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The bridge to possible

Fixed Line Broadband Services

A Cloud Native Approach

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BRKSPG-2025

A New Era For Subscriber Services is Here

Agenda

- Chapter 1
  - Wireline Transition
  - Control and User Plane Separation
- Chapter 2
  - Cloud Native BNG Solution
  - Simplified Subscriber Monitoring
- Chapter 3
  - Wireless Wireline Convergence
  - Summary

Chapter – 1

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The New Era is here

>75%
of all Internet traffic will be video
Up from 60% in 2018

66%
connected flat-panel TV sets will be 4K
Up from 33% in 2018

3.6
Networked devices and connections per person
Up from 2.4 in 2018

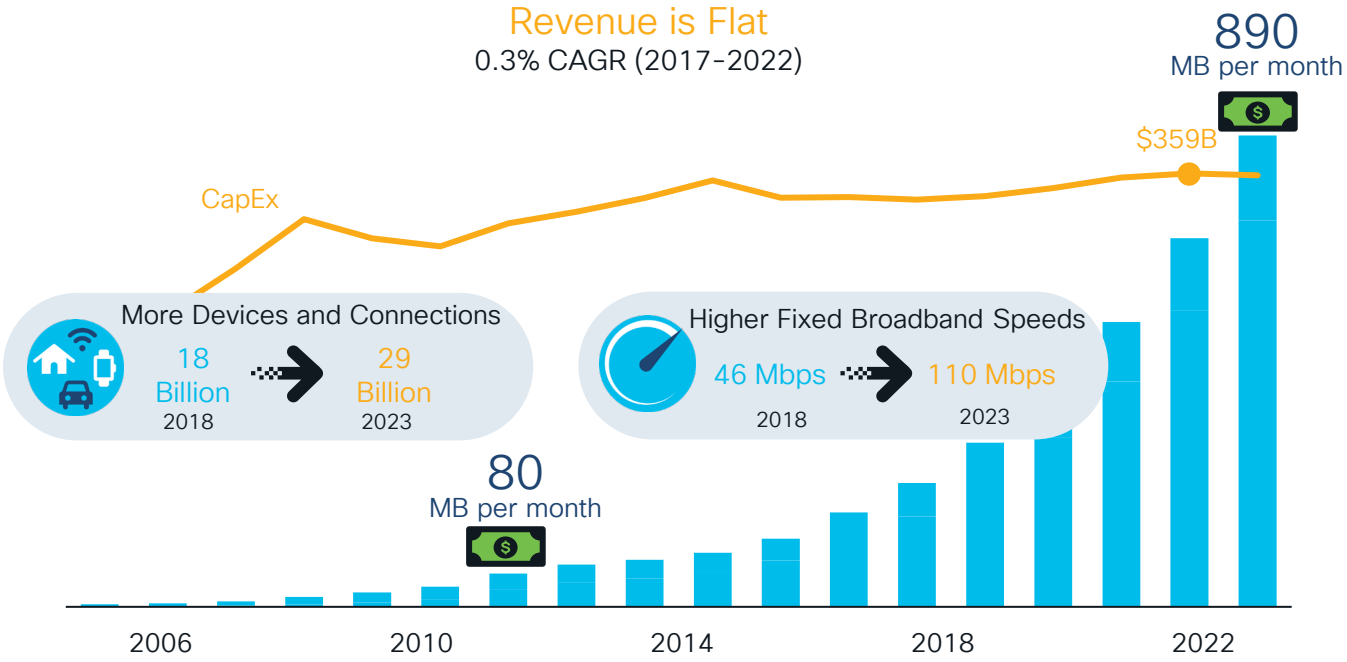
66%
Of the population will be using internet by 2023
Up from 51% in 2018

110 Mbps
Average broadband speed
Up from 45.9Mbps in 2018

44 Mbps
Average mobile speed
Up from 13.2Mbps in 2018

Source: Cisco VNI Global IP 2018-2023

Business Challenges at Mass Scale
Traditional economics are beginning to break



$1 CAPEX in 2022

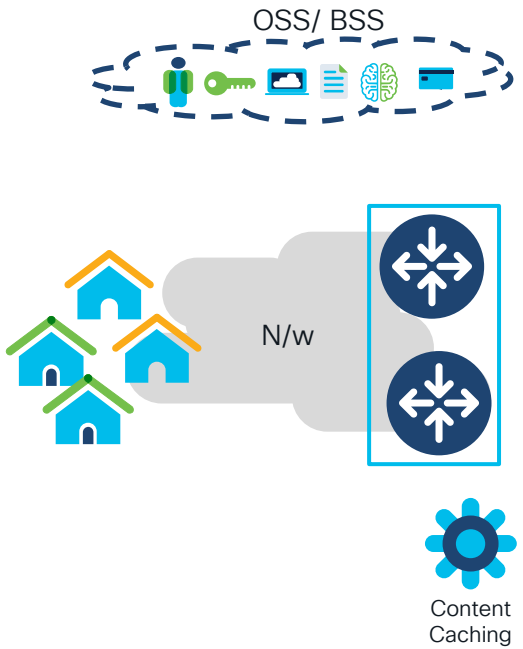
11X the work it did in 2012

$5 OPEX today

for each $1 of CAPEX

Fixed Line Network Design Challenges

- Growth Planning
- Faster Time To Market
- TCO Reduction
- OSS/BSS Integration



New Architecture Drivers

Services closer to subscriber

Independent CP and UP scaling and ease of integration

Common Policy, Convergence, New Business Models

Common infrastructure for different access technologies

Control and User Plane Separation (CUPS)

