



Cloud Native BNG Control Plane Configuration Guide, Release 2022.01.0

First Published: 2022-01-31

Americas Headquarters

Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
<http://www.cisco.com>
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883



CONTENTS

PREFACE

About this Guide	xiii
Conventions Used	xiii

CHAPTER 1

cnBNG Overview	1
Feature Summary and Revision History	1
Summary Data	1
Overview	1
Evolution of cnBNG	2
cnBNG Architecture	3
cnBNG Components	5
Subscriber Microservices Infrastructure	5
cnBNG Control Plane	6
cnBNG User Plane	7
License Information	7
Standard Compliance	8
Limitations and Restrictions	8

CHAPTER 2

cnBNG Installation and Configuration	9
Feature Summary and Revision History	9
Summary Data	9
Revision History	9
Feature Description	10
BNG Ops Center	10
Installing cnBNG and Accessing BNG Ops Center	11
Prerequisites	11
Installing cnBNG in an Offline Environment	12

Accessing BNG Ops Center	16
CP and UP Service Configuration	19
Mapping Pods with Node Labels	49
High Availability Support on Bare Metal Server	50

CHAPTER 3**Pods and Services Reference 51**

Feature Summary and Revision History	51
Summary Data	51
Revision History	51
Feature Description	52
Pods	53
Services	57
Open Ports and Services	57
Associating Pods to the Nodes	58
Viewing the Pod Details and Status	59
States	59

CHAPTER 4**Smart Licensing 61**

Feature Summary and Revision History	61
Summary Data	61
Revision History	61
Smart Software Licensing	61
Cisco Software Central	62
Smart Accounts and Virtual Accounts	62
Requesting a Cisco Smart Account	62
cnBNG CP Smart Licensing	63
Software Tags and Entitlement Tags	63
Configuring Smart Software Licensing for cnBNG CP	66
Users with Access to CSC	66
Users without Access to CSC	70
Monitoring and Troubleshooting Smart Licensing	76

CHAPTER 5**Cisco Common Data Layer 77**

Feature Summary and Revision History	77
--------------------------------------	----

Summary Data	77
Revision History	77
Feature Description	78
Limitations	78

CHAPTER 6**Authentication, Authorization, and Accounting Functions 79**

Feature Summary and Revision History	79
Summary Data	79
Revision History	79
Feature Description	80
AAA Overview	81
Using RADIUS Server Group	82
Specifying Method Order	82
Defining AAA Attributes	82
Creating Attributes of Specific Format	83
Making RADIUS Server Settings	85
Balancing Transaction Load on the RADIUS Server	86
RADIUS Change of Authorization Overview	86
Multi-Action Change of Authorization	88
User Authentication and Authorization in the Local Network	89
Service Accounting	90
Standard Compliance	91
Configuring AAA Functions	92
Configuring AAA Attributes	92
Configuring the CoA-NAS Interface	95
Configuring Method Order for AAA	95
Configuring RADIUS Accounting Options	98
Configuring RADIUS Accounting Server Group	100
Configuring RADIUS Attributes	101
Configuring RADIUS Attribute Format	101
Configuring RADIUS Dead Time	104
Configuring RADIUS Detect Dead Server	104
Configuring RADIUS NAS-IP	105
Configuring RADIUS Pod	107

- Configuring RADIUS Retries 107
- Configuring RADIUS Server 108
- Configuring RADIUS Server Group 108
- Configuring RADIUS Server Selection Logic 108
- Configuring RADIUS Timeout 109

CHAPTER 7 Control Plane and User Plane Association 111

- Feature Summary and Revision History 111
 - Summary Data 111
 - Revision History 111
- Feature Description 112
- Enabling Control Plane and User Plane Association 112
 - Associating the User Plane 112
- UP Session Disconnect Notification 112
 - Feature Description 112
- UP Rollback Failure Handling Notification 113
 - Feature Description 113

CHAPTER 8 DHCP and IPoE Subscriber Management 115

- Feature Summary and Revision History 115
 - Summary Data 115
 - Revision History 115
- Feature Description 116
 - DHCP and IPoE Functionalities 116
 - How it Works 122
 - Call Flows 122
 - Standard Compliance 123
 - Limitations and Restrictions 123
- Configuring the DHCP and IPoE Subscriber Management Feature 125
 - Configuring the IPv4 DHCP Server Profile 125
 - Configuring the IPv4 DHCP Class 126
 - Configuring the IPv6 DHCP Server Profile 127
 - Configuring the IPv6 DHCP Class 127

CHAPTER 9	End-to-End Flow Control	129
	Feature Summary and Revision History	129
	Summary Data	129
	Revision History	129
	Feature Description	129
	How it Works	130
	Limitations and Restrictions	131
	Configuring End-to-End Flow Control	132
	Configuring Dispatcher for N4 Interfaces	132
	Configuring Dispatcher for GTPu Interface	133
	Configuring Overload Control for Message Types	135

CHAPTER 10	High Availability and CP Reconciliation	137
	Feature Summary and Revision History	137
	Summary Data	137
	Revision History	137
	Feature Description	137
	How it Works	138
	Synchronizing Sessions Across CP Pods and UP	140
	Limitations and Restrictions	141
	Configuring High Availability and CP Reconciliation	142
	Reconciling Sessions Across CP Pods and UP	142
	Configuring CDL Bulk Notifications	143

CHAPTER 11	IP Address Management	145
	Feature Summary and Revision History	145
	Summary Data	145
	Revision History	145
	Feature Description	146
	IPAM Components	146
	IPAM Sub-Modules	146
	IPAM Integration in cnBNG	147
	Configuration Recommendations	148

How it Works	149
Call Flows	149
Limitations	152
Configuring IPAM Feature	153
Configuring IPAM Source	153
Configuring Global Threshold	154
Configuring IPAM Address Pool	154
Configuring IPAM Quarantine Timer	155
Configuring IP Address Reservation	155
Configuring IPv4 Address Ranges	156
Configuring IPv6 Address Ranges	156
Configuring IPv6 Prefix Ranges	157
Configuring IPv4 Threshold	157
Configuring IPv6 Prefix-Range Threshold	158
Configuring IPv4 Address Range Split	159
Configuring IPv6 Address and Prefix Address-Range-Split	159
IPAM Enhancements	160
Static IP Support	162
Feature Summary and Revision History	162
Summary Data	162
Revision History	162
Feature Description	162
Configuring Static IP Support	163
Configuring Static IPv4 Address Ranges	163

CHAPTER 12

L2TP Subscriber Management	165
Feature Summary and Revision History	165
Summary Data	165
Revision History	165
Feature Description	166
L2TP Overview	166
L2TP Features	167
How it Works	168
L2TP Handling	168

	Call Flows	169
	Standard Compliance	177
	Limitations	177
	Configuring the L2TP Subscriber Management Feature	178
	Creating the L2TP Profile	178

CHAPTER 13	Log Generation Support	181
	Feature Summary and Revision History	181
	Summary Data	181
	Revision History	181
	Feature Description	181

CHAPTER 14	Monitor Protocol and Subscriber	183
	Feature Summary and Revision History	183
	Summary Data	183
	Revision History	183
	Feature Description	184
	Configuring Monitor Subscriber and Protocol	184
	Configuring Monitor Subscriber	184
	Configuring Monitor Protocol	195
	Copying Log Files	196
	Viewing Log Files	199

CHAPTER 15	Multiple Replica Support for cnBNG Services	201
	Feature Summary and Revision History	201
	Summary Data	201
	Revision History	201
	Feature Description	202
	How it Works	202
	Configuring Multiple Replica Support for cnBNG Services	203
	Replicating Multiple cnBNG Service Instances	203

CHAPTER 16	PPPoE Subscriber Management	205
	Feature Summary and Revision History	205

- Summary Data 205
- Revision History 205
- Feature Description 206
 - PPPoE Overview 206
 - PPPoE Features 206
 - PPP Overview 207
 - PPP Features 208
 - Address Assignment Strategies 208
- How it Works 208
 - PPPoE Handling 208
 - PPP Handling 210
 - Call Flows 210
 - Standard Compliance 212
 - Limitations 212
- Configuring the PPPoE Subscriber Management Feature 212
 - Creating PPPoE Profile 213
 - Creating the PPP Feature Template 214

CHAPTER 17

- Rolling Software Update 217**
 - Feature Summary and Revision History 217
 - Summary Data 217
 - Revision History 217
 - Feature Description 217
 - How it Works 218
 - Rolling Software Update Using SMI Cluster Manager 219
 - Installing the Rolling Software Update 220
 - Prerequisites 220
 - Performing Rolling Software Update 223
 - Monitoring the Rolling Software Update 224
 - Viewing the Pod Details 225

CHAPTER 18

- Subscriber Manager 235**
 - Feature Summary and Revision History 235
 - Summary Data 235

Revision History	235
Feature Description	236
How it Works	237
Configuring Subscriber Manager Features	238
Configuring the HTTPR Policy Name	238
Configuring IPv4 Options	238
Configuring IPv6 Options	239
Configuring QoS Parameters	240
Configuring the VRF Name	240
Configuring a Subscriber Profile	240
Automatic Session Reconciliation	243
Feature Description	243
How it Works	243
Framed Route Support	243
Feature Description	243
Subscriber Accounting Functions	245
Feature Description	245
Limitations and Restrictions	246
Configuring Subscriber Accounting Functions	246
Configuring Service Accounting	246
Configuring Session Accounting	247
Subscriber QoS Policy	247
Feature Description	247

APPENDIX A	RADIUS Attributes	249
	RADIUS IETF Attributes	249
	IETF Tagged Attributes on LAC	250
	RADIUS Vendor-Specific Attributes	251
	Vendor-Specific Attributes for Account Operations	255
	RADIUS ADSL Attributes	256
	RADIUS ASCEND Attributes	256
	RADIUS Disconnect-Cause Attributes	256



About this Guide



Note The documentation set for this product strives to use bias-free language. For purposes of this documentation set, bias-free is defined as language that does not imply discrimination based on age, disability, gender, racial identity, ethnic identity, sexual orientation, socioeconomic status, and intersectionality. While any existing biased terms are being substituted, exceptions may be present in the documentation due to language that is hardcoded in the user interfaces of the product software, language used based on RFP documentation, or language that is used by a referenced third-party product.

This preface describes the Cloud Native Broadband Network Gateway (cnBNG) Control Plane (CP) Configuration Guide, how it is organized, and its document conventions.

This guide describes the Cloud Native BNG solution and includes feature descriptions, specification compliance, session flows, configuration instructions, CLI commands and so on.

- [Conventions Used, on page xiii](#)

Conventions Used

The following tables describe the conventions used throughout this documentation.

Notice Type	Description
Information Note	Provides information about important features or instructions.
Caution	Alerts you of potential damage to a program, device, or system.
Warning	Alerts you of potential personal injury or fatality. May also alert you of potential electrical hazards.

Typeface Conventions	Description
Text represented as a screen display	This typeface represents displays that appear on your terminal screen, for example: <code>Login :</code>

Typeface Conventions	Description
Text represented as commands	This typeface represents commands that you enter, for example: show ip access-list This document always gives the full form of a command in lowercase letters. Commands are not case sensitive.
Text represented as a command <i>variable</i>	This typeface represents a variable that is part of a command, for example: show card <i>slot_number</i> <i>slot_number</i> is a variable representing the desired chassis slot number.
Text represented as menu or sub-menu names	This typeface represents menus and sub-menus that you access within a software application, for example: Click the File menu, then click New



CHAPTER 1

cnBNG Overview

- [Feature Summary and Revision History, on page 1](#)
- [Overview, on page 1](#)
- [License Information, on page 7](#)
- [Standard Compliance, on page 8](#)
- [Limitations and Restrictions, on page 8](#)

Feature Summary and Revision History

Summary Data

Table 1: Summary Data

Applicable Product(s) or Functional Area	Cloud Native Broadband Network Gateway
Applicable Platform(s)	SMI
Feature Default Setting	Not Applicable
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Overview

This chapter provides an overview of the Cloud Native Broadband Network Gateway (cnBNG) solution.

The Broadband Network Gateway (BNG) is the access point for subscribers, through which they connect to the broadband network. When a connection is established between BNG and Customer Premise Equipment (CPE), the subscriber can access the broadband services provided by the Network Service Provider (NSP) or Internet Service Provider (ISP).

BNG establishes and manages subscriber sessions. When a session is active, BNG aggregates traffic from various subscriber sessions from an access network, and routes it to the network of the service provider.

BNG is deployed by the service provider and is present at the first aggregation point in the network, such as the edge router. An edge router, like the Cisco ASR 9000 Series Router, needs to be configured to act as the BNG. Because the subscriber directly connects to the edge router, BNG effectively manages subscriber access, and subscriber management functions such as:

- Authentication, Authorization, and Accounting (AAA) of subscriber sessions
- Address assignment
- Security
- Policy management
- Quality of Service (QoS)

Implementing the BNG provides the following benefits:

- Communicates with authentication, authorization, and accounting (AAA) server to perform session management and billing functions besides the routing function. This feature makes the BNG solution more comprehensive.
- Provides different network services to the subscriber. This enables the service provider to customize the broadband package for each customer based on their needs.

Cisco provides two BNG solutions:

- **Physical BNG** where the BNG Control Plane (CP) and the User Plane (UP) are tightly coupled inside a Cisco IOS XR platform where the CP runs on an x86 CPU and the UP runs on a physical NPU or ASIC.

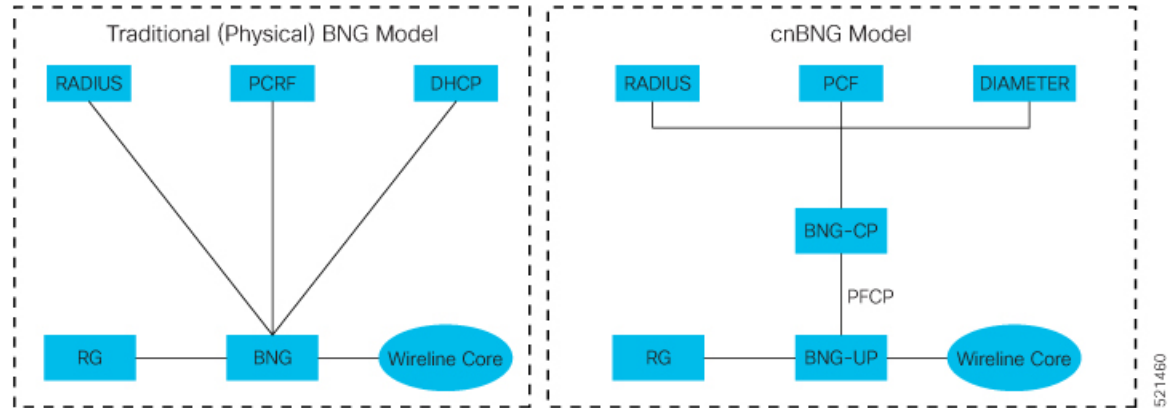
For more information about the physical BNG, refer to the latest version of the *Broadband Network Gateway Configuration Guide* for Cisco ASR 9000 Series Routers.

- **Virtual BNG (vBNG)** where the BNG CP and UP run in separate VM-based Cisco IOS XR software on general purpose x86 UCS servers.

Evolution of cnBNG

The Cisco Cloud Native Broadband Network Gateway (cnBNG) provides a new dimension to the Control Plane and User Plane Separation (CUPS) architecture of the Broadband Network Gateway (BNG), enabling flexibility and rapid scaling for Internet Service Providers (ISPs).

Figure 1: Evolution of BNG to cnBNG



The architectural change is an evolution from an integrated traditional BNG running on a single router to a disaggregated solution, where the centralized subscriber management runs on an elastic and scalable Cloud Native Control Plane (CP) and the User Plane (UP) delivers the forwarding functionality.

cnBNG Architecture

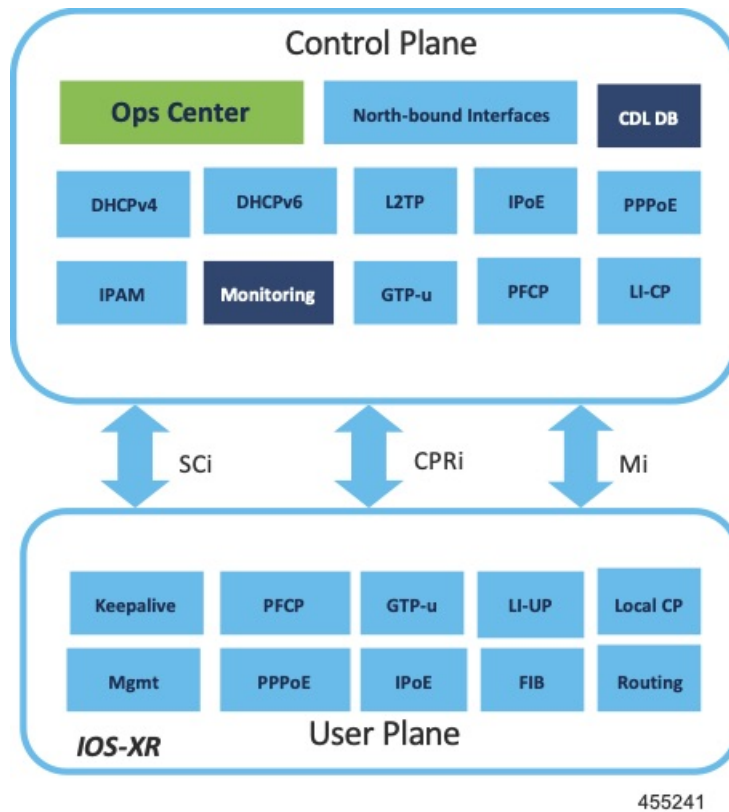
In the cnBNG architecture, the CPs and UPs are clearly and cleanly separated from each other and run in completely distinct and independent environments.

The BNG CP is moved out to a container-based microservice cloud environment.

The UP can be on any of the physical platforms that supports the BNG UP, like Cisco ASR 9000 Series Routers.

The following figure illustrates the overall cnBNG architecture.

Figure 2: cnBNG Architecture



Features and Benefits

The cnBNG supports the following features:

- **Path to convergence:** With shared Subscriber Management infrastructure, common microservices across the policy layer and shared UPs for BNG and Mobile back-haul, cnBNG paves the way for real Fixed Mobile Convergence (FMC).
- **Flexibility of scaling:** cnBNG architecture provides flexibility by decoupling the required scalability dimensions. The CP can be scaled with requirement of number of subscribers to be managed and UPs can be augmented based on the bandwidth requirements. Instead of building the CP for peak usage, the orchestrator can be triggered to deploy the relevant microservices as needed to handle the increased rate of transactions.
- **Distributed UPs:** With reduced operational complexity and minimal integration efforts with centralize CP, UPs can be distributed, closer to end-users to offload traffic to nearest peering points and CDNs. This feature reduces the core transport costs.
- **Cost effective and Leaner User planes:** With the subscriber management functions moved to cloud, you can choose cost-effective UP models for optimized deployment requirements.

The benefits of the cnBNG architecture are:

- Simplified and unified BNG CP
- Platform independent and Network Operation System (NOS) agnostic BNG CP

- Unified Policy interface across both BNG and mobility
- Common infrastructure across wireline and mobility
- Seamless migration from existing deployments
- Leverage the common infrastructure across access technologies
- Standardized model driven interface with the UP
- Data externalization for North-bound interfaces (NBI)
- Highly available and fault tolerant
- Simplified Subscriber Geo redundancy
- Horizontally scalable CP
- Independent CP and UP upgrades
- Feature agility with CI and CD
- Manageability and Operational Simplification

cnBNG Components

The cnBNG solution comprises of the following components:

Subscriber Microservices Infrastructure

The Cisco Ultra Cloud Core Subscriber Microservices Infrastructure (SMI) is a layered stack of cloud technologies that enable the rapid deployment, and seamless life-cycle operations for microservices-based applications.

The SMI stack consists of the following:

- SMI Cluster Manager—Creates the Kubernetes (K8s) cluster, creates the software repository, and provides ongoing LCM for the cluster including deployment, upgrades, and expansion.
- Kubernetes Management—Includes the K8s master and etcd functions, which provide LCM for the NF applications deployed in the cluster. This component also provides cluster health monitoring and resources scheduling.
- Common Execution Environment (CEE)—Provides common utilities and OAM functionalities for Cisco cloud native NFs and applications, including licensing and entitlement functions, configuration management, telemetry and alarm visualization, logging management, and troubleshooting utilities. Additionally, it provides consistent interaction and experience for all customer touch points and integration points in relation to these tools and deployed applications.
- Common Data Layer (CDL)—Provides a high performance, low latency, stateful data store, designed specifically for 5G and subscriber applications. This next generation data store offers HA in local or geo-redundant deployments.
- Service Mesh—Provides sophisticated message routing between application containers, enabling managed interconnectivity, additional security, and the ability to deploy new code and new configurations in low risk manner.

- NB Streaming—Provides Northbound Data Streaming service for billing and charging systems.
- NF/Application Worker nodes—The containers that comprise an NF application pod.
- NF/Application Endpoints (EPs)—The NF's/application's interfaces to other entities on the network.
- Application Programming Interfaces (APIs)—SMI provides various APIs for deployment, configuration, and management automation.

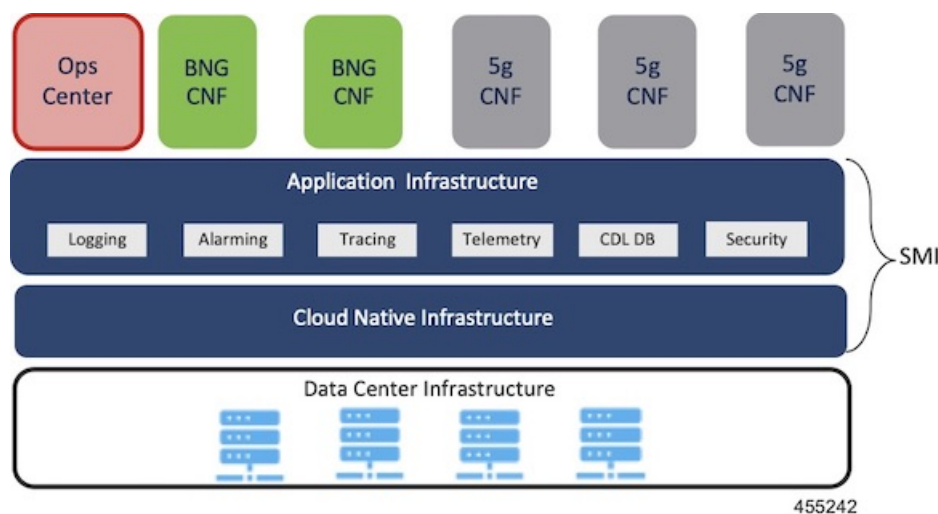
For more information on SMI components, refer to the "Overview" chapter of the *Ultra Cloud Core Subscriber Microservices Infrastructure* documentation—*Deployment Guide*.

For information on the Cisco Ultra Cloud Core, see <https://www.cisco.com/c/en/us/products/collateral/wireless/packet-core/datasheet-c78-744630.html>.

cnBNG Control Plane

The Cisco cnBNG CP is built on Cisco® Cloud Native Infrastructure, which is a Kubernetes-based platform that provides a common execution environment for container-based applications. This CP is built on principles of stateless microservices, to scale at-ease, introduce services much faster and more cost-effective.

Figure 3: cnBNG Control Plane Architecture



The CP runs as a Virtual Machine (VM) to adapt to existing service provider-deployed virtual infrastructure. It is built ground-up on a clean-slate architecture with a view on 'Converged Subscriber Services' and is aligned to 3gpp and BBF standards.

The cnBNG CP effectively manages the subscriber management functions such as:

- Authentication, authorization, and accounting of subscriber sessions
- IP Address assignment
- In-built DHCP Server
- Security
- Policy management
- Quality of Service (QoS)

Service providers can choose from wide choice of available ASR 9000 form factors, based on exact deployment requirements. The CUPS architecture allows to run these UPs in a distributed mode, to the edge of network, for early traffic offloads.

cnBNG User Plane

The UP delivers the forwarding functionality of the entire cnBNG solution. With the CP handling the subscriber management functionality, the cnBNG architecture enables the UP to be more distributed and interoperable with cnBNG CP with minimal integration efforts. The cnBNG Subscriber Provisioning Agent (SPA), which is the common interface between UP and CP, is bundled with the existing Cisco IOS XR image to transform an integrated physical BNG router to a cnBNG user plane.

For more information about the cnBNG UP, see the *Cloud Native BNG User Plane Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 7.3.x*.

License Information

cnBNG supports the following licenses:

License	Description
Application Base	Per cluster
Session (Increments)	Network-wide

These are the software license PIDs for cnBNG:

Cisco cnBNG Control Plane:

Product IDs	Description
CN-BNG-BASE-L	Base PID for cnBNG Control Plane (per cluster)
CN-BNG-100k-L	Session scale for 100,000 subscribers (network-wide) base licenses
CN-BNG-400k-L	Session scale for 400,000 subscribers (network-wide) base licenses
CN-BNG-1M-L	Session scale for 1,000,000 subscribers (network-wide) base licenses
CN-BNG-2M-L	Session scale for 2,000,000 subscribers (network-wide) base licenses

Cisco cnBNG User Planes:

Refer the ASR9000 data sheet for ordering information:

<https://www.cisco.com/c/en/us/products/routers/asr-9000-series-aggregation-services-routers/datasheet-listing.html>

Standard Compliance

cnBNG solution is aligned with the following standard:

TR-459 Control and User Plane Separation for a disaggregated BNG

Limitations and Restrictions

The cnBNG has the following limitations and restrictions in this release:

- High availability on CP is not supported.
- Only one subnet is supported per VRF.
- QoS provisioning is supported only through service.



CHAPTER 2

cnBNG Installation and Configuration

- [Feature Summary and Revision History, on page 9](#)
- [Feature Description, on page 10](#)

Feature Summary and Revision History

Summary Data

Table 2: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 3: Revision History

Revision Details	Release
cnBNG CP deployment on bare metal server is supported (with support for IPoE, PPPoE, LAC and LNS call models and High Availability) and fully qualified in this release.	2022.01.0
First introduced.	2021.01.0

Feature Description

This chapter describes cnBNG installation and configuration using the Ultra Cloud Core Subscriber Microservices Infrastructure (SMI) Cluster Manager and the BNG Operations (Ops) Center. The BNG Ops Center is based on the ConfD command line interface (CLI).

To install the SMI Cluster Manager, refer to the "Deploying the SMI Cluster Manager on VMware vCenter" section in the *Ultra Cloud Core Subscriber Microservices Infrastructure - Deployment Guide*.

The SMI Ops Center is the platform to install the cnBNG cluster with the offline or online repository. It is mandatory to install the SMI Ops Center to set up and access the BNG Ops Center.



Note

To access the offline or online repository, contact your Cisco Account Manager or representative to get access to the offline or online repository.

