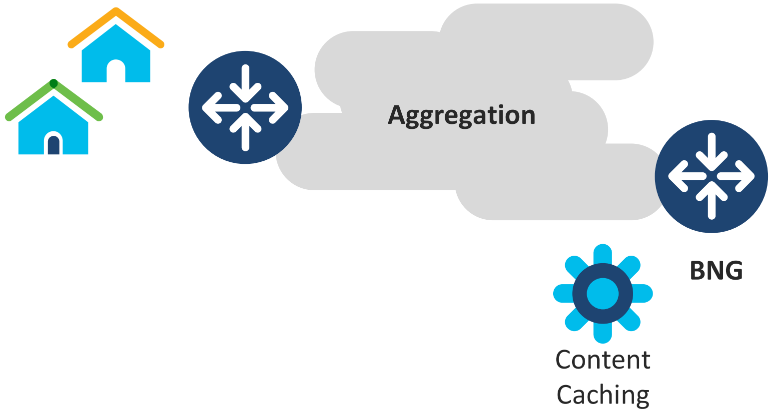
Traffic profile is lighter today and end user device Traffic Managers handle more

Subscriber GW scale and functional requirements are getting lighter as distribution is happening

New transport protocols (QUIC, TCPLS) optimizes traffic behavior that no longer require heavy network level QoS

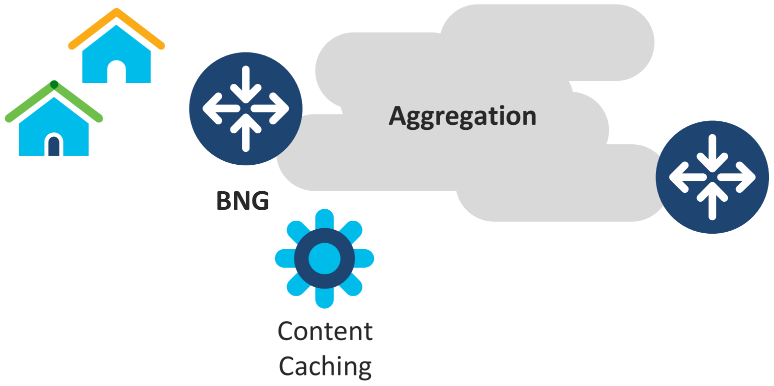
BNG Deployment Options – So Far…

Centralized



- Recommended for Lower N/w wide subscriber density
- Recommended for Lower Per Subscriber Bandwidth
- Easier to manage and troubleshoot
- Challenge: Higher Bring-up time in case of outages
- Challenge: Frequent network wide bandwidth upgrades required

Distributed



- Recommended for High Network wide subscriber density
- Recommended for High Speed Per Subscriber bandwidth
- Localization of failure
- Local Service insertion at the distributed location (CDN)
- Challenge: Cost & Complexity increase with Distribution?

How to achieve best of both?

Wireline BB Service Comparison – Legacy vs Todays Evolution

Service Attribute	Legacy BB Service and BNG	Next Gen BB Service and Subscriber GW	
Termination endpoint	Home RG	Home RG or Individual end device in-home	**All broadband attributes are either simplified or reduced in scale leads to a simple subscriber management architecture**
SLA Type	Best Effort, non-guaranteed thput & counted quota	Per Device SLA driven, **Flat per month**	
Network Positioning	Centralized BNG, High Subs Scale – **256-512k Subs**	**Distributed** to Metro – Lower Scale – **32-64k Subs**	
QoS type	Heavy H-QoS per home, Shaper per traffic class	**Simplified QoS, reduced traffic classes**	
Service control	Individual and heavy per BNG signaling with AAA, policy and charging – **mostly vendors specific**	**CUPS** based simplified and centralized signaling with light AAA and policy – **standardized AVPs**	
Thput	Low thput per home – **less the few Mbps**	**High thput** per home and selective per endpoint – In the order of **few 100s Mbps**	
BNG type	Physical Edge router – Heavy ASICs	**Lighter** MSE and Virtual User Plane, Cloud CP,	
OSS Integration/Operations	Heavy OSS integration, mostly snmp or vendor EMS on **proprietary NBI**, **mono vendor dependency**	Multi vendor, Open APIs from CP to NBI, **Abstracted and simplified**	
Accounting	Strict accounting for charging and policy, App level accounting for usage control	**Light** accounting for reporting and monitoring	
Policy & Charging	Complex Policy logic , down to app level charging control	Flat policy for unlimited broadband, Flat charging per month	
Access Type	Fixed access only, DSL and PON	**Converged Access**, FWA, PON, DSL, Wifi etc.	
Application Visibility	Yes, DPI enabled BB services	**No**, exclude DPI and all related app based services	
Service Signaling	Fixed only services	Wireline, Wireless, FWA and Wifi- **Converged**	
Value Add Services	On BNG - services blades	Not on BNG but On Distributed Edge Compute	
Subscriber Placement	Fixed and static on a predefined BNG	Dynamic and steered per Service ask	

New Architecture Drivers

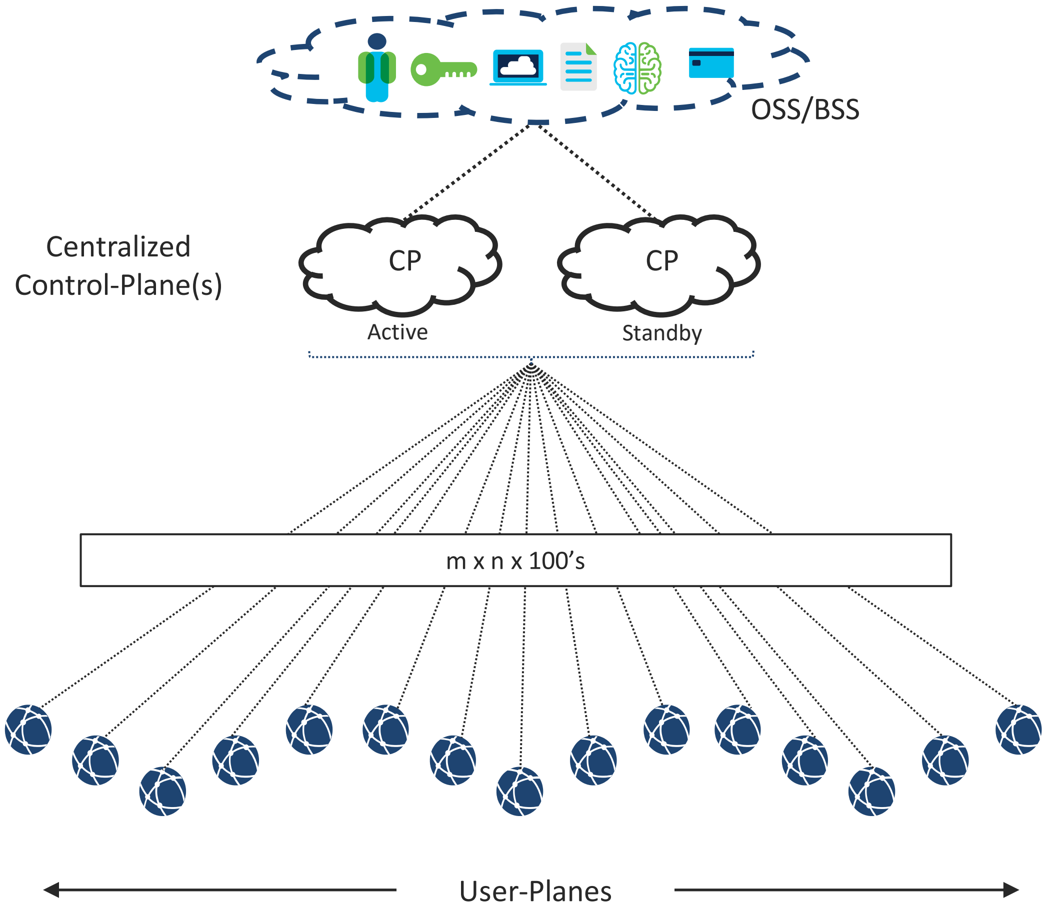
Services closer to subscriber with flexible GW options