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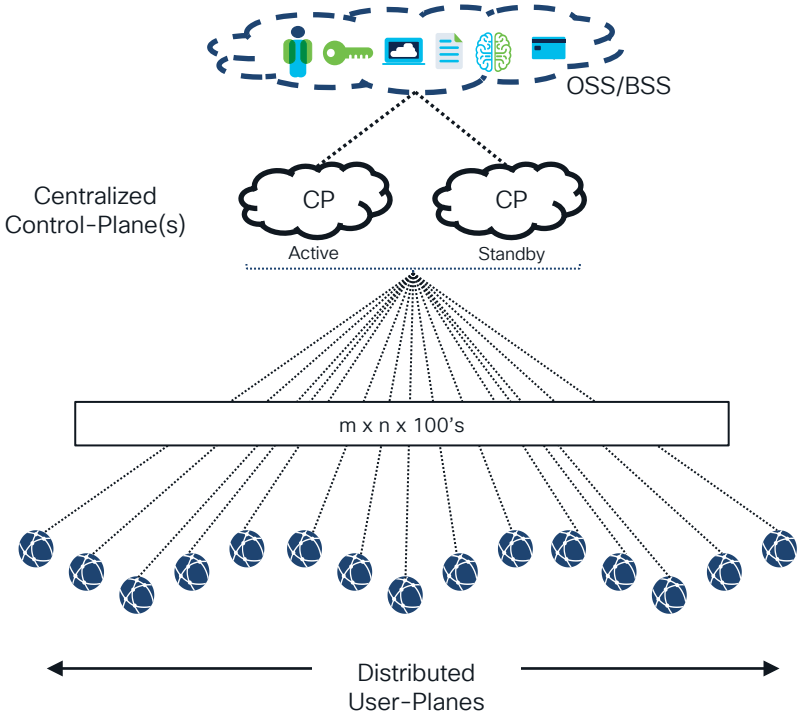
Control and User Plane Separation

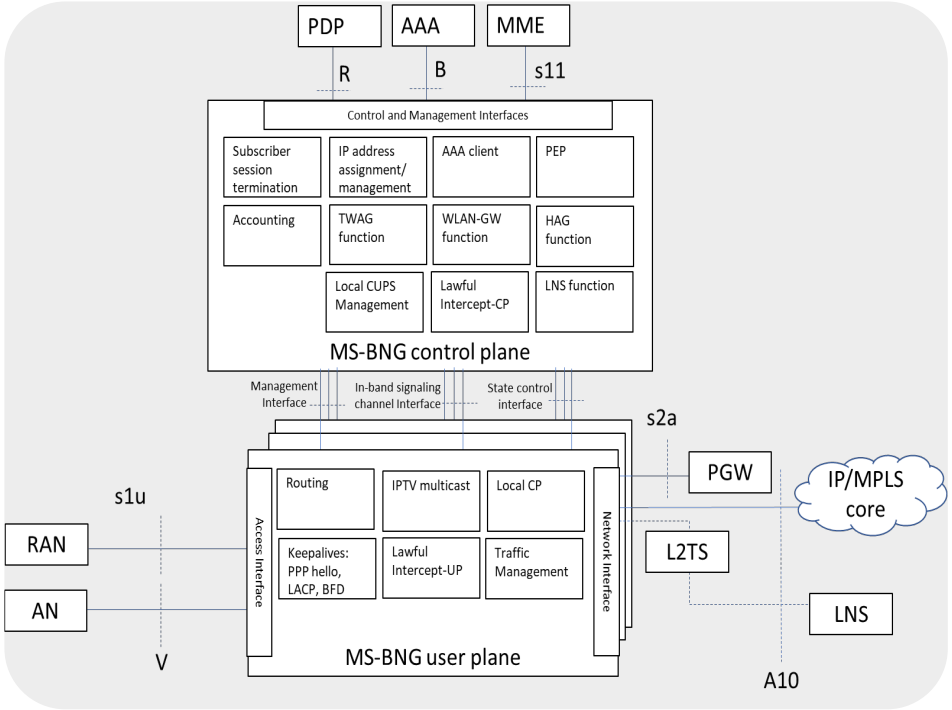


- Easier OSS/ BSS Integration
- Faster Time To Market
- TCO Reduction
- Grow when Required

CUPS Interface?

Standardization of CUPS BNG

- TR-459 is a CUPS Disaggregated BNG standard defined by Broadband forum
- State Control interface (SCi)
  - To install traffic forwarding rules and states on UP
  - Flexible Packet Match rules with actions to be programmed
- Control Packet Redirect Interface (CPRi)
  - In-band signaling channel to trigger subscriber authentication
- Management Interface (Mi)
  - Pushing configuration and retrieving operational state and status from the UPs



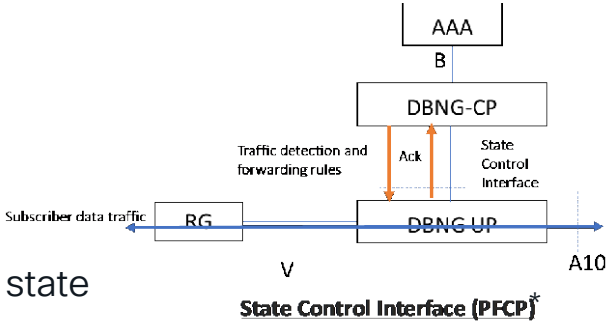
Source TR-459

Cisco and CUPS

- Initial proprietary solution demonstrated in 2016 with mobility CUPS
- Adoption of Sx and N4
- Adoption of PFCP for cnBNG CUPS protocol
- PFCP is a 3GPP protocol for CUPS
  - Standardized since rel14 *(TS29.244)*
  - BBF Selected protocol for CUPS DBNG *(TR-459)*
  - BBF and 3GPP continue to develop PFCP

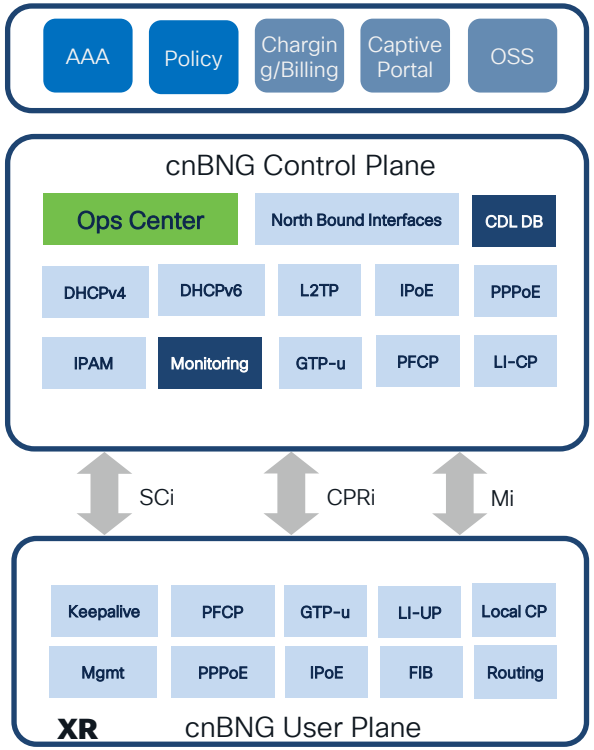
PFCP Overview

- Message Types:
  - Node Messages: Association Setup, Update, Release and Heartbeat
  - Session Messages: Establishment, Modification, Deletion, Report
- IEs are added to exchange information
  - Allows extension, flexibility
  - Defined by 3GPP and extended by BBF
- Rules are used in Session Messages to program forwarding state
  - Packet Detection Rule (PDR) contains a selection of the objects
  - Matching criterion is specified by Packet Detection Identifier (PDI)
  - Action (e.g. forward/drop/mirror) specified by Forward action Rule (FAR)
  - QoS Enforcement Rule (QER) specifies QoS
  - Usage Reporting Rule (URR) specifies usage reporting and charging