BNG Ops Center

The BNG Ops Center is a system-level infrastructure that provides the following functionality:

- A user interface to trigger a deployment of microservices with the flexibility of providing variable helm chart parameters to control the scale and properties of Kubernetes objects (deployment, pod, services, and so on) associated with the deployment.
- A user interface to push application-specific configuration to one or more microservices through Kubernetes configuration maps.
- A user interface to issue application-specific execution commands (such as show and clear commands). These commands:
 - Invoke some APIs in application-specific pods
 - Display the information returned on the user interface application

The following figure shows a sample of the web-based CLI presented to the user.


```

Username: admin
Warning: Permanently added '[localhost]:2024' (RSA) to the list of known hosts.
admin@localhost's password:

Welcome to the bng CLI on unknown
Copyright © 2016-2020, Cisco Systems, Inc.
All rights reserved.

admin connected from 127.0.0.1 using ssh on ops-center-bng-ops-center-68bb45476f-62jvw
Warning!!! Your password will expire in 9 days!

[unknown] bng# show running-config
helm default-repository bng-master
helm repository bng-lac
access-token eglditnr:AKCp5ekcbPU5siifdwWVxqXjSchQkweH7sd1Xve8JktjKbpg6Yj9xufvMn9djkAy8lp2Jo
url https://engcl-maven-master.cisco.com/artifactory/smi-fuse-internal-snapshot/mobile-cnat-bng/bng-products/dev-bng-lac/
exit
helm repository bng-master
access-token eglditnr:AKCp5ekcbPU5siifdwWVxqXjSchQkweH7sd1Xve8JktjKbpg6Yj9xufvMn9djkAy8lp2Jo
url https://engcl-maven-master.cisco.com/artifactory/smi-fuse-internal-snapshot/mobile-cnat-bng/bng-products/master/
exit
k8s name unknown
k8s namespace bng
k8s nf-name bng
k8s registry dockerhub.cisco.com/smi-fuse-docker-internal
k8s single-node true
k8s use-volume-claims false
k8s ingress-host-name 10.84.102.189.nip.io
aaa authentication users user admin
uid 117
gid 117
password $1sk7Evtccp9MPhn3TJHzjNcfnlMispM61
ssh_keydir /tmp/admin/.ssh
homedir /tmp/admin
exit
aaa ios level 0
prompt "h> "
exit
aaa ios level 15
prompt "h# "

```

The BNG Ops Center allows you to configure features such as licensing, REST endpoint, and CDL.

For information on how to deploy BNG Ops Center on bare metal servers (currently Cisco UCS-C servers) environment, see "Operating the SMI Cluster Manager on Bare Metal" section in the *Ultra Cloud Core Subscriber Microservices Infrastructure — Operations Guide*.

Installing cnBNG and Accessing BNG Ops Center

This section describes how to install cnBNG and access the BNG Ops Center.

The Ultra Cloud Core SMI platform is responsible for setting up and managing the Cloud Native Broadband Network Gateway application.

Prerequisites

Before installing cnBNG on the SMI layer in an offline environment:

- Ensure that the SMI Cluster Manager all-in-one (AIO) is installed. This helps orchestrate the K8s Cluster and load the image.
- Ensure that all SMI K8s cluster nodes are in Ready state.
- Run the SMI synchronization operation for the BNG Ops Center and Cloud Native Common Execution Environment (CN-CEE).

For CEE installation, refer to the *Ultra Cloud Core Common Execution Environment- Configuration and Administration Guide*.

- Ensure that the local repositories, which host the product offline TAR ball version, is installed.

System Requirements

Feature	Description
Disk Space	2 x 800 GB SSD (RAID 1) or equivalent input/output operations per second (IOPS) and redundancy.
Hardware	<ul style="list-style-type: none"> • High-performance x86 64-bit chipset • CPU performance Passmark benchmark of 13K rating per chip and 1,365 rating per thread, or better • VMware ESXi-compatible <p>Note The following is recommended:</p> <ul style="list-style-type: none"> • Cisco UCSM5 series blade servers to achieve the best performance. • All the host servers should be UCSC-C240-M5SX or UCSC-C220-M5SX. • All the UCS systems should have SSD storage type. • UCS C240M5 servers for better performance and to avoid infrastructure issues.
Platform	VMware ESXi and VMware vCenter versions 6.5 and 6.7 <p>Note SMI Cluster Manger support is qualified on the preceding platforms.</p>
Memory	<ul style="list-style-type: none"> • At least DDR3-1600 or better than 1600 MT/s • ECC
Deployment Requirement	Hardware oversubscription, network saturation, or CPU oversubscription reduces application performance and productivity. The Cisco Ultra Cloud Core Subscriber Microservices Infrastructure detects and takes action when infrastructure requirements are not met.

Installing cnBNG in an Offline Environment

Using the SMI Cluster Manager, download the offline TAR ball of the cnBNG, the host and its charts, and corresponding images in the local registries. The SMI Cluster Manager supports the deployment of the BNG Ops Center and all the applications and services associated with it. This section describes the procedures involved in installing cnBNG in an offline environment using the SMI Cluster Manager.

To install cnBNG, complete the following steps:

1. Download the TAR ball from the URL.

software-packages download *URL*

Example:

```
SMI Cluster Manager# software-packages download
http://<ipv4address>:<port_number>/packages/bng-2021-02-1.tar
```

2. Verify whether the TAR balls are loaded.

```
software-packages list
```

Example:

```
BNG Cluster Manager# software-packages list
[ bng-2021-02-1 ]
[ sample ]
```

3. Configure the necessary SMI Ops Center parameters in the cluster to install cnBNG.

```
configure
```

```
cluster cluster_name
  ops-centers app_name instance_name
    repository url
    netconf-ip ipv4_address
    netconf-port port
    ssh-ip ipv4_address
    ssh-port port
    ingress-hostname <ipv4_address>.<customer_specific_domain_name>
    initial-boot-parameters use-volume-claims true/false
    initial-boot-parameters first-boot-password password
    initial-boot-parameters auto-deploy true/false
    initial-boot-parameters single-node true/false
    initial-boot-parameters image-pull-secrets
  exit
```

```
exit
```

Example:

```
SMI Cluster Manager# config
Entering configuration mode terminal
SMI Cluster Manager(config)# clusters cnbng-smi-cluster-01
SMI Cluster Manager(config-clusters-cnbng-smi-cluster-01)# ops-centers bng bng
SMI Cluster Manager(config-ops-centers-bng/bng)# repository
https://charts.10.10.105.50.nip.io/bng-2021.02.1
SMI Cluster Manager(config-ops-centers-bng/bng)# ingress-hostname 10.10.105.34.nip.io
SMI Cluster Manager(config-ops-centers-bng/bng)# initial-boot-parameters use-volume-claims
true
SMI Cluster Manager(config-ops-centers-bng/bng)# initial-boot-parameters
first-boot-password test123
SMI Cluster Manager(config-ops-centers-bng/bng)# initial-boot-parameters auto-deploy
false
SMI Cluster Manager(config-ops-centers-bng/bng)# initial-boot-parameters single-node
false
SMI Cluster Manager(config-ops-centers-bng/bng)# exit
SMI Cluster Manager(config-clusters-cnbng-smi-cluster-01)# exit
SMI Cluster Manager(config)#
```

4. Configure the secrets, if your local registry contains secrets.

```
configure
```

```
cluster cluster_name
  secrets docker-registry secret_name
    docker-server server_name
    docker-username username
    docker-password password
```

```

docker-email email
namespace k8s namespace
commit
exit
exit

```

Example:

```

SMI Cluster Manager# config
SMI Cluster Manager(config)# clusters test2
SMI Cluster Manager(config-clusters-test2)# secrets docker-registry sec1
SMI Cluster Manager(config-docker-registry-sec1)# docker-server serv1
SMI Cluster Manager(config-docker-registry-sec1)# docker-username user1
SMI Cluster Manager(config-docker-registry-sec1)# docker-password Cisco@123
SMI Cluster Manager(config-docker-registry-sec1)# docker-email reg@cisco.com
SMI Cluster Manager(config-docker-registry-sec1)# bng bng
SMI Cluster Manager(config-docker-registry-sec1)# exit
SMI Cluster Manager(config-clusters-test2)# exit
SMI Cluster Manager(config)#

```

5. Run the cluster synchronization.

```

clusters cluster_name actions sync run

```

Example:

```

SMI Cluster Manager# clusters cnbng-smi-cluster-01 actions sync run

```

Notes:

- **software-packages download** *url*—Specifies the software packages to be downloaded through HTTP/HTTPS.
- **software-packages list**—Specifies the list of available software packages.
- **ops-centers** *app_name instance_name*—Specifies the BNG Ops Center and instance. *app_name* is the application name. *instance_name* is the name of the instance.
- **repository** *url*—Specifies the local registry URL for downloading the charts.
- **netconf-ip** *ipv4_address*—Specifies the BNG Ops Center netconf IPv4 address.
- **netconf-port** *port*—Specifies the BNG Ops Center netconf port number.
- **ssh-ip** *ipv4_address*—Specifies the SSH IPv4 address for the BNG Ops Center.
- **ssh-port** *port*—Specifies the SSH port number for the BNG Ops Center.
- **ingress-hostname** *<ipv4_address>. <customer_specific_domain_name>*—Specifies the ingress hostname to be set to the BNG Ops Center. *<customer_specific_domain_name>* specifies the domain name of the customer.
- **initial-boot-parameters**—Specifies the initial boot parameters for deploying the helm charts.
 - **use-volume-claims** *true/false*—Specifies the usage of persistent volumes. Set this option to True to use persistent volumes. The default value is true.
 - **first-boot-password** *password*—Specifies the first boot password for the product's Ops Center.
 - **auto-deploy** *true/false*—Auto deploys all the services of the product. Set this option to false to deploy only the product's Ops Center.

- **single-node** *true/false*— Specifies the product deployment on a single node. Set this option to false for multi node deployments.
- **image-pull-secrets**— Specifies the docker registry secret name to be used.
- **secrets docker-registry** *secret_name*— Specifies the secret name for your docker registry.
 - **docker-server** *server_name*— Specifies the docker server name.
 - **docker-username** *username*— Specifies the docker registry user name.
 - **docker-password** *password*— Specifies the docker registry password.
 - **docker-email** *email*— Specifies the docker registry email.
 - **namespace** *namespace*— Specifies the docker registry namespace.

Verifying the cnBNG Installation

Verify the status of the cnBNG installation deployment through the cnBNG CLI. To verify, use the following commands:

1. Log in to the cnBNG product CLI.
2. Verify whether the charts are loaded in the specific instance (verify the namespace).

show helm charts

Example:

```
bng# show helm charts
CHART      INSTANCE  STATUS   VERSION  REVISION  RELEASE  NAMESPACE
-----
infra-charts - DEPLOYED 0.0.6-rel-2021-01-0073-210208130850-fac5207 1 bng-bng-infra-charts
  bng-bng
oam-pod - DEPLOYED 0.1.2-rel-2021-01-0144-210122165946-fcb74ed 1 bng-bng-oam-pod bng-bng
bng-dashboard - DEPLOYED 0.0.1-rel-2021-01-0039-210122165311-0d542be 1
bng-bng-bng-dashboard bng-bng
etcd-cluster - DEPLOYED 0.7.0-0-7-0060-210203074532-f118407 1 bng-bng-etcd-cluster bng-bng
ngn-datastore - DEPLOYED 1.3.0-1-3-0782-210125161812-f50a892 1 bng-bng-ngn-datastore
bng-bng
```

3. Verify the status of the system.

show system status

Example:

```
bng# show system status
system status deployed true
system status percent-ready 100.0
```

Notes:

- **show helm charts**— Displays the helm release details.
- **show system status**— Displays the status of the system.

Accessing BNG Ops Center

You can connect to the BNG Ops Center through SSH or the web-based CLI console.

1. SSH:

```
ssh admin@ops_center_pod_ip -p 2024
```

2. Web-based console:

a. Log in to the Kubernetes master node.

b. Run the following command:

```
kubectl get ingress <namespace>
```

The available ingress connections get listed.

c. Select the appropriate ingress and access the BNG Ops Center.

d. Access the following URL from your web browser:

```
cli.<namespace>-ops-center.<ip_address>.nip.io
```

By default, the Day 0 configuration is loaded into the cnBNG.

Day 0 Configuration

To view the Day 0 configuration, run the following command.

```
show running-config
```

The following is a sample Day 0 configuration:

```
luser@cnbng-smi-cluster-master1:~$ kubectl get svc -n bng-bng | grep
ops-center-bng-bng-ops-center
NAME                                TYPE                CLUSTER-IP          EXTERNAL-IP         PORT(S)
AGE
ops-center-bng-bng-ops-center      ClusterIP           10.96.151.115       <none>
8008/TCP,8080/TCP,2024/TCP,2022/TCP,7681/TCP   7m37s
luser@cnbng-smi-cluster-master1:~$ ssh admin@10.96.151.115 -p 2024
Warning: Permanently added '[10.96.151.115]:2024' (RSA) to the list of known hosts.
admin@10.96.151.115's password:

Welcome to the bng CLI on cnbng-smi-cluster/bng
Copyright © 2016-2020, Cisco Systems, Inc.
All rights reserved.

admin connected from 192.202.0.1 using ssh on ops-center-bng-bng-ops-center-7bddd4cc48-fmb61
[cnbng-smi-cluster/bng] bng# show running-config
system mode running
helm default-repository base-repos
helm repository base-repos
url
https://engci-maven-master.cisco.com/artifactory/smi-fuse-internal-snapshot/mobile-cnat-bng/bng-products/master/
username <username>
password <password>
exit
k8s name           cnbng-smi-cluster
k8s namespace     bng-bng
k8s nf-name       bng
k8s registry      dockerhub.cisco.com/smi-fuse-docker-internal
k8s single-node   false
```

```
k8s use-volume-claims true
k8s ingress-host-name 1.1.1.2.nip.io
aaa authentication users user admin
uid          1117
gid          1117
password    $1$EmkQjvc0$o8K5tXmUzN1.drQgCL0A2/
ssh_keydir  /tmp/admin/.ssh
homedir     /tmp/admin
exit
aaa ios level 0
prompt "\h> "
exit
aaa ios level 15
prompt "\h# "
exit
aaa ios privilege exec
level 0
  command action
  exit
  command autowizard
  exit
  command enable
  exit
  command exit
  exit
  command help
  exit
  command startup
  exit
exit
level 15
  command configure
  exit
exit
nacm write-default deny
nacm groups group admin
user-name [ admin ]
exit
nacm rule-list admin
group [ admin ]
rule any-access
  action permit
exit
exit
nacm rule-list confd-api-manager
group [ confd-api-manager ]
rule any-access
  action permit
exit
exit
nacm rule-list ops-center-security
group [ * ]
rule change-self-password
  module-name      ops-center-security
  path              /smiuser/change-self-password
  access-operations exec
  action            permit
exit
rule smiuser
  module-name      ops-center-security
  path              /smiuser
  access-operations exec
  action            deny
```

```

exit
exit

deployment
  app-name      BNG
  cluster-name  Local
  dc-name       DC
exit
k8 bng
  etcd-endpoint      etcd:2379
  datastore-endpoint datastore-ep-session:8882
  tracing
    enable
    enable-trace-percent 30
    append-messages      true
    endpoint              jaeger-collector:9411
  exit
exit
k8 label protocol-layer key smi.cisco.com/node-type value protocol
exit
k8 label service-layer key smi.cisco.com/node-type value service
exit
k8 label cdl-layer key smi.cisco.com/node-type value session
exit
k8 label oam-layer key smi.cisco.com/node-type value oam
exit
instances instance 1
  system-id DC
  cluster-id Local
  slice-name 1
exit
local-instance instance 1
system mode shutdown
helm default-repository base-repos
helm repository base-repos
  url
  https://engci-maven-master.cisco.com/artifactory/smi-fuse-internal-snapshot/mobile-cnat-bng/bng-products/master/

  username smf-deployer.gen
  password ***
exit
k8s name          svi-cn-bng-tb3
k8s namespace     bng-bng
k8s nf-name       bng
k8s registry      dockerhub.cisco.com/smi-fuse-docker-internal
k8s single-node   false
k8s use-volume-claims true
k8s ingress-host-name 10.81.103.86.nip.io
aaa authentication users user admin
  uid          1117
  gid          1117
  password     $1$vDWeJvJm$v46wiBWqdOj7eWgoPoZZE/
  ssh_keydir   /tmp/admin/.ssh
  homedir      /tmp/admin
exit
aaa ios level 0
  prompt "\h> "
exit
aaa ios level 15
  prompt "\h# "
exit
aaa ios privilege exec
  level 0
  command action
  exit

```



```

command autowizard
exit
command enable
exit
command exit
exit
command help
exit
command startup
exit
exit
level 15
command configure
exit
exit
exit
nacm write-default deny
nacm groups group admin
user-name [ admin ]
exit
nacm rule-list admin
group [ admin ]
rule any-access
action permit
exit
exit
nacm rule-list confd-api-manager
group [ confd-api-manager ]
rule any-access
action permit
exit
exit
nacm rule-list ops-center-security
group [ * ]
rule change-self-password
module-name ops-center-security
path /smiuser/change-self-password
access-operations exec
action permit
exit
rule smiuser
module-name ops-center-security
path /smiuser
access-operations exec
action deny
exit
exit

```

CP and UP Service Configuration

The CP service requires the basic configuration to process the API calls.



Note For information about the User Plane service configuration, refer to the *Cloud Native BNG User Plane Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 7.3.x*

Configuring the CP

The CP configuration is provided using the Ops Center infrastructure.

The following is a sample CP configuration:

```

ipam
source local
address-pool Default-Pool
address-quarantine-timer 60
vrf-name default
ipv4
split-size
per-cache 131072
per-dp 131072
exit
address-range 13.0.0.1 13.1.255.255
exit
ipv6
address-ranges
split-size
per-cache 65536
per-dp 65536
exit
address-range 1:4::1 1:4::ffff
address-range 1:5::1 1:5::ffff
address-range 1:6::1 1:6::ffff
address-range 1:7::1 1:7::ffff
exit
prefix-ranges
split-size
per-cache 65536
per-dp 65536
exit
prefix-range 2003:db0:: length 48
prefix-range 2003:db1:: length 48
prefix-range 2003:db2:: length 48
prefix-range 2003:db3:: length 48
exit
exit
address-pool VRF-Pool
address-quarantine-timer 60
vrf-name it_vrf
ipv4
split-size
per-cache 131072
per-dp 131072
exit
address-range 14.0.0.1 14.1.255.255
exit
ipv6
address-ranges
split-size
per-cache 65536
per-dp 65536
exit
address-range 2:4::1 2:4::ffff
address-range 2:5::1 2:5::ffff
address-range 2:6::1 2:6::ffff
address-range 2:7::1 2:7::ffff
exit
prefix-ranges
split-size
per-cache 65536
per-dp 65536
exit
prefix-range 2004:db0:: length 48
prefix-range 2004:db1:: length 48
prefix-range 2004:db2:: length 48

```

```
    prefix-range 2004:db3:: length 48
  exit
exit
address-pool pool-ISP
  address-quarantine-timer 60
  vrf-name default
  ipv4
    split-size
      per-cache 131072
      per-dp 131072
    exit
  address-range 11.0.0.1 11.1.255.255
  exit
  ipv6
    address-ranges
      split-size
        per-cache 65536
        per-dp 65536
      exit
      address-range 4:2::1 4:2::ffff
      address-range 4:3::1 4:3::ffff
      address-range 4:4::1 4:4::ffff
      address-range 4:5::1 4:5::ffff
    exit
    prefix-ranges
      split-size
        per-cache 65536
        per-dp 65536
      exit
      prefix-range 2001:db0:: length 48
      prefix-range 2001:db1:: length 48
      prefix-range 2001:db2:: length 48
      prefix-range 2001:db3:: length 48
    exit
  exit
address-pool pool-st
  vrf-name default
  static enable user-plane asr9k-2
  ipv4
    split-size
      per-cache 262144
      per-dp 262144
    exit
  address-range 12.0.0.1 12.3.255.254 default-gateway 12.0.0.1
  exit
  ipv6
    address-ranges
      split-size
        per-cache 8192
        per-dp 8192
      exit
      address-range 2:2::1 2:2::ff00
    exit
    prefix-ranges
      split-size
        per-cache 8192
        per-dp 8192
      exit
      prefix-range 3001:db0:: length 48
    exit
  exit
exit
```

```
address-pool static-pool
vrf-name access-vrf-1
static enable user-plane asr9k-1
ipv4
  split-size
  no-split
  exit
  address-range 20.20.0.0 20.20.0.255 default-gateway 20.20.0.1
  exit
exit
exit
cdl node-type session
cdl logging default-log-level error
cdl datastore session
  endpoint replica 2
  endpoint settings slot-timeout-ms 750
  index replica 2
  index map 1
  slot replica 2
  slot map 2
  slot notification limit 300
exit
cdl kafka replica 2
profile dhcp dhcp-server1
  ipv4
  mode server
  server
  pool-name pool-ISP
  dns-servers [ 8.8.8.8 ]
  lease hours 6
  lease minutes 40
  exit
exit
  ipv6
  mode server
  server
  iana-pool-name pool-ISP
  iapd-pool-name pool-ISP
  lease days 0
  lease hours 4
  lease minutes 2
  exit
exit
profile dhcp dhcp-server3
  ipv4
  mode server
  server
  pool-name Default-Pool
  dns-servers [ 8.8.8.8 ]
  lease days 1
  lease hours 6
  lease minutes 3
  exit
exit
  ipv6
  mode server
  server
  iana-pool-name Default-Pool
  iapd-pool-name Default-Pool
  lease days 1
  lease hours 6
  lease minutes 3
  exit
```

```
exit
exit
profile dhcp dhcp-server4
  ipv4
    mode server
    server
      pool-name VRF-Pool
      dns-servers [ 8.8.8.8 ]
      lease hours 6
      lease minutes 40
    exit
  exit
  ipv6
    mode server
    server
      iana-pool-name VRF-Pool
      iapd-pool-name VRF-Pool
      lease hours 6
    exit
  exit
exit
profile pppoe bng
  ctrl-pkt-priority 7
  max-payload deny
  service-name [ value]
  ac-name 123@acname
  ac-cookie 123@accokie
exit
profile aaa aaa-profl
  authorization
    type subscriber method-order [ local ]
    username value <username>
    password <password>
  exit
  accounting
    method-order [ local ]
  exit
exit
profile server-group local
  radius-group local
exit
profile subscriber subs-default
  dhcp-profile dhcp-server3
  session-type ipv4v6
  activate-feature-templates [ svc1 QOS_HSI QOS_IPTV QOS_VOICE ]
  aaa authorize aaa-profl
exit
profile subscriber subs-profl
  dhcp-profile dhcp-server1
  session-type ipv4v6
  activate-feature-templates [ svc1 ]
  aaa authorize aaa-profl
exit
profile subscriber subs-profl-pppoe
  dhcp-profile dhcp-server1
  pppoe-profile bng
  session-type ipv4v6
  class ppp_cls_map
  activate-feature-templates [ bng_ft_start ]
  matches
    match-type all
    match protocol [ ppp ]
  exit
exit
```

```

event session-activate
class ppp_cls_map
  activate-feature-templates [ bng_ft_activate ]
  matches
    match-type all
    match protocol [ ppp ]
  exit
  aaa authenticate aaa-prof1
  exit
exit
exit
profile subscriber subs-vrf
  dhcp-profile          dhcp-server4
  session-type          ipv4v6
  activate-feature-templates [ svc3 QOS_VOICE QOS_IPTV QOS_HSI ]
  aaa authorize aaa-prof1
exit
profile subscriber test-ppp-subscriber
  dhcp-profile          dhcp-server3
  pppoe-profile         test-ppp-pppoeprofile
  session-type          ipv4v6
  activate-feature-templates [ svc1 test-ppp-featuretemplate QOS_VOICE QOS_IPTV QOS_HSI ]
  aaa authorize aaa-prof1
exit
profile feature-template ACL-V4
  ipv4
  ingress-acl iACL_BNG_IPv4_IN
  egress-acl  iACL_BNG_IPv4_OUT
  exit
exit
profile feature-template ACL-V6
  ipv6
  ingress-acl v6-IN
  egress-acl  v6-out
  exit
exit
profile feature-template QOS_HSI
  qos
  in-policy   QOS_HSI_100B_IN
  out-policy  QOS_HSI_100B_OUT
  merge-level 30
  exit
  service-accounting
  enable
  aaa-profile   aaa-prof1
  periodic-interval 1800
  exit
exit
profile feature-template QOS_VOICE
  qos
  in-policy   QOS_VOICE_INGRESS
  out-policy  QOS_VOICE_EGRESS
  merge-level 40
  exit
exit
profile feature-template QOS_IPTV
  qos
  in-policy   QOS_IPTV_INGRESS
  out-policy  QOS_IPTV_EGRESS
  merge-level 50
  exit
exit
profile feature-template QOS
  qos

```

```
in-policy QOS-IN
out-policy QOS-OUT
merge-level 10
exit
service-accounting
enable
aaa-profile aaa-profl
exit
exit
profile feature-template bng_ft_activate
ipv4
mtu 1492
ingress-acl in4acl3
disable-unreachables
verify-unicast-source reachable-via-rx
exit
ipv6
mtu 1492
ingress-acl match-ipv6-acl
disable-unreachables
verify-unicast-source reachable-via-rx
exit
session-accounting
enable
aaa-profile aaa-profl
periodic-interval 1200
exit
ppp
ipcp dns 8.8.8.8 1.2.3.4
ipcp peer-address-pool pool-ISP
ipcp renegotiation ignore
ipv6cp renegotiation ignore
exit
exit
profile feature-template bng_ft_start
vrf-name default
session-accounting
enable
aaa-profile aaa-profl
periodic-interval 1200
exit
ppp
authentication [ pap ]
lcp delay seconds 1 milliseconds 0
lcp renegotiation ignore
exit
exit
profile feature-template svcl
vrf-name default
ipv4
mtu 1492
ingress-acl iACL_BNG_IPv4_IN_1
egress-acl iACL_BNG_IPv4_OUT_1
disable-unreachables
verify-unicast-source reachable-via-rx
exit
ipv6
mtu 1492
ingress-acl ipv6-acl-in-1
egress-acl ipv6-acl-out-1
disable-unreachables
verify-unicast-source reachable-via-rx
exit
session-accounting
```

```

    enable
    aaa-profile      aaa-prof1
    periodic-interval 1800
  exit
exit
profile feature-template svc2
  ppp
  ipcp peer-address-pool poolv4
  ipcp renegotiation ignore
  lcp renegotiation ignore
  exit
exit
profile feature-template svc3
  vrf-name it_vrf
  ipv4
  mtu 1492
  ingress-acl      iACL_BNG_IPv4_IN_1
  egress-acl       iACL_BNG_IPv4_OUT_1
  disable-unreachables
  verify-unicast-source reachable-via-rx
  exit
  ipv6
  mtu 1492
  ingress-acl      ipv6-acl-in-1
  egress-acl       ipv6-acl-out-1
  disable-unreachables
  verify-unicast-source reachable-via-rx
  exit
  session-accounting
  enable
  aaa-profile      aaa-prof1
  periodic-interval 1800
  exit
exit
profile feature-template svc4
  vrf-name default
  session-accounting
  enable
  aaa-profile      aaa-prof1
  periodic-interval 1800
  exit
exit
profile feature-template test-ppp-featuretemplate
  vrf-name default
  ipv4
  mtu 1400
  exit
  ppp
  ipcp peer-address-pool Default-Pool
  ipcp renegotiation ignore
  ipv6cp renegotiation ignore
  lcp renegotiation ignore
  exit
exit
profile feature-template uRPF
  ipv4
  verify-unicast-source reachable-via-rx
  exit
  ipv6
  verify-unicast-source reachable-via-rx
  exit
exit
profile radius
  algorithm round-robin