Independent CP and UP scaling and ease of integration

Common Infrastructure, Common Policy, Convergence, New Business Models

New and Differentiated Broadband Offerings

Control and User Plane Separation



CUPS means Control and User Plane Separation

- Defined by Broadband Forum in TR-459

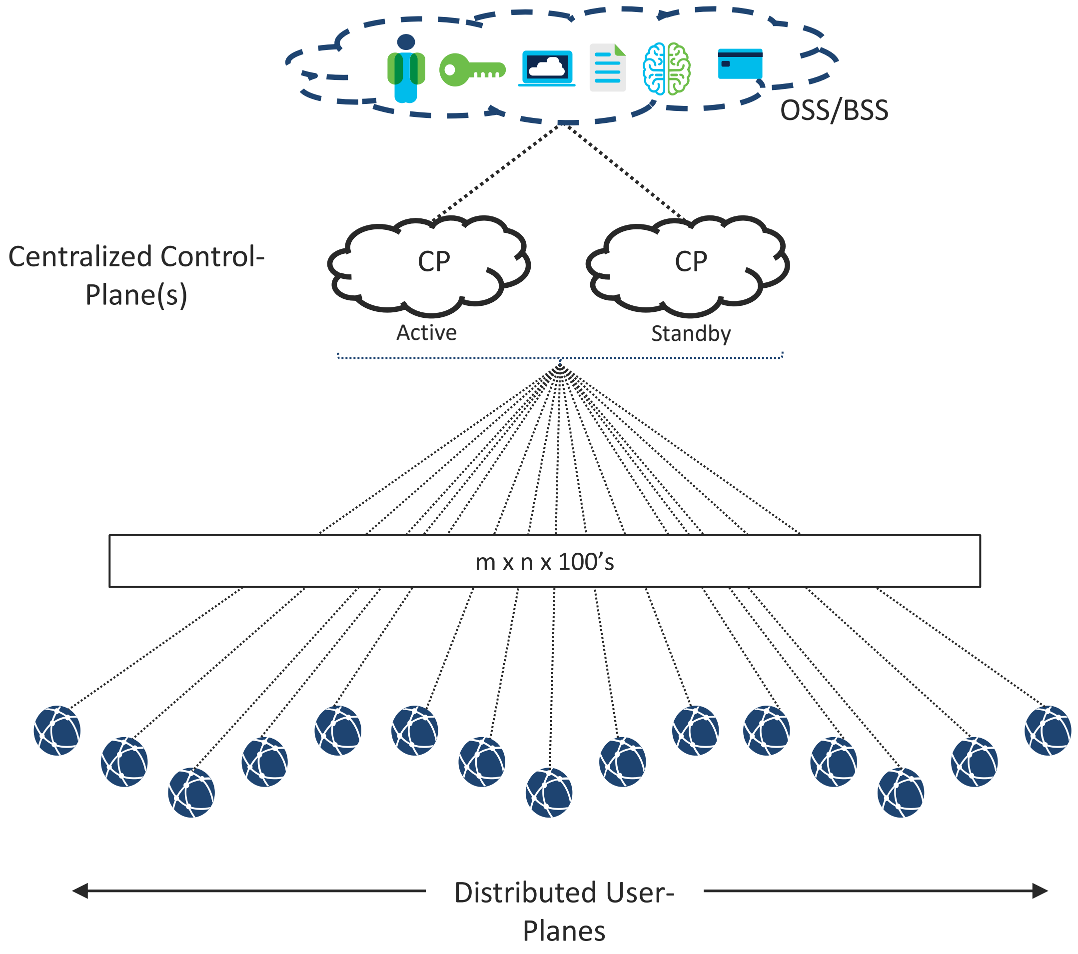
CUPS BNG means separation of

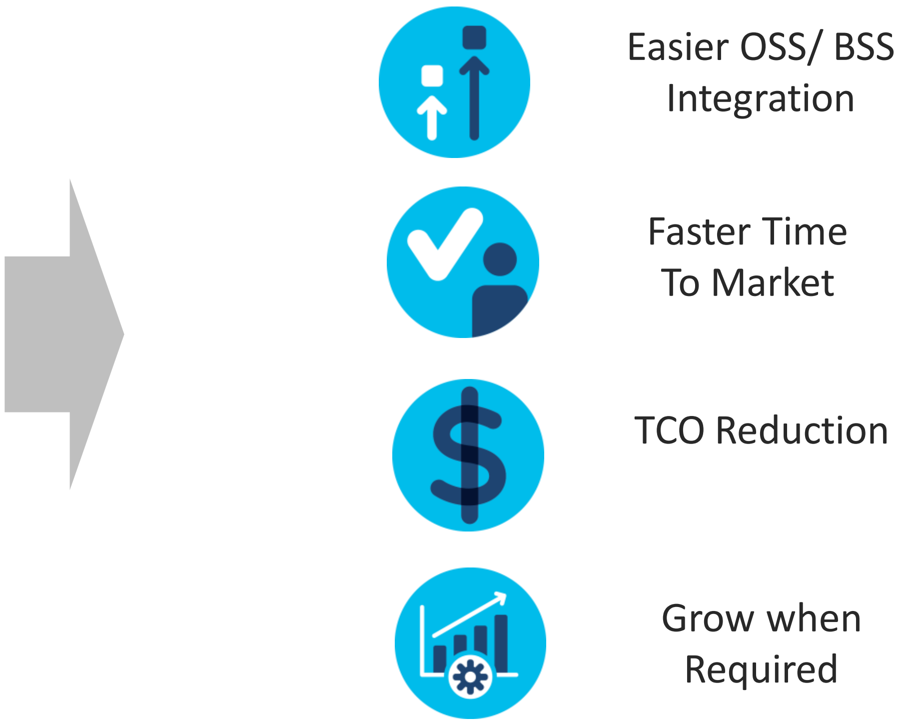
- BNG Control Plane and BNG data/user plane

With CUPS BNG

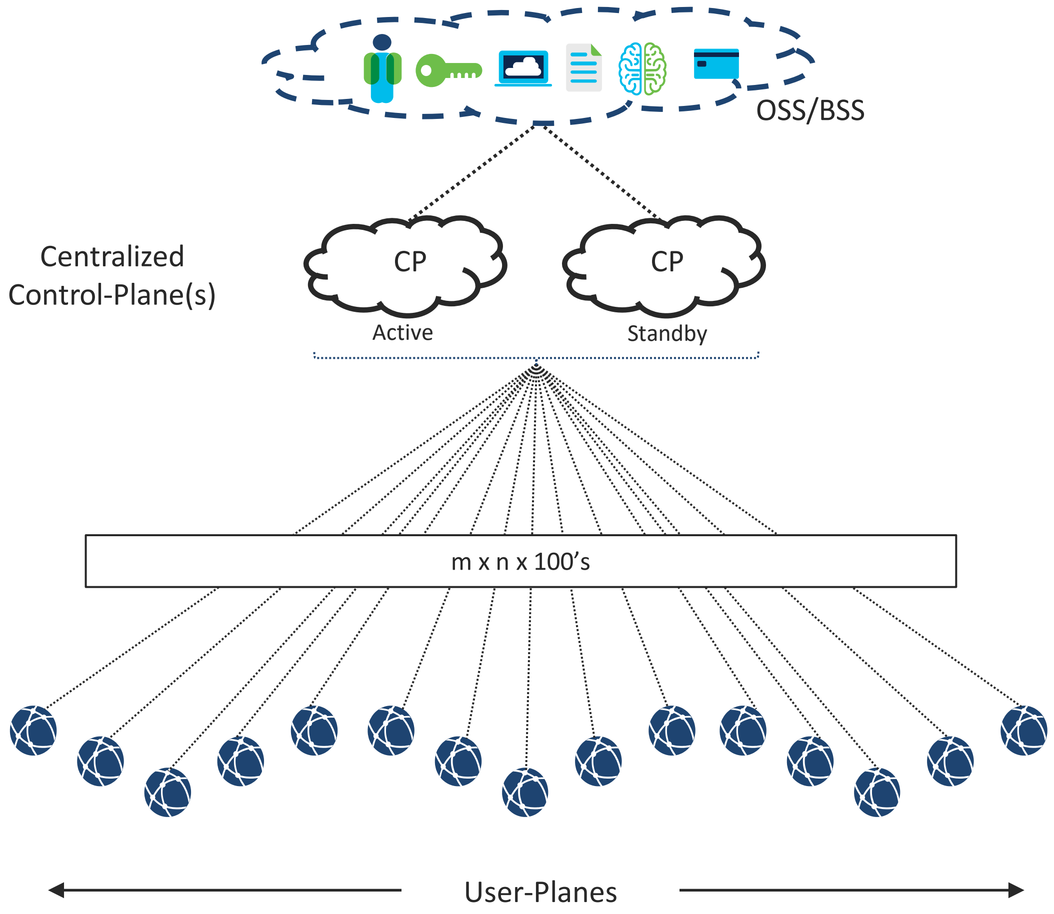
- BNG Control Plane moves to Cloud (centralized)
- OSS/BSS Interacts with Centralized Control Plane Function
- CP becomes centralized entity to manage and troubleshoot entire distributed BNG deployment base
- Customization possible in Cloud Based CP for easier OSS/BSS integration
- BNG Data Plane can be either: Hardware or Software
- Leaner Data Plane as control functions move to cloud
- A Single CP controls 100s of UPs enable new use cases

Control and User Plane Separation





CUPS BNG Function Split and simplification of DP



Control plane functions

- Authentication
- Authorization
- Accounting-data reporting
- Address assignment
- Security and policy management
- Centralized Management

Data plane functions

- Access termination
- Accounting data collection
- Security and Policy enforcement
- Quality of service (QoS)

Cisco cnBNG Architecture

Why Cloud Native?

- **State separation**
  Session state is deployed in separate containers enabling simplified scalability and availability of application services
- **Lightweight Footprint**
  Container startup times in seconds as opposed to minutes for VMs.
  Deploying patches and upgrades target only updated containers.
- **Service Discovery**
  As containers become available, they are dynamically discovered and added to runtime.
  As containers fail or are removed, dependent containers are made aware.
- **Elastic Scalability and High Availability**
  Dynamic scheduling of containers enables for simplified scale up/down of each individual service.
  Lightweight stateless containers can be more quickly detected and recovered.
- **Highly Portable**
  Container technology encapsulates the program and its dependencies to enable portability across bare metal and virtual machines running on public and private clouds.

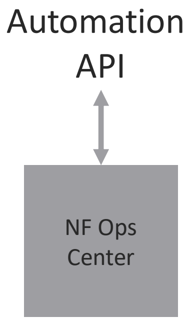
Subscriber Management Infrastructure (SMI)

SMI K8s Cluster Manager

SMI CM provides K8s CaaS LCM:

- Provision K8s cluster,
- Deploy K8s Addons
- Customize OS
- Offline Registry & Image Repository
- Launch Apps
- K8s Upgrade

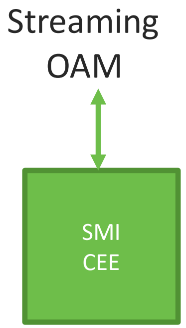
Ops Center Framework



OPS Center provides Common MGMT API:

- NETCONF/REST API
- CLI Interface
- YANG Model
- Config DB
- Operational Callback
- Security: NACM/AAA

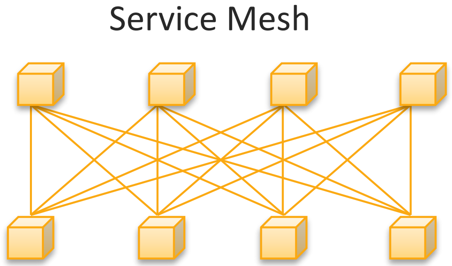
CEE: Common Execution Environment



CEE provides shared platform capabilities:

- Telemetry
- Alarming
- Logging
- Tracing
- Health-checks

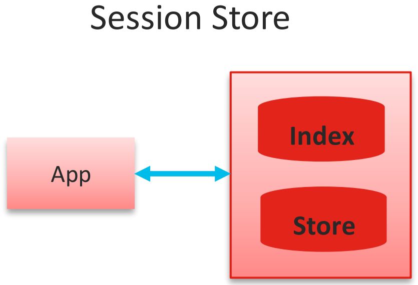
Intelligent Service Mesh



Intelligent Service Mesh connect microservices:

- Traffic Steering
- Load balancing
- Service-to-service authentication
- Policy
- Monitoring

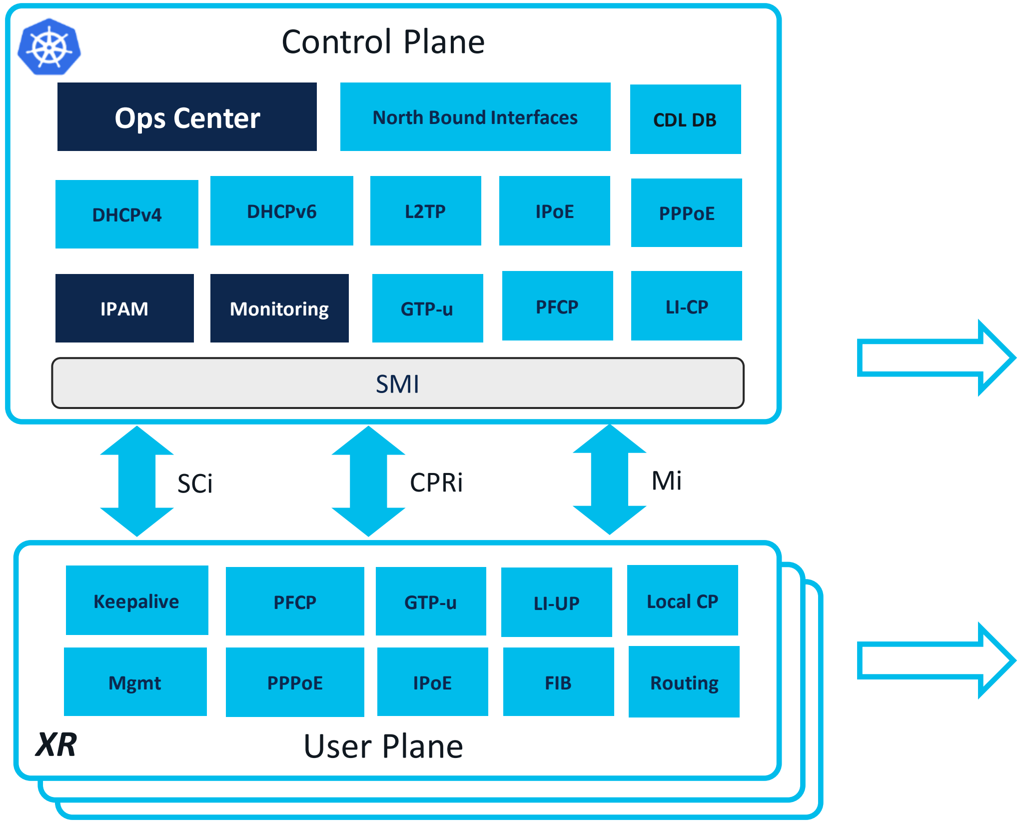
Common Data Layer



Common Data Layer for stateless microservices:

- In-memory session store
- Geo-redundancy
- High Performance
- Low latency

cnBNG High Level Architecture



- **Control Plane:**
  - Built as cloud-native application for greater resiliency
  - Runs on SMI (Cisco CaaS) which is a common infrastructure for BNG and Mobility
  - Key BNG functions split into multiple containers
  - Multiple containers allow: in-service upgrade, independent patching, easy scale-in/out of services, faster feature delivery
  - Network wide licensing model
  - Varying deployment models: VMWare, CVIM, Openstack, Baremetal, Public cloud
  - Cloud Native LNS only CP

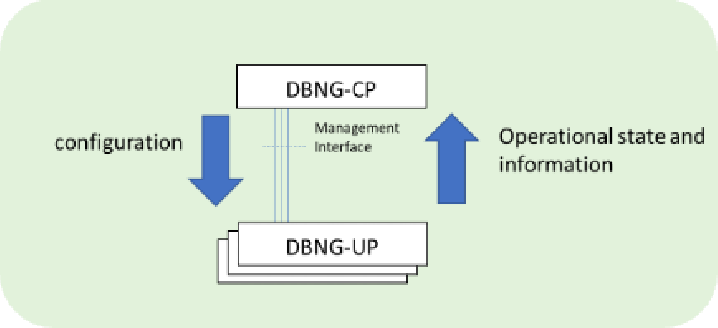
- **User/Data Plane:**
  - ASR9k IOS-XR based UP
  - XRv9k / XRd Virtual UP

cnBNG High Level Architecture: CUPS Interfaces

1

Mi (Management Interface)

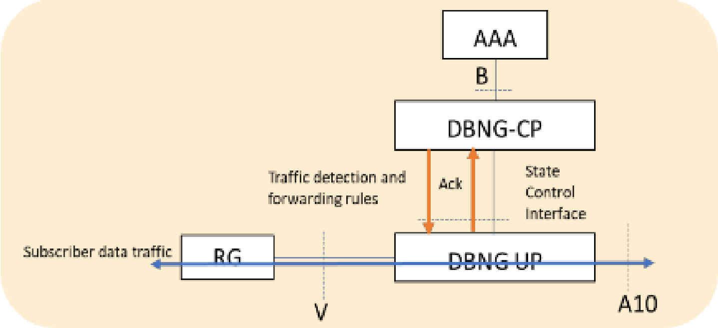
- Model Driven Interface
- Configure User Plane
- Retrieve Operational State and Information from User Plane



2

SCi (State Control Interface) - PFCP

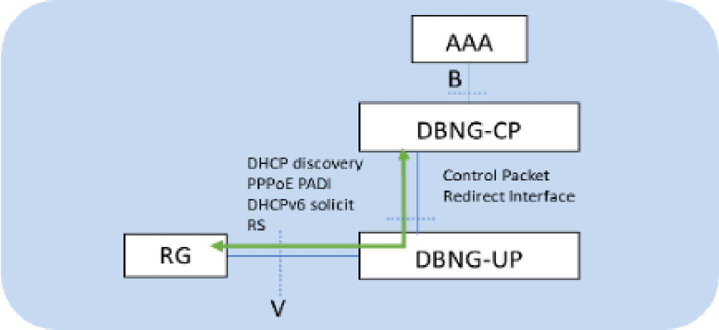
- Defined by 3GPP TS 29.244, BBF has additions for wireline use cases
- Used to program Subscriber sessions and redirection rules on the UP



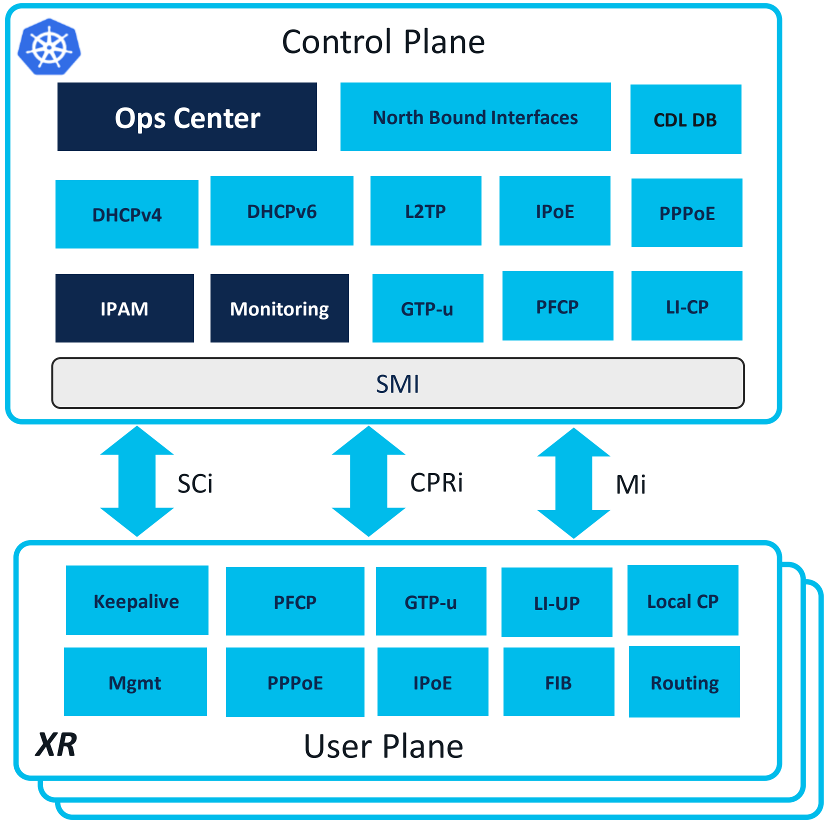
3

CPRi (Control Packet Redirect) – GTP-u

- GTP-u as the tunnel
- Tunnels Control packets between RG and CP over the UP
- Implements a tunnel per subscriber



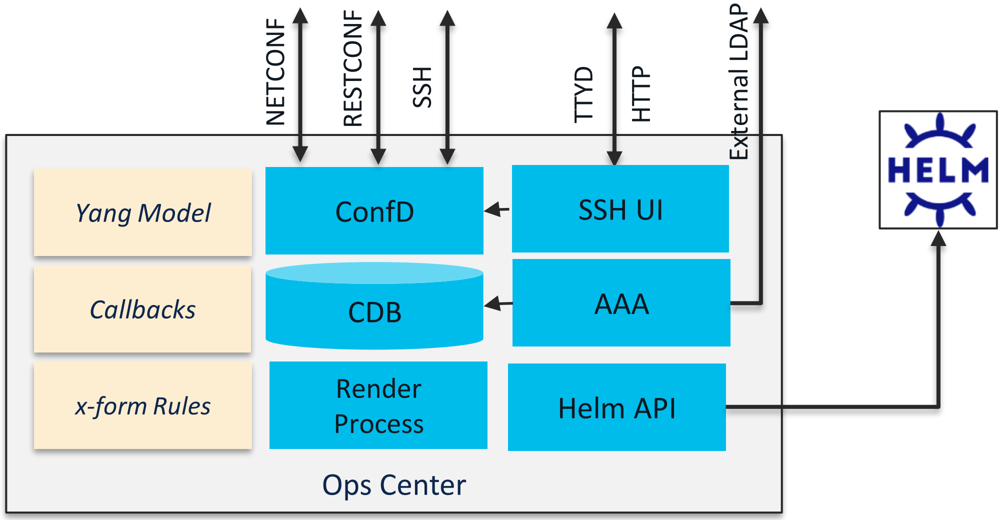
cnBNG High Level Architecture: CP Main Functions