*source TR-459

cnBNG High Level Architecture



Architecture Highlights

- TR-459 aligned Architecture
- Clean slate CP architecture written from ground-up in GO
- Control and User Separation (CUPS) advantage
- Common Infrastructure: BNG, 5GC, Cable
- IOS-XR user planes optimized for various deployment options
- Model driven Manageability
- Smooth migration of Policy interface and Platforms
- Simplified Northbound interface independent of the number of User Planes
- Simplified Subscriber Monitoring

Cloud Native Advantages

- Microservices deployed and managed on elastic infrastructure using Kubernetes
- Subscriber Management services packaged in containers
- DevOps processes with CI/CD workflows
- Smoother upgrades with no downtime
- Each micro-service can be scaled up or down easily

CPRi: Control Packet Redirect Interface (GTP-u)
SCi: State Control Interface (PFCP)

Chapter – 2

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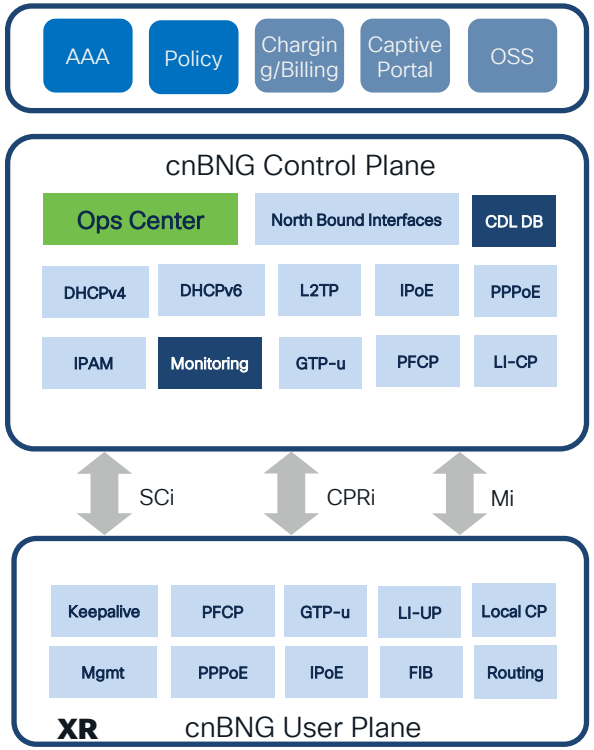

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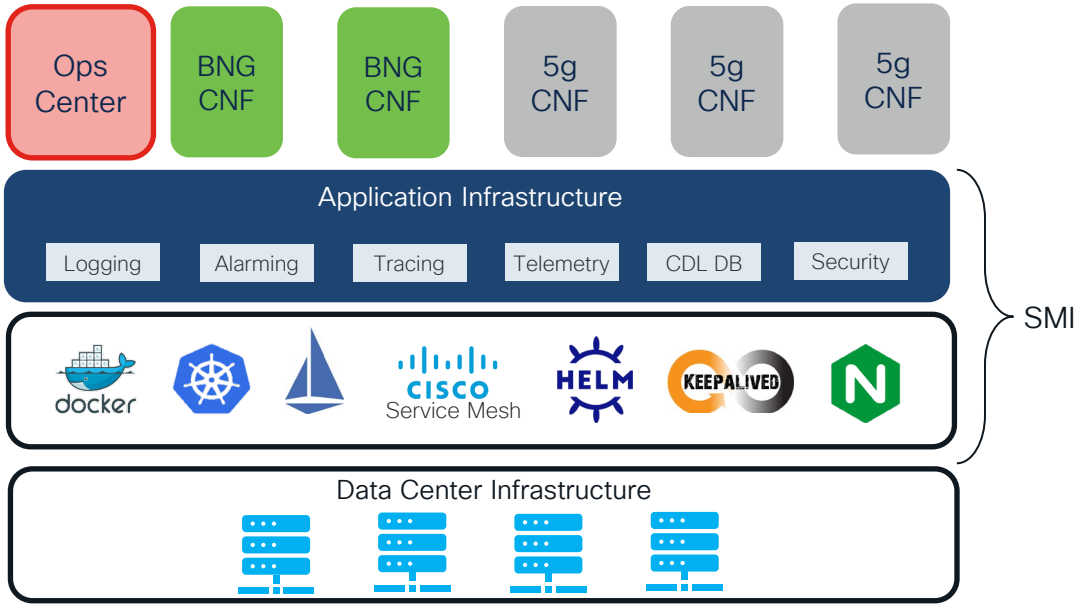
Cloud Native Tenets

Microservices	Containers	DevOps	Continuous Delivery
• Application is split in several discrete microservices • Deployed, managed and scaled independently	• Virtualization of microservices • Highly portable to deployment scenarios	• Automation and management of rapid deployments • Validate and deploy in production	• Develop, build, test and release at rapid speed • Automated continuous integration, validation and availability of containers
• Easy to deploy; easy to scale • Smaller impact domains	• Faster bring-up • Lower infrastructure restriction	• Faster fallback and bug-fixes • Faster Feature rollout	• Lower Time to Market • Always on latest code-base