```



```
deadtime 3
detect-dead-server response-timeout 60
max-retry 1
timeout 5
server 172.16.254.55 1812
    type auth
    secret <secret_value>
exit
server 172.16.254.55 1813
    type acct
    secret <secret_value>
exit
server 172.16.254.56 1812
    type auth
    secret <secret_value>
exit
server 172.16.254.56 1813
    type acct
    secret <secret_value>
exit
attribute
    nas-identifier < any identifier>
    nas-ip 172.16.254.86
    nas-port-id < add_unique_id>
exit
server-group local
    server auth 172.16.254.55 1812
    exit
    server auth 172.16.254.56 1812
    exit
    server acct 172.16.254.55 1813
    exit
    server acct 172.16.254.56 1813
    exit
exit
profile coa
    client 172.16.254.55
    server-key < key >
    exit
    client 172.16.254.56
    server-key < key >
    exit
exit
user-plane <add UP name like asr9k-11>
    peer-address ipv4 172.16.247.72
    subscriber-profile subs-default
exit
endpoint sm
exit
endpoint nodemgr
exit
endpoint n4-protocol
exit
endpoint dhcp
exit
endpoint radius
    replicas 1
    vip-ip 172.16.254.86
    interface coa-nas
    sla response 140000
    vip-ip 172.16.254.86 vip-port 2000
    exit
exit
```

```

endpoint udp-proxy
  replicas 1
  nodes 2
  vip-ip 172.16.254.86 vip-port 3799
  interface n4
    sla response 150000
  exit
  interface gtpu
    sla response 150000
  exit
exit
endpoint charging
exit
logging transaction duplicate enable
logging name bng-dhcp0.bngfsol.collision level application info
logging name bng-dhcp0.bngfsol.collision level transaction info
logging name infra.application.core level application warn
logging name infra.config.core level application error
logging name infra.config.core level transaction error
k8 bng
  etcd-endpoint etcd:2379
  datastore-endpoint datastore-ep-session:8882
  tracing
    enable
    enable-trace-percent 30
    append-messages true
    endpoint jaeger-collector:9411
  exit
exit
k8 label protocol-layer key smi.cisco.com/vm-type value protocol
exit
k8 label service-layer key smi.cisco.com/vm-type value service
exit
k8 label cdl-layer key smi.cisco.com/vm-type value session
exit
k8 label oam-layer key smi.cisco.com/vm-type value oam
exit
system mode running
exit

ipam
  instance 1
    source local
    address-pool POOL_1
    address-quarantine-timer 60
    vrf-name default
    ipv4
      split-size
        per-cache 32768
        per-dp 32768
      exit
      threshold
        upper-threshold 80
      exit
      address-range 11.0.0.2 11.10.255.254
    exit
    ipv6
      address-ranges
        split-size
          per-cache 32768
          per-dp 32768
        exit
        address-range 2405:1::2 2405:1::ffff
        address-range 2405:2::2 2405:2::ffff
        address-range 2405:3::2 2405:3::ffff
    exit
  exit

```

```
    address-range 2405:4::2 2405:4::ffff
  exit
  prefix-ranges
    split-size
      per-cache 32768
      per-dp    32768
    exit
    prefix-range 3405:1:: length 46
    prefix-range 3405:2:: length 46
    prefix-range 3405:3:: length 46
    prefix-range 3405:4:: length 46
  exit
exit
address-pool POOL_2
address-quarantine-timer 60
vrf-name          VRF-GOLD
ipv4
  split-size
    per-cache 32768
    per-dp    32768
  exit
  threshold
    upper-threshold 80
  exit
  address-range 12.0.0.2 12.10.255.254
exit
ipv6
  address-ranges
    split-size
      per-cache 32768
      per-dp    32768
    exit
    address-range 2406:1::2 2406:1::ffff
    address-range 2406:2::2 2406:2::ffff
    address-range 2406:3::2 2406:3::ffff
    address-range 2406:4::2 2406:4::ffff
  exit
  prefix-ranges
    split-size
      per-cache 32768
      per-dp    32768
    exit
    prefix-range 3406:1:: length 46
    prefix-range 3406:2:: length 46
    prefix-range 3406:3:: length 46
    prefix-range 3406:4:: length 46
  exit
exit
address-pool POOL_3
address-quarantine-timer 60
vrf-name          vrf_lps_asr9k
ipv4
  split-size
    per-cache 32768
    per-dp    32768
  exit
  threshold
    upper-threshold 80
  exit
  address-range 13.0.0.1 13.255.255.255
exit
ipv6
```

```
address-ranges
  split-size
    per-cache 16384
    per-dp    16384
  exit
  address-range 2404:1::1 2404:1::ffff
  address-range 2404:2::1 2404:2::ffff
  address-range 2404:3::1 2404:3::ffff
  address-range 2404:4::1 2404:4::ffff
  address-range 2404:5::1 2404:5::ffff
  address-range 2404:6::1 2404:6::ffff
  address-range 2404:7::1 2404:7::ffff
  address-range 2404:8::1 2404:8::ffff
  address-range 2404:9::1 2404:9::ffff
  address-range 2404:10::1 2404:10::ffff
  address-range 2404:11::1 2404:11::ffff
  address-range 2404:12::1 2404:12::ffff
  address-range 2404:13::1 2404:13::ffff
  address-range 2404:14::1 2404:14::ffff
  address-range 2404:15::1 2404:15::ffff
  address-range 2404:16::1 2404:16::ffff
  address-range 2404:17::1 2404:17::ffff
  address-range 2404:18::1 2404:18::ffff
  address-range 2404:19::1 2404:19::ffff
  address-range 2404:20::1 2404:20::ffff
  address-range 2404:21::1 2404:21::ffff
  address-range 2404:22::1 2404:22::ffff
  address-range 2404:23::1 2404:23::ffff
  address-range 2404:24::1 2404:24::ffff
  address-range 2404:25::1 2404:25::ffff
  address-range 2404:26::1 2404:26::ffff
  address-range 2404:27::1 2404:27::ffff
  address-range 2404:28::1 2404:28::ffff
  address-range 2404:29::1 2404:29::ffff
  address-range 2404:30::1 2404:30::ffff
  address-range 2404:31::1 2404:31::ffff
  address-range 2404:32::1 2404:32::ffff
  address-range 2404:33::1 2404:33::ffff
  address-range 2404:34::1 2404:34::ffff
  address-range 2404:35::1 2404:35::ffff
  address-range 2404:36::1 2404:36::ffff
  address-range 2404:37::1 2404:37::ffff
  address-range 2404:38::1 2404:38::ffff
  address-range 2404:39::1 2404:39::ffff
  address-range 2404:40::1 2404:40::ffff
  exit
prefix-ranges
  split-size
    per-cache 32768
    per-dp    32768
  exit
  prefix-range 2404:db0:: length 42
  prefix-range 2404:db1:: length 42
  prefix-range 2404:db2:: length 42
  prefix-range 2404:db3:: length 42
  prefix-range 2404:db4:: length 42
  prefix-range 2404:db5:: length 42
  prefix-range 2404:db6:: length 42
  prefix-range 2404:db7:: length 42
  prefix-range 2404:db8:: length 42
  prefix-range 2404:db9:: length 42
  exit
exit
exit
```

```
exit
exit
cdl node-type session
cdl logging default-log-level error
cdl datastore session
  slice-names [ 1 ]
  endpoint replica 2
  endpoint settings slot-timeout-ms 750
  index replica 2
  index map 1
  slot replica 2
  slot map 2
  slot notification limit 300
exit
cdl kafka replica 1
profile dhcp DHCP_SERVER_1
  ipv4
  mode server
  server
  pool-name          POOL_1
  dns-servers        [ 8.8.8.8 8.8.8.88 8.8.88.88 ]
  netbios-name-server [ 9.9.9.9 9.9.9.99 9.9.99.99 ]
  domain-name        cisco.com
  boot-filename       cisco.cfg
  next-server         7.7.7.7
  netbios-node-type  broadcast-node
  lease days 1
  lease hours 4
  lease minutes 2
  exit
exit
  ipv6
  mode server
  server
  iana-pool-name     POOL_1
  iapd-pool-name     POOL_1
  dns-servers        [ 2002::1 2002::2 ]
  domain-name        cisco.com
  preference          255
  aftr-name          aftr.cisco.com
  lease days 1
  lease hours 4
  lease minutes 2
  exit
exit
profile dhcp DHCP_SERVER_2
  ipv4
  mode server
  server
  pool-name          POOL_1
  dns-servers        [ 8.8.8.8 8.8.8.88 8.8.88.88 ]
  netbios-name-server [ 9.9.9.9 9.9.9.99 9.9.99.99 ]
  domain-name        cisco.com
  boot-filename       cisco.cfg
  next-server         7.7.7.7
  netbios-node-type  broadcast-node
  lease days 1
  lease hours 4
  lease minutes 2
  exit
exit
  ipv6
  mode server
```

```

server
  iana-pool-name POOL_1
  iapd-pool-name POOL_1
  lease days 1
  lease hours 4
  lease minutes 2
exit
exit
profile dhcp DHCP_SERVER_3
  ipv4
  mode server
  server
    pool-name POOL_3
    dns-servers [ 8.8.8.8 ]
    lease hours 6
    lease minutes 1
  exit
exit
  ipv6
  mode server
  server
    iana-pool-name POOL_3
    iapd-pool-name POOL_3
    lease days 1
    lease hours 4
    lease minutes 2
  exit
exit
profile dhcp DHCP_SERVER_4
  ipv4
  mode server
  server
    pool-name POOL_2
    dns-servers [ 8.8.8.8 ]
    lease hours 6
    lease minutes 1
  exit
exit
  ipv6
  mode server
  server
    iana-pool-name POOL_2
    iapd-pool-name POOL_2
    lease days 1
    lease hours 4
    lease minutes 2
  exit
exit
profile pppoe PPPOE_PROFILE_1
  ctrl-pkt-priority 7
  service-name [ cisco ]
  ac-name 123@acname
  ac-cookie 123@accookie
exit
profile aaa AAA_PROF_1
  authentication
  method-order [ SERVER_GROUP_PROF_1 ]
exit
  authorization
  type subscriber method-order [ SERVER_GROUP_PROF_1 ]
  username identifier client-mac-address

```

```
password cisco
exit
accounting
method-order [ SERVER_GROUP_PROF_1 ]
exit
exit
profile aaa AAA_PROF_2
authentication
method-order [ SERVER_GROUP_PROF_2 ]
exit
authorization
type subscriber method-order [ SERVER_GROUP_PROF_2 ]
username identifier client-mac-address
password cisco
exit
accounting
method-order [ SERVER_GROUP_PROF_2 ]
exit
exit
profile server-group SERVER_GROUP_PROF_1
radius-group SERVER_GROUP_1
exit
profile server-group SERVER_GROUP_PROF_2
radius-group SERVER_GROUP_2
exit
profile subscriber SUBS_IPoE_1
dhcp-profile          DHCP_SERVER_1
session-type          ipv4v6
activate-feature-templates [ BASE_TPL_1 ]
aaa authorize AAA_PROF_1
exit
profile subscriber SUBS_IPoE_2
dhcp-profile          DHCP_SERVER_3
session-type          ipv4v6
activate-feature-templates [ BASE_TPL_2 ]
aaa authorize AAA_PROF_2
exit
profile subscriber SUBS_IPoE_3
dhcp-profile          DHCP_SERVER_4
session-type          ipv4v6
activate-feature-templates [ BASE_TPL_3 ]
aaa authorize AAA_PROF_2
exit
profile subscriber SUBS_PPPOE_1
dhcp-profile          DHCP_SERVER_2
pppoe-profile PPPOE_PROFILE_1
session-type          ipv4v6
class ppp_cls_map
activate-feature-templates [ FT_START_1 ]
matches
match-type all
match protocol [ ppp ]
exit
exit
event session-activate
class ppp_cls_map
activate-feature-templates [ FT_ACTIVATE_1 ]
matches
match-type all
match protocol [ ppp ]
exit
aaa authenticate AAA_PROF_1
exit
exit
```

```

exit
profile subscriber SUBS_PPpOE_2
dhcp-profile DHCP_SERVER_3
pppoe-profile PPPOE_PROFILE_1
session-type ipv4v6
class ppp_cls_map
  activate-feature-templates [ FT_START_1 ]
  matches
    match-type all
    match protocol [ ppp ]
  exit
exit
event session-activate
class ppp_cls_map
  activate-feature-templates [ FT_ACTIVATE_2 HSI_100MB ]
  matches
    match-type all
    match protocol [ ppp ]
  exit
  aaa authenticate AAA_PROF_1
exit
exit
exit
profile subscriber SUBS_PPpOE_3
dhcp-profile DHCP_SERVER_4
pppoe-profile PPPOE_PROFILE_1
session-type ipv4v6
class ppp_cls_map
  activate-feature-templates [ FT_START_2 ]
  matches
    match-type all
    match protocol [ ppp ]
  exit
exit
event session-activate
class ppp_cls_map
  activate-feature-templates [ FT_ACTIVATE_3 ]
  matches
    match-type all
    match protocol [ ppp ]
  exit
  aaa authenticate AAA_PROF_1
exit
exit
exit
profile feature-template BASE_TPL_1
vrf-name default
ipv4
  mtu 1492
  disable-unreachables
  verify-unicast-source reachable-via-rx
exit
ipv6
  mtu 1492
  disable-unreachables
  verify-unicast-source reachable-via-rx
exit
session-accounting
  enable
  aaa-profile AAA_PROF_1
exit
exit
profile feature-template BASE_TPL_2
vrf-name vrf_lps_asr9k

```



```
ipv4
  mtu 1492
  disable-unreachables
  verify-unicast-source reachable-via-rx
exit
ipv6
  mtu 1492
  disable-unreachables
  verify-unicast-source reachable-via-rx
exit
qos
  in-policy qos_svcl_in
  out-policy qos_svcl_out
exit
session-accounting
  enable
  aaa-profile AAA_PROF_2
exit
profile feature-template BASE_TPL_3
  vrf-name VRF-GOLD
  ipv4
    mtu 1492
    disable-unreachables
    verify-unicast-source reachable-via-rx
  exit
  ipv6
    mtu 1492
    disable-unreachables
    verify-unicast-source reachable-via-rx
  exit
  session-accounting
    enable
    aaa-profile AAA_PROF_2
  exit
profile feature-template FT_ACTIVATE_1
  vrf-name default
  ipv4
    mtu 1492
    disable-unreachables
    verify-unicast-source reachable-via-rx
  exit
  ipv6
    mtu 1492
    disable-unreachables
    verify-unicast-source reachable-via-rx
  exit
  ppp
    ipcp dns 8.8.8.8 1.2.3.4
    ipcp peer-address-pool POOL_1
    ipcp renegotiation ignore
    ipcp wins 4.4.4.4 3.3.3.3
    ipv6cp renegotiation ignore
  exit
profile feature-template FT_ACTIVATE_2
  vrf-name vrf_lps_asr9k
  ipv4
    mtu 1492
    disable-unreachables
    verify-unicast-source reachable-via-rx
  exit
  ipv6
```

```

    mtu 1492
    disable-unreachables
    verify-unicast-source reachable-via-rx
  exit
  ppp
    ipcp dns 8.8.8.8 1.2.3.4
    ipcp peer-address-pool POOL_3
    ipcp renegotiation ignore
    ipcp wins 4.4.4.4 3.3.3.3
    ipv6cp renegotiation ignore
  exit
exit
profile feature-template FT_ACTIVATE_3
  vrf-name VRF-GOLD
  ipv4
    mtu 1492
    disable-unreachables
    verify-unicast-source reachable-via-rx
  exit
  ipv6
    mtu 1492
    disable-unreachables
    verify-unicast-source reachable-via-rx
  exit
  ppp
    ipcp dns 8.8.8.8 1.2.3.4
    ipcp peer-address-pool POOL_2
    ipcp renegotiation ignore
    ipcp wins 4.4.4.4 3.3.3.3
    ipv6cp renegotiation ignore
  exit
exit
profile feature-template FT_START_1
  session-accounting
    enable
    aaa-profile AAA_PROF_1
  exit
  ppp
    authentication [ pap chap ]
    lcp delay seconds 1 milliseconds 0
    lcp renegotiation ignore
    max-bad-auth 4
    max-failure 5
    timeout retry 3
    keepalive interval 60 retry 5
  exit
exit
profile feature-template FT_START_2
  session-accounting
    enable
    aaa-profile AAA_PROF_2
  exit
  ppp
    authentication [ pap chap ]
    lcp delay seconds 1 milliseconds 0
    lcp renegotiation ignore
    max-bad-auth 4
    max-failure 5
    timeout retry 3
    keepalive interval 60 retry 5
  exit
exit
profile feature-template HSI_100MB
  qos

```

```
    in-policy HSI_UPLOAD_RATE_100MB_IN
    out-policy HSI_DOWNLOAD_RATE_100MB_OUT
  exit
exit
profile feature-template HSI_100MB_NO_Merge
  qos
    in-policy HSI_UPLOAD_RATE_100MB_IN_V4
    out-policy HSI_DOWNLOAD_RATE_100MB_OUT_V4
  exit
exit
profile feature-template HSI_100MB_V4
  qos
    in-policy HSI_UPLOAD_RATE_100MB_IN_V4
    out-policy HSI_DOWNLOAD_RATE_100MB_OUT_V4
  merge-level 40
  exit
  service-accounting
    enable
    aaa-profile AAA_PROF_1
    periodic-interval 1200
  exit
exit
profile radius
  algorithm round-robin
  deadtime 1
  detect-dead-server response-timeout 60
  max-retry 1
  timeout 5
  server 203.203.203.12 1812
    type auth
    secret $8$uCC1/DzxkoOTeUFsUIUQoqF1Gbrzt6bo2HWRmUH9Sck=
  exit
  server 203.203.203.12 1813
    type acct
    secret $8$lmsqnr3OZYu6j0+DRGgvic5mOa/wmNw6sAnH4G7BYms=
  exit
  server 203.203.203.13 1812
    type auth
    secret $8$sI2jG0E3TLnPZ6+EpaSKxIYNayfX6pOo3nV8Y6w2R8I=
  exit
  server 203.203.203.13 1813
    type acct
    secret $8$49TVXKEXstB7DyK/r/QuxbzGcQ6avG1A4wrgSukSp9s=
  exit
  server 203.203.203.14 1812
    type auth
    secret $8$qdAzfoAmxVBIX04Xjw//Xywsire0AuNYC8EbKy11kiQ=
  exit
  server 203.203.203.14 1813
    type acct
    secret $8$Fxs0QXKUmz93ULLuQo6yH6pjR0mB3CgTx7TRYL2U1Ao=
  exit
  server 203.203.203.15 1812
    type auth
    secret $8$j6PMUylUXz9Uggo42Zm2z6xfL0icZ8R5ry7tBP60BYo=
  exit
  server 203.203.203.15 1813
    type acct
    secret $8$oAbeghiPAJ88qqtjZqYihS39VmycliU85WUo6pHpaAw=
  exit
  attribute
    nas-identifier CISCO-BNG
    nas-ip 203.203.203.51
  exit
```

```

server-group SERVER_GROUP_1
  server auth 203.203.203.12 1812
  exit
  server auth 203.203.203.13 1812
  exit
  server acct 203.203.203.12 1813
  exit
  server acct 203.203.203.13 1813
  exit
exit
server-group SERVER_GROUP_2
  server auth 203.203.203.12 1812
  exit
  server auth 203.203.203.13 1812
  exit
  server acct 203.203.203.12 1813
  exit
  server acct 203.203.203.13 1813
  exit
exit
exit
profile coa
  client 203.203.203.11
    server-key $8$l0ZSTRkSki7VIU9Ld31kIFALUH4VipxvUKS0lOskSho=
  exit
  client 203.203.203.13
    server-key $8$ViHTNL8bYPDcrTYXO24AJ1TnsnUJRXp6DBfWF/FX1/8=
  exit
exit
user-plane ASR9k-UP-1
  peer-address ipv4 101.101.101.52
  subscriber-profile SUBS_IPoE_1
  port-id Bundle-Ether5011.1
    subscriber-profile SUBS_IPoE_1
  exit
  port-id Bundle-Ether5011.1011015
    subscriber-profile SUBS_PPpOE_1
  exit
  port-id Bundle-Ether5011.1021015
    subscriber-profile SUBS_PPpOE_1
  exit
  port-id Bundle-Ether5011.1031015
    subscriber-profile SUBS_PPpOE_1
  exit
  port-id Bundle-Ether5011.1041015
    subscriber-profile SUBS_PPpOE_1
  exit
  port-id Bundle-Ether5011.2
    subscriber-profile SUBS_IPoE_1
  exit
  port-id Bundle-Ether5011.3
    subscriber-profile SUBS_IPoE_1
  exit
  port-id Bundle-Ether5011.4
    subscriber-profile SUBS_IPoE_1
  exit
  port-id Bundle-Ether5012.1
    subscriber-profile SUBS_IPoE_3
  exit
  port-id Bundle-Ether5012.1011015
    subscriber-profile SUBS_PPpOE_3
  exit
  port-id Bundle-Ether5012.1021015
    subscriber-profile SUBS_PPpOE_3

```

```
exit
port-id Bundle-Ether5012.1031015
  subscriber-profile SUBS_PPpOE_3
exit
port-id Bundle-Ether5012.1041015
  subscriber-profile SUBS_PPpOE_3
exit
port-id Bundle-Ether5012.2
  subscriber-profile SUBS_IPoE_3
exit
port-id Bundle-Ether5012.3
  subscriber-profile SUBS_IPoE_3
exit
port-id Bundle-Ether5012.4
  subscriber-profile SUBS_IPoE_3
exit
exit
user-plane ASR9k-UP-2
peer-address ipv4 101.101.101.51
subscriber-profile SUBS_IPoE_1
port-id Bundle-Ether1.1011015
  subscriber-profile SUBS_PPpOE_1
exit
port-id Bundle-Ether1.1021015
  subscriber-profile SUBS_PPpOE_1
exit
port-id Bundle-Ether1.1031015
  subscriber-profile SUBS_PPpOE_1
exit
port-id Bundle-Ether1.1041015
  subscriber-profile SUBS_PPpOE_1
exit
exit
user-plane lps_asr9k-1
peer-address ipv4 192.69.1.1
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-10
peer-address ipv4 192.69.1.10
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-11
peer-address ipv4 192.69.1.11
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
```

```
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPPoE_2
exit
exit
user-plane lps_asr9k-12
peer-address ipv4 192.69.1.12
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPPoE_2
exit
exit
user-plane lps_asr9k-13
peer-address ipv4 192.69.1.13
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPPoE_2
exit
exit
user-plane lps_asr9k-14
peer-address ipv4 192.69.1.14
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPPoE_2
exit
exit
user-plane lps_asr9k-15
peer-address ipv4 192.69.1.15
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPPoE_2
exit
exit
user-plane lps_asr9k-16
peer-address ipv4 192.69.1.16
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPPoE_2
exit
```

```
exit
user-plane lps_asr9k-17
peer-address ipv4 192.69.1.17
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-18
peer-address ipv4 192.69.1.18
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-19
peer-address ipv4 192.69.1.19
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-2
peer-address ipv4 192.69.1.2
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-20
peer-address ipv4 192.69.1.20
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-21
peer-address ipv4 192.69.1.21
port-id 8805
```

```
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.2
    subscriber-profile SUBS_PPpOE_2
  exit
exit
user-plane lps_asr9k-22
  peer-address ipv4 192.69.1.22
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.2
    subscriber-profile SUBS_PPpOE_2
  exit
exit
user-plane lps_asr9k-23
  peer-address ipv4 192.69.1.23
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.2
    subscriber-profile SUBS_PPpOE_2
  exit
exit
user-plane lps_asr9k-24
  peer-address ipv4 192.69.1.24
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.2
    subscriber-profile SUBS_PPpOE_2
  exit
exit
user-plane lps_asr9k-25
  peer-address ipv4 192.69.1.25
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.2
    subscriber-profile SUBS_PPpOE_2
  exit
exit
user-plane lps_asr9k-26
  peer-address ipv4 192.69.1.26
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
```



```
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPPE_2
exit
exit
user-plane lps_asr9k-27
peer-address ipv4 192.69.1.27
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-28
peer-address ipv4 192.69.1.28
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-29
peer-address ipv4 192.69.1.29
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-3
peer-address ipv4 192.69.1.3
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPPE_2
exit
exit
user-plane lps_asr9k-30
peer-address ipv4 192.69.1.30
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-31
peer-address ipv4 192.69.1.31
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-32
peer-address ipv4 192.69.1.32
```

```
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-33
peer-address ipv4 192.69.1.33
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-34
peer-address ipv4 192.69.1.34
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-35
peer-address ipv4 192.69.1.35
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-36
peer-address ipv4 192.69.1.36
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-37
peer-address ipv4 192.69.1.37
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-38
peer-address ipv4 192.69.1.38
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-39
peer-address ipv4 192.69.1.39
port-id 8805
```

```
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
exit
user-plane lps_asr9k-4
  peer-address ipv4 192.69.1.4
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.2
    subscriber-profile SUBS_PPPE_2
  exit
exit
user-plane lps_asr9k-40
  peer-address ipv4 192.69.1.40
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
exit
user-plane lps_asr9k-41
  peer-address ipv4 192.69.1.41
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
exit
user-plane lps_asr9k-42
  peer-address ipv4 192.69.1.42
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
exit
user-plane lps_asr9k-43
  peer-address ipv4 192.69.1.43
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
exit
user-plane lps_asr9k-44
  peer-address ipv4 192.69.1.44
  port-id 8805
    subscriber-profile SUBS_IPoE_2
  exit
  port-id Bundle-Ether1.1
    subscriber-profile SUBS_IPoE_2
  exit
exit
user-plane lps_asr9k-45
```

```
peer-address ipv4 192.69.1.45
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-46
peer-address ipv4 192.69.1.46
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-47
peer-address ipv4 192.69.1.47
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-48
peer-address ipv4 192.69.1.48
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-49
peer-address ipv4 192.69.1.49
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
exit
user-plane lps_asr9k-5
peer-address ipv4 192.69.1.5
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpPoE_2
exit
exit
user-plane lps_asr9k-50
peer-address ipv4 192.69.1.50
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
```

```
exit
user-plane lps_asr9k-6
peer-address ipv4 192.69.1.6
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-7
peer-address ipv4 192.69.1.7
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-8
peer-address ipv4 192.69.1.8
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
user-plane lps_asr9k-9
peer-address ipv4 192.69.1.9
port-id 8805
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.1
  subscriber-profile SUBS_IPoE_2
exit
port-id Bundle-Ether1.2
  subscriber-profile SUBS_PPpOE_2
exit
exit
instance instance-id 1
  endpoint sm
  exit
  endpoint nodemgr
  exit
  endpoint n4-protocol
    retransmission timeout 0 max-retry 1
  exit
  endpoint dhcp
  exit
  endpoint pppoe
  exit
  endpoint radius
    replicas 1
    vip-ip 203.203.203.51
```

```

interface coa-nas
  sla response 165000
  vip-ip 203.203.203.51 vip-port 3799
exit
exit
endpoint udp-proxy
  replicas 1
  nodes 2
  vip-ip 203.203.203.51 vip-port 2000
interface n4
  sla response 165000
exit
interface gtpu
  sla response 165000
exit
exit
exit
logging transaction duplicate disable
logging level application error
logging level transaction error
logging level tracing error
system mode running
exit

```

Configuring the UP

The following is a sample UP configuration:

```

user-plane asr9k-11
peer-address ipv4 10.105.247.124
subscriber-profile subs-default
port-id Bundle-Ether2.10
  subscriber-profile subs-vrf
exit
port-id Bundle-Ether2.20
  subscriber-profile subs-vrf
port-id Bundle-Ether2.10
exit
port-id Bundle-Ether2.30
  subscriber-profile subs-vrf
port-id Bundle-Ether2.10
exit
port-id Bundle-Ether2.40
  subscriber-profile subs-vrf
port-id Bundle-Ether2.10
exit
exit

```

Loading Day1 Configuration

To load the Day 1 configuration for cnBNG, run the following command:

```
ssh admin@ops_center_pod_ip -p 2024 < Day1config.cli
```



Note

The **day1config.cli** file contains the necessary parameters required for the Day 1 configuration.