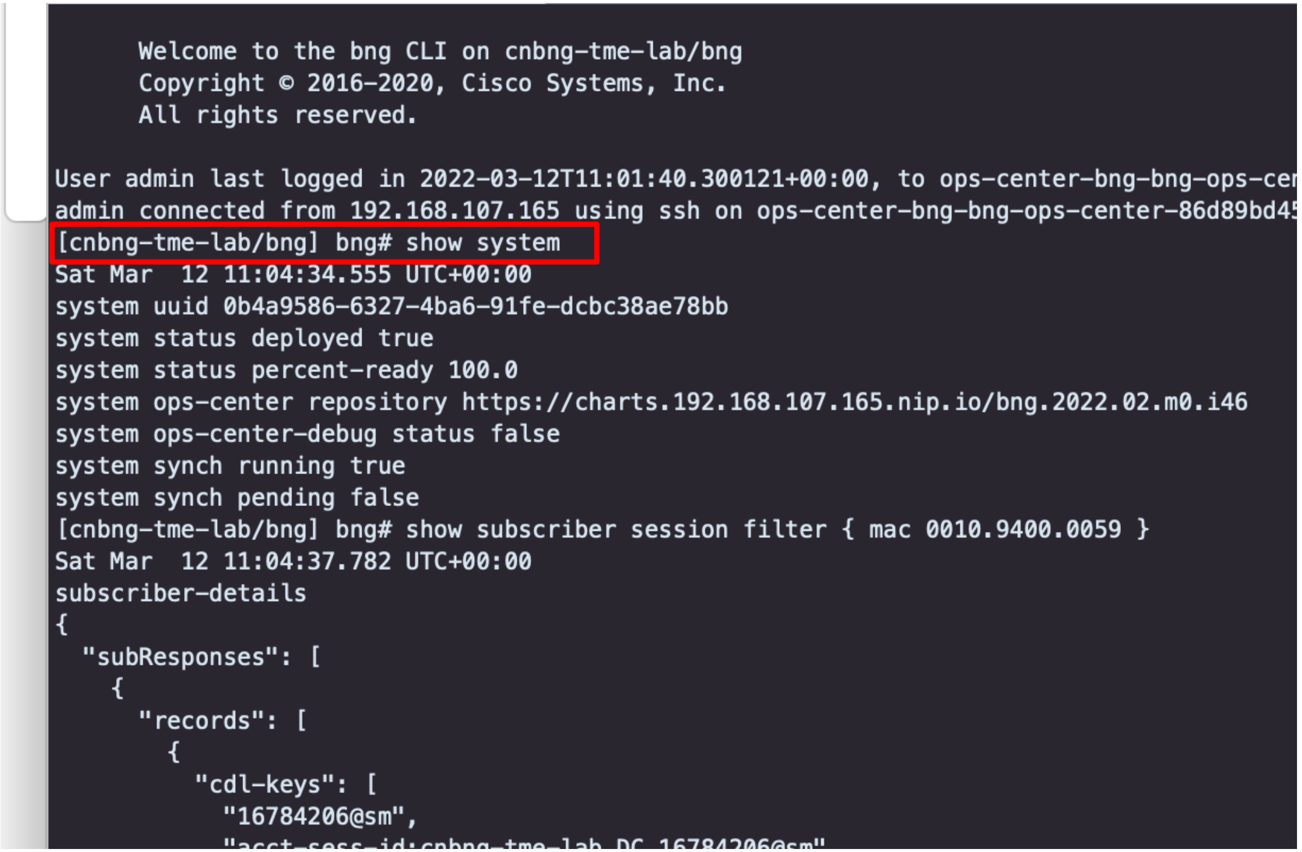


- **Ops Center:**
  - Provides Model driven netconf/restconf/cli interface
  - Abstracts K8s details for day2day operations
- **IPAM:**
  - Stands for IP Address Manager
  - Provides a centralized mechanism to manage IP address
  - Flexible chunks, allocation on demand,
- **Subscriber Monitoring:**
  - A unified view of BNG Deployment
  - Exposes 100s of metrics and KPIs for BNG monitoring
  - Includes an in-built, user customizable Grafana dashboard
  - Can generate alerts through Alert Manager

Ops Center

- <u>**cnBNG CP Ops Center embeds Cisco Conf-D and Provides:**</u>
  - Model Driven NETCONF, RESTCONF, and CLI interfaces
    - Allows for NSO integration without custom NED
  - YANG Models
  - Application specific rules to transform the configuration data into Helm chart configuration
  - Audit logging and validation of the configuration
  - Connection to an external LDAP server
  - Cisco Smart Licensing integration
  - Call-backs into the application to execute operational commands
  - NACM security model



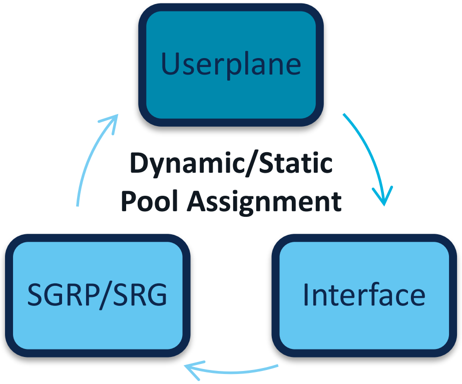


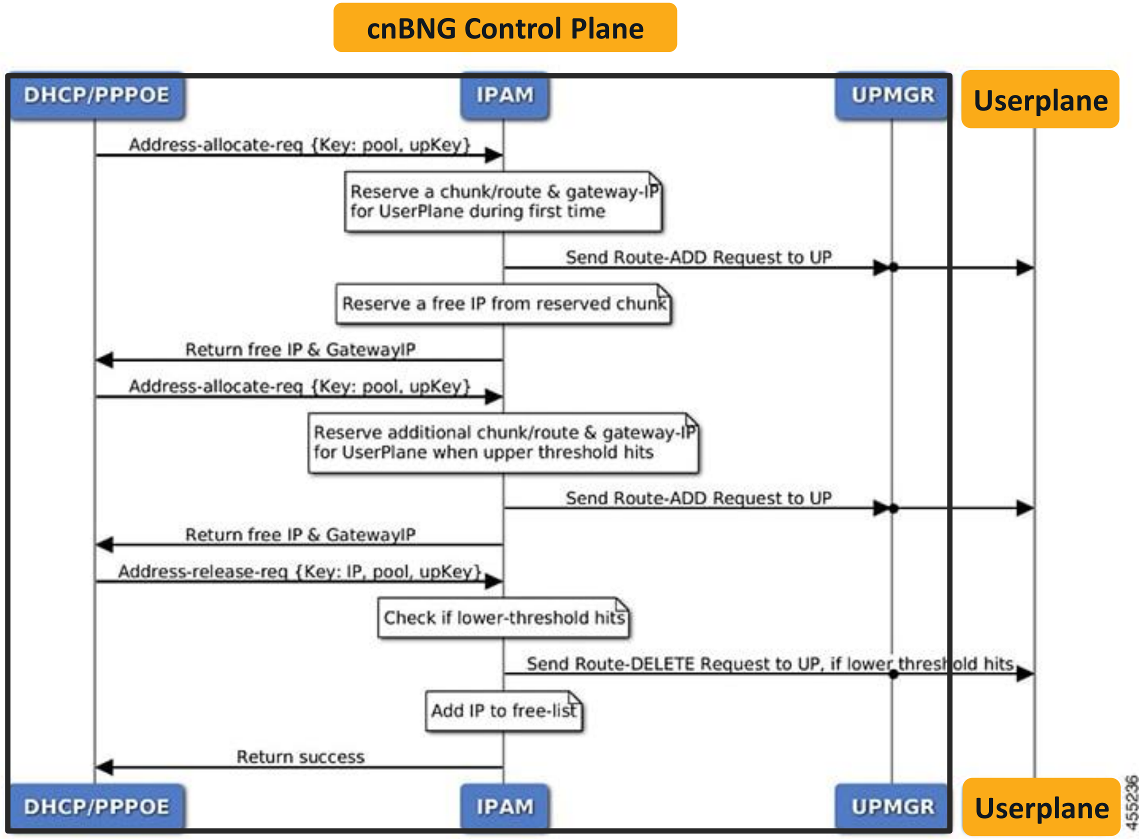
IP Pool and Address Management: IPAM

```
[svi-cn-bng-tb3/bng]  bng# show ipam pool

=========================================================================================
PoolName                Ipv4Utilization  Ipv6AddrUtilization  Ipv6PrefixUtilization
=========================================================================================
POOL_2              1.46%          4.01%              1.00%
POOL_1              1.46%          4.01%              1.00%
POOL_3              2.86%          18.30%             1.14%
=========================================================================================
```