Cloud Native Architecture

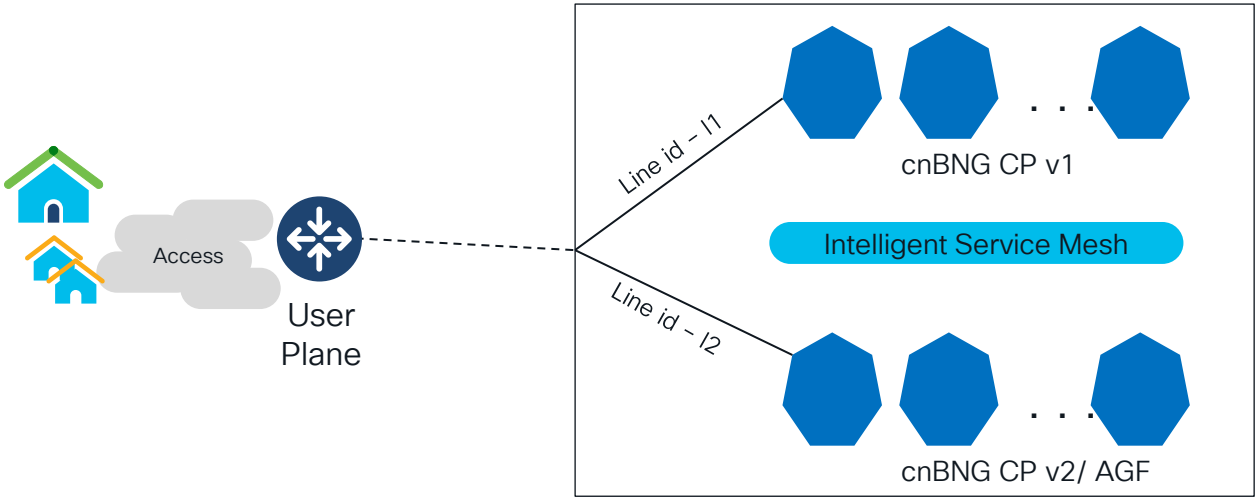
OPS Center provides Common MGMT API:
- NETCONF/REST API
- CLI Interface
- YANG Model
- Config DB
- Operational Callback
- Security: NACM/AAA

Common Data Layer for stateless microservices:
- In-memory session store
- Geo-redundancy
- High Performance
- Low latency



Intelligent Service Mesh

Rollout Services Faster

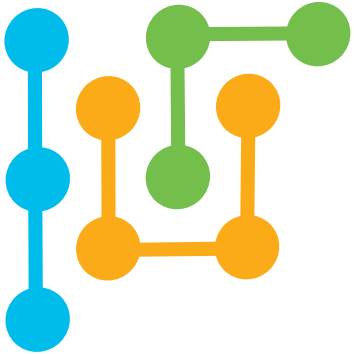


Routing based on message contents i.e. apn, imsi, supi, line-id, circuit-info etc

cNF Scalability

Ops Center

```
endpoint dhcp
  replicas X
exit
endpoint pppoe
  replicas Y
exit
```



- Simplified scale up/down of each individual service

cNF Scalability

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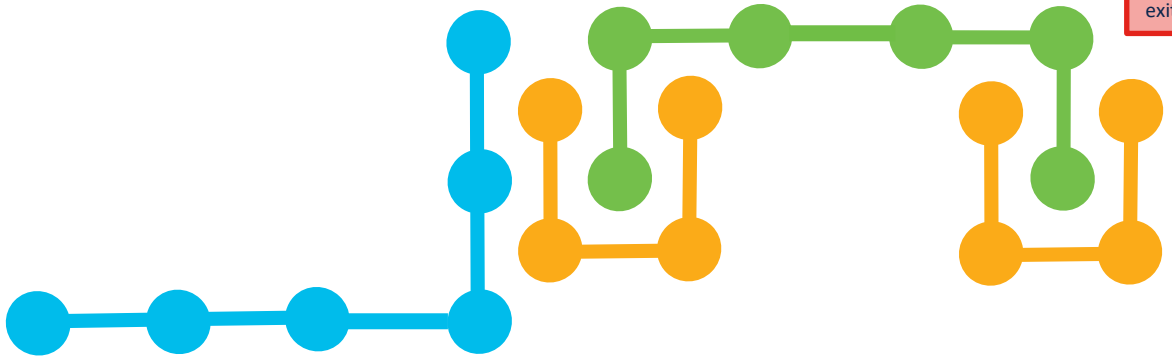

- Simplified scale up/down of each individual service
- Scale up when load is high

cNF Scalability

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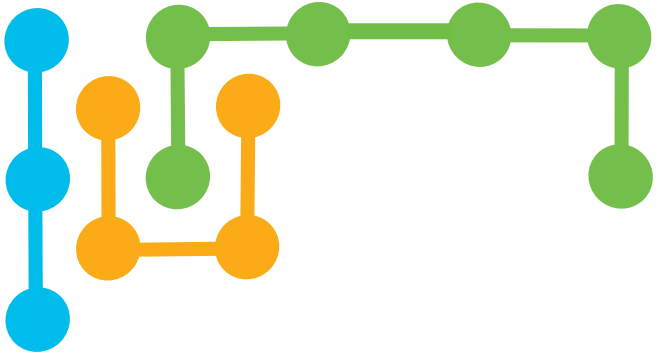


- Simplified scale up/down of each individual service
- Scale up when load is high
- Scale down when load is low

cNF High Availability

- Maintains the steady state

*by Orchestrator

cNF High Availability

- Maintains the steady state
- Whenever a microservice fails

*by Orchestrator

cNF High Availability

- Maintains the steady state
- Whenever a microservice fails
  - It's started automatically

*by Orchestrator

cNF High Availability

*by Orchestrator

cNF High Availability

- Whenever a node fails

*by Orchestrator

cNF High Availability

- Whenever a node fails
  - All microservices are automatically moved to other working nodes