Alternatively, you can copy the configuration and paste it in the BNG Ops Center CLI to load the Day 1 configuration.

configure

```
<Paste the Day 1 configuration here>
```

```
commit
exit
```

Day1config.cli

The `day1config.cli` file contains the Day 1 configuration for cnBNG. For a sample day1 configuration, see [Configuring the CP, on page 19](#).

Mapping Pods with Node Labels

Prerequisites

- Ensure that the node labels are according to the pod deployment layout.
- Ensure that the external VIPs are according to the requirement of NF.
- Enable Istio for pod to pod traffic load balancing.

Node Labels are key and value pairs that are attached to nodes at cluster synchronization. Each node can have a set of key and value labels defined. Each key must be unique for a node. With labels, users can map their NF pods onto nodes in a loosely coupled manner.



Important

- The pod-level labeling configuration is applicable only when the cnBNG CP is deployed on a bare metal server.
- Ensure to configure the node label on the SMI cluster deployer before mapping the pods. Following is the sample command for master-1 labeling:

```
[cndp-clpnc-cm-cm-primary] SMI Cluster Deployer (config-nodes-master-1)# k8s node-labels
smi.cisco.com/svc-type bng-node
```

To map the pods with node labels, use the following sample configuration:

```
config
k8 label protocol-layer key label_key value label_value
k8 label service-layer key label_key value label_value
k8 label cdl-layer key label_key value label_value
k8 label oam-layer key label_key value label_value
end
```

Following is an example configuration of pod to node-label mapping:

```
k8 label protocol-layer key smi.cisco.com/node-type value bng-proto
exit
k8 label service-layer key vm-type value bng-svc
exit
k8 label cdl-layer key smi.cisco.com/node-type value bng-cdl
exit
k8 label oam-layer key smi.cisco.com/node-type value oam
exit
```

High Availability Support on Bare Metal Server

High Availability on cnBNG CP is validated on bare metal server deployment. For more information about High Availability, see [High Availability and CP Reconciliation](#), on page 137.



CHAPTER 3

Pods and Services Reference

- [Feature Summary and Revision History, on page 51](#)
- [Feature Description, on page 52](#)
- [Associating Pods to the Nodes, on page 58](#)

Feature Summary and Revision History

Summary Data

Table 4: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Subscriber Manager, on page 235
Related Documentation	Not Applicable

Revision History

Table 5: Revision History

Revision Details	Release
Enhancement Introduced: The Subscriber Manager pod supports the charging functionality, that is, subscriber access and subscriber management.	2021.03.0
First introduced.	2021.01.0

Feature Description

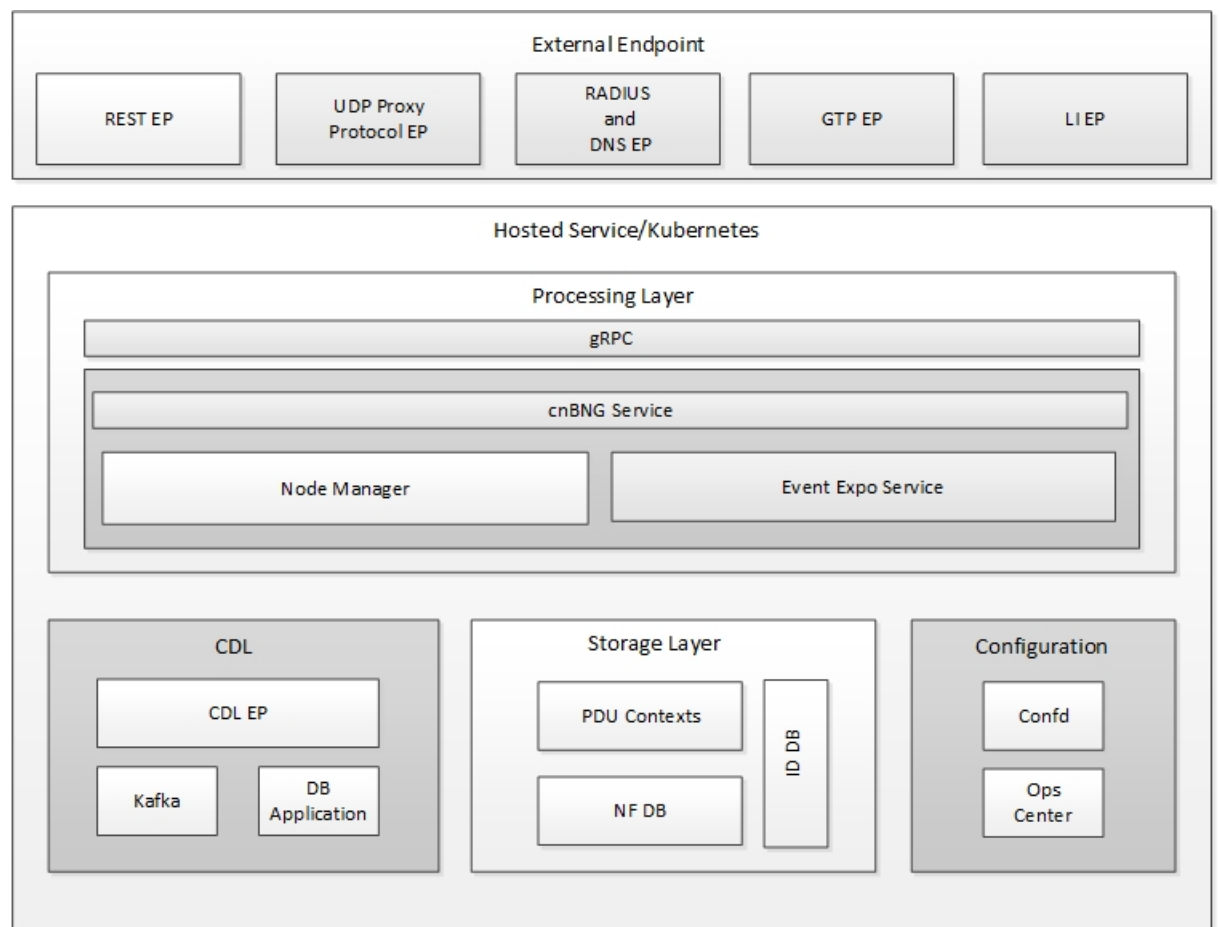
The SMI Ops Center is the platform to deploy cnBNG cluster with the offline or online repository. It is mandatory to deploy the SMI Ops Center to install the BNG Ops Center.

The cnBNG is built on the Kubernetes cluster strategy, which implies that it has adopted the native concepts of containerization, high availability, scalability, modularity, and ease of deployment. To achieve the benefits offered by Kubernetes, cnBNG uses the construct that includes the components such as pods and services.

Depending on the deployment environment, the cnBNG deploys the pods on the virtual machines that you have configured. Pods operate through the services that are responsible for the intra-pod communications. If the machine hosting the pods fail or experiences network disruption, the pods are terminated or deleted. However, this situation is transient and BNG spins new pods to replace the invalid pods.

The following workflow provides a high-level visibility into the host machines, and the associated pods and services. It also represents how the pods interact with each other. The representation might defer based on your deployment infrastructure.

Figure 4: Communication Workflow of Pods



The following figure shows the cnBNG cluster pod layout.

Figure 5: cnBNG Cluster Pod Layout

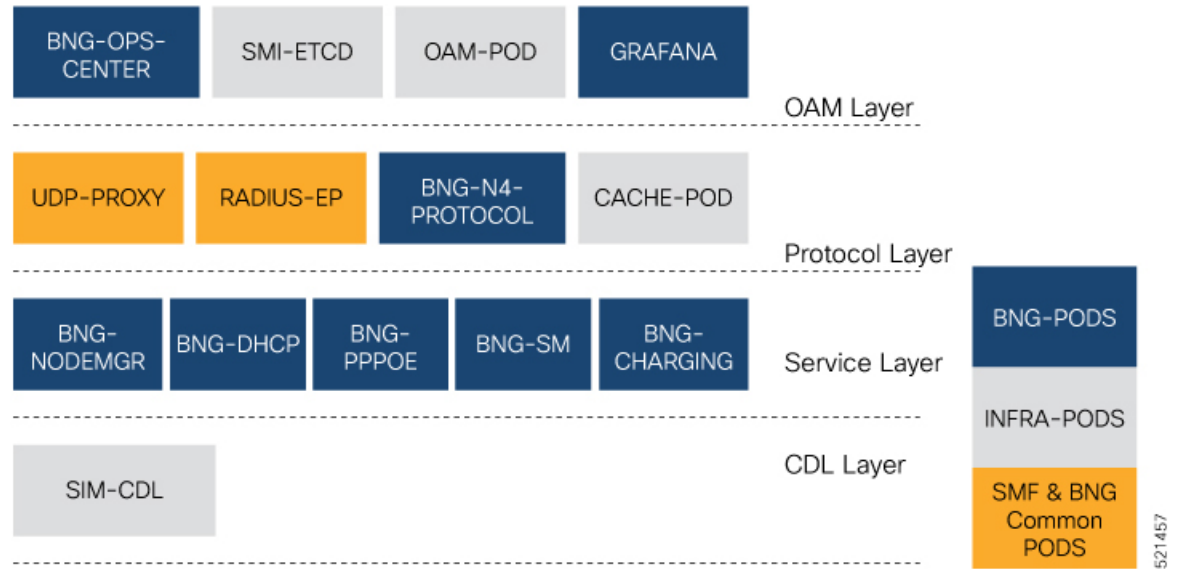
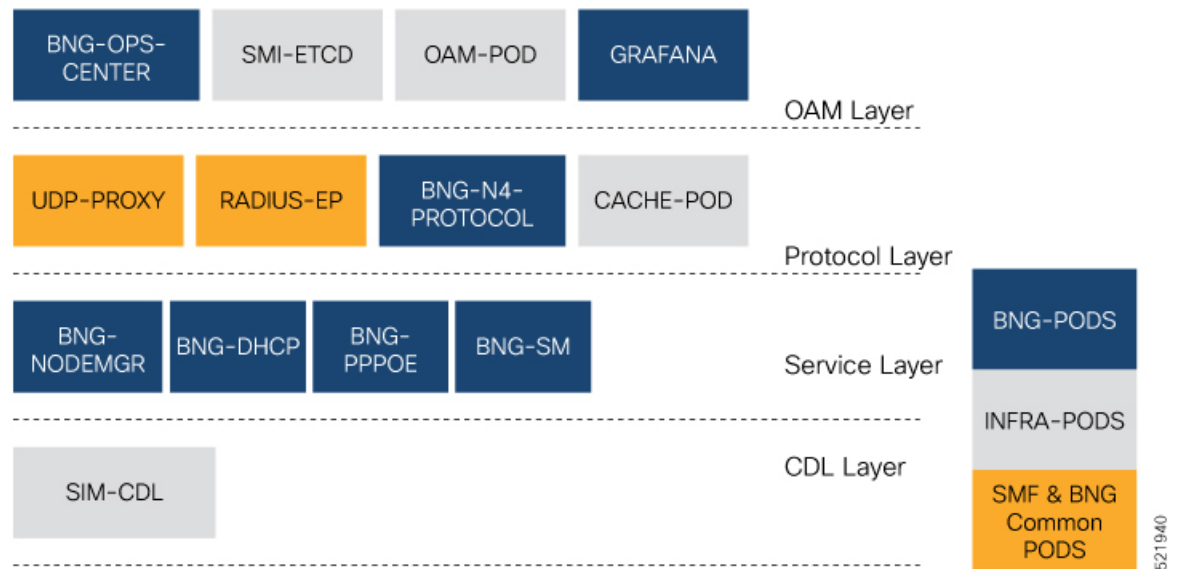


Figure 6: cnBNG Cluster Pod Layout



Kubernetes deployment includes the **kubectl** command-line tool to manage the Kubernetes resources in the cluster. You can manage the pods, nodes, and services.

For generic information on the Kubernetes concepts, see the Kubernetes documentation.

The following sections provide more information on the Kubernetes components in cnBNG.

Pods

A pod is a process that runs on your Kubernetes cluster. It encapsulates a granular unit known as a container. A pod contains one or multiple containers.

Kubernetes deploys one or multiple pods on a single node which can be a physical or virtual machine. Each pod has a discrete identity with an internal IP address and port space. However, the containers within a pod can share the storage and network resources.

The following tables list the cnBNG and Common Execution Environment (CEE) pod names and the hosts on which they are deployed depending on the labels that you assign. For information on how to assign the labels, see [Associating Pods to the Nodes, on page 58](#).

Table 6: cnBNG Pods

Pod Name	Description	Host Name
api-bng-bng-ops-center	Functions as the <i>confD</i> API pod for the BNG Ops Center.	OAM
bng-charging-n0	Enables subscriber session and service charging for BNG subscribers.	Service
bng-dhcp-n0	Operates as the DHCP server and handles all DHCP related control messages.	Service
bng-n4-protocol-n0	Operates as encoder and decoder of application protocols (PFCP, GTP, RADIUS, and so on) whose underlying transport protocol is UDP.	Protocol
bng-nodemgr-n0	Performs node level interactions Service such as N4 link establishment, management (heart-beat), and so on.	Service
bng-pppoe-n0	Runs the combined Control Plane (CP) for PPPoE and PPP.	Service
bng-sm-n0	Enables subscriber binding with the BNG CP protocol and services.	Service
bng-sm-n0	Manages subscriber access and subscriber management functions such as Authentication, Authorization, Accounting, and policy management..	Service
cache-pod-0	Operates as the pod to cache any sort of system information that will be used by other pods as applicable.	Protocol
cdl-ep-session-c1-d0	Provides an interface to the CDL.	Session
cdl-index-session-c1-m1-0	Preserves the mapping of keys to the session pods.	Session
cdl-slot-session-c1-m1-0	Operates as the CDL Session pod Session to store the session data.	Session
documentation	Contains the documentation.	OAM
etcd-bng-bng-etcd-cluster-0	Hosts the etcd for the BNG application to store information such as pod instances, leader information, NF-UUID, endpoints, and so on.	OAM
grafana-dashboard-app-infra	Contains the default dashboard of app-infra metrics in Grafana.	OAM

Pod Name	Description	Host Name
grafana-dashboard-bng	Contains the default dashboard of the cnBNG-service metrics in Grafana.	OAM
grafana-dashboard-cdl	Contains the default dashboard of CDL metrics in Grafana.	OAM
kafka	Hosts theKafka details for the CDL replication.	Protocol
oam-pod	Operates as the pod to facilitate Ops Center actions like show commands, configuration commands, monitor protocol monitor subscriber, and so on.	OAM
ops-center-bng-bng-ops-center	Acts as the BNG Ops Center.	OAM
prometheus-rules-cdl	Contains the default alerting rules and recording rules for Prometheus CDL.	OAM
radius-ep-n0-0	Operates as RADIUS endpoint of cnBNG.	
smart-agent-bng-bng-ops-center	Operates as the utility pod for the BNG Ops Center.	OAM
bng-udp-proxy-0	Operates as proxy for all UDP messages. Owns UDP client and server functionalities.	Protocol
swift-bng-bng-ops-center	Operates as the utility pod for the BNG Ops Center.	OAM
zookeeper	Assists Kafka for topology management.	OAM

Table 7: CEE Pods

Pod Name	Description	Host Name
alert-logger	Stores the history of active and resolved alerts.	OAM
alertmanager	Duplicates alerts and sends out resolution of alerts when they are resolved in Prometheus.	OAM
api-cee-global-ops-center	Functions as the confD API pod for the CEE Ops Center.	OAM
bulk-stats	Assists to retrieve bulkstats saved by Prometheus containers.	OAM
cee-global-product-documentation	Contains the product documentation (API, CLI, and so on).	OAM
core-retriever	Assists in retrieving the core dumps.	All the nodes except ETCD nodes.
documentation	Contains the documentation (metrics and usage).	OAM
grafana-dashboard-metrics	Assists in collating Grafana metrics on the dashboard.	OAM

Pod Name	Description	Host Name
grafana	Contains the Grafana metrics for CEE.	OAM
kube-state-metrics	Assists in generating metrics about the state of Kubernetes objects: node status, node capacity (CPU and memory), and so on.	OAM
logs-retriever	Assists in retrieving Kernel, Kubelet, and Container level logs through output to JournalD driver.	All the nodes except ETCD nodes.
node-exporter	Exports the node metrics.	All the nodes.
ops-center-cee-global-ops-center	Provides NETCONF and CLI interface to the application.	OAM
path-provisioner	Provisions the local storage volume.	All the nodes except ETCD nodes.
pgpool	<i>Pgpool</i> is a middleware that works between <i>PostgreSQL</i> servers and a <i>PostgreSQL</i> database.	OAM
postgres	Storage of alerts and Grafana dashboards.	OAM
prometheus-hi-res	Stores all metrics and generates alerts by alerting rules.	OAM
prometheus-rules	Contains the default alerting rules and recording rules for Prometheus.	OAM
prometheus-scrapeconfigs-synch	Synchronizes the Prometheus scrape configuration.	OAM
pv-manager	Provisions the local storage volume.	OAM
pv-provisioner	Provisions the local storage volume.	OAM
show-tac-manager	Assists in creating and deleting debug package.	OAM
smart-agent-cee-global-ops-center	Operates as the utility pod for the CEE Ops Center.	OAM
snmp-trapper	Sends the SNMP traps based on triggered alerts.	OAM
swift-cee-global-ops-center	Operates as the utility pod for the CEE Ops Center.	OAM
thanos-query-hi-res	Implements the Thanos query for Prometheus HA.	OAM
fluentbit	Assists in log forwarding to the external logs collector.	All the nodes except ETCD nodes.

Services

The cnBNG configuration is composed of several microservices that run on a set of discrete pods. Microservices are deployed during the cnBNG deployment. The cnBNG uses these services to enable communication between the pods. When interacting with another pod, the service identifies the IP address of the pod to initiate the transaction and acts as an endpoint for the pod.

The following table describes the BNG services and the pod on which they run.

Table 8: BNG Services and Pods

Service Name	Pod Name	Description
bng-nodemgr	bng-nodemgr-n0	Responsible for node level interactions Service such as N4 link establishment, management (heart-beat), and so on.
bng-charging	bng-charging-n0	Responsible for subscriber session and service charging for BNG subscribers.
bng-dhcp	bng-dhcp-n0	Functions as the DHCP server and handles all DHCP related control messages.
bng-pppoe	bng-pppoe-n0	Functions as the combined Control Plane (CP) for PPPoE and PPP.
bng-sm	bng-sm-n0	Responsible for the subscriber binding with the BNG CP protocol and services.
bng-sm	bng-sm-n0	Manages subscriber access and subscriber management functions such as Authentication, Authorization, Accounting, and policy management..

Open Ports and Services

cnBNG uses different ports for communication purposes. The following table describes the default open ports and the associated services in an SMI based cnBNG system.

Application Infrastructure (App-infra)

Port	Service
8850	Golang net/HTTP server TCP Golang net/HTTP server
8879	Golang net/HTTP server TCP Golang net/HTTP server
8850	DefaultPProfPort

Port	Service
8879	DefaultAdminEndPointPort

UDP

Port	Service	CP to UP Interfaces
2152	GTPU	CPRi
8805	PFCP	SCi

Associating Pods to the Nodes

This section describes how to associate a pod to the node based on their labels.

After you have configured a cluster, you can associate pods to the nodes through labels. This association enables the pods to get deployed on the appropriate node based on the key-value pair.

Labels are required for the pods to identify the nodes where they must get deployed and to run the services. For example, when you configure the protocol-layer label with the required key-value pair, the pods are deployed on the nodes that match the key-value pair.

To associate pods to the nodes through the labels, use the following configuration:

- To associate pods to the nodes through the labels, use the following configuration:

```
configure
k8 label protocol-layer key key_value vm-type value protocol
exit
k8 label service-layer key key_value vm-type value service
exit
k8 label cdl-layer key key_value vm-type value cdl
exit
k8 label oam-layer key key_value vm-type value oam
exit
```

NOTES:

- If you opt not to configure the labels, then BNG assumes the labels with the default key-value pair.
 - k8 label protocol-layer key key_value vm-type value protocol:** Configures the key value pair for protocol layer.
 - k8 label service-layer key key_value vm-type value service:** Configures the key value pair for the service layer.
 - k8 label cdl-layer key key_value vm-type value cdl:** Configures the key value pair for CDL.
 - k8 label oam-layer key key_value vm-type value oam:** Configures the key value pair for OAM layer.

Viewing the Pod Details and Status

If the service requires additional pods, BNG creates and deploys the pods. You can view the list of pods that are participating in your deployment through the BNG Ops Center.

You can run the **kubect1** command from the master node to manage the Kubernetes resources.

1. To view the comprehensive pod details, use the following command.

```
kubect1 get pods -n bng_namespace pod_name -o yaml
```

The pod details are available in YAML format. The output of this command results in the following information:

- The IP address of the host where the pod is deployed.
- The service and application that is running on the pod.
- The ID and name of the container within the pod.
- The IP address of the pod.
- The current state and phase in which the pod is.
- The start time from which pod is in the current state.

2. Use the following command to view the summary of the pod details.

```
kubect1 get pods -n bng_namespace -o wide
```

States

Understanding the pod's state lets you determine the current health and prevent the potential risks. The following table describes the pod's states.

Table 9: Pod States

State	Description
Running	The pod is healthy and deployed on a node. It contains one or more containers.
Pending	The application is in the process of creating the container images for the pod.
Succeeded	Indicates that all the containers in the pod are successfully terminated. These pods cannot be restarted.
Failed	One ore more containers in the pod have failed the termination process. The failure occurred as the container either exited with non zero status or the system terminated the container.
Unknown	The state of the pod could not be determined. Typically, this could be observed because the node where the pod resides was not reachable.



CHAPTER 4

Smart Licensing

- [Feature Summary and Revision History](#), on page 61
- [Smart Software Licensing](#), on page 61
- [Configuring Smart Software Licensing for cnBNG CP](#), on page 66
- [Monitoring and Troubleshooting Smart Licensing](#), on page 76

Feature Summary and Revision History

Summary Data

Table 10: Summary Data

Applicable Products or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Enabled – Always-on
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 11: Revision History

Revision Details	Release
First introduced.	2022.01.0

Smart Software Licensing

Cisco employs two types of license models - Legacy Licensing and Smart Software Licensing. Legacy Licensing consists of software activation by installing Product Activation Keys (PAK) on to the Cisco product.

A Product Activation Key is a purchasable item, ordered in the same manner as other Cisco equipment and used to obtain license files for feature set on Cisco Products. This traditional licensing does not need any online communication with the Cisco licensing server.

Smart Software Licensing is a cloud-based licensing of the end-to-end platform through the use of a few tools that authorize and deliver license reporting. Smart Software Licensing functionality incorporated into the NFs complete the product registration and authorization. The cnBNG Control Plane (CP) supports the Smart Software Licensing model.

Smart Licensing simplifies the purchase, deployment, and management of Cisco software assets. Entitlements are purchased through your Cisco account through Cisco Commerce Workspace (CCW) and immediately available in your Virtual Account for usage. This approach eliminates the need to install license files on every device. Smart-enabled products communicate directly to Cisco to report consumption. A single location—Cisco Software Central—is available for customers to manage Cisco software licenses. License ownership and consumption are readily available to help make a better purchase decision that is based on consumption or business need.

For more information on Cisco Smart Licensing, see <https://www.cisco.com/c/en/us/buy/smart-accounts/software-licensing.html>.

Cisco Software Central

Cisco Software Central (CSC) enables the management of software licenses and the smart account from a single portal. The CSC interface allows you to enable your product, manage entitlements, renew, and upgrade software. You need a functioning smart account to complete the registration process.

To access Cisco Software Central, see <https://software.cisco.com>.

Smart Accounts and Virtual Accounts

A Smart Account provides a single location for all smart-enabled products and entitlements. It helps in procurement, deployment, and maintenance of Cisco Software. When creating a smart account, you must have the authority to represent the requesting organization. After submission, the request goes through approval process.

A Virtual Account exists as a sub-account within the smart account. Virtual Accounts are customer-defined based on the organizational layout, business function, geography, or any defined hierarchy. Smart account administrator creates and maintains the virtual accounts.

For information on setting up or managing the Smart Accounts, see <https://software.cisco.com>.

Requesting a Cisco Smart Account

A Cisco Smart Account is an account where smart licensing-enabled products are available. A Cisco smart account allows you to manage and activate your licenses to devices, monitor license use, and track Cisco license purchases. Through transparent access, you have a real-time view into your smart licensing products. IT administrators can manage licenses and account users within the organization's smart account through Cisco Software Central. To create a Cisco Smart Account, perform the following steps:

Step 1 Visit the following URL:

`https://software.cisco.com`

- Step 2** Log in using your credentials, and click **Request a Smart Account** in the **Administration** area. The **Smart Account Request** window appears.
- Step 3** Under **Create Account**, select one of the following options:
- **Yes, I have authority to represent my company and want to create the Smart Account.** If you select this option, you agree to authorize to create and manage product and service entitlements, users, and roles, on behalf of the organization.
 - **No, the person specified below will create the account.** If you select this option, you must enter the email address of the person who creates the smart account.
- Step 4** Under **Account Information**,
- a) Click **Edit** beside **Account Domain Identifier**.
 - b) In the **Edit Account Identifier** dialog box, enter the domain, and click **OK**. By default, the domain is based on the email address of the person creating the account, and must belong to the company that will own this account.
 - c) Enter the **Account Name** (typically, the company name).
- Step 5** Click **Continue**.
The Smart Account request will be in pending status until it is approved by the Account Domain Identifier. After the approval, you will receive an email confirmation with instructions for completing the setup process.
-

cnBNG CP Smart Licensing

The Smart Licensing feature supports application entitlement for online and offline licensing for all applications (PCF, SMF, cnBNG CP, and NRF). The application usage is unrestricted during all stages of licensing including Out of Compliance (OOC) and expired stages.