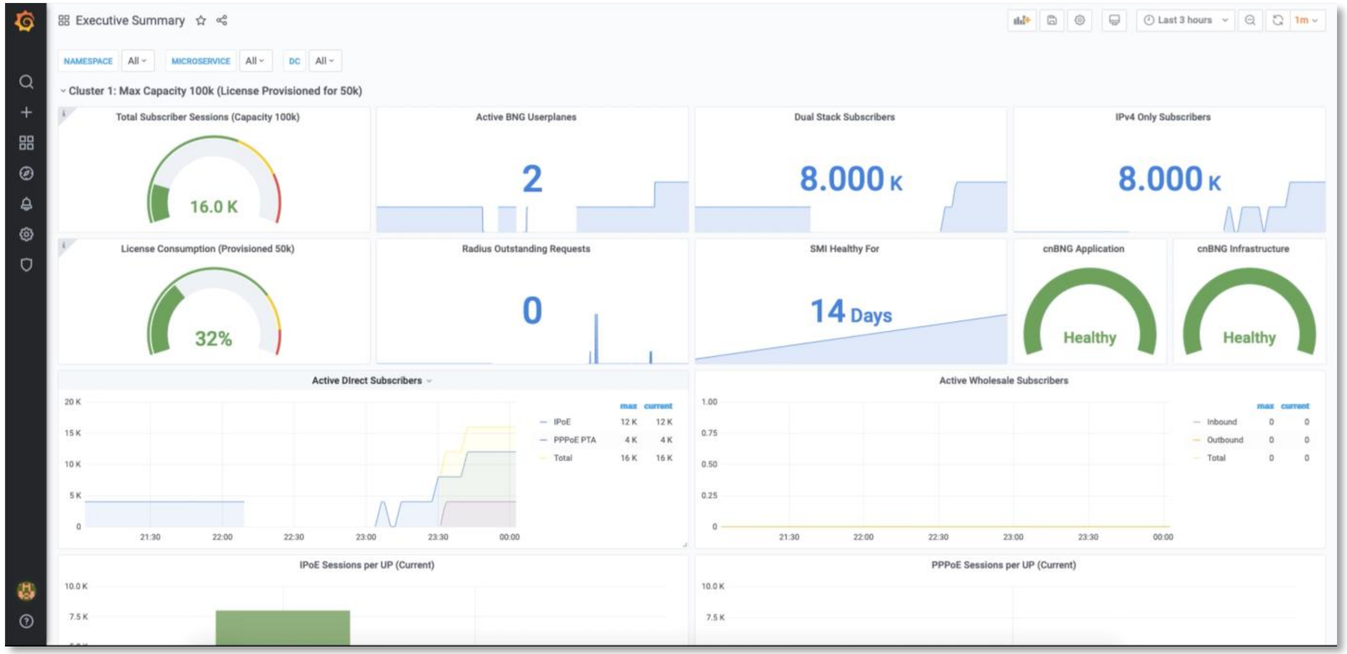
```
ipam
 instance 1
  address-pool POOL_2
   address-quarantine-timer  60
   vrf-name                 default
   ipv4
    split-size
     per-dp    256
    exit
    address-range 12.0.0.2 12.10.255.254
   exit
```

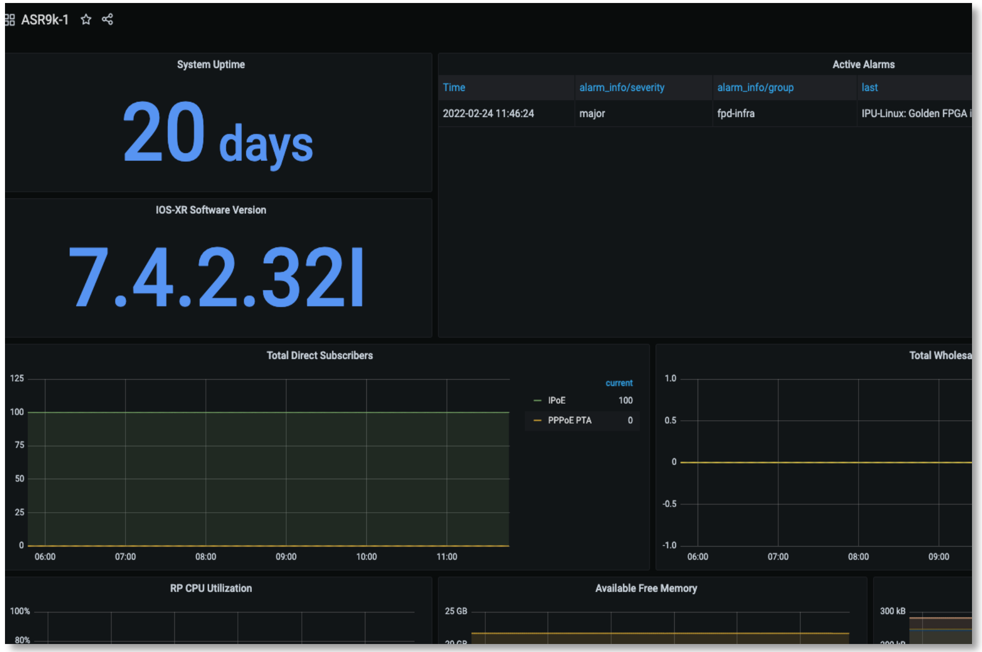




Simplified Subscriber Monitoring

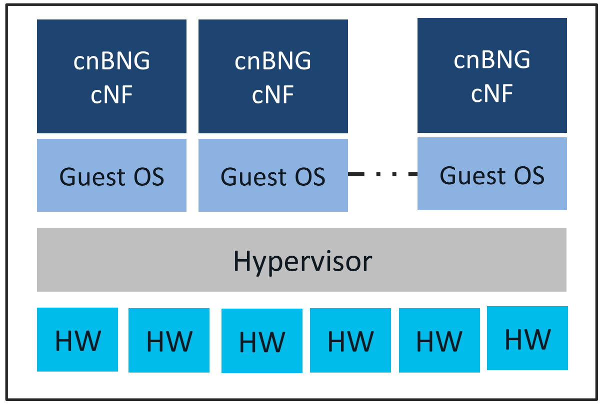
Collection	Visualization	Alerts
• Controlplane metric collection inbuilt • Model Driven Telemetry for UP stats collection • 100s of subscriber metrics already available from Control Plane	• Metrics Visualization on Inbuilt Dashboard (Grafana) • Integration with external visualization also supported	• Alert Manager for generating alerts • Alerts via Email, Webhooks, SNMP or on Grafana dashboard • Netconf/ Restconf/ CLI to set alerts





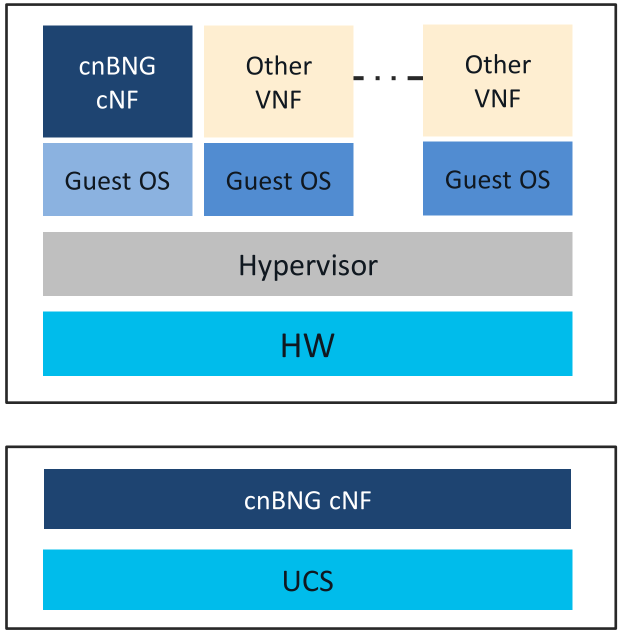
cnBNG CP Deployment Options

Multi VM



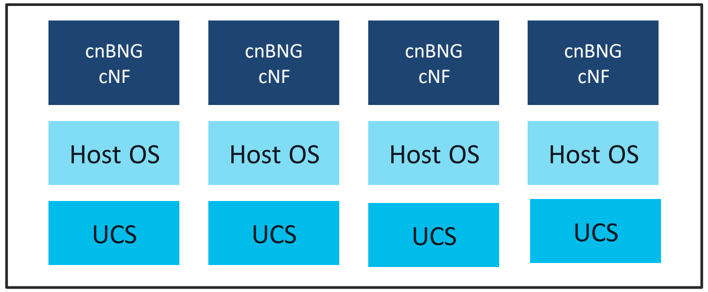
- For limited deployments only
- Deploy cnBNG CP in multiple VMs for Scale

All-in-one



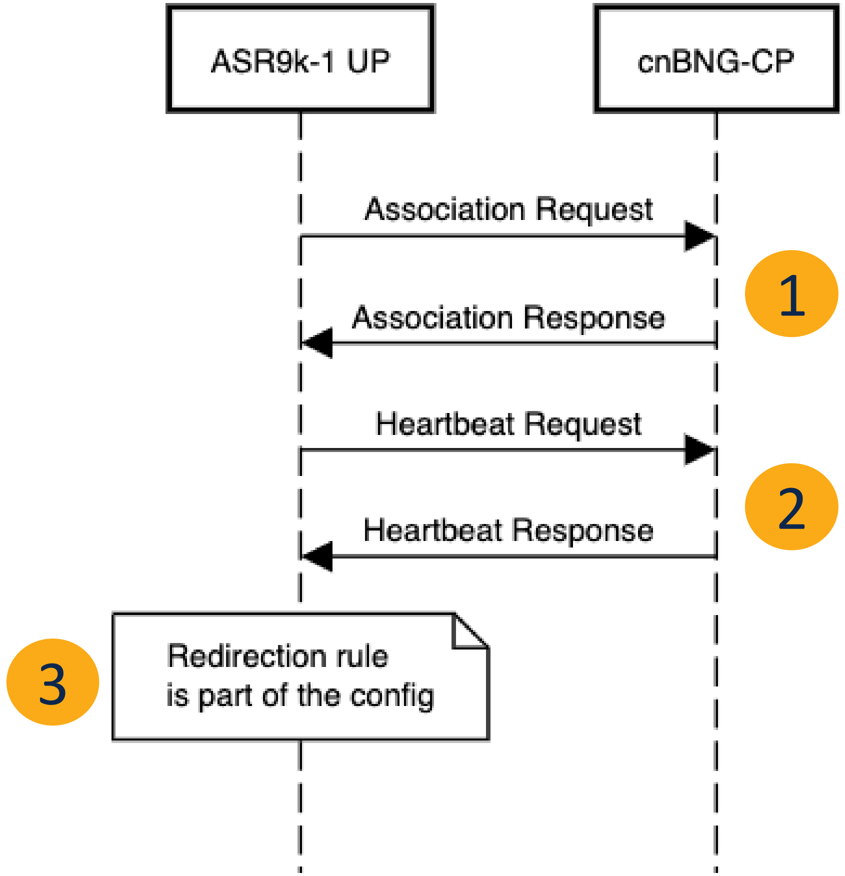
- Deploy cnBNG CP in a single App or a UCS Server