*by Orchestrator

CP and UP Redundancy Options

User Plane Redundancy

1 : 1

User Plane Redundancy

M : N

Control Plane Redundancy

Active Standby

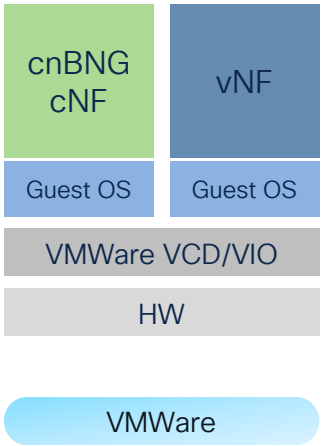
CP

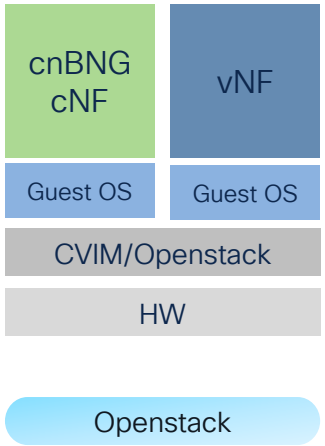
Hot Standby
Warm Standby

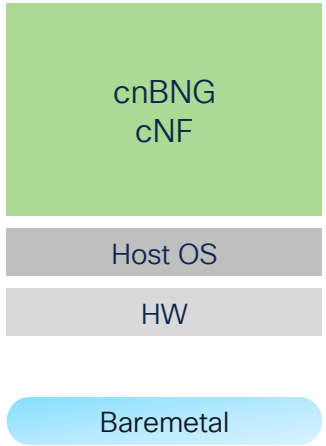
CP

CDL DB
HA Only
HA w/ Geo Redundancy

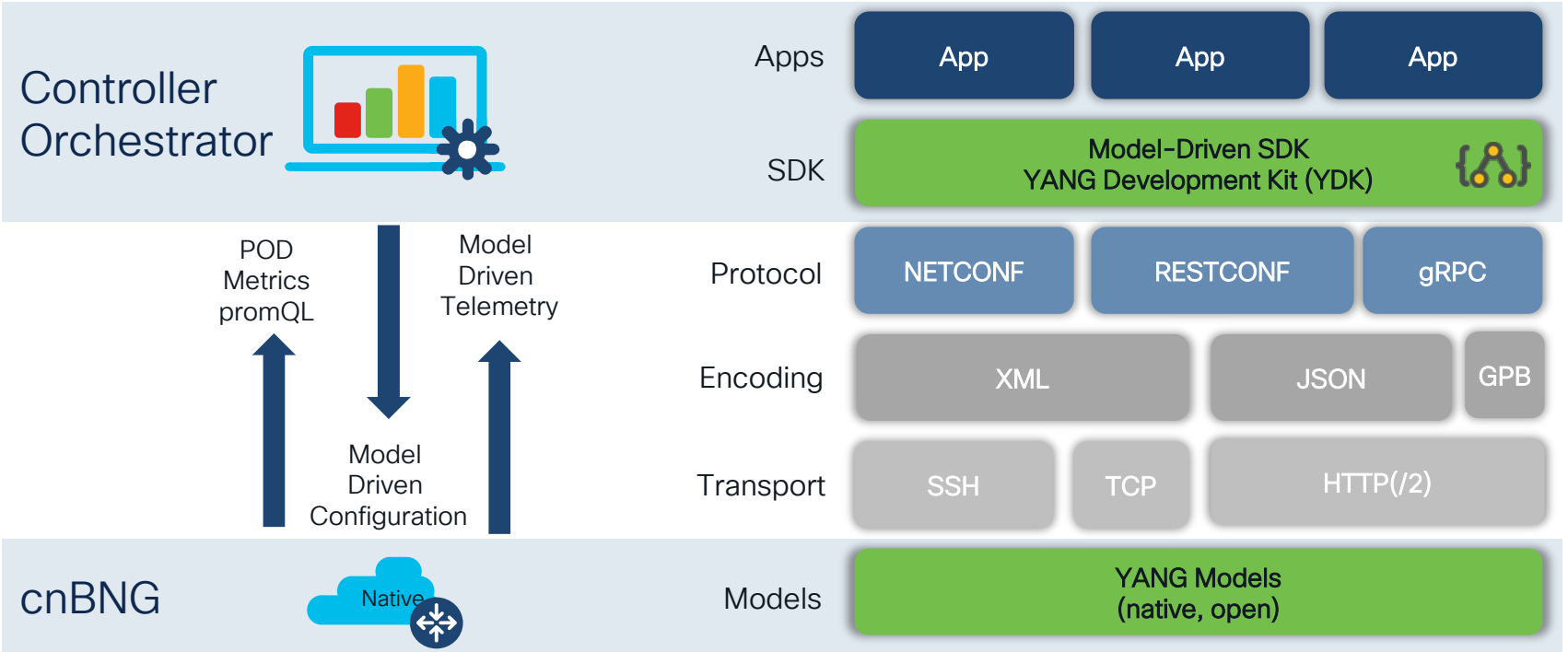
Deployment Options







Simplified Manageability



Simplified Monitoring

Collection

Visualization

Alert

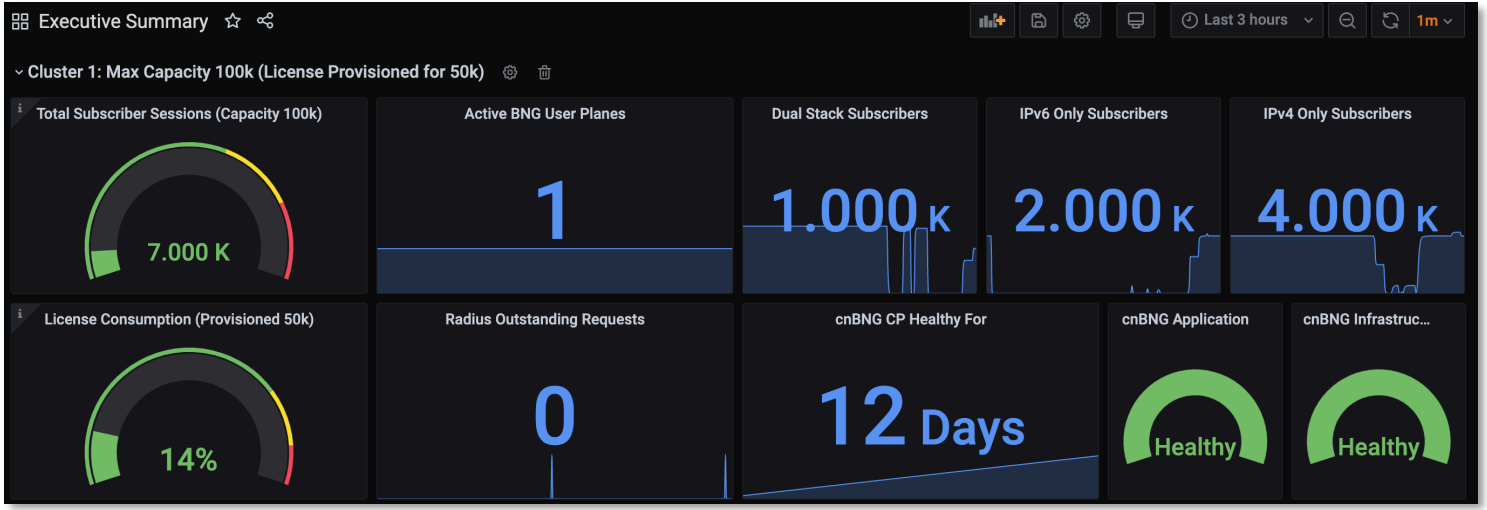
- POD metric collection
- Model Driven Telemetry for UP stats collection
- 100s of subscriber metrics already available