Note A 90-day evaluation period is granted for all licenses in use. The functionality and operation of the applications is unrestricted even after the end of the evaluation period.

Software Tags and Entitlement Tags

This section describes the software and entitlement tags that are available to identify report, and enforce licenses.

Software Tags

Software tags, also known as product tags, are unique identifiers for the Smart Licensing system to identify each licensable software product or product suite on a device. The Smart client uses this tag for identification during the addition of smart product instance in Cisco Software Central (CSC).

The following software tags exist for the cnBNG CP.

Tag Name	Smart Tag	Condition for License Calculation
CNBNG_CP_SYS_RTU	regid.2021-07.com.cisco.CNBNG_CP_SYS_RTU,1.0_2e15ed3f-929d-47b5-8495-c96531c416b8	These are base licenses and the count is always one (1).
CNBNG_CP_SYS_SIA	regid.2021-07.com.cisco.CNBNG_CP_SYS_SIA,1.0_f6cab505-581f-41ec-8170-3d8c325f7f73	

Entitlement Tags

Entitlement tag is a part of the software that identifies the features in an image that are being used. These tags underlay the communication on usage and entitlements of software products that are installed on devices. The entitlement tag maps to both the product IDs (PID) license and the software image. Every Smart-enabled PID contains one or more entitlement tags.

The following entitlement tags identify licenses in use:

Tag Name	Smart Tag	Condition for License Calculation
CNBNG_CP_ESS_RTU	regid.2021-07.com.cisco.CNBNG_CP_ESS_RTU,1.0_cb8f62c6-1acf-4e65-9d8c-35b12acfbaaf	Per 1000 session only one (1) license is consumed for each entitlement tag.
CNBNG_CP_ESS_SIA	regid.2021-07.com.cisco.CNBNG_CP_ESS_SIA,1.0_c40ac644-7a76-41b8-a3dc-b66159c0f1ae	<p>The sessions are rounded off when calculating the number of licenses required:</p> <p>For Example:</p> <p>If num of session count is ≤ 1000, one license is consumed.</p> <p>If number of sessions are: 1001 to 2000, two licenses are consumed; similarly, from 2001 to 3000, three licenses are consumed and so on.</p> <p>Note The number of sessions (session count) is derived from CDL.</p>

**Note**

- The license information is retained during software upgrades and rollback.
- If the entitlements service has no entitlements information, the BNG Ops Center does not send any request to the Smart License server and does not install any license.
- If the entitlement is not reported to the BNG Ops Center, then that entitlement is not listed under the **show license *** commands.
- If the given entitlement is reported at least once (license consumed for an entitlement) to the BNG Ops Center, then that entitlement is shown under the **show license *** commands with count zero (0) even though the license is not used in the future.

Sample Output of License Consumption

The following is an example of the output of the license consumption.

```
show license summary
Wed Dec 22 14:56:24.665 UTC+00:00

Smart Licensing is ENABLED

Registration:
  Status: REGISTERED
  Smart Account: BU Production Test 1
  Virtual Account: CNBNG_QA_PROD_TEST
  Export-Controlled Functionality: Allowed
  Initial Registration: SUCCEEDED on Dec 22 14:56:08 2021 GMT
  Last Renewal Attempt: SUCCEEDED on Dec 22 14:56:08 2021 GMT
  Next Renewal Attempt: Jun 20 14:56:08 2022 GMT
  Registration Expires: Dec 22 14:51:08 2022 GMT

License Authorization:
  Status: AUTHORIZED on Dec 22 14:56:24 2021 GMT
  Last Communication Attempt: SUCCEEDED on Dec 22 14:56:24 2021 GMT
  Next Communication Attempt: Jan 21 14:56:24 2022 GMT
  Communication Deadline: Mar 22 14:51:23 2022 GMT

License Conversion:
  Automatic Conversion Enabled: true
  Status: NOT STARTED

Utility:
  Status: DISABLED

Transport:
  Type: Smart Transport
  Registration URL: null
  Utility URL: null

License Usage:
  License                               Entitlement Tag
                               Count           Status

2e15ed3f-929d-47b5-8495-c96531c416b8regid.2021-07.com.cisco.CNBNG_CP_SYS_RTU,1.0_2e15ed3f-929d-47b5-8495-c96531c416b8
1                               InCompliance
```

```
f6cab505-581f-41ec-8170-3d8c325f7f73regid.2021-07.com.cisco.CNBNG_CP_SYS_SIA,1.0_f6cab505-581f-41ec-8170-3d8c325f7f73
1          InCompliance

cb8f62c6-1acf-4e65-9d8c-35b12acfbafregid.2021-07.com.cisco.CNBNG_CP_ESS_RTU,1.0_cb8f62c6-1acf-4e65-9d8c-35b12acfbaf
34          InCompliance

c40ac644-7a76-41b8-a3dc-b66159c0f1aeregid.2021-07.com.cisco.CNBNG_CP_ESS_SIA,1.0_c40ac644-7a76-41b8-a3dc-b66159c0f1ae
34          InCompliance
```

Configuring Smart Software Licensing for cnBNG CP

Smart Software Licensing for cnBNG CP can be configured after a new cnBNG CP installation.

[Users with Access to CSC, on page 66](#)

[Users without Access to CSC, on page 70](#)

Users with Access to CSC

This section describes how to configure Smart Licensing if you have access to CSC portal from your environment.

Setting Up the Product and Entitlement in CSC

Before you begin, you need to set up your product and entitlement in the CSC. To set up your product and entitlement:

1. Log on to your CSC account.
2. Click **Add Product** and enter the following details:
 - **Product name**—Specify the name of the deployed product. For example, cnBNG CP.
 - **Primary PM CEC ID**—Specify the primary Project Manager's CEC ID for the deployed product.
 - **Dev Manager CEC ID**—Specify the Development Manager's CEC ID for the deployed product.
 - **Description (Optional)**—Specify a brief description of the deployed product.
 - **Product Type**—Specify the product type.
 - **Software ID Tag**—Specify the software ID Tag provided by the Cisco Accounts team.
3. Click **Create**.
4. Select your product from the **Product/Entitlement Setup** grid.
5. From the **Entitlement** drop-down list, select **Create New Entitlement**.
6. Select **New Entitlement** in **Add Entitlement** and enter the following details:
 - **Entitlement Name**—Specify the license entitlement name. For example, CNBNG_CP_SYS_RTU.
 - **Description (Optional)**—Enter a brief description about the license entitlement.
 - **Entitlement Tag**—Specify the entitlement tag provided by the Cisco Accounts team.

- **Entitlement Type**—Specify the type of license entitlement.
 - **Vendor String**—Specify the vendor name.
7. Click **Entitlement Allocation**.
 8. Click **Add Entitlement Allocation**.
 9. In **New License Allocation**, enter the following details:
 - **Product** – Select your product from the drop-down list.
 - **Entitlement** – Select your entitlement from the drop-down list.
 10. Click **Continue**.
 11. In **New License Allocation** window, enter the following details:
 - **Quantity**—Specify the number of licenses.
 - **License Type**—Specify the type of license.
 - **Expiring Date**—Specify the date of expiry for the license purchased.
 12. Click **Create**.
 13. Verify the status of Smart Licensing by using the following command.

```
show license status
```

Example:

```
bng# show license status
Smart Licensing is ENABLED

Registration:
  Status: UNREGISTERED
  Export-Controlled Functionality: Not Allowed

License Authorization:
  Status: No licenses in use
  Last Communication Attempt: NONE

License Conversion:
  Automatic Conversion Enabled: true
  Status: NOT STARTED

Utility:
  Status: DISABLED

Transport:
  Type: Smart Transport
  Registration URL: null
  Utility URL: null
bng#
```

Registering Smart Licensing

You must register the product entitled to the license with CSC. To register, you must generate an ID token from CSC.

1. Log on to your CSC account.
2. Click **General** > **New Token** and enter the following details:
 - **Description**—Provide a brief description about the ID token.
 - **Expires After**—Specify the number of days for the token to expire.
 - **Max. Number of Uses**—Specify the maximum number of uses.
3. Click **Create Token**.
4. Select **New ID token** in **Product Instance Registration Token**.
5. Click **Actions** > **Copy**.
6. Log on to BNG Ops Center CLI and paste the **ID token** by using the following command.

```
license smart register idtoken
```

Example:

```
bng# license smart register
Value for 'idtoken' (<string>): MTI2Y2FlNTAtOTkMi00YTaxLWE4M2QtOTNhNzNjNjY4ZmFiLTE2MTc4N
Tky%0AMTA5MDh8ck1jUHNwc3k1ZC9nWFFCSnVEcUp4QU1jTFoxOGxDTU5kQ3lpa25E%0Ab04wST0%3D%0A
bng#
```

7. Verify the Smart Licensing status by using the following command.

```
show license status
```

Example:

```
show license status
Wed Jan 12 14:31:16.858 UTC+00:00

Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
  Status: REGISTERED
  Smart Account: BU Production Test 1
  Virtual Account: CNBNG_QA_PROD_TEST
  Export-Controlled Functionality: Allowed
  Initial Registration: SUCCEEDED on Jan 12 14:31:35 2022 GMT
  Last Renewal Attempt: SUCCEEDED on Jan 12 14:31:35 2022 GMT
  Next Renewal Attempt: Jul 11 14:31:35 2022 GMT
  Registration Expires: Jan 12 14:26:55 2023 GMT

License Authorization:
  Status: AUTHORIZED on Jan 12 14:31:40 2022 GMT
  Last Communication Attempt: SUCCEEDED on Jan 12 14:31:40 2022 GMT
  Next Communication Attempt: Feb 11 14:31:40 2022 GMT
  Communication Deadline: Apr 12 14:27:00 2022 GMT

License Conversion:
  Automatic Conversion Enabled: true
  Status: NOT STARTED

Utility:
  Status: DISABLED

Transport:
  Type: Smart Transport
```

```
Registration URL: null
Utility URL: null
```

NOTES:

- **license smart register** : Register Smart Licensing with CSC.
- *idtoken* : Specify the ID token generated from CSC.

Deregistering Smart Licensing

To deregister Smart Licensing:

1. Log on to BNG Ops Center CLI and use the following command.
license smart deregister
2. Verify the Smart Licensing status by using the following command:

```
show license all
```

Example:

```
bng# show license all
Mon Dec 13 05:29:03.370 UTC+00:00

Smart Licensing Status
=====
Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
  Status: UNREGISTERED
  Export-Controlled Functionality: Not Allowed

License Authorization:
  Status: EVAL MODE
  Evaluation Period Remaining: 86 days, 13 hr, 52 min, 39 sec
  Last Communication Attempt: NONE

License Conversion:
  Automatic Conversion Enabled: true
  Status: NOT STARTED

Utility:
  Status: DISABLED

Transport:
  Type: CALLHOME

Evaluation Period:
  Evaluation Mode: In Use
  Evaluation Period Remaining: 86 days, 13 hr, 52 min, 39 sec

License Usage
=====
License Authorization Status: EVALUATION MODE
  Evaluation Period Remaining: 86 days, 13 hr, 52 min, 39 sec

(CNBNG_CP_SYS_RTU)
Description: <empty>
Count: 1
Version: 1.0
```

```

Status: EVAL MODE
Export status: NOT RESTRICTED
Feature Name: <empty>
Feature Description: <empty>

(CNBNG_CP_SYS_SIA)
Description: <empty>
Count: 1
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Feature Name: <empty>
Feature Description: <empty>

Product Information
=====
UDI: PID:cnBNG,SN:QHJZRXY-IRNN3JA

Agent Version
=====
Smart Agent for Licensing: 3.1.11
bng#

```

NOTES:

- **license smart deregister** : Deregisters Smart Licensing from CSC.

Users without Access to CSC

The Smart License Reservation feature – Perpetual Reservation – is reserved for customers without access to CSC from their internal environments. With this feature, Cisco allows customers to reserve licenses from their virtual account and tie them to their devices Unique Device Identifier (UDI). Smart License Reservation enables customers to use their devices with reserved licenses in a disconnected mode.

The subsequent sections describe the procedure involved in reserving Smart License for users without access to CSC from their internal environment.

Enabling Smart License Reservation

To enable Smart License reservation through BNG Ops Center CLI:

Log on to BNG Ops Center CLI and use the following configuration.

```

config
  license smart reservation
  commit
  exit

```

NOTES:

license smart reservation : Enable license reservation.

Generating Smart License Reservation Request Code



Note Before generating the Smart License reservation request code, complete the "Enabling Smart License Reservation" procedure.

To generate the Smart License reservation request code:

1. Enter the following command.

```
license smart reservation request
```

Example:

```
bng# license smart reservation request
reservation-request-code CJ-ZBNG:6GKJ2OA-NMUWA7Y-Ai75GxtBs-3B
```

NOTES:

- **license smart reservation request** : Generate the license reservation request code.



important You must copy the generated license request code from the BNG Ops Center CLI.

Generating an Authorization Code from CSC

To generate an authorization code from CSC using the license reservation request code:

1. Log on to your CSC account.
2. Click **License Reservation** from the Licenses tab.
3. Copy the request code from the BNG Ops Center CLI and paste the request code in the **Reservation Request Code** text-box.
4. Click **Reserve a Specific License** option and select the required licenses and counts to be reserved.
5. Review your selection.
6. Click **Generate Authorization Code**.
7. The authorization code is generated and displayed on-screen. Either click **Copy to Clipboard** or **Download as File** to download the authorization code.
8. Click **Close**.

Reserving Smart Licensing

There are two methods available to reserve the Smart License:

- Key-based: Using the copied clipboard content of the authorization code directly from the CSC.
- URL-based: Using the downloaded file containing the authorization code from CSC, saved on the local server.

To reserve Smart License for the deployed product:

1. Log on to BNG Ops Center CLI and enter the following command.

Key-based:

```
license smart reservation install key authorization_code
```

Example:

```

bng# license smart reservation install key
Value for 'key' (<string>): <specificPLR><authorizationCode><flag>A</flag><version>
C</version><piid>73ce7376-4631-45db-bccc-f8b4d31acd33</piid><timestamp>1642000062377
</timestamp><entitlements><entitlement><tag>regid.2021-07.com.cisco.CNBNG_CP_ESS_RTU,
1.0_cb8f62c6-1acf-4e65-9d8c-35b12acfbaaf</tag><count>1</count><startDate>
2021-Dec-01 UTC</startDate><endDate>2022-May-30
UTC</endDate><licenseType>TERM</licenseType><
displayName>CNBNG Control Plane - Essentials - RTU</displayName><tagDescription>
CNBNG Control Plane - Essentials Tier - RTU</tagDescription><subscriptionID>
</subscriptionID></entitlement><entitlement><tag>regid.2021-07.com.cisco.
CNBNG_CP_ESS_SIA,1.0_c40ac644-7a76-41b8-a3dc-b66159c0flae</tag><count>1</count>
<startDate>2021-Dec-01 UTC</startDate><endDate>2022-May-30 UTC
<licenseType>TERM</licenseType><displayName>CNBNG Control Plane - Essentials -
SIA</displayName><tagDescription>CNBNG Control Plane - Essentials Subscription -
SIA</tagDescription><subscriptionID></subscriptionID></entitlement><entitlement>
<tag>regid.2021-07.com.cisco.CNBNG_CP_SYS_RTU,1.0_2e15ed3f-929d-47b5-8495-c96531c416b8
</tag><count>1</count><startDate>2021-Dec-01 UTC</startDate><endDate>2022-May-30 UTC
</endDate><licenseType>TERM</licenseType><displayName>CNBNG Control Plane - System -
RTU</displayName><tagDescription>CNBNG Control Plane - System - RTU</tagDescription>
<subscriptionID></subscriptionID></entitlement><entitlement><tag>regid.2021-07.com.cisco.
CNBNG_CP_SYS_SIA,1.0_f6cab505-581f-41ec-8170-3d8c325f7f73</tag><count>1</count><startDate>
2021-Dec-01 UTC</startDate><endDate>2022-May-30
UTC</endDate><licenseType>TERM</licenseType>
<displayName>CNBNG Control Plane - System - SIA</displayName><tagDescription>
CNBNG Control Plane - System Subscription - SIA</tagDescription><subscriptionID>
</subscriptionID></entitlement></entitlements></authorizationCode><signature>
MEYCIQC3VB12XNo+gi00fE23PqdlGZ67MOxzk1+DCVPhS0LonQIhANP27J3skpMnd30
Qwzm82knoUBFM8Fk0yf21llqQvuByi</signature><udi>P:cnBNG,
S:6OUP5ZY-LMXHB2A</udi></specificPLR>

```

URL-based:

```

license smart reservation install url { path httpPath
[ username username | password password ] }

```

Example:

```

bng# license smart reservation install url { username cnbng password **** path http://
10.105.254.55:8000/AuthorizationCode_SN_6OUP5ZY-LMXHB2A.txt }

```

2. Verify the smart licensing status by using the following command.

```
show license all
```

Example:

```

bng# show license all

Smart Licensing Status
=====
Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
  Status: REGISTERED - SPECIFIC LICENSE RESERVATION
  Export-Controlled Functionality: Allowed
  Initial Registration: SUCCEEDED on Thu Jan 20 10:02:40 GMT 2022
  Last Renewal Attempt: None

License Authorization:
  Status: AUTHORIZED - RESERVED on Thu Jan 20 10:02:40 GMT 2022

```

```
Utility:
  Status: DISABLED

Transport:
  Type: Smart Transport
  Registration URL: null
  Utility URL: null

Evaluation Period:
  Evaluation Mode: Not In Use
  Evaluation Period Remaining: 83 days, 6 hr, 14 min, 43 sec

License Usage
=====
License Authorization Status:
  Status: AUTHORIZED - RESERVED on Thu Jan 20 10:02:40 GMT 2022
  Last Communication Attempt: SUCCEEDED on Jan 20 10:02:40 2022 GMT
  Next Communication Attempt: NONE
  Communication Deadline: NONE

CNBNG Control Plane - System - RTU (CNBNG_CP_SYS_RTU)
  Description: CNBNG Control Plane - System - RTU
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Feature Name: <empty>
  Feature Description: <empty>
  Reservation:
    Reservation Status: SPECIFIC INSTALLED
    Total Reserved Count: 1
    Term expiration: 2022-May-30 GMT

CNBNG Control Plane - System - SIA (CNBNG_CP_SYS_SIA)
  Description: CNBNG Control Plane - System Subscription - SIA
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Feature Name: <empty>
  Feature Description: <empty>
  Reservation:
    Reservation Status: SPECIFIC INSTALLED
    Total Reserved Count: 1
    Term expiration: 2022-May-30 GMT

CNBNG Control Plane - Essentials - RTU (CNBNG_CP_ESS_RTU)
  Description: CNBNG Control Plane - Essentials Tier - RTU
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
  Export status: NOT RESTRICTED
  Feature Name: <empty>
  Feature Description: <empty>
  Reservation:
    Reservation Status: SPECIFIC INSTALLED
    Total Reserved Count: 10
    Term expiration: 2022-May-30 GMT

CNBNG Control Plane - Essentials - SIA (CNBNG_CP_ESS_SIA)
  Description: CNBNG Control Plane - Essentials Subscription - SIA
  Count: 1
  Version: 1.0
  Status: AUTHORIZED
```

```

Export status: NOT RESTRICTED
Feature Name: <empty>
Feature Description: <empty>
Reservation:
  Reservation Status: SPECIFIC INSTALLED
  Total Reserved Count: 10
  Term expiration: 2022-May-30 GMT

```

Product Information

```
=====
```

```
UDI: PID:cnBNG,SN:3WI5UXQ-5XPKM6A
```

Agent Version

```
=====
```

```
Smart Agent for Licensing: 3.1.11
```

Returning the Reserved License

To return the reserved license to CSC if required, generate a return code at the BNG Ops Center.



Note If there is an issue with the return code generation, open a case with the Cisco Technical Assistance Center.

To return the reserved license:

1. When the license reservation authorization code is installed in the BNG Ops Center:

- a. Log on to the BNG Ops Center CLI and use the following command.

```
license smart reservation return
```

Example:

```

bng# license smart reservation return
reservation-return-code CJ6m3k-RAVu6b-hMNmwf-mrdcko-NoSwKL-tF7orz-9aNtEu-yVjGAm-D6j
bng#

```

- b. Copy the license reservation return code generated in BNG Ops Center CLI.
- c. Log on to your CSC account.
- d. Select your product instance from the list in the Product Instances tab.
- e. Click **Actions > Remove**.
- f. Paste the license reservation return code in **Return Code** text-box.
- g. Select **Remove Product Instance**.

NOTES:

- **license smart reservation return** : Return a reserved Smart License.

2. When the license reservation authorization code is not installed in the BNG Ops Center.

- a. Log on to the BNG Ops Center CLI and use the following command to generate the return code.

```
license smart reservation return authorization
authorization_code
```

Paste the license reservation authorization code generated in CSC to generate the return code.

- b. Log on to your CSC account.
 - c. Select your product instance from the list in the Product Instances tab.
 - d. Click **Actions > Remove**.
 - e. Paste the license reservation return code in **Return Code** text-box.
 - f. Select **Remove Product Instance**.
3. Verify the smart licensing status by using the following command.

```
show license all
```

Example:

```
bng# show license all
Mon Dec 13 05:29:03.370 UTC+00:00

Smart Licensing Status
=====
Smart Licensing is ENABLED
License Reservation is ENABLED

Registration:
  Status: UNREGISTERED
  Export-Controlled Functionality: Not Allowed

License Authorization:
  Status: EVAL MODE
  Evaluation Period Remaining: 86 days, 13 hr, 52 min, 39 sec
  Last Communication Attempt: NONE

License Conversion:
  Automatic Conversion Enabled: true
  Status: NOT STARTED

Utility:
  Status: DISABLED

Transport:
  Type: CALLHOME

Evaluation Period:
  Evaluation Mode: In Use
  Evaluation Period Remaining: 86 days, 13 hr, 52 min, 39 sec

License Usage
=====
License Authorization Status: EVALUATION MODE
  Evaluation Period Remaining: 86 days, 13 hr, 52 min, 39 sec

(CNBNG_CP_SYS_RTU)
  Description: <empty>
  Count: 1
  Version: 1.0
  Status: EVAL MODE
  Export status: NOT RESTRICTED
  Feature Name: <empty>
  Feature Description: <empty>

(CNBNG_CP_SYS_SIA)
  Description: <empty>
  Count: 1
```

```
Version: 1.0
Status: EVAL MODE
Export status: NOT RESTRICTED
Feature Name: <empty>
Feature Description: <empty>

Product Information
=====
UDI: PID:cnBNG,SN:QHJZRXY-IRNN3JA

Agent Version
=====
Smart Agent for Licensing: 3.1.11
```

Canceling License Reservation Request

To cancel a license reservation request through the BNG Ops Center CLI:

Log on to the BNG Ops Center CLI and use the following command.

```
license smart reservation cancel
```

Monitoring and Troubleshooting Smart Licensing

You can use the following show commands to view Smart Licensing related information in the BNG Ops Center.

```
show license [ all | UDI | displaylevel | reservation | smart | status |  
summary | tech-support | usage ]
```

NOTES:

- **all** –Displays an overview of Smart Licensing information that includes license status, usage, product information and Smart Agent version.
- **UDI** –Displays Unique Device Identifiers (UDI) details.
- **displaylevel** –Depth to display information.
- **reservation** –Displays Smart Licensing reservation information.
- **smart** –Displays Smart Licensing information.
- **status** –Displays the overall status of Smart Licensing.
- **summary** –Displays a summary of Smart Licensing.
- **tech-support** –Displays Smart Licensing debugging information.
- **usage** –Displays the license usage information for all the entitlements that are currently in use.



CHAPTER 5

Cisco Common Data Layer

- [Feature Summary and Revision History, on page 77](#)
- [Feature Description, on page 78](#)
- [Limitations, on page 78](#)

Feature Summary and Revision History

Summary Data

Table 12: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 13: Revision History

Revision Details	Release
Enhancement Introduced: The CDL feature is NSO-integrated.	2021.04.0
First introduced.	2021.01.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

The Cisco Common Data Layer (CDL) is a high-performance next generation Key-value (KV) data store layer for all the Cloud Native applications. These applications use the CDL as a state management with High Availability (HA) and Geo HA functions. The CDL provides:

- Different Network Functions (NFs) - such as AMF, cnBNG Control Plane, SMF, and PCF - microservices.
- Multi-master support to achieve low latency read and write.
- Pure in-memory storage.
- Session related timers to notify NF on timer expiry.

Deploying CDL provides the following benefits:

- Service-Based Architecture (SBA) with auto discovery and global accessibility.
- High performance, in-memory caching and in-memory data store.
- Container-based solution from the ground up.
- CDL can deploy and scale with simple API calls.
- Geo Redundant Replication among multiple cnBNG clusters.

For detailed information about CDL, refer to the *UCC SMI Common Data Layer Configuration and Administration Guide* at <https://www.cisco.com/c/en/us/support/wireless/ultra-cloud-core-subscriber-microservices-infrastructure/products-installation-and-configuration-guides-list.html>.

Limitations

The CDL feature has the following limitation on cnBNG.

Geo-redundancy is not supported.



CHAPTER 6

Authentication, Authorization, and Accounting Functions

- [Feature Summary and Revision History](#), on page 79
- [Feature Description](#), on page 80
- [Configuring AAA Functions](#), on page 92

Feature Summary and Revision History

Summary Data

Table 14: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	<i>Cloud Native BNG Control Plane Command Reference Guide</i>

Revision History

Table 15: Revision History

Revision Details	Release
Enhancement Introduced: The AAA feature is NSO-integrated.	2021.04.0

Revision Details	Release
<ul style="list-style-type: none"> This release introduces support for the Multi-Action Change of Authorization. Updated the following sections: <ul style="list-style-type: none"> Configuring AAA Attributes: The user-plane is added as the one of the format-order identifiers while formatting AAA attributes. The format-string keyword was added to the AAframe format of the attribute. Configuring RADIUS Accounting Options: The <i>nas_port</i> variable is added to explicitly specify the nas-port value. The { format-e format_e { nas-port-type nas_port_type } } options are added to the nas-port keyword. Configuring RADIUS Attribute Format: The <i>nas_port</i> variable is added to explicitly specify the nas-port value. The { format-e format_e { nas-port-type nas_port_type } } options are added to the nas-port keyword. 	2021.03.0
First introduced.	2021.01.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

Note: All references to BNG in this chapter refer to the Cloud-Native Broadband Network Gateway (cnBNG).

This chapter provides information about configuring authentication, authorization, and accounting (AAA) functions on the BNG. BNG interacts with the RADIUS server to perform AAA functions. A group of RADIUS servers form a server group that is assigned specific AAA tasks. A method list defined on a server or server group lists methods by which authorization is performed. Some of the RADIUS features include creating specific AAA attribute formats, load balancing of RADIUS servers, throttling of RADIUS records, Change of Authorization (CoA), Session Accounting, and Service Accounting for QoS.

AAA Overview

AAA acts as a framework for effective network management and security. It helps in managing network resources, enforcing policies, auditing network usage, and providing bill-related information. BNG connects to an external RADIUS server that provides the AAA functions.