Baremetal

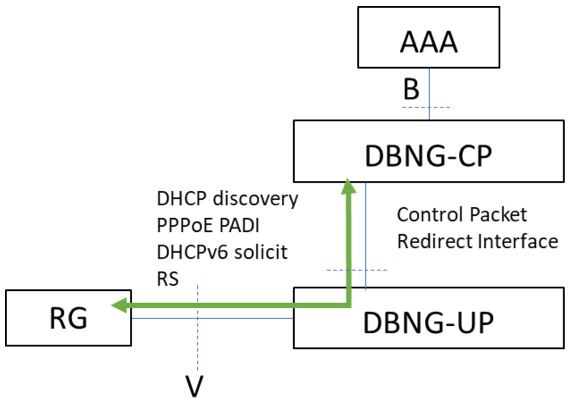


- Run containers directly on bare metal; i.e. no VIM layer
- Removes hypervisor over head & license Cost
- 20% to 30% more available CPU cores
- Server savings in the magnitude of 4 to 9 blades
- Single monitoring endpoint for both server and application health

Sample CP-UP Association Call Flow



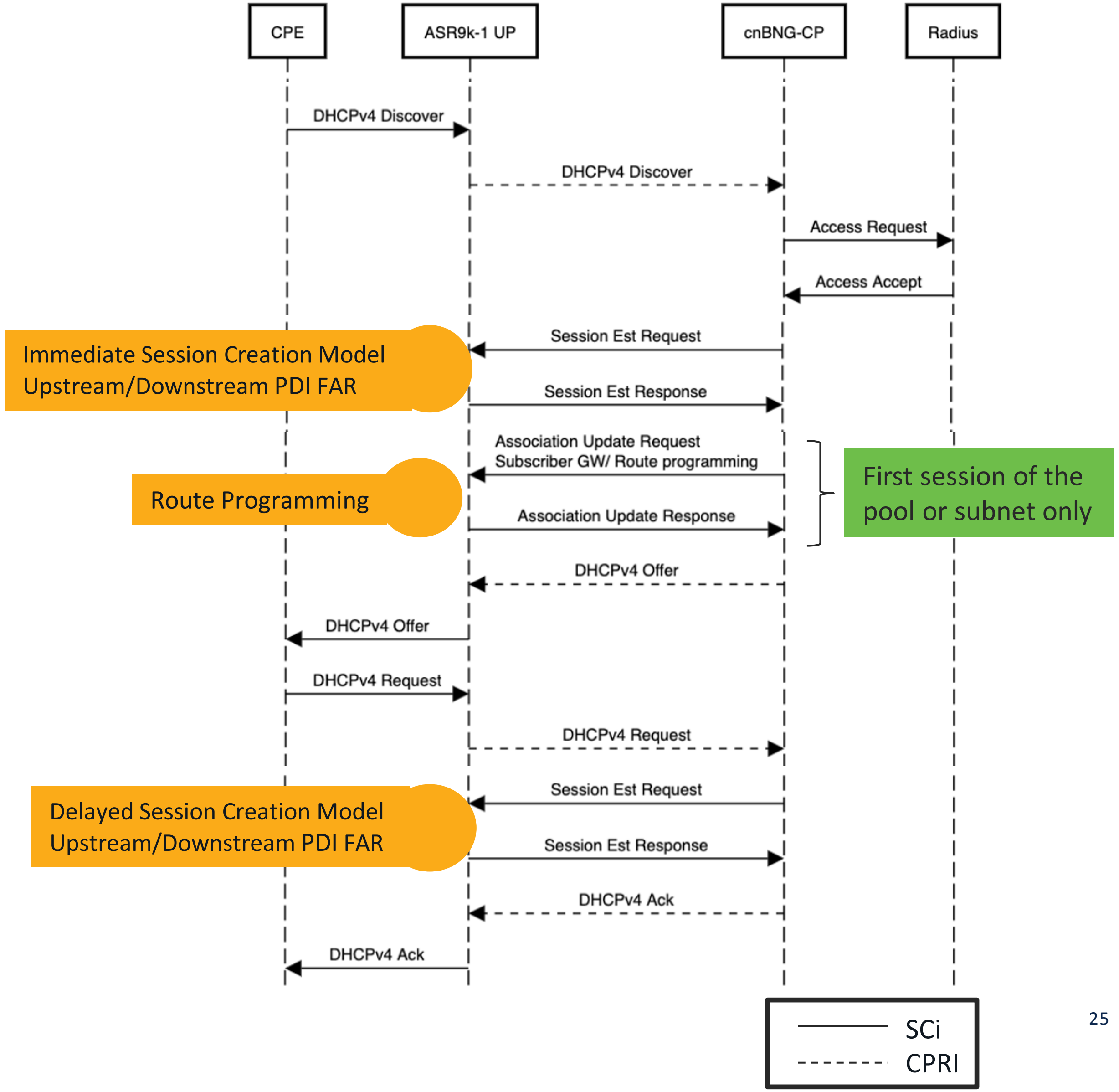
Control Packet Redirect Interface (GTP-u)



- Control PDRs to program traffic tunneling between RG and CP
- All CPR models are supported in order to allow most flexibility to our customers deployment models;
  - Support for per UserPlane Defaul CPR
  - Support for per Logical Port Default CPR
  - Support for Upstream Only dafault CPR
  - Support for Upstream / Downstream Default CPRs

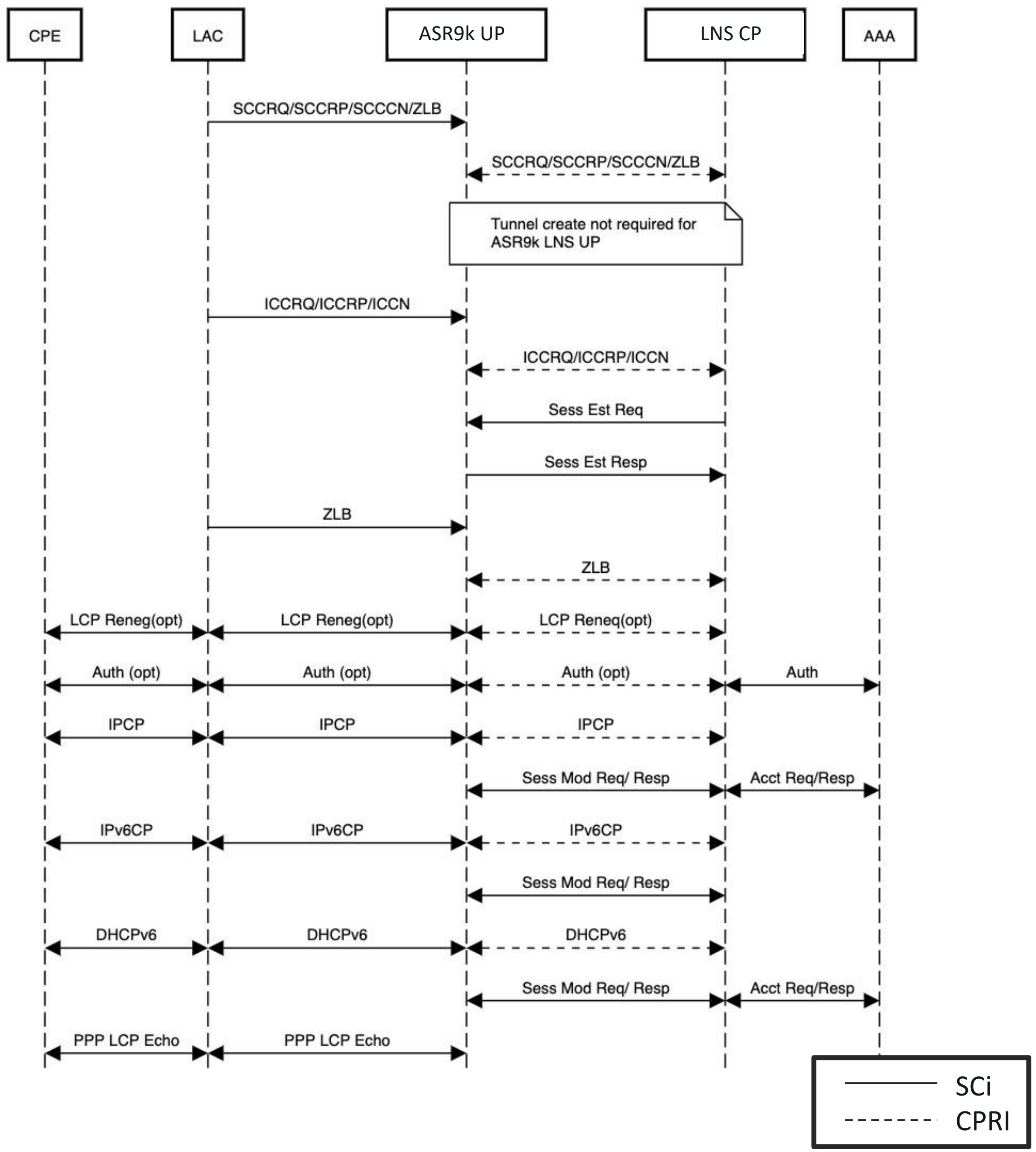
Sample IPoE Call Flow

- Support for both Immediate and delayed session creation models to optimize session resources.
    - Session resources are not immediately allocated /consumed until session reality is validated
- Pool Allocation for subscriber group is done only once in first subscirber session of the group
- Subscriber subnet router programming is programmed from Control Plane to Userplane, to optimize routing behaviour.