- Metrics Visualization on Dashboard
- Telemetry integration with external visualization also supported

- Alert Manager for generating alerts
- Alerts via Email, Webhooks, SNMP or on dashboard
- YANG based alert setting

Integrated with cnBNG

Metrics Visualization: Inbuilt



Metrics Collection and Alert

- Uses pull/push model for metric collection
- Model based metrics monitoring using telemetry
- Can integrate with PIG stack
- Alert Manager

Unified Monitoring Framework

- Metrics monitoring from CP:
  - Node and PODs health
  - IPAM Allocation
  - UP Binding and Health
  - Session Scale
  - DS vs SS Sessions etc.
- Metrics from UP:
  - Alarms
  - Non BNG Services
  - Anomaly detection
  - Consistency check between CP and UP etc.

Metric Query Example

```
curl '10.36.0.24:9090/api/v1/query?query=IPAM_chunk_allocations_current'
```

promQL

PPPoE_session_summary_current

DHCP_Session_total

Radius_requests_statistics

...

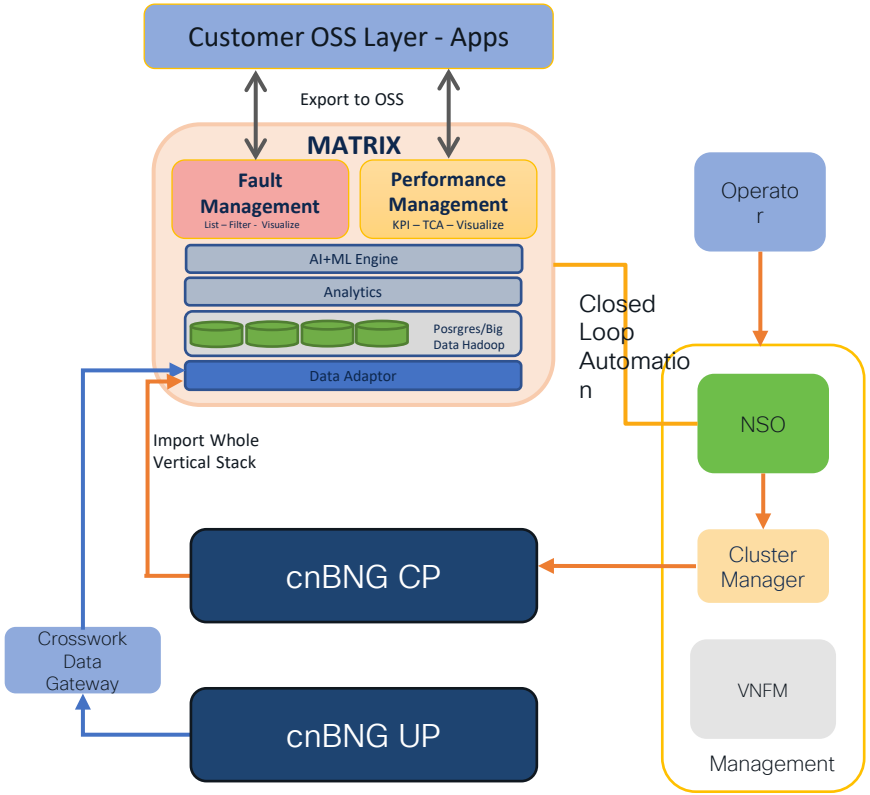
...

JSON

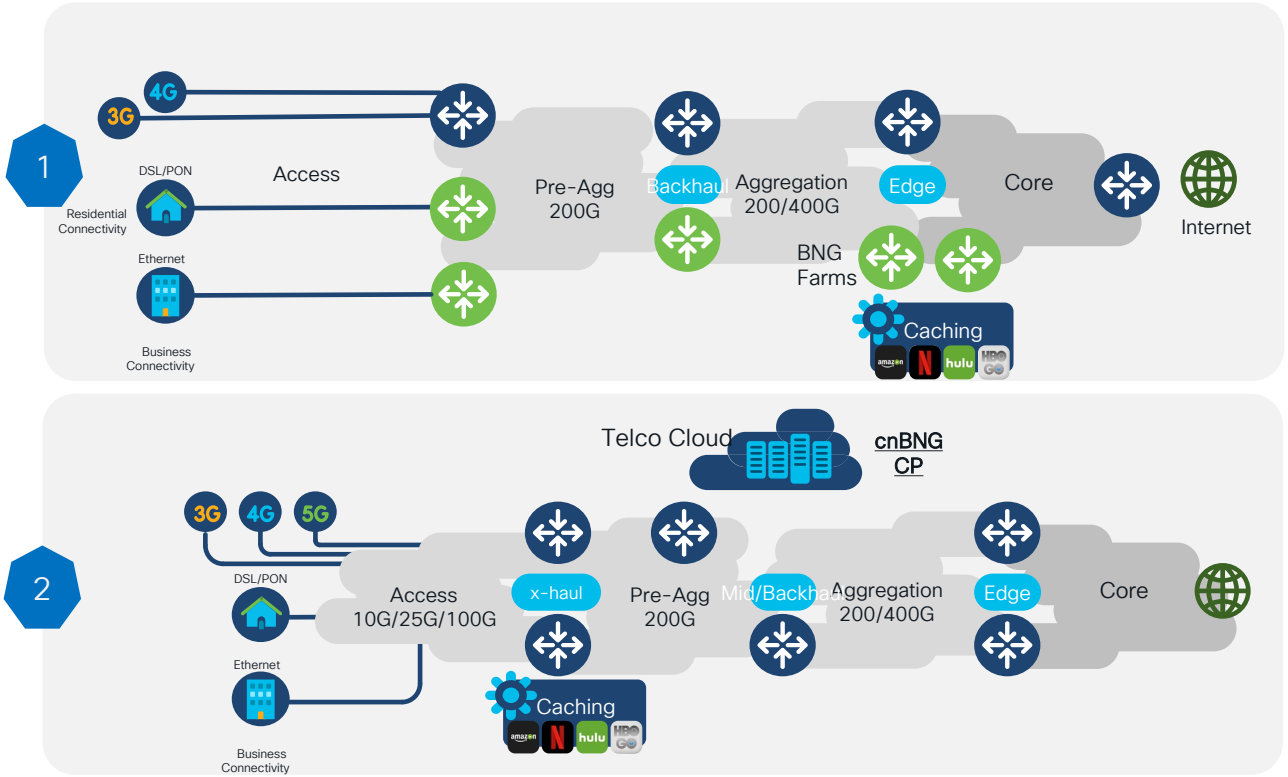

```
{
  "status": "success",
  "data": {
    "resultType": "vector",
    "result": [
      {
        "metric": {
          "__name__": "IPAM_address_allocations_current",
          "addressType": "IPv4",
          "allocationType": "dynamic",
          "app_name": "BNG",
          "cluster": "Local",
          "component": "bng-nodemgr",
          "controller_revision_hash": "bng-nodemgr-n0-7c648fb7d8",
          "data_center": "DC",
          "dnai": "NA",
          "dnn": "NA",
          "hostname": "smf-knode1",
          "instance": "10.36.0.12:8080",
          "instance_id": "0",
          "job": "kubernetes-pods",
          "nID": "0",
          "namespace": "bng",
          "nssai": "NA",
          "pod": "bng-nodemgr-n0-0",
          "pool": "pool-ISP",
          "release": "bng-bng-nodemgr",
          "service_name": "bng-nodemgr",
          "statefulset_kubernetes_io_pod_name": "bng-nodemgr-n0-0",
          "upf": "asr9k-1"
        },
        "value": [
          1593427409.1,
          "100"
        ]
      }
    ]
  }
}
```