The RADIUS server performs the three independent security functions (authentication, authorization, and accounting) to secure networks against unauthorized access. The RADIUS server runs the Remote Authentication Dial-In User Service (RADIUS) protocol. (For details about RADIUS protocol, refer to RFC 2865). The RADIUS server manages the AAA process by interacting with BNG, and databases and directories containing user information.

The RADIUS protocol runs on a distributed client-server system. The RADIUS client runs on BNG (Cisco ASR 9000 Series Router) that sends authentication requests to a central RADIUS server. The RADIUS server contains all user authentication and network service access information.

The AAA processes, the role of RADIUS server during these processes, and some BNG restrictions, are explained in these sections:

Authentication

The authentication process identifies a subscriber on the network, before granting access to the network and network services. The process of authentication works on a unique set of criteria that each subscriber has for gaining access to the network. Typically, the RADIUS server performs authentication by matching the credentials (user name and password) the subscriber enters with those present in the database for that subscriber. If the credentials match, the subscriber is granted access to the network. Otherwise, the authentication process fails, and network access is denied.

Authorization

After the authentication process, the subscriber is authorized for performing certain activity. Authorization is the process that determines what type of activities, resources, or services a subscriber is permitted to use. For example, after logging into the network, the subscriber may try to access a database, or a restricted website. The authorization process determines whether the subscriber has the authority to access these network resources.

AAA authorization works by assembling a set of attributes based on the authentication credentials provided by the subscriber. The RADIUS server compares these attributes, for a given username, with information contained in a database. The result is returned to BNG to determine the actual capabilities and restrictions that are to be applied for that subscriber.

Accounting

The accounting keeps track of resources used by the subscriber during network access. Accounting is used for billing, trend analysis, tracking resource utilization, and capacity planning activities. During the accounting process, a log is maintained for network usage statistics. The information monitored include, but are not limited to - subscriber identities, applied configurations on the subscriber, the start and stop times of network connections, and the number of packets and bytes transferred to, and from, the network.

BNG reports subscriber activity to the RADIUS server in the form of accounting records. Each accounting record comprises of an accounting attribute value. This value is analyzed and used by the RADIUS server for network management, client billing, auditing, etc.

The accounting records of the subscriber sessions may timeout if the BNG does not receive acknowledgments from the RADIUS server. This timeout can be due to RADIUS server being unreachable or due to network connectivity issues leading to slow performance of the RADIUS server. It is therefore recommended that a

RADIUS server **deadtime** be configured on the BNG, to avoid loss of sessions. Once this value is configured, and if a particular session is not receiving an accounting response even after retries, then that particular RADIUS server is considered to be non-working and further requests are not sent to that server.

Restrictions

- On session disconnect, transmission of the Accounting-Stop request to RADIUS may be delayed for a few seconds while the system waits for the "final" session statistics to be collected from the hardware. The Event-Timestamp attribute in that Accounting-Stop request should, however, reflect the time the client disconnects, and not the transmission time.

Using RADIUS Server Group

A RADIUS server group is a named group of one or more RADIUS servers. Each server group is used for a particular service. For example, in an AAA network configuration having two RADIUS server groups, the first server group can be assigned the authentication and authorization task, while the second group can be assigned the accounting task.

Server groups can include multiple host entries for the same server. Each entry, however, must have a unique identifier. This unique identifier is created by combining an IP address and a UDP port number. Different ports of the server, therefore, can be separately defined as individual RADIUS hosts providing a specific AAA service. In other words, this unique identifier enables RADIUS requests to be sent to different UDP ports on the same server. Further, if two different host entries on the same RADIUS server are configured for the same service (like the authentication process), then the second host entry acts as a fail-over backup for the first one. That is, if the first host entry fails to provide authentication services, BNG tries with the second host entry. (The RADIUS host entries are tried in the order in which they are created.)

For assigning specific actions to the server group, see [Configuring RADIUS Server Group, on page 108](#).

Specifying Method Order

Method order for AAA defines the methods using which authorization is performed, and the sequence in which these methods are executed. Before any defined authentication method is performed, the method order must be applied to the configuration mechanism responsible for validating user-access credentials.

On BNG, you have to specify the method order and the server group that will be used for AAA services. For specifying method order, see [Configuring Method Order for AAA, on page 95](#).

Defining AAA Attributes

The AAA attribute is an element of RADIUS packet. A RADIUS packet transfers data between a RADIUS server and a RADIUS client. The AAA attribute parameter, and its value - form a Attribute Value Pair (AVP). The AVP carries data for both requests and responses for the AAA transaction.

The AAA attributes either can be predefined as in Internet Engineering Task Force (IETF) attributes or vendor defined as in vendor-specific attributes (VSAs). For more information about the list of BNG supported attributes, see [RADIUS Attributes, on page 249](#).

The RADIUS server provides configuration updates to BNG in the form of attributes in RADIUS messages. The configuration updates can be applied on a subscriber during session setup through two typical methods—per-user attributes, which applies configuration on a subscriber as part of the subscriber's authentication Access

Accept, or through explicit domain, port, or service authorization Access Accepts. This is all controlled by the Policy Rule Engine's configuration on the subscriber.

When BNG sends an authentication or an authorization request to an external RADIUS server as an Access Request, the server sends back configuration updates to BNG as part of the Access Accept. In addition to RADIUS configuring a subscriber during setup, the server can send a change of authorization (CoA) message autonomously to the BNG during the subscriber's active session life cycle, even when the BNG did not send a request. These RADIUS CoA updates act as dynamic updates, referencing configured elements in the BNG and instructing the BNG to update a particular control policy or service policy.

BNG supports the concept of a "service", which is a group of configured features acting together to represent that service. Services can be represented as either features configured on dynamic-templates through CLI, or as features configured as RADIUS attributes inside Radius Servers. Services are activated either directly from CLI or RADIUS through configured "activate" actions on the Policy Rule Engine, or through CoA "activate-service" requests. Services can also be deactivated directly (removing all the involved features within the named service) through configured "deactivate" action on the Policy Rule Engine or through CoA "deactivate-service" requests.

The attribute values received from RADIUS interact with the subscriber session in this way:

- BNG merges the values received in the RADIUS update with the existing values that were provisioned statically by means of CLI commands, or from prior RADIUS updates.
- In all cases, values received in a RADIUS update take precedence over any corresponding CLI provisioned values or prior RADIUS updates. Even if you reconfigured the CLI provisioned values, the system does not override session attributes or features that were received in a RADIUS update.
- Changes made to CLI provision values on the dynamic template take effect immediately on all sessions using that template, assuming the template features have not already been overridden by RADIUS. Same applies to service updates made through CoA "service-update" requests.

AAA Attribute Format

It is possible to define a customized format for some attributes. For the configuration syntax for creating a new format, see [Configuring AAA Attributes, on page 92](#).

Once the format is defined, the FORMAT-NAME can be applied to various AAA attributes such as username, nas-port-ID, calling-station-ID, and called-station-ID. The configurable AAA attributes that use the format capability are explained in the section [Creating Attributes of Specific Format, on page 83](#).

To create a customized nas-port attribute and apply a predefined format to nas-port-ID attribute, see [Configuring RADIUS Attribute Format, on page 101](#).

Specific functions can be defined for an attribute format for specific purposes. For example, if the input username is "text@abc.com", and only the portion after "@" is required as the username, a function can be defined to retain only the portion after "@" as the username. Then, "text" is dropped from the input, and the new username is "abc.com". To apply username truncation function to a named-attribute format, see [Configuring AAA Attributes, on page 92](#).

Creating Attributes of Specific Format

BNG supports the use of configurable AAA attributes. The configurable AAA attributes have specific user-defined formats. The following sections list some of the configurable AAA attributes used by BNG.

Username

BNG has the ability to construct AAA username and other format-supported attributes for subscribers using MAC address, circuit-ID, remote-ID, and DHCP Option-60 (and a larger set of values available in CLI). The DHCP option-60 is one of the newer options that is communicated by the DHCP client to the DHCP server in its requests; it carries Vendor Class Identifier (VCI) of the DHCP client's hardware.

The MAC address attribute is specified in the CLI format in either of these forms:

- mac-address: for example, 0000.4096.3e4a
- mac-address-ietf: for example, 00-00-40-96-3E-4A
- mac-address-raw: for example, 000040963e4a
- mac-address-custom1: for example, 01.23.45.67.89.AB

(This particular MAC address format is available only from Release 6.2.1 and later).

NAS-Port-ID

The NAS-Port-ID is constructed by combining BNG port information and access-node information. The BNG port information consists of a string in this form:

```
"eth phy_slot/phy_subslot/phy_port:XPI.XCI"
```

For 802.1Q tunneling (QinQ), XPI is the outer VLAN tag and XCI is the inner VLAN tag.

If the interface is QinQ, the default format of nas-port-ID includes both the VLAN tags; if the interface is single tag, it includes a single VLAN tag.

In the case of a single VLAN, only the outer VLAN is configured, using this syntax:

```
<slot>/<subslot>/<port>/<outer_vlan>
```

In the case of QinQ, the VLAN is configured using this syntax:

```
<slot>/<subslot>/<port>/<inner_vlan>.<outer_vlan>
```

In the case of a bundle-interface, the phy_slot and the phy_subslot are set to zero (0); whereas the phy_port number is the bundle number. For example, 0/0/10/30 is the NAS-Port-ID for a Bundle-Ether10.41 with an outer VLAN value 30.

The nas-port-ID command is extended to use the 'nas-port-type' option so that the customized format (configured with the command shown above) can be used on a specific interface type (nas-port-type).

If 'type' option is not specified, then the nas-port-ID for all interface types is constructed according to the format name specified in the command.

Calling-Station-ID and Called-Station-ID

BNG supports the use of configurable calling-station-ID and called-station-ID. The calling-station-ID is a RADIUS attribute that uses Automatic Number Identification (ANI), or similar technology. It allows the network access server (NAS) to send to the Access-Request packet, the phone number from which the call came from. The called-station-ID is a RADIUS attribute that uses Dialed Number Identification (DNIS), or similar technology. It allows the NAS to send to the Access-Request packet, the phone number that the user called from.

NAS-Port Format

NAS-Port is a 4-byte value that has the physical port information of the Broadband Remote Access Server (BRAS), which connects the Access Aggregation network to BNG. It is used both by Access-Request packets and Accounting-Request packets. To uniquely identify a physical port on BRAS, multiple pieces of information such as shelf, slot, adapter, and so on is used along with the port number. A configurable format called format-e is defined to allow individual bits or group of bits in 32 bits of NAS-Port to represent or encode various pieces that constitute port information.

Individual bits in NAS-Port can be encoded with these characters:

- Zero: 0
- One: 1
- PPPoX slot: S
- PPPoX adapter: A
- PPPoX port: P
- PPPoX VLAN Id: V
- PPPoX VPI: I
- PPPoX VCI: C
- Session-Id: U
- PPPoX Inner VLAN ID: Q

The permissible nas-port type values are:

Nas-port-types	Values	Whether value can be derived from associated interface
VIRTUAL_PPPOEOVLAN	36	Yes
VIRTUAL_PPPOEQINQ	37	Yes
VIRTUAL_IPOEOVLAN	43	Yes
VIRTUAL_IPOEQINQ	44	Yes



Note If a NAS-Port format is not configured for a NAS-Port-Type, the system looks for a default CLI configuration for the NAS-Port format. In the absence of both these configurations, for sessions with that particular NAS-Port-Type, the NAS-Port attribute is not sent to the RADIUS server.

Making RADIUS Server Settings

In order to make BNG interact with the RADIUS server, certain server specific settings must be made on the BNG router.

For more making RADIUS server settings, see [Configuring RADIUS Server, on page 108](#).

Restriction

The service profile push or asynchronously pushing a profile to the system is not supported. To download a profile from Radius, the profile must be requested initially as part of the subscriber request. Only service-update is supported and can be used to change a service that was previously downloaded.

Balancing Transaction Load on the RADIUS Server

The RADIUS load-balancing feature is a mechanism to share the load of RADIUS access and accounting transactions, across a set of RADIUS servers. Each AAA request processing is considered to be a transaction. BNG distributes batches of transactions to servers within a server group.

When the first transaction for a new is received, BNG determines the server with the lowest number of outstanding transactions in its queue. This server is assigned that batch of transactions. BNG keeps repeating this determination process to ensure that the server with the least-outstanding transactions always gets a new batch. This method is known as the least-outstanding method of load balancing.

For configuring the load balancing on the RADIUS server, see [Configuring RADIUS Server Selection Logic, on page 108](#).

RADIUS Change of Authorization Overview

The RADIUS Change of Authorization (CoA) function allows the RADIUS server to change the authorization settings for a subscriber who is already authorized. CoA is an extension to the RADIUS standard that allows sending asynchronous messages from RADIUS servers to a RADIUS client, like BNG.



Note

A CoA server can be a different from the RADIUS server.

To identify the subscriber whose configuration needs to be changed, a RADIUS CoA server supports and uses a variety of keys (RADIUS attributes) such as Accounting-Session-ID, Username, IP-Address, and ipv4:vrf-id.

The RADIUS CoA supports:

- account-update — BNG parses and applies the attributes received as part of the CoA profile. Only subscriber-specific attributes are supported and applied on the user profile.
- activate-service — BNG starts a predefined service on a subscriber. The service settings can either be defined locally by a dynamic template, or downloaded from the RADIUS server.
- deactivate-service — BNG stops a previously started service on the subscriber, which is equivalent to deactivating a dynamic-template.

For a list of supported Vendor-Specific Attributes for account operations, see [Vendor-Specific Attributes for Account Operations, on page 255](#).



Note In order for BNG to enable interim accounting, it is mandatory for the CoA request to have both accounting method list from the dynamic-template and Acct-Interim-Interval attribute from the user profile. This behavior is applicable for accounting enabled through dynamic-template. Whereas, from Cisco IOS XR Software Release 5.3.0 and later, the CoA request needs to have only the Acct-Interim-Interval attribute in the user profile.

Service Activate from CoA

BNG supports activating services through CoA requests. The CoA **service-activate** command is used for activating services. The CoA request for the service activate should contain these attributes:

- "subscriber:command=activate-service" Cisco VSA
- "subscriber:service-name=<service name>" Cisco VSA
- Other attributes that are part of the service profile

The "<subscriber:sa=<service-name>" can also be used to activate services from CoA and through RADIUS.

Duplicate service activate requests can be sent to BNG from the CoA server. BNG does not take any action on services that are already activated. BNG sends a CoA ACK message to the CoA server under these scenarios:

- When a duplicate request with identical parameters comes from the CoA for a service that is already active.
- When a duplicate request with identical parameters comes from the CoA to apply a parameterized service.

BNG sends a CoA NACK message to the CoA server with an error code as an invalid attribute under these scenarios:

- When a request comes from the CoA to deactivate a non-parameterized service that is not applied to the session.
- When a request comes from the CoA to deactivate a parameterized service that is not applied to the session.
- When a duplicate request to apply a parameterized service is made with non-identical parameters from the CoA.
- When a request with non-identical parameters comes from CoA to deactivate a parameterized service.

Service Update from CoA

The service update feature allows an existing service-profile to be updated with a new RADIUS attribute list representing the updated service. This impacts any subscriber who is already activated with the service and new subscriber who activate the service in the future. The new CoA **service-update** command is used for activating this feature. The CoA request for the service update should have these attributes:

- "subscriber:command=service-update" Cisco VSA
- "subscriber:service-name=<service name>" Cisco VSA
- Other attributes that are part of the service profile

A service update CoA should have a minimum of these attributes:

- `vsa cisco generic 1 string "subscriber:command=service-update"`
- `vsa cisco generic 1 string "subscriber:service-name=<service name>"`

Web Logon with RADIUS Based CoA

To support Web Logon, a set of Policy Rule Events need to be configured in an ordered manner. These events are as follows:

- **session-start:**
 - On the start of a session, a subscriber is setup to get internet connectivity. The service is activated to redirect HTTP traffic to a Web portal for web-based logon.
 - Start the timer with duration for the maximum waiting period for authentication.
- **account-logon**—The Web portal collects the user credentials such as username and password and triggers a CoA account-logon command. When this event is triggered, subscriber username and password are authenticated by the RADIUS server. Once the authentication is successful, the HTTP redirect service is deactivated, granting user access to already connected internet setup. Also, the timer established in session-start must be stopped. However, if the authentication fails during account-logon, BNG sends a NAK CoA request, allowing for further authentication attempts to take place.
- **timer expiry**—When the timer expires, the subscriber session is disconnected based on the configuration.

Multi-Action Change of Authorization

BNG supports multi-action Change of Authorization (CoA) wherein service providers can activate and deactivate multiple services using a single CoA request. Multi-action CoA is supported for **Service-Activate** and **Service-Deactivate** commands.

During the multi-action CoA request, if any of the COA requests fail to activate or deactivate, then any of the services which have been activated or deactivated as part of that CoA request is rolled back to its previous state. The session restores back to the its pre-MA-CoA state upon failure to activation or deactivation.

An Example of a Multi-Action Change of Authorization Use Case

The following example lists the sequence of events that occur in the case of a PTA session initiation.

1. PTA session's web traffic redirected to a service portal (HTTP Redirect)
2. The user activates the first level of service through the service portal. A multi-action COA request is initiated in the following sequence.
 - a. Deactivate redirection
 - b. Activate Turbo Button 1
 - c. Activate VoIP with two channels
3. The user activates the second level of service through the service portal. A multi-action COA request is initiated in the following sequence.
 - a. Deactivate Turbo Button 1

- b. Activate Turbo Button 2
- c. Deactivate VoIP with two channels
- d. Activate VoIP with 4 channels

Interworking with Service-Level Accounting

BNG supports Service-Level Accounting, where a service is a collection of features that are activated and deactivated as a group. Service-Level Accounting and MA-CoA features are independent, that is, they can be applied separately. However, MA-CoA accounts for services that are activated or deactivated that have Service-Level Accounting enabled through the dynamic template configuration.

Generating Accounting Records

The following cases describes how the multi-action CoA records are generated for accounting purposes.

MA-CoA ACK Case

- If MA-CoA request contains only service activate commands, then START accounting record for those services are generated after the CoA Ack is sent out.
- If MA-CoA request contains only deactivate services or combination of activate and deactivate services, then for those services START or STOP accounting records are generated after the CoA Ack is sent out.

MA-CoA NAK Case (Rollback scenario)

- If MA-CoA request fails due to presence of invalid command formats or due to internal software failure or due to presence of invalid service names, that are not defined in the box, in such cases the accounting START or STOP messages are not generated upon rollback.
- If MA-CoA request fails due to internal feature programming failure, then the Service-START or Service-STOP accounting records may be generated for the services that were activated or deactivated before the failure. After the failure, the rollback is initiated and appropriate Service-START or Service-STOP records are generated for these services.

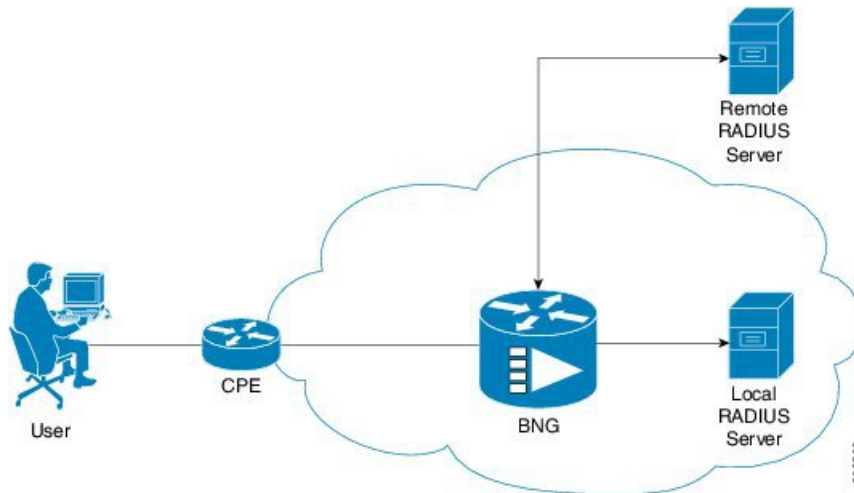
Sample MA-COA Request

```
exec /bin/echo
"Cisco-AVPair='subscriber:sd=svcQoSacct1',Cisco-AVPair='subscriber:sd=svcQoSacct2',
Cisco-AVPair='subscriber:sd=svcQoSacct3',Cisco-AVPair='subscriber:sa=qosin_coa',
Cisco-AVPair='subscriber:sa=qosout_coa',
Acct-Session-Id=00000001" | /usr/local/bin/radclient -r 1 -x 5.11.17.31:1700 coa coa
```

User Authentication and Authorization in the Local Network

The user authentication and authorization in the local network feature in BNG provides the option to perform subscriber authorization locally (in a subscriber's network), instead of both remote authentication and authorization that occurs in RADIUS servers. With the User Authentication and Authorization in the Local Network feature, you can run the RADIUS server locally in your network, manage, and configure the RADIUS server locally in your network to the profile that is required for the environment. In the case of a remote RADIUS server, the RADIUS server is maintained by an external regulatory body (not within the subscriber's network) and subscriber will not be able to manage or configure the server.

Figure 7: User Authentication and Authorization in the Local Network



User Authentication and Authorization in the Local Network feature is used in a case when a user wants to perform a two-level authentication or authorization, first, a remote authentication (or authorization) followed by a local authorization (or authentication).



Note All the debug commands applicable to AAA server are applicable on User Authentication and Authorization in the Local Network feature.

Service Accounting

Accounting records for each service enabled on a subscriber can be sent to the configured RADIUS server. These records can include service-start, service-stop, and service-interim records containing the current state of the service and any associated counters. This feature is the Service Accounting feature. Service accounting records are consolidated accounting records that represent the collection of features that make up a service as part of a subscriber session.

Service accounting starts when a subscriber session comes up with a service enabled on it. This can happen through a dynamic template applied through a control policy, through access-accept (AA) messages when the session is authorized, or through a change of authorization (CoA), when a new service is applied on a subscriber session. Service accounting stops either when the session is terminated, or a service is removed from the session through CoA, or some other event that deactivates the service. Start records have no counters; interim and stop records with QoS counters are generated when service accounting is enabled for QoS. Interim accounting records can be generated, in between start and stop accounting, as an option with a pre-defined periodic interval. When the interim period is zero, interim accounting records are not created. Different interim intervals are based on every service for each session. Service accounting is enabled on each template, based on the configuration.

Service Accounting is supported on bundle subscriber interfaces as well as line card subscriber interfaces.

For more information on service accounting for QoS, refer to [Authentication, Authorization, and Accounting Functions, on page 79](#). For more information on commands to configure service accounting, refer to the [Configuring Service Accounting, on page 246](#).



Note The policy-map associated to a dynamic template can be edited to change the service parameters. However, this does not update the accounting records. Therefore, to generate all the accounting records accurately, it is recommended that a new service with all the required service parameters be created and associated to the new service, through a CoA.

For service accounting, statistics for ingress and egress QoS policies, which are applied under each service for a given subscriber, may need to be reported as part of the accounting interim and stop records. For each service, these QoS counters can be reported as part of the accounting records:

- BytesIn — Aggregate of bytes matching all classes of the ingress QoS policy for the service minus the policer drops.
- PacketsIn — Aggregate of packets matching all classes of the ingress QoS policy for the service minus the policer drops.
- BytesOut — Aggregate of bytes matching all classes of the egress QoS policy for the service minus the queuing drops.
- PacketsOut — Aggregate of packets matching all classes of the egress QoS policy for the service minus the queuing drops.

Dynamic template features that support accounting statistic collection and require that their statistics be reported in the AAA service accounting records can enable accounting statistics on their features using the newly-introduced optional **acct-stats** configuration option. This option is not available for the features that do not support statistic collection. By default, QoS accounting statistics are disabled to optimize performance.



Note The QoS counters for each direction is reported only if a QoS policy is applied for that service in the given direction. For example, if a service does not have an ingress policy applied, BytesIn and PacketsIn counters are reported as being 0.

Pre-requisites

- Subscriber accounting, the parent accounting record for service accounting, must be configured to enable the service accounting feature to work.
- The keyword **acct-stats** must be configured in service-policy configuration to enable the service accounting feature to report feature counter information as part of the records.

Restriction

- IPv4 and IPv6 subscriber sessions has a single set of service accounting records. They are merged into one set of bytes_in, bytes_out, packets_in, packets_out counters.
- Service accounting is not supported for static sessions.

Standard Compliance

The AAA features are aligned with the following standards:

- RFC 2865 - Remote Authentication Dial In User Service (RADIUS)
- RFC 2866 - RADIUS Accounting
- RFC 5176 - Dynamic Authorization Extensions to Remote Authentication Dial In User Service (RADIUS)

Configuring AAA Functions

This section describes how to configure the following Authentication, Authorization, and Accounting (AAA) functions on the Control Plane (CP).

The configuration of the AAA functions involves the following procedures:

- Configuring AAA Attributes
- Configuring the CoA-NAS Interface
- Configuring Method Order for AAA
- Configuring RADIUS Accounting Options
- Configuring RADIUS Accounting Server Group
- Configuring RADIUS Attributes
- Configuring RADIUS-Dead Time
- Configuring RADIUS-Detect Dead Server
- Configuring RADIUS Pod
- Configuring RADIUS Maximum Retry
- Configuring RADIUS NAS-IP
- Configuring RADIUS Server
- Configuring RADIUS Server Group
- Configuring RADIUS Server Selection Logic
- Configuring RADIUS Timeout

Configuring AAA Attributes

Use the following commands to configure a function for the AAA attribute format.

```
configure
  profile attribute-format attribute_format_name
    format-order { addr | circuit-id-tag | client-mac-address |
client-mac-address-custom1 | client-mac-address-custom2 |
client-mac-address-ietf | client-mac-address-raw | dhcp-client-id |
dhcp-client-id-spl | dhcp-user-class | dhcp-vendor-class |
dhcpv4-client-id-spl | dhcpv4-vendor-class | dhcpv6-client-id-ent-ident
| dhcpv6-interface-id | dhcpv6-vendor-class-string | inner-vlan-id |
outer-vlan-id | physical-adapter | physical-chassis | physical-port |
```

```
physical-slot | physical-subslot | port-type | pppoe-session-id |
remote-id-tag | service-name | username }
commit
```

configure

```
profile attribute-format attribute_format_name
  format-order { addr | circuit-id-tag | client-mac-address |
  addr | circuit-id-tag | client-mac-address |
  client-mac-address-custom1 | client-mac-address-custom2 |
  client-mac-address-ietf | client-mac-address-raw |
  dhcp-client-id | dhcp-client-id-spl | dhcp-user-class |
  dhcp-vendor-class | dhcpv4-client-id-spl |
  dhcpv4-vendor-class | dhcpv6-client-id-ent-ident |
  dhcpv6-interface-id | dhcpv6-vendor-class-string |
  inner-vlan-id | outer-vlan-id | physical-adapter |
  physical-chassis | physical-port | physical-slot |
  physical-subslot | port-type | pppoe-session-id |
  remote-id-tag | service-name | user-plane | username }
format-string format_string
```

NOTES:

- **profile attribute-format** *attribute_format_name*: Specifies the AAA attributes and enters the Attribute Format Configuration mode.
- **authorization**: Enters the Authorization sub-mode.
- **format-order** *attribute_format* | **identifier** { *addr* | *circuit-id-tag* | *client-mac-address* | *client-mac-address-custom1* | *client-mac-address-custom2* | *client-mac-address-ietf* | *client-mac-address-raw* | *dhcp-client-id* | *dhcp-client-id-spl* | *dhcp-user-class* | *dhcp-vendor-class* | *dhcpv4-client-id-spl* | *dhcpv4-vendor-class* | *dhcpv6-client-id-ent-ident* | *dhcpv6-interface-id* | *dhcpv6-vendor-class-string* | *inner-vlan-id* | *outer-vlan-id* | *physical-adapter* | *physical-chassis* | *physical-port* | *physical-slot* | *physical-subslot* | *port-type* | *pppoe-session-id* | *remote-id-tag* | *service-name* | *username* } | **value** *value* }: Specifies the AAA attribute format order as follows:
 - **addr**: Specifies the IPv4 address of the subscriber.
 - **circuit-id-tag**: Specifies the circuit identifier tag.
 - **client-mac-address**: Specifies the client MAC address in AABB.CCDD.EEFF format.
 - **client-mac-address-custom1**: Specifies the first custom client MAC address in AABB.CCDD.EEFF format.
 - **client-mac-address-custom2**: Specifies the second custom client MAC address in AABB.CCDD.EEFF format.
 - **client-mac-address-ietf**: Specifies the client MAC address in Internet Engineering Task Force (IETF) format. That is, AA-BB-CC-DD-EE-FF format.
 - **client-mac-address-raw**: Specifies the client MAC address in raw (AABBCCDDEEFF) format.
 - **dhcp-client-id**: Specifies the DHCP client identifier.
 - **dhcp-client-id-spl**: Specifies the DHCP client identifier special string.
 - **dhcp-user-class**: Specifies the DHCP user class.