L2TP LNS Call Flow

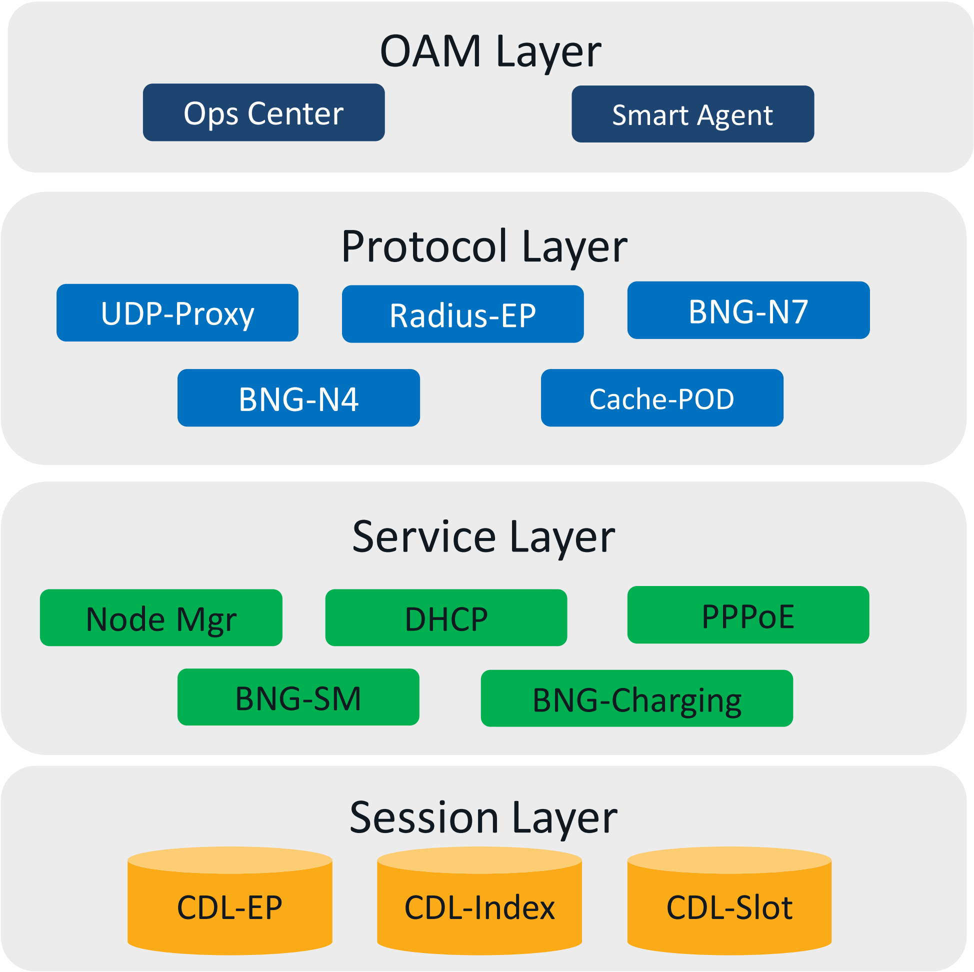
AVAILABLE NOW



Session ID

Resiliency

Resilient Control Plane Layered Architecture



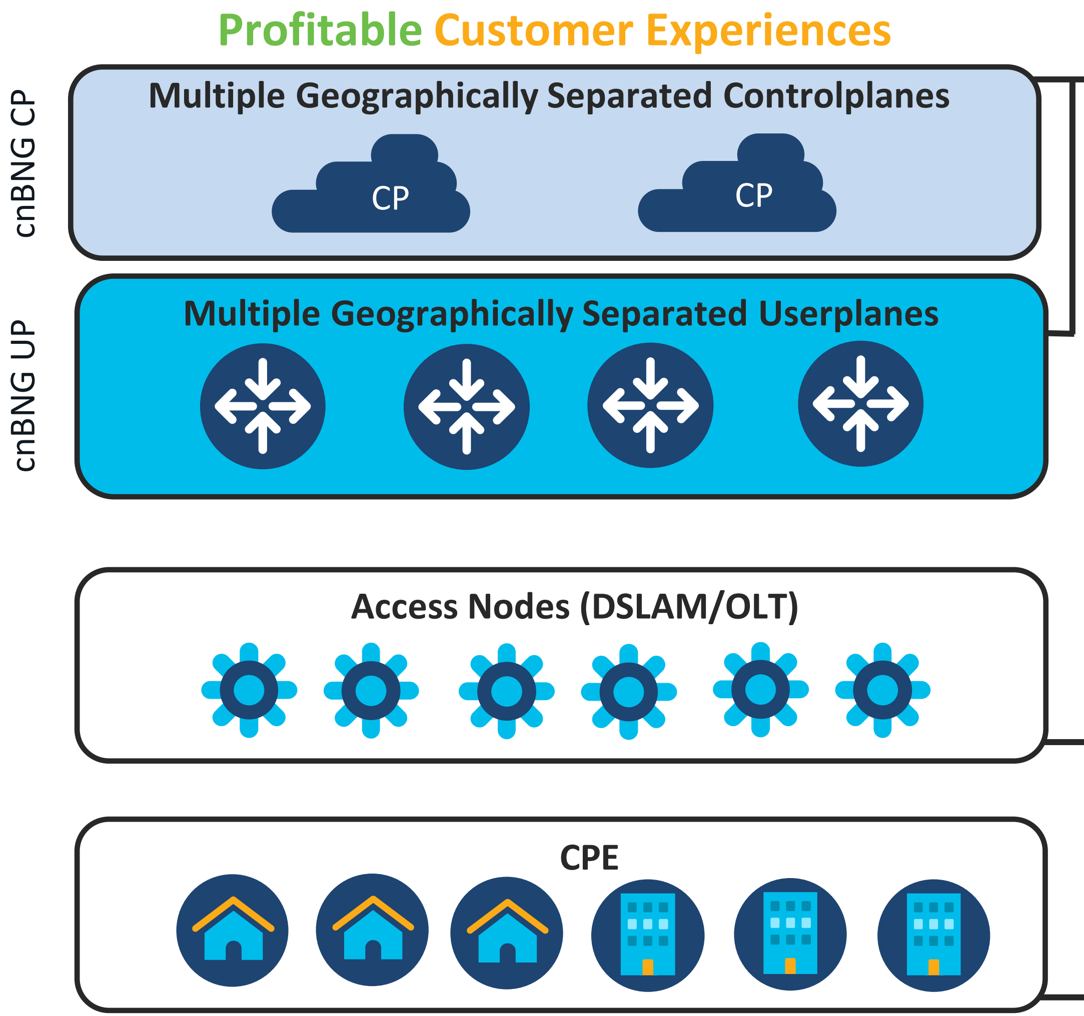
Multiple k8s Nodes can be deployed per Layer

K8s Node labeling is used to separate deployments

Multi-replicas of similar container are possible within each Layer

All containers are stateless except CDL which can be Local or Geo Redundant

cnBNG Geo redundancy



Stateful Redundancy

Cisco cnBNG CP and UP can be geographically spread out with L3 connectivity. **ICL is not required.**

1:1, M:1 and M:N Redundancy for Userplanes
1:1 Active-Active Redundancy for CP through CDL DB

Hot-standby and Warm Standby Redundancy Models for UP
Redundancy in case of

- Access/Core Link Failures, CP-UP link failure
- Site Failures , UP Failures: Line Card, RP, Chassis Failures
- Control Plane failure/ degradation
    - Local Monitoring: Node, POD, VIP
    - Peer Health Check
    - Reception of Control Traffic on Backup

Multiple Technology Support

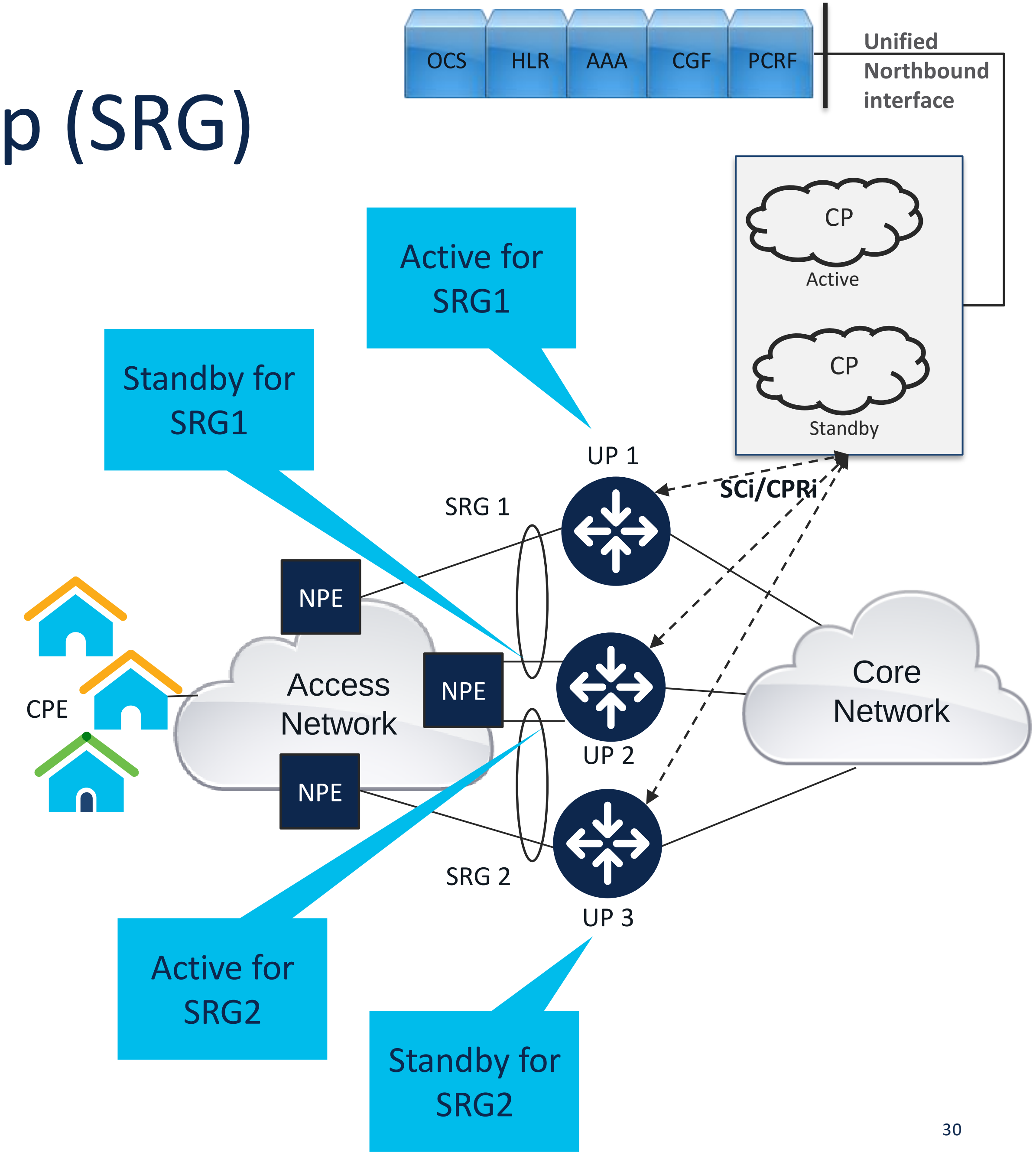
Access Nodes are dual/multi-homed for redundancy using a variety of technologies based on the SP network design and choices - MCLAG, Dual Homed, Ring (G.8032), PWHE, Routed, EVPN etc…

Transparent Switching

CPEs see one Gateway

Subscriber Redundancy Group (SRG)

- SRG is a set of subscriber sessions that switchover from one cnBNG Userplane to another as a group
  - A unit of failover for geo redundancy
  - Can be defined as a set of : Port, VLAN, BE, PWHE, Mix
  - Provisioned in consideration of the redundancy design in access & core networks – capacity planning, load balance, routing preference, etc.
- Active and Standby state defined at Control-plane
- Control-plane determines the state of SRG on User-plane and controls subscriber traffic flows and sessions
- Tracking is leveraged to inform failure conditions on User-plane to Control-plane
- No Accounting change at backend



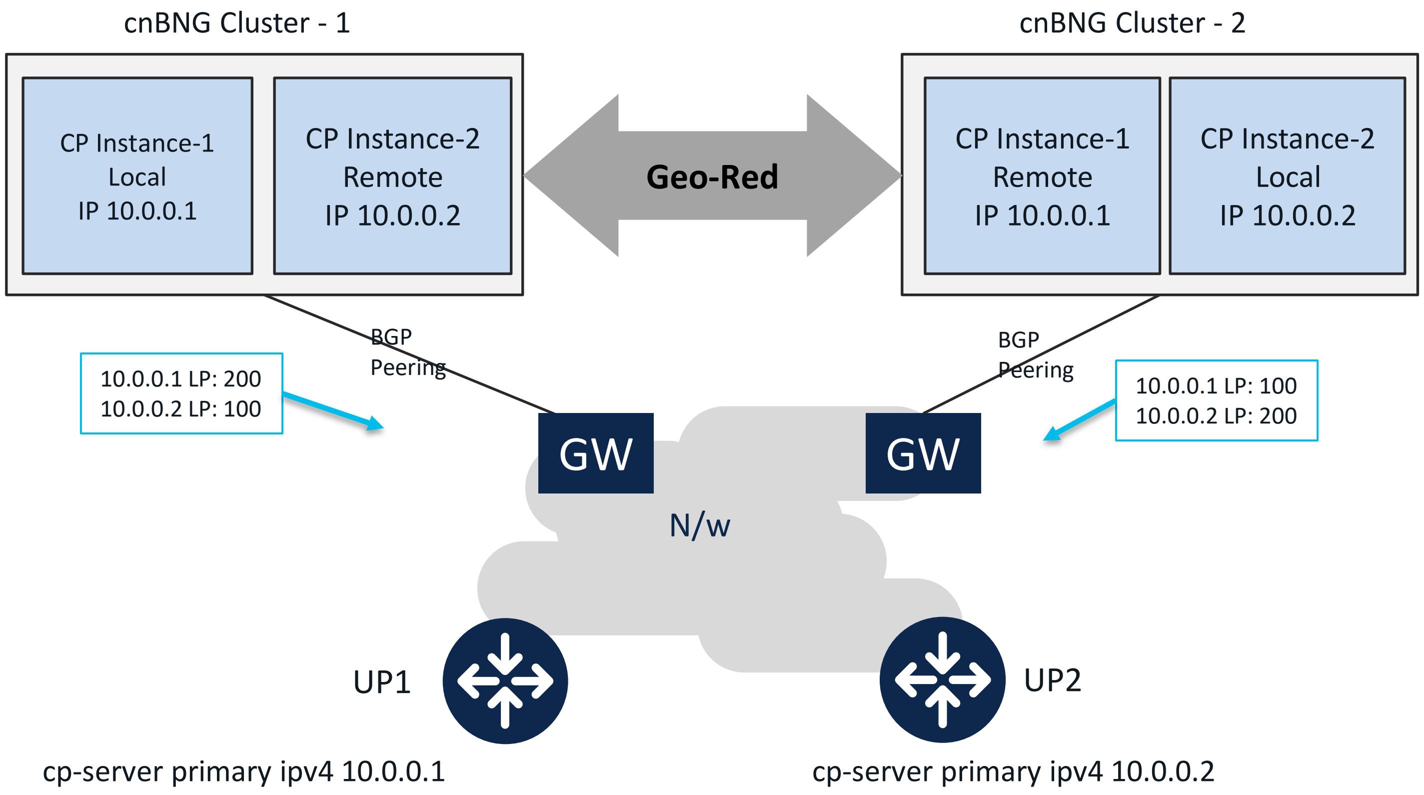
Control Plane Geo Redundancy

Instance is a logical Entity that segregates subscriber sessions

All options with Local and Remote Instances per cluster are possible

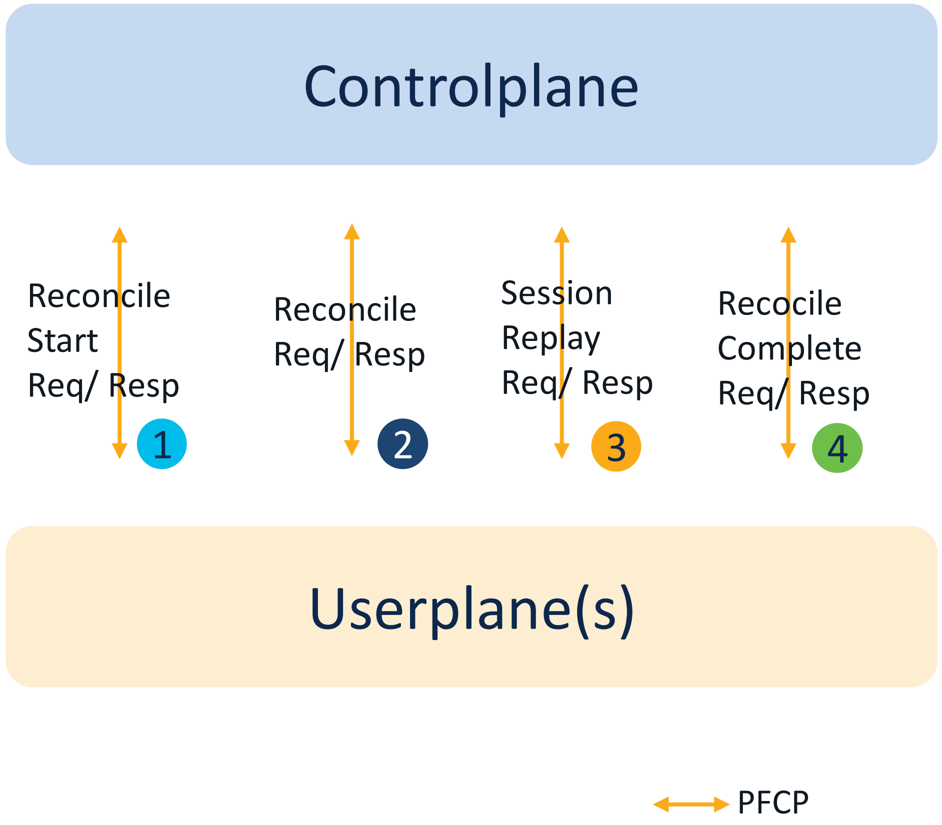
Redundancy in case of:

- Local Monitoring: Node, POD, VIP
- Peer Health Check
- Reception of Control Traffic on Backup



CP-UP Reconciliation of subscriber sessions

- Reconcile to synchronize subscriber state between CP and UP with CP as master
- Detection of Inconsistency
- Checks Subscribers and their states
- Session Replay helps restore lost or stale sessions
- Triggers:
  - Through Configuration
  - On failures: Link, LC, RP, UP, Association etc.
  - Periodically



Conclusion

Take Away

- Broadband networks “**NOT all same**”
- BNGs/User planes at a single network are also “**NOT same**”

- Cisco Cloud Native BNG provides flexibility with all deployment options to realize best outcomes.

- You want to hear more?
  - Please reach “*Mustafa Bostanci or Gurpreet Dhaliwal*”

References

Explore and learn more on cnBNG

- Cloud Native BNG Config Guides
  - CP: https://www.cisco.com/c/en/us/td/docs/routers/cnBNG/cnBNG-CP/2022-02-x/Config-Guide/b_cnbng_cp_config_guide-2022-02.html
  - ASR9k UP: https://www.cisco.com/c/en/us/td/docs/routers/asr9000/software/asr9k-r7-6/cloud-native-bng/configuration/guide/b-cnbng-user-plane-cg-asr9000-76x.html
  - XRDocs Tutorials/Blogs: https://xrdocs.io/cnbng/
- XRDocs Youtube Channel: https://youtube.com/xrdocs