Advanced Monitoring with Cisco Matrix

1. Single Pane Of Glass for Fault & Performance Mngt. for Complete Vertical Stack with Ai and ML capabilities
2. Single Tool for all cnBNG Infrasructure and cnBNG Applications in the network
3. Single point of integration for Customer OSS Layer and Applications



Optimize with cnBNG



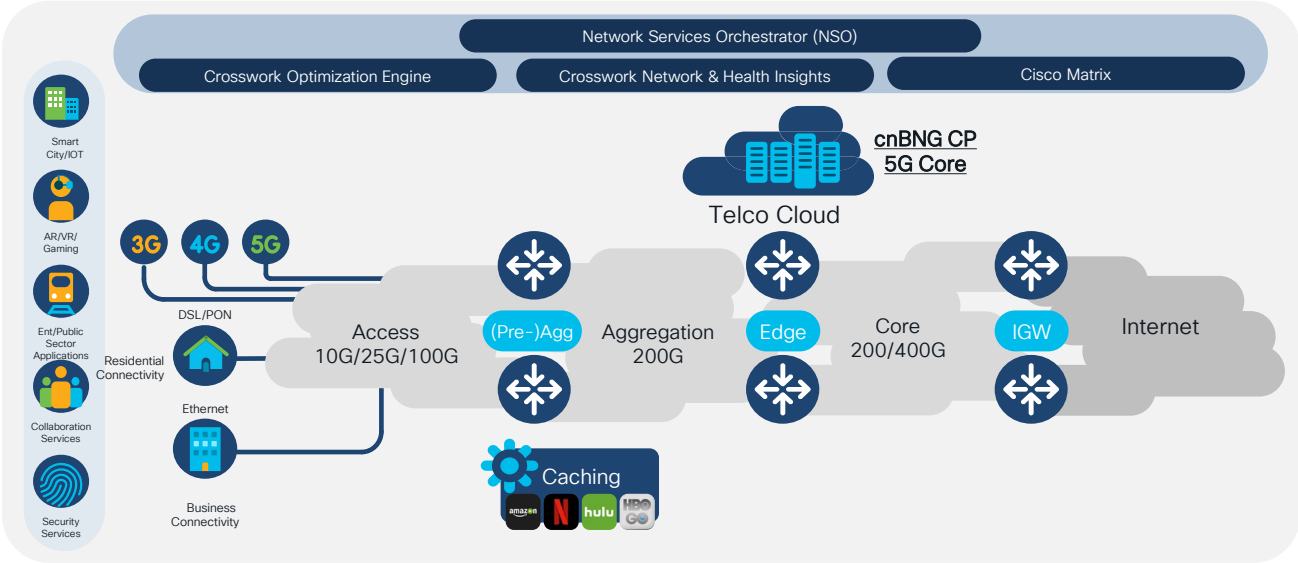
TCO Reduction

Upto 55%

- Lean BNG User Planes
- \+
- Subscriber termination at Pre-agg / Agg layer
- \+
- CDNs and Peering at Agg Layer
- \+
- Early offload of traffic to CDN or peering`

Design It Better With cnBNG

Reduced OpEx: 5x less OSS/BSS integration points Reduced CapEx: 50%+ savings vs traditional deployments



Offload Traffic Closer to Subscriber

Varying UP Choices Based on Requirements

Deploy Based on Today's Scale

Faster Service Rollout with Cloud Native CP

Converged Architecture

Chapter – 3

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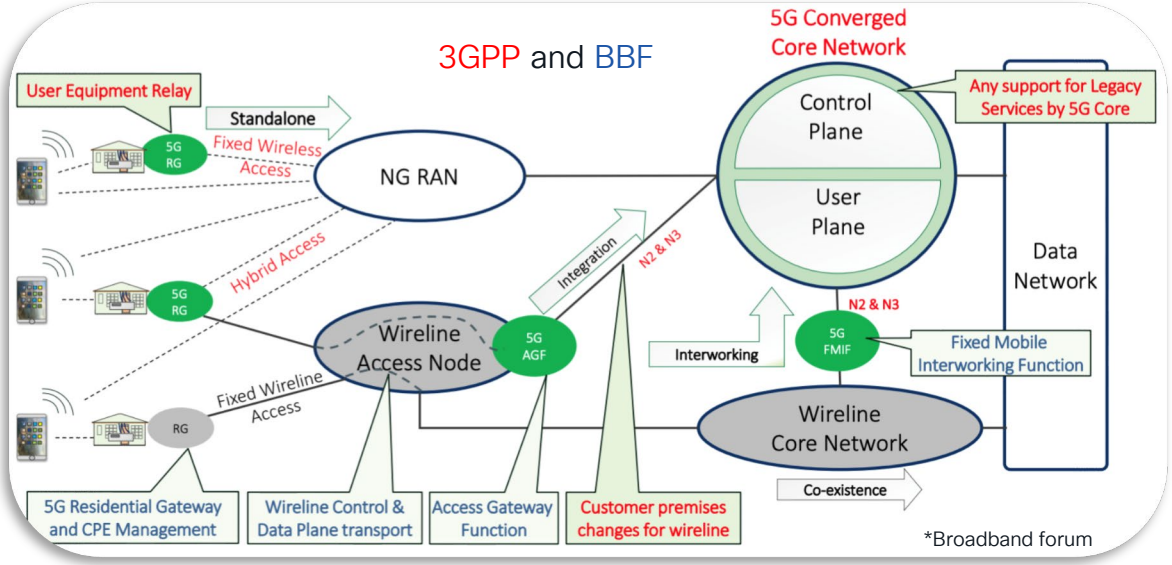
WWC Standardization