- **dhcp-vendor-class**: Specifies the DHCP vendor class.
 - **dhcpv4-client-id-spl**: Specifies the DHCPv4 client identifier special string.
 - **dhcpv4-vendor-class**: Specifies the DHCPv4 vendor class.
 - **dhcpv6-client-id-ent-ident**: Specifies the DHCPv6 client and enterprise identifiers.
 - **dhcpv6-interface-id**: Specifies the DHCPv6 interface identifier.
 - **dhcpv6-vendor-class-string**: Specifies the DHCPv6 vendor class string.
 - **inner-vlan-id**: Specifies the inner VLAN identifier.
 - **outer-vlan-id**: Specifies the outer VLAN identifier.
 - **physical-adapter**: Specifies the physical adapter.
 - **physical-chassis**: Specifies the physical chassis.
 - **physical-port**: Specifies the physical port.
 - **physical-slot**: Specifies the physical slot.
 - **physical-subslot**: Specifies the physical subslot.
 - **port-type**: Specifies the interface or port type.
 - **pppoe-session-id**: Specifies the PPPoE physical identifier.
 - **remote-id-tag**: Specifies the remote identifier tag.
 - **service-name**: Specifies the service name.
 - **user-plane**: Specifies the User Plane (UP).
 - **username**: Specifies the username.
- **format-string** *format_string*: Specifies the AAA format pattern. The *format_string* specifies the format string. Each identifier is represented by ‘%s’ tuple. Any other character set is treated as a delimiter. For each ‘%s’ in the format-string, the format-order identifier is used.



Note

- Validation on the number of ‘%s’ in format-string and number of entries in format-order are not performed.
 - For backward compatibility, the format-order still takes the delimiter configuration. In this scenario, the format-order takes precedence and the format-string is silently ignored.
 - Use the delimiters either in the format-order (as in Release 2021.01) or in format-string (as in Release 2021.03).
-

Configuring the CoA-NAS Interface

Use the following configuration to define Change of Authorization (CoA) NAS interface in the RADIUS endpoint.

```
configure
  endpoint radius
    interface coa-nas
      vip-ip ipv4_address vip-port port_number
    end
```

NOTES:

- **endpoint radius**: Enters the RADIUS endpoint configuration mode.
- **interface coa-nas**: This keyword defines a new interface "coa-nas", and allows to enter the CoA NAS interface configuration mode.
- **vip-ip ipv4_address vip-port port_number**: Configures the IP address of the host. *ipv4_address* must be in standard IPv4 dotted decimal notation.

You can configure a list of VIP-IPs to listen to the inbound CoA or DM requests.

vip-port port_number: Specify the port number of the UDP proxy. By default, the port number is 3799. This default value is used only when the VIP-IP is specified.



ipmt This configuration allows only port to be specified per IP.

The BNG (udp-pxy) listens to the inbound CoA or DM request messages on these ports and ACK or NAK messages sent with the respective source ip and port.

Configuring Method Order for AAA

Use the following commands to assign the method order for the server group to use for subscriber authentication, authorization, and accounting.

Authentication

```
configure
  profile aaa aaa_name
    authentication
      method-order custom_server_group
    commit
```

NOTES:

- **profile aaa aaa_name**: Specifies the AAA profile name and enters the AAA Configuration mode.
- **authentication**: Enters the Authentication sub-mode.
- **method-order custom_server_group**: Specifies the method-order to be applied by default for subscriber authentication.

custom_server_group specifies the name of the server group where the method-order is applied.

Authorization

```

configure
  profile aaa aaa_name
    authorization
      password password
      type subscriber method-order custom_server_group
      username { format attribute_format | identifier { addr | circuit-id-tag
| client-mac-address | client-mac-address-custom1 |
client-mac-address-custom2 | client-mac-address-ietf |
client-mac-address-raw | dhcp-client-id | dhcp-client-id-spl |
dhcp-user-class | dhcp-vendor-class | dhcpv4-client-id-spl |
dhcpv4-vendor-class | dhcpv6-client-id-ent-ident | dhcpv6-interface-id |
dhcpv6-vendor-class-string | inner-vlan-id | outer-vlan-id |
physical-adapter | physical-chassis | physical-port | physical-slot |
physical-subslot | port-type | pppoe-session-id | remote-id-tag |
service-name | username } | value value }
      commit

```

NOTES:

- **profile aaa *aaa_name***: Specifies the AAA profile name and enters the AAA Configuration mode.
- **authorization**: Enters the Authorization sub-mode.
- **password *password***: Specifies the password for subscriber authentication.
- **type subscriber method-order *custom_server_group***: Specifies the method-order to be applied by default for subscriber authorization.

custom_server_group specifies the name of the server group where the method-order is applied.

- **username { format *attribute_format* | identifier { addr | circuit-id-tag | client-mac-address | client-mac-address-custom1 | client-mac-address-custom2 | client-mac-address-ietf | client-mac-address-raw | dhcp-client-id | dhcp-client-id-spl | dhcp-user-class | dhcp-vendor-class | dhcpv4-client-id-spl | dhcpv4-vendor-class | dhcpv6-client-id-ent-ident | dhcpv6-interface-id | dhcpv6-vendor-class-string | inner-vlan-id | outer-vlan-id | physical-adapter | physical-chassis | physical-port | physical-slot | physical-subslot | port-type | pppoe-session-id | remote-id-tag | service-name | username } | value *value* }**: Specifies the username format, identifier, or value.
 - **format *attribute_format***: Specifies the username attribute format.
 - **identifier { addr | circuit-id-tag | client-mac-address | client-mac-address-custom1 | client-mac-address-custom2 | client-mac-address-ietf | client-mac-address-raw | dhcp-client-id | dhcp-client-id-spl | dhcp-user-class | dhcp-vendor-class | dhcpv4-client-id-spl | dhcpv4-vendor-class | dhcpv6-client-id-ent-ident | dhcpv6-interface-id | dhcpv6-vendor-class-string | inner-vlan-id | outer-vlan-id | physical-adapter | physical-chassis | physical-port | physical-slot | physical-subslot | port-type | pppoe-session-id | remote-id-tag | service-name | username }**: Specifies the username identifiers as follows:
 - **addr**: Specifies the IPv4 address of the subscriber.
 - **circuit-id-tag**: Specifies the circuit identifier tag.
 - **client-mac-address**: Specifies the client MAC address in AABB.CCDD.EEFF format.

- **client-mac-address-custom1**: Specifies the first custom client MAC address in AABB.CCDD.EEFF format.
- **client-mac-address-custom2**: Specifies the second custom client MAC address in AABB.CCDD.EEFF format.
- **client-mac-address-ietf**: Specifies the client MAC address in Internet Engineering Task Force (IETF) format. That is, AA-BB-CC-DD-EE-FF format.
- **client-mac-address-raw**: Specifies the client MAC address in raw (AABBCCDDEEFF) format.
- **dhcp-client-id**: Specifies the DHCP client identifier.
- **dhcp-client-id-spl**: Specifies the DHCP client identifier special string.
- **dhcp-user-class**: Specifies the DHCP user class.
- **dhcp-vendor-class**: Specifies the DHCP vendor class.
- **dhcpv4-client-id-spl**: Specifies the DHCPv4 client identifier special string.
- **dhcpv4-vendor-class**: Specifies the DHCPv4 vendor class.
- **dhcpv6-client-id-ent-ident**: Specifies the DHCPv6 client and enterprise identifiers.
- **dhcpv6-interface-id**: Specifies the DHCPv6 interface identifier.
- **dhcpv6-vendor-class-string**: Specifies the DHCPv6 vendor class string.
- **inner-vlan-id**: Specifies the inner VLAN identifier.
- **outer-vlan-id**: Specifies the outer VLAN identifier.
- **physical-adapter**: Specifies the physical adapter.
- **physical-chassis**: Specifies the physical chassis.
- **physical-port**: Specifies the physical port.
- **physical-slot**: Specifies the physical slot.
- **physical-subslot**: Specifies the physical subslot.
- **port-type**: Specifies the interface or port type.
- **pppoe-session-id**: Specifies the PPPoE physical identifier.
- **remote-id-tag**: Specifies the remote identifier tag.
- **service-name**: Specifies the service name.
- **username**: Specifies the username.

Accounting

```
configure
  profile aaa aaa_name
    accounting
```

```

    method-order custom_server_group
  commit

```

NOTES:

- **profile aaa *aaa_name***: Specifies the AAA profile name and enters the AAA Configuration mode.
- **accounting**: Enters the Accounting sub-mode.
- **method-order *custom_server_group***: Specifies the method-order to be applied by default for subscriber accounting.
custom_server_group specifies the name of the server group where the method-order is applied.

Configuring RADIUS Accounting Options

This section describes how to configure the RADIUS accounting options.

```

configure
  profile radius accounting
    algorithm { first-server | round-robin }
    attribute { nas-identifier value | nas-ip ipv4_address }
    deadtime value
    detect-dead-server response-timeout value
    max-retry value
    timeout value
  commit

```

```

configure
  profile radius accounting
    algorithm { first-server | round-robin }
    attribute { nas-identifier value | nas-ip ipv4_address |
      nas-port { nas_port } | { format-e format_e
        { nas-port-type nas_port_type } }
    deadtime value
    detect-dead-server response-timeout value
    max-retry value
    timeout value
  commit

```

NOTES:

- **profile radius accounting**: Enters the RADIUS accounting configuration mode.
- **algorithm { first-server | round-robin }**: Defines the algorithm for selecting the RADIUS server.
 - **first-server**: Sets the selection logic as highest priority first. This is the default behavior.
 - **round-robin**: Sets the selection logic as round-robin order of servers.
- **attribute { nas-identifier value | nas-ip ipv4_address }**: Configures the RADIUS identification parameters.
 - **nas-identifier value**: Specifies the attribute name by which the system will be identified in Accounting-Request messages. *value* must be an alphanumeric string.

- **nas-ip** *ipv4_address*: Specifies the NAS IPv4 address. *ipv4_address* must be an IPv4 address in dotted decimal notation.
- **attribute** { **nas-identifier** *value* | **nas-ip** *ipv4_address* | **nas-port** { **format-e** *format_e_value* | **nas-port-type** *nas_port_type* } }: Configures the RADIUS identification parameters.
 - **nas-identifier** *value*: Specifies the attribute name by which the system will be identified in Accounting-Request messages. *value* must be an alphanumeric string.
 - **nas-ip** *ipv4_address*: Specifies the NAS IPv4 address. *ipv4_address* must be an IPv4 address in dotted decimal notation.
 - **nas-port** { *nas_port* } | { **format-e** *format_e* { **nas-port-type** *nas_port_type* } }: Specifies the nas-port attributes.
 - *nas_port* configures the NAS port value. The NAS port value ranges from 1 to 4294967295.



Note If none of the NAS port configurations are present, the existing default nas-port logic is applied. That is, setting a fixed-number per radius-pod.

- **format-e** *format_e_value* : Specifies the custom attribute formation support for nas-port. The nas-port is a 32 bit integer format. The configuration takes a 32 length of characters, each presenting a particular attribute mapping. The *format_e_value* pattern is: 01FSAPRiLUVQ]*):
 - 0 – Set bit to 0
 - 1 – Set bit to 1
 - F - PHY_SHELF
 - S – PHY_SLOT
 - A – PHY_ADAPTER
 - P - PHY_PORT
 - R - PHY_CHASSIS
 - i - PHY_SUBSLOT
 - L - PHY_CHANNEL
 - V - OUTER_VLAN_ID
 - Q - INNER_VLAN_ID
 - U - PPPOE_SESSION_ID
- **nas-port-type** *nas_port_type*: Specifies the NAS port type. The supported values range from 0 to 44.

**Note**

- The nas-port-type configuration is not in scope of the Control Plane. It is derived from the interface-type.
- The supported NAS port types are 36 , 37, 43, and 44.
- The NAS port type value takes precedence over the common NAS port format-e.

- **deadtime value:** Sets the time to elapse between RADIUS server marked unreachable and when we can re-attempt to connect.
value must be an integer from 0 through 65535. Default: 10 minutes.
- **detect-dead-server response-timeout value:** Sets the timeout value that marks a server as "dead" when a packet is not received for the specified number of seconds.
value must be an integer from 1 through 65535. Default: 10 seconds.
- **max-retry value:** Sets the maximum number of times that the system will attempt retry with the RADIUS server.
value must be an integer from 0 through 65535. Default: 2
- **timeout value:** Sets the time to wait for response from the RADIUS server before retransmitting.
value must be an integer from 1 through 65535. Default: 2 seconds.
- **commit:** Commits the configuration.
- All the keyword options under the RADIUS accounting configuration mode are also available within the RADIUS configuration mode.

Configuring RADIUS Accounting Server Group

This section describes how to configure the RADIUS server group.

```
configure
  profile radius
    server-group group_name
  commit
```

NOTES:

- **profile radius:** Enters the RADIUS configuration mode.
- **server group group_name:** Specifies the name of server group for use in RADIUS accounting.
group_name must be an alphanumeric string.
- **commit:** Commits the configuration.

Configuring RADIUS Attributes

This section describes how to configure the RADIUS attributes for authentication and accounting.

```
configure
  profile radius
    attribute { nas-identifier value | nas-ip ipv4_address }
  commit
```

NOTES:

- **profile radius**: Enters the RADIUS configuration mode.
- **attribute { nas-identifier value | nas-ip ipv4_address }**: Configures the RADIUS identification parameters.
 - **nas-identifier value**: Specifies the attribute name by which the system will be identified in Accounting-Request messages. *value* must be an alphanumeric string.
 - **nas-ip ipv4_address**: Specifies the NAS IPv4 address. *ipv4_address* must be an IPv4 address in dotted decimal notation.
- **commit**: Commits the configuration.

Sample Configuration

The following is a sample configuration.

```
configure
  profile radius
    attribute
      nas-identifier CiscoBng
    exit
  exit
```

Configuring RADIUS Attribute Format

Use the following commands to configure the RADIUS identification parameters.

```
configure
  profile radius attribute
    called-station-id { format-name format_name | nas-port-type
                        nas_port_type }
    calling-station-id { format-name format_name | nas-port-type
                        nas_port_type }
    calling-station-id { format-name format_name | nas-port-type
                        nas_port_type }
    nas-identifier nas_identifier
    nas-ip ipv4_address
    nas-port-id nas_port_id { format-name format_name
                              | nas-port-type nas_port_type }
  commit
```

NOTES:

- **profile attribute attribute**: Enters the Profile RADIUS Attribute Configuration mode.

- **called-station-id** { **format-name** *format_name* | **nas-port-type** *nas_port_type* } : Specifies the AAA called-station-id attribute.

format-name *format_name*: Specifies the called-station-id format name.

nas-port-type *nas_port_type*: Specifies the NAS port type. The supported values range from 0 to 44.



Note

- nas-port-type configuration is not in scope of the Control Plane. It is derived depending on the interface-type.
 - The supported NAS port types are 36 , 37, 43, and 44.
-

- **calling-station-id** { **format-name** *format_name* | **nas-port-type** *nas_port_type* } : Specifies the AAA calling-station-id attribute.
- **nas-identifier** { **format-name** *format_name* | **nas-port-type** *nas_port_type* } : Specifies the attribute name with which the system is identified in the Access-Request messages. The identifier string ranges from 1 to 32 characters.
- **nas-identifier-format** { **format-name** *format_name* | **nas-port-type** *nas_port_type* } : Specifies the AAA nas-identifier-format attribute.
- **nas-ip** *ipv4_address*: Specifies the AAA NAS IPv4 address.
- **nas-port-id** *nas_port_id*: Specifies the AAA NAS port-id attribute.

Use the following commands to configure the RADIUS identification parameters.

```
configure
profile radius attribute
  called-station-id { format-name format_name
                    | nas-port-type nas_port_type }
  calling-station-id { format-name format_name
                     | nas-port-type nas_port_type }
  nas-identifier nas_identifier
  nas-identifier-format nas_identifier_format
  nas-ip ipv4_address
  nas-port { nas_port } | { format-e format_e
                        { nas-port-type nas_port_type } }
  nas-port-id nas_port_id { format-name format_name
                          | nas-port-type nas_port_type }
commit
```

NOTES:

- **profile attribute attribute**: Enters the Profile RADIUS Attribute Configuration mode.
- **called-station-id** { **format-name** *format_name* | **nas-port-type** *nas_port_type* } : Specifies the AAA called-station-id attribute.
format-name *format_name*: Specifies the called-station-id format name.
nas-port-type *nas_port_type*: Specifies the NAS port type. The supported values range from 0 to 44.

- `nas-port-type` configuration is not in scope of the Control Plane. It is derived depending on the `interface-type`.
- The supported NAS port types are 36, 37, 43, and 44.
- **calling-station-id** { **format-name** *format_name* | **nas-port-type** *nas_port_type* } : Specifies the AAA calling-station-id attribute.
- **nas-identifier** { **format-name** *format_name* | **nas-port-type** *nas_port_type* } : Specifies the attribute name with which the system is identified in the Access-Request messages. The identifier string ranges from 1 to 32 characters.
- **nas-identifier-format** { **format-name** *format_name* | **nas-port-type** *nas_port_type* } : Specifies the AAA nas-identifier-format attribute.
- **nas-ip** *ipv4_address*: Specifies the AAA NAS IPv4 address.
- **nas-port** { *nas_port* } | { **format-e** *format_e* { **nas-port-type** *nas_port_type* } } : Specifies the nas-port attributes.
 - *nas_port* configures the NAS port value. The NAS port value ranges from 1 to 4294967295.



Note If none of the NAS port configurations are present, the existing default nas-port logic is applied. That is, setting a fixed-number per radius-pod.

- **format-e** *format_e_value* : Specifies the custom attribute formation support for nas-port. The nas-port is a 32 bit integer format. The configuration takes a 32 length of characters, each presenting a particular attribute mapping. The *format_e_value* pattern is: 01FSAPRiLUVQ]*):
- 0 – Set bit to 0
- 1 – Set bit to 1
- F - PHY_SHELF
- S - PHY_SLOT
- A - PHY_ADAPTER
- P - PHY_PORT
- R - PHY_CHASSIS
- i - PHY_SUBSLOT
- L - PHY_CHANNEL
- V - OUTER_VLAN_ID
- Q - INNER_VLAN_ID
- U - PPPOE_SESSION_ID
- **nas-port-type** *nas_port_type*: Specifies the NAS port type. The supported values range from 0 to 44.

**Note**

- The nas-port-type configuration is not in scope of the Control Plane. It is derived from the interface-type.
- The supported NAS port types are 36 , 37, 43, and 44.
- The NAS port type value takes precedence over the common NAS port format-e.

- **nas-port-id** *nas_port_id*: Specifies the AAA NAS port-id attribute.

Configuring RADIUS Dead Time

This section describes how to configure the RADIUS dead time.

```
configure
  profile radius
    deadtime value
  commit
```

NOTES:

- **profile radius**: Enters the RADIUS configuration mode.
- **deadtime *value***: Sets the time to elapse between RADIUS server marked unreachable and when an reattempt to connect can be made.
value must be an integer from 0 through 65535. Default: 10 minutes.
- **commit**: Commits the configuration.

Sample Configuration

The following is a sample configuration.

```
configure
  profile radius
    deadtime 15
  exit
```

Configuring RADIUS Detect Dead Server

This section describes how to configure the RADIUS detect dead server.

```
configure
  profile radius
    detect-dead-server response-timeout value
  commit
```

NOTES:

- **profile radius**: Enters the RADIUS configuration mode.

- **detect-dead-server response-timeout** *value*: Sets the timeout value that marks a server as "dead" when a packet is not received for the specified number of seconds.
value must be an integer from 1 through 65535. Default: 10 seconds.
- **commit**: Commits the configuration.

Sample Configuration

The following is a sample configuration.

```
configure
  profile radius
    detect-dead-server response-timeout 100
  exit
```

Configuring RADIUS NAS-IP

This section describes how to configure the RADIUS NAS-IP.

Global RADIUS NAS-IP Configuration



Important

This configuration is obsolete in 2020.02.x, 2021.1.0 and later releases.

Use the following configuration to configure the NAS-IP address.

```
configure
  endpoint radius-dns
  interface radius-client
    vip-ip ipv4_address
  commit
```

NOTES:

- **endpoint radius-dns**: Enters the endpoint radius-ep configuration mode.
- **interface radius-client**: Enters the radius-client interface-type configuration mode.
- **vip-ip** *ipv4_address*: Sets the NAS-IP value, which is also used as the source-IP in UDP requests towards the RADIUS server.
- **commit**: Commits the configuration.

Configuration Example:

```
configure
  endpoint radius-dns
  interface radius-client
    vip-ip 10.86.73.89
  exit
exit
```

Multiple RADIUS NAS-IP Configuration

Use the following configuration to configure multiple RADIUS NAS-IP addresses at various levels.

```
configure
  profile radius
    attribute nas-ip-address ipv4_address
    accounting attribute nas-ip-address ipv4_address
    server-group group_name attribute nas-ip-address ipv4_address
    server-group group_name accounting attribute nas-ip-address ipv4_address

  commit
```

NOTES:

- **profile radius:** Enters the RADIUS accounting configuration mode.
- **attribute nas-ip-address ipv4_address:** Sets the global NAS-IP address value.
- **accounting attribute nas-ip-address ipv4_address:** Sets the global accounting NAS-IP address value.
- **server-group group_name attribute nas-ip-address ipv4_address:** Sets the per server-group common NAS-IP address value.
- **server-group group_name accounting attribute nas-ip-address ipv4_address:** Sets the per server-group accounting NAS-IP address value.
- **commit:** Commits the configuration.

Configuration Example:

```
configure
  profile radius
    attribute
      nas-ip-address 1.2.3.4
    exit
  accounting
    attribute
      nas-ip-address 1.2.3.5
    exit
  exit
  server-group grp1
    attribute
      nas-ip-address 1.2.3.6
    exit
    accounting
      attribute
        nas-ip-address 1.2.3.7
      exit
    exit
  server-group grp2
    attribute
      nas-ip-address 1.2.3.78
    exit
    accounting
      attribute
        nas-ip-address 1.2.3.9
      exit
    exit
  exit
exit
```


Configuring RADIUS Pod

This section describes how to configure the RADIUS pod.

```
configure
  endpoint radius
    replicas number_of_replicas
  commit
```

NOTES:

- **endpoint radius**: Enters the RADIUS endpoint configuration mode.
- **replicas *number_of_replicas***: Sets the number of replicas required.
- **commit**: Commits the configuration.

Sample Configuration

The following is a sample configuration.

```
configure
  endpoint radius
    replicas 3
  exit
```

Configuring RADIUS Retries

This section describes how to configure the maximum RADIUS retries.

```
configure
  profile radius
    max-retry value
  commit
```

NOTES:

- **profile radius**: Enters the RADIUS configuration mode.
- **max-retry *value***: Sets the maximum number of times that the system will attempt retry with the RADIUS server.
value must be an integer from 0 through 65535. Default: 2
- **commit**: Commits the configuration.

Sample Configuration

The following is a sample configuration.

```
configure
  profile radius
    max-retry 2
  exit
```

Configuring RADIUS Server

This section describes how to configure the RADIUS server settings.

```
configure
  profile radius
    server ipv4_address port_num
    secret secret_key
    priority priority_value
    type { acct | auth }
  commit
```

NOTES:

- **profile radius**: Enters the RADIUS configuration mode.
- **server ipv4_address port_num**: Specifies the IPv4 address and port of the RADIUS server.
- **secret secret_key**: Specifies the secret key.
- **priority priority_value**: Specifies the server priority.
- **type { acct | auth }**: Specifies the type of the RADIUS server. It can be one of the following:
 - acct: RADIUS server used for the accounting requests
 - auth: RADIUS server used for the authentication requests
- **commit**: Commits the configuration.

Configuring RADIUS Server Group

Use the following commands to configure the RADIUS server group.

```
configure
  profile server-group server_group_name
    radius-group radius_server_group_name
  commit
```

NOTES:

- **profile server-group server_group_name**: Specifies the profile server group name to enter the Profile Server Group Configuration mode.
- **radius-group radius_server_group_name**: Specifies the RADIUS group server name.

Configuring RADIUS Server Selection Logic

This section describes how to configure the RADIUS server selection logic.

```
configure
  profile radius
    algorithm { first-server | round-robin | weighted }
  commit
```

NOTES:

- **profile radius**: Enters the RADIUS configuration mode.
- **algorithm { first-server | round-robin }**: Defines the algorithm for selecting the RADIUS server.
 - **first-server**: Sets the selection logic as highest priority first. This is the default behavior.
 - **round-robin**: Sets the selection logic as round-robin order of servers.
 - **weighted**: Sets the selection logic as weighted based on the tunnel weight to distribute sessions across tunnels.
- **commit**: Commits the configuration.

Sample Configuration

The following is a sample configuration.

```
configure
  profile radius
    algorithm round-robin
  exit
```

Configuring RADIUS Timeout

This section describes how to configure the RADIUS Timeout.

```
configure
  profile radius
    timeout value
  commit
```

NOTES:

- **profile radius**: Enters the RADIUS configuration mode.
- **timeout *value_in_seconds***: Sets the time to wait for response from the RADIUS server before retransmitting.
value must be an integer from 1 through 65535. Default: 2 seconds.
- **commit**: Commits the configuration.

Sample Configuration

The following is a sample configuration.

```
configure
  profile radius
    timeout 4
  exit
```




CHAPTER 7

Control Plane and User Plane Association

- [Feature Summary and Revision History](#), on page 111
- [Feature Description](#), on page 112
- [Enabling Control Plane and User Plane Association](#), on page 112
- [UP Session Disconnect Notification](#), on page 112
- [UP Rollback Failure Handling Notification](#), on page 113

Feature Summary and Revision History

Summary Data

Table 16: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 17: Revision History

Revision Details	Release
UP Rollback Failure Handling Notification support added.	
UP Session Disconnect Notification support added.	2021.03.0
First introduced.	2021.01.0

Feature Description

The Control Plane (CP) associates with a peer User Plane to synchronize with the number of subscriber sessions and state of each session. The CP and UP must maintain the total number of active sessions and their state on both sides.

To associate a UP to the CP, see the [Associating the User Plane, on page 112](#).

Enabling Control Plane and User Plane Association

This section describes how to enable CP to UP association.

Associating the CP and UP involves the following procedure.

Associating the User Plane

Associating the User Plane

Use the following commands to associate the Control Plane (CP) to the peer User Plane.

```
configure
  user-plane user_plane_name
  offline
  peer-address ipv4 ipv4_address
  port-id port_identifiersubscriber-profile subscriber_profile
  subscriber-profile subscriber_profile
exit
```

NOTES:

- **user-plane** *user_plane_name*: Specifies the User Plane (UP) name and enter UP Configuration mode.
- **offline**: Marks the UP offline for a graceful disconnect.
- **peer-address ipv4** *ipv4_address*: Specifies the peer ipv4 address of the UP.
- **port-id** *port_identifier***subscriber-profile** *subscriber_profile*: Specifies the port identifier of the UP. **subscriber-profile** *subscriber_profile* associates the subscriber profile at the port identifier level.
- **subscriber-profile** *subscriber_profile*: Associates the subscriber profile at UP level.

UP Session Disconnect Notification

Feature Description

The User Plane (UP) Session Disconnect Notification feature enables the UP to send a session disconnect notification to the Control Plane (CP) in the following scenario:

When the UP deletes a session locally following any local event (for example, mark and sweep).

For a list of scenarios that trigger a session disconnect notification, see the *Broadband Network Gateway Configuration Guide for Cisco ASR 9000 Series Routers* here: <https://www.cisco.com/c/en/us/support/routers/asr-9000-series-aggregation-services-routers/products-installation-and-configuration-guides-list.html>.

This notification carries the final statistics for the session and for all services, if accounting is enabled.

The CP initiates the session disconnect for this session only in the CP. The CP then deletes this session. If the session accounting is enabled for this session, the CP sends an accounting "stop record" message to RADIUS.

The UP deletes the session after initiating the session disconnect request to the CP. Therefore, the CP doesn't send a session release Packet Forwarding Control Protocol (PFCP) message to the UP.

UP Rollback Failure Handling Notification

Feature Description

The User Plane (UP) Rollback Failure Handling Notification feature sends a failure notification to the Control Plane (CP) as follows:

- The CP sends the subscriber configuration in a session modification request to the UP. The UP rolls back the configuration if the application of the configuration fails. The UP deletes the session if the rollback configuration also fails and returns the rollback failure error in the session modification response to the CP.
- The UP sends the final statistics, if applicable, for the session and for each service activated for the failed session, in the session modification response.
- The CP deletes the session in the CP only after receiving a rollback failure in the session modification response from the UP.



CHAPTER 8

DHCP and IPoE Subscriber Management

- [Feature Summary and Revision History, on page 115](#)
- [Feature Description, on page 116](#)
- [Configuring the DHCP and IPoE Subscriber Management Feature, on page 125](#)

Feature Summary and Revision History

Summary Data

Table 18: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 19: Revision History

Revision Details	Release
Enhancement Introduced: The IPoE (DHCP) feature is NSO-integrated.	2021.04.0
First introduced.	2021.01.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

A session represents the logical connection between the customer premise equipment (CPE) and the network resource. To enable a subscriber to access the network resources, the network has to establish a session with the subscriber. The Cloud Native Broadband Network Gateway (cnBNG) supports the following subscriber session types:

- IPoE (DHCP)
- PPP (PPPoE)

For more information, see [PPPoE Subscriber Management](#) , on page 205.

In an IPoE subscriber session, subscribers run IPv4 or IPv6 on the CPE device and connect to the BNG through a Layer-2 aggregation or Layer-3 routed network. The IP subscriber sessions that connect through a Layer-2 aggregation network are called L2-connected and sessions that connect through routed access network are called L3-connected or routed subscriber sessions. IPoE subscriber sessions are always terminated on BNG and then routed into the service provider network. IPoE relies on DHCP to assign the IP address.

On the BNG, the DHCPv4 or DHCPv6 trigger creation of these subscribers based on the First-Sign-Of-Life (FSOL) protocol. The IP sessions to the CPE can be either:

- Single stacked, that is, running only IPv4 or IPv6
- Dual stacked, that is, running both IPv4 and IPv6

The DHCP runs as a pod to handle the FSOL for the IPoE subscribers. It handles the DHCP packet encode and decode, IP address assignment, DHCP FSM handling, and DHCP feature and rule application for the IPoE sessions. The DHCP module handles both DHCPv4 and DHCPv6 control packets to bring up corresponding address family interface (AFI).



Note In this release, only the DHCP server mode functionality is supported.

A common DHCP module handles the DHCP finite state machines (FSM) for both 5G subscribers (in SMF service) and wireline subscribers in the cnBNG. The network function (NF) specific DHCP module handles the NF specific functionality.

DHCP and IPoE Functionalities

The DHCP and IPoE Subscriber Management feature supports the following functionalities:

DHCP Server

The cnBNG CP implementation supports the DHCPv4 server mode. The DHCP server FSM handles the DHCP packets from client, IP allocation, and IP lease management.

The FSM handles the following Rx control packets:

- Discover
- Request (DORA request and renew request)
- Decline
- Inform
- Release

The DHCP server FSM sends the following control packets to the client based on the FSM states and events:

- Offer
- Ack (DORA Ack, Renew Ack and Inform Ack)
- Noack

The DHCP server implementation associates a DHCP profile to a group of subscribers. This server implementation supports the following functionalities:

- IP address allocation for the client from the configured pool in the DHCP profile.
- IP address lease allocation based on DHCP profile configuration.
- Passing Host configurations to the client using the following configurable DHCP options in the DHCP profile:
 - IP subnet mask (Option 1)
 - Boot filename (Option 67)
 - Domain name (Option 15)
 - NetBIOS node type (Option 46)
 - NetBIOS name server (Option 44)
 - Domain name server (Option 6)
 - Default router (Option 3)
 - Time server (Option 4)

Processing Option 82

cnBNG supports Option 82, which is the relay agent information option to figure out the sub-options. The various sub-options that the DHCP processes are:

- Circuit ID (Sub option 1)
- Remote ID (Sub option 2)

The circuit ID and remote ID field is passed to the Session Manager during session start trigger and the same is used for north-bound interactions.

DHCPv4 RADIUS Proxy

The cnBNG CP supports DHCP IPv4 RADIUS proxy for RADIUS-based authorization of DHCP leases. This is a RADIUS-based address assignment mechanism in which a DHCP server authorizes remote clients and allocates IP addresses, based on replies from a RADIUS server.

These are the steps involved in the address assignment mechanism:

- The DHCP server sends the DHCP client information to the RADIUS server.
- The RADIUS server returns all required information, primarily IPV4 address, to the DHCP server in the form of RADIUS attributes. The subnet mask is derived from the CP based on the static pool configuration. The IPv4 address sent from the RADIUS must be part of the static pool associated to the UP.
- The DHCP server translates the RADIUS attributes into DHCP options and sends this information back in a DHCP Offer message to the DHCP client.

If the IETF attribute, such as Framed-IP-Address is received from the RADIUS server, and if it is present in the user profile, then this attribute is used instead of allocating the IP address from the configured pool. The basic attributes that can come from the RADIUS server that are relevant for DHCP server options are:

- Framed IPv4 Address
- IPv4 Subnet Mask (derived in the CP from the static pool configuration)
- IPv4 Default gateway (derived in the CP from the static pool configuration)

Apart from these attributes, the dhcp-class name and address pool name attribute also can come from RADIUS. If the RADIUS sets the address pool name, then it uses this for IP allocation instead of the pool that is specified as part of the DHCP profile.

If the RADIUS server sends the dhcp-class attribute to the DHCP server, then that attribute value is used to decide other configuration parameters in the reply that is to be sent to the DHCP client. For example, if the DHCPv4 server profile has both Class A and Class B in it, and if RADIUS server sends a reply to the DHCP server with the class name as 'B', then Class B is used to send the options back to the DHCP client. Classes can be defined under DHCP profile. The parameters and options that can be configured under DHCP profile can be configured under class also.

Additional RADIUS server attributes are allowed, but not mandatory. If a RADIUS server user profile contains a required attribute that is empty and is not available via configuration as well, the DHCP server does not generate the DHCP options.

DHCPv6 Local Server for IPv6 Subscribers

The DHCPv6 server assigns IPv6 address and prefix and other configuration attributes (such as domain name, the domain name server address and SIP servers and so on) to requesting clients. On receiving a valid request, the server assigns the client IPv6 address or prefix, a lease for the assigned IPv6 address or prefix and other requested configuration parameters. The DHCP server FSM is implemented to handle the address allocation and lease management. The FSM would handle the following control packets from the client:

- Solicit
- Request
- Renew
- Rebind

- Decline
- Information-Request
- Release

The DHCPv6 server FSM sends the following control packets to the client based on the FSM states and events:

- Advertisement
- Reply (SARR Reply, Release Reply, Renew Reply, Rebind Reply and Information request Reply)
- Relay-Reply

The DHCPv6 server implementation associates a DHCPv6 profile to a group of subscribers. The server implementation caters to the following functionalities:

- IANA address and IAPD address allocation for the client from configured pool in DHCPv6 profile.
- IANA and IAPD address lease allocation based on DHCPv6 profile configuration.
- Passing Host configurations to client using below configurable DHCP options in DHCP profile
 - AFTR support (Option 64)
 - Preference option (Option 7)
 - Domain list (Option 24)
 - DNS server IPv6 address (Option 23)

The DHCPv6 server sends the following options to the Policy plane:

- interface-id (DHCP Option 18)
- remote-id (DHCP Option 37)
- vendor-class (DHCP Option 16)
- user-class (DHCP Option 15)
- client-id(DHCP Options 1)

DHCPv6 Server - Prefix Delegation

The DHCPv6 Prefix Delegation feature enables the DHCPv6 server to hand out network address prefixes to the requesting clients. The clients use these network prefixes to assign /128 addresses to the hosts on their network. The [RFC-3633](#) and [RFC-3769](#) is supported for prefix delegation. The DHCPv6 Prefix Delegation feature is enabled by default for cnBNG DHCPv6 server. No other configuration is required to enable the prefix delegation. The DHCPv6 option `OPTION_IA_PD` (25) and `OPTION_IAPREFIX` (26) support to meet the prefix delegation requirement.



Note

- Only one delegated prefix per subscriber and client is supported.
- Only one `OPTION_IAPREFIX` is supported under one `OPTION_IA_PD` (25).

The cnBNG allocates addresses from the prefix pool configured under the DHCP profile.

DHCPv6 Server - Address Assignment

The DHCPv6 Address Assignment feature enables the DHCPv6 server to hand out /128 addresses to the clients. The cnBNG DHCPv6 server implementation supports the DHCPv6 OPTION_IA_NA(3) and OPTION_IAADDR(5) to enable address assignment to the client.



Note

- Only one delegated prefix per subscriber and client is supported.
- Only one OPTION_IAPREFIX is supported under one OPTION_IA_PD (25).

The cnBNG allocates addresses from the prefix pool configured under the DHCP profile.

Prefix and Address Pool Support for IPv6

The cnBNG supports the configuring of the DHCPv6 address and prefix pool and associating it to the DHCPv4 and DHCPv6 server profiles. The address and prefix ranges is under the pool. cnBNG also supports downloading of the address and prefix pool name via the user profile on a per subscriber basis. The pool name downloaded via user profile is given priority over the pool name association via the DHCPv6 profile.

DHCPv6 Server with RADIUS-based Address Assignment

The cnBNG supports RADIUS-based address assignment, that is, the IANA address is downloaded as part of the user profile and is allocated to the client. Address from the user profile is given priority over the local configuration.

DHCPv6 Server with RADIUS-based Prefix Delegation

The cnBNG supports RADIUS-based prefix assignment, that is, the IAPD address is downloaded as part of the user profile and is allocated to the client. The delegated prefix from the user profile is given priority over the local configuration.

DHCPv6-provided IPv6 address of DNS server for IPv6 Subscribers

The cnBNG CP DHCPv6 server implementation supports the provision of DNS server information to clients via the DNS option (23). It supports a configuration of up to 8 DNS server ipv6 addressees via the DHCPv6 profile. The DHCPv6 server information is downloaded via the user profile on a per subscriber basis. The per subscriber DNS information in the user profile is given priority over the profile configuration.

DHCPv4 DHCPv6 Lease Timeout

The cnBNG CP provides the configuration to set the lease value under the DHCPv4 and DHCPv6 profile. This configuration determines the lease for the IP addresses allocated to the clients.

For DHCPv4 clients, the lease is set in the address time (T) option (option 51). By default, the renewal time is set as $(\frac{1}{2}) * T$ [option 58] and rebinding time is set as $(\frac{7}{8}) * T$ [option 59]. For DHCPv6 client, the lease is populated in the IA address and IA prefix option for the respective address types. By default, preferred time is set as $0.5 * T$ and valid time T2 is set as $0.8 * T$. By default, renewal time (T1) is set as $0.5 * T$ and rebinding time T2 is set as $0.8 * T$ in OPTION_IA_PD.

The cnBNG CP tracks the lease time allocated to the clients. Ideally the client should renew (Renew request) the lease at T1 to extend the lease. If renew is failing, the client uses the rebind (broadcast request message for DHCPv4 and rebind message for DHCPv6). If the cnBNG CP does not receive the lease renewal request from the client, the lease times out after T and the corresponding address is released to the pool and removed from the client session. This can lead to an update or disconnect to the Session Manager based on the other address states. The lease timeout is applicable to both IPv4 and IPv6 addresses.

IPv6 IPoE Sessions

The IPv6 subscribers run the IPv6 from the CPE device to the BNG router and are created using the DHCPv6 protocol. The IPv6 subscribers natively run IPv6 on the CPE device and are connected to the router via a Layer-2 network or through Layer-2 aggregation.

The IPv6 subscribers are supported when they are directly connect to the cnBNG UP or via a Layer-2 aggregator. The cnBNG CP DHCPv6 server treats only DHCPv6 SOLICIT message from the subscriber / client as FSOL (First Sign Of Life) packet in case of IPoE and initiates the subscriber session creation.



Note Routed subscribers are not supported.

Dual Stack IPv6/IPv4 over IPoE

The cnBNG CP supports dual-stack IPoE subscribers, that is, both IPv4 and IPv6 address allocation for the same subscriber. In this release, cnBNG supports up to one IPv4 address, one IANA address, and one IAPD address.

Subscriber Termination over Non-default VRF

The cnBNG CP DHCPv4 and DHCPv6 servers are VRF aware. The DHCPv4 and DHCPv6 servers support the access interface in either default VRF or non-default VRF. The following table shows the VRF combination supported by DHCPv6 server.

Table 20: DHCP Supported VRF Combinations

Client Access Interface	Subscriber Interface	DHCPv6 Supported
Default VRF	Default VRF	Supported
Default VRF	Non-default VRF	Supported
Non-default VRF	Non-default VRF	Supported

DHCPv4 Raw Option Support

The cnBNG DHCP Profile configuration enables the operator to configure specific DHCPv4 options, under the DHCPv4 profile. The option value can range from 1 to 255. The option value can be either an ascii string or a hexadecimal string.

DHCPv4 and DHCPv6 Class Support

The cnBNG DHCP Profile configuration enables the operator to configure classes of DHCP options and to selectively associate them during the session setup. The DHCP Options class are selected based on certain

matching DHCP options received from access network against the configured class key parameters. The DHCP Options class can also be selected based on the class name received from Policy plane. The priority is always given to the DHCP class name that the Policy plane provides. However, if the Policy plane does not provide a class name, then class selection depends on the operator-configured key parameters. The operator can configure multiple DHCP option classes for DHCPv4 and DHCPv6 separately.

The DHCP Profile consist of profile elements. Each of the DHCPv4 and DHCPv6 profiles contain the 'default' DHCP options list and zero or more classes of DHCP options of corresponding DHCP version.

The DHCPv4 and DHCPv6 Options Class contains a list of DHCP options and the "Match-Info" holds the information about the keys to be matched to select that class. The operator can also specify under Match-Info" the class selection that should match 'any' or 'all' the key parameters of that class.

If the DHCP Option class does not match an ongoing session or any requested DHCP Options is not found in the selected class, then the requested option is selected from the 'default' DHCP Options of that profile.

How it Works

This section provides a brief of how the DHCP and IPoE Subscriber Management feature works.

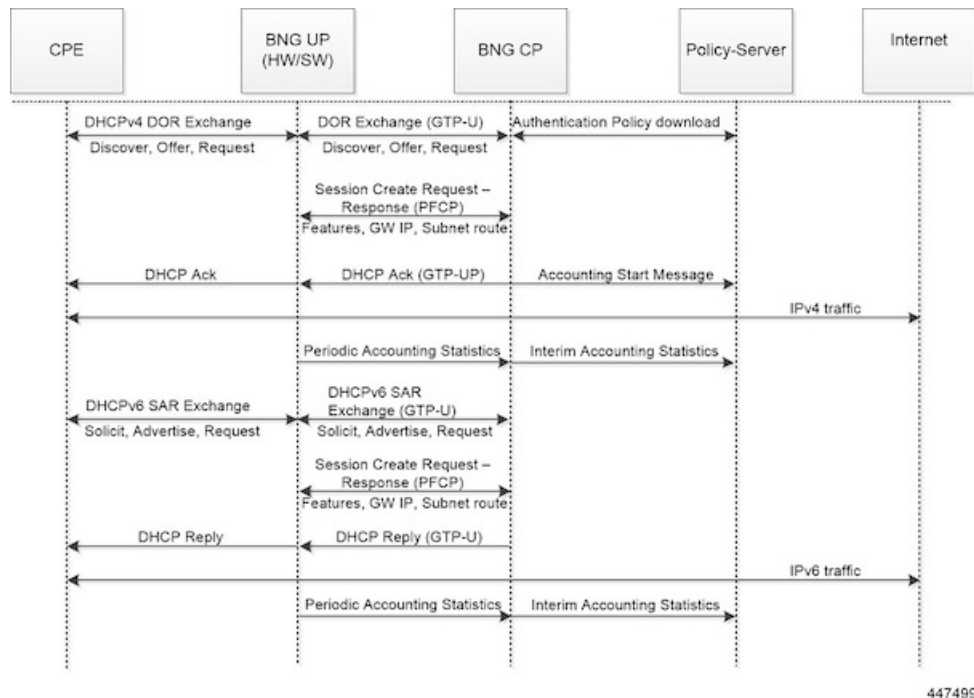
Call Flows

This section includes the following call flow.

cnBNG IPoE Call Flow

For IPoE session establishment, the BNG User Plane (UP) sends the DHCP packets to the BNG Control Plane (CP) using the GTP-U protocol. The following figure shows the DHCP packet call-flow and session programming between the BNG-UP and BNG-CP for IPoE session establishment.

Figure 8: cnBNG IPoE Call Flow



447499

Table 21: cnBNG IPoE Call Flow Description

Step	Description
1	The subscriber running IPv4 or IPv6 stack on the CPE device connects to the BNG-UP via DHCPv4, DHCv6, or DHCPv4 and DHCPv6.
2	The BNG-UP forwards the DHCP(v4/v6) request packets received from the CPE to the BNG-CP over the GTPU protocol. It then returns the DHCP response packets received from the BNG-CP to the CPE device.
3	The BNG-CP performs the subscriber authentication via the Policy Server before establishing a subscriber session on the BNG-UP.
4	After the BNG-CP successfully establishes a session on the BNG-UP, the BNG-UP initiates the Accounting Start and trigger Session Establishment Success (DHCPv4 Ack / DHCPv6 Reply) message towards the CPE via the BNG-UP.
5	The subscriber on the CPE device initiates the data traffic (DHCPv4 / DHCPv6) via the BNG-UP or BNG-CP towards the Internet.
6	The BNG-UP forwards the periodic accounting information to the BNG-CP and the BNG-CP triggers periodic accounting towards the Policy server.

Standard Compliance

The DHCP and IPoE Subscriber Management feature caters to the DHCP server requirements only. The DHCP Server implementation is aligned with the following standards:

- RFC 2131 Dynamic Host Configuration Protocol
- RFC 2132 DHCP Options and BOOTP Vendor Extensions [Subset of options]
- RFC 3046 DHCP Relay Agent Information Option
- RFC 3004 The User Class Option for DHCP
- RFC 3315 Dynamic Host Configuration Protocol for IPv6 (DHCPv6)
- RFC 3633 IPv6 Prefix Options for Dynamic Host Configuration Protocol(DHCP)version 6
- RFC 3646 DNS Configuration options for Dynamic Host Configuration Protocol for IPv6 (DHCPv6)
- RFC 4649 Dynamic Host Configuration Protocol for IPv6 (DHCPv6) Relay Agent Remote-ID Option
- RFC 6334 Dynamic Host Configuration Protocol for IPv6 (DHCPv6) Option for Dual-Stack Lite

Limitations and Restrictions

The DHCP and IPoE Subscriber Management feature has the following limitations in this release:

- Only Layer 2 connected subscribers are supported.
- DHCPv6 addresses and prefixes do not get released at IPv6CP disconnect.
- For DHCPv4 sessions, subnet mask and default gateway are derived from the IPAM pool configuration and IP pool split logic. The first subnet route, subnet mask, and default gateway IP is derived from the

IPAM and pushed to the UP for each chunk of the pool. Subnet mask and default gateway cannot be assigned via the AAA configuration.

- For DHCPv4 sessions, subnet selection is not supported. The IP is selected from the mapped IP pool. Subnet selection cannot be controlled via the AAA gateway IP, giaddr, or subnet selection suboption.
- For DHCPv4 sessions, requested IP option (option 50) that helps in requesting specific IP is not supported. However on client reboot (discover in bound state), the already assigned IP is retained.
- DHCP Inform packet and DHCPv6 Information Request packet handling for unbound sessions are not supported. That is, the client cannot get only the host configurations without requesting for IP assignment via BNG.
- For DHCPv6 session, multihop relay forward DHCPv6 message is not supported (as in physical BNG).
- For DHCPv4 session, broadcast flag check, and discovery, offer, request, and acknowledgement (DORA) unicast is not supported.
- If DHCP client initiated packet options like requested options (option 55 for IPv4, ORO option 6 for IPv6), circuit-id, remote-id, user class, vendor class changes in the packet over the session lifecycle, the cnBNG server behaviour is not defined. cnBNG assumes that the client will not change these options over the lifecycle of session. The client should also maintain the same values for attributes like remote-id, vendor class, user class for both IPv4 and IPv6 afi (AFI). In case these value are required to be changed, it is recommended to clear the session and bring it up again.
- Client reboot scenarios do not tear down the session in cnBNG in the following scenarios: If the Discover message is received in the Bound state or Solicit message is received for the already bound IANA, cnBNG does not tear down the existing session. Instead, the already allocated IP is assigned to the subscriber. In this case, fresh lease is assigned to the client. This is a difference in behaviour from physical BNG where on receiving Discover message in Bound state, IPv4 stack is brought down and new IP is assigned.
- No parity support for RADIUS attribute formatting with ASR 9000. The supported RADIUS attribute list and formatting would be updated based on feedback from customer. For example, some attributes like remote-id format is different for IPv4 and IPv6 clients. Hence, the value going to the Policy Plane differs based on whether the IPv4 or IPv6 afi comes up first.
- Change of Authorization (CoA) for DHCP consumed RADIUS attributes are not supported.
- RFC recommended DHCPv4/v6 packet validations are not supported.
- A common DHCP class attribute is used for class specification for DHCPv4 and DHCPv6 stack via AAA attribute. The attribute is dhcp-class.
- Framed route is not supported.
- Manual pod restart is not supported or entertained. Pod restart can lead to inconsistencies between the CP pods with regard to session count and session state. To recover the inconsistent sessions, the **clear** command must be used explicitly.
- After subscriber is up, if the subscriber is deleted from the cnBNG CP (for reasons like admin clear or Pod) the subscriber is not notified. Therefore, the client must be explicitly rebooted for re-establishing the session. However, if the client is not rebooted explicitly, on receiving the Renew request. cnBNG ignores the renew request. Because the subscriber will retry till the lease expiry, renegotiation (with Discover and Solicit) occurs when the lease time is expired. Therefore, the subscriber loses connectivity till lease expiry (as session is already cleared in CP & UP) and explicit client reboot is required.

Configuring the DHCP and IPoE Subscriber Management Feature

This section describes how to configure the DHCP and IPoE Subscriber Management feature.

Configuring the DHCP and IPoE Subscriber Management feature involves the following steps:

1. Configure the IPv4 DHCP Profile
2. Configure the IPv4 DHCP Class
3. Configure the IPv6 DHCP Profile
4. Configure the IPv6 DHCP Class

Configuring the IPv4 DHCP Server Profile

Use the following commands to configure the IPv4 DHCP server profile.

```

configure
  profile dhcp  dhcp_profile_name
  ipv4
    server { boot-filename boot_filename } | { dns-servers dns_server } | {
domain-name domain_name} |
    { netbios-name-server netbios_name_server } | { netbios-node-type {
broadcast-node | hexadecimal | hybrid-node | mixed-node | peer-to-peer-node
} |
    { next-server ipv4_address } | { ntp-servers ipv4_address } | { pool-name
ipam_pool_name} |
    { option-codes option_codes_range { ascii-string value | force insert {
true | false } | hex-string value|
    { ip-address ip_address } | { lease { days value| hoursvalue| minutesvalue}

  exit
exit

```

NOTES:

- **profile dhcp** *dhcp_profile_name*: Specifies the DHCP profile name.
- **ipv4**: Enters IPv4 configuration mode.
- **server { boot-filename** *boot_filename* } | { **dns-servers** *dns_server* } | { **domain-name** *domain_name* } | { **netbios-name-server** *netbios_name_server* } | { **netbios-node-type** { **broadcast-node** | **hexadecimal** | **hybrid-node** | **mixed-node** | **peer-to-peer-node** } | { **next-server** *ipv4_address* } | { **ntp-servers** *ipv4_address* } | { **pool-name** *ipam_pool_name* } | { **option-codes** *option_codes_range* { **ascii-string** *value* | **force insert** { **true** | **false** } | **hex-string** *value* } | { **ip-address** *ip_address* } | { **lease** { **days** *value* | **hours** *value* | **minutes** *value* }): Specifies the IPv4 server details.
 - **boot-filename** *boot_filename*: Configures the boot file.
 - **dns-servers** *dns_server*: Specifies the Domain Name System (DNS) IPv4 servers available to a DHCP for an IPv4 client.
 - **domain-name** *domain_name*: Specifies the domain name for the IPv4 client.

- **netbios-name-server** *netbios_name_server*: Configures the NetBIOS name servers.
- **netbios