Broadband forum-
- WT-456: AGF Functional Requirements
- WT-458: CUPS for 5G FMC
- WT-470: 5G FMC Architecture

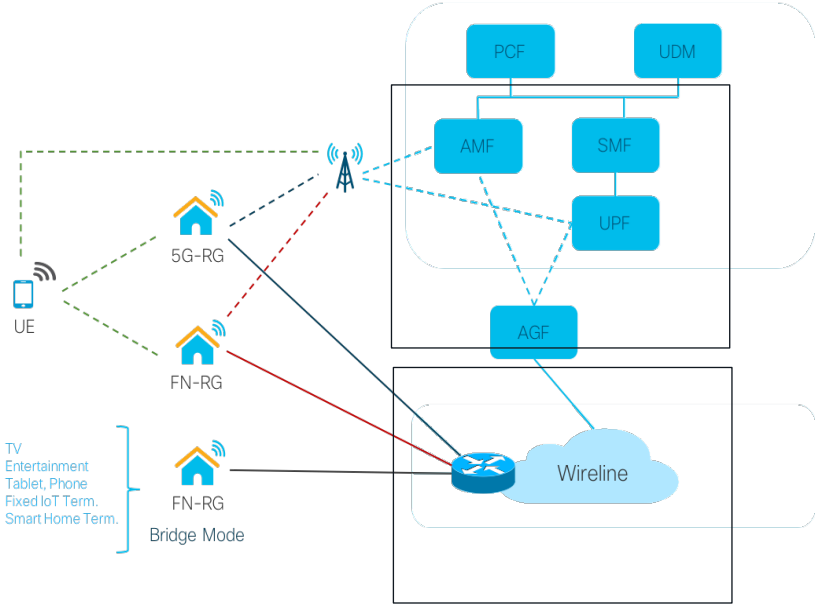
3GPP Rel16-
TS23.316: Wireless and wireline convergence access support for the 5G System (5GS)

Converged Core

- 3GPP R16 and BBF are defining convergence
- 5GC Control Plane anchors Wireline and Wireless sessions
- Converged core strategies: standalone, integration, interworking, co-existence
- Common Access Edge drives wireline and wireless onto the same platforms
- Simplifies common billing and charging integration

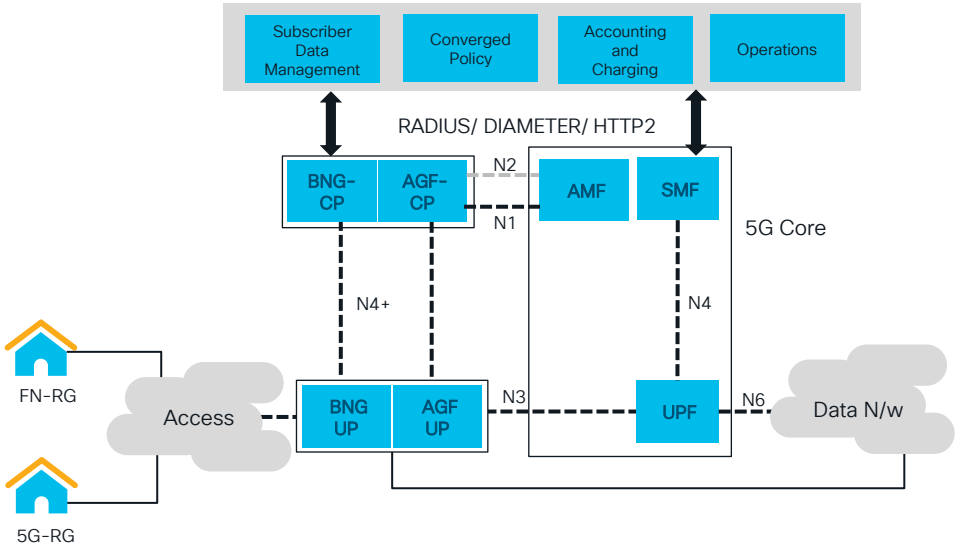
WWC Scenarios

- Multi access
  - Bandwidth Augmentation
  - Active standby (Radio / Fixed network)
    - Seamless transition
    - Differentiated services
- Convergence
  - Application level
    - IT / Backend systems convergence (Policy layer, Service Assurance)
  - Network level convergence
    - Combined Transport network
    - Combined Packet core, single breakout to internet
- Fixed Wireless Access



Converged Architecture

- Policy plane convergence for common billing and subscriber management
- For 5G-RG steer to AGF-UP
- For FN-RG steer to BNG-UP or AGF-UP
- BNG-UP and AGF-UP can be a converged UP
- BNG-CP and AGF-CP can be a converged CP
- Migration from BNG to 5G Core possible through converged architecture



Summary

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  - Cloud Native BNG Solution
  - Simplified Subscriber Monitoring
- Chapter 3
  - Wireless Wireline Convergence
  - Architecture evolution

References

Explore and learn more

- Cloud Native BNG Config Guides
  - https://www.cisco.com/c/en/us/td/docs/routers/cnBNG/cnBNG-CP/2021-01-x/Config-Guide/b_cnbng_cp_config_guide.html
  - https://www.cisco.com/c/en/us/td/docs/routers/asr9000/software/asr9k-r7-3/cloud-native-bng/configuration/guide/b-cnbng-user-plane-cg-asr9000-73x/cloud-native-bng-overview.html
- ASR9k Routers: http://xrdocs.io/asr9k/
- NCS5500 Router: https://xrdocs.io/ncs5500/
- XRDocs Youtube Channel: https://youtube.com/xrdocs

The bridge to possible

Thank you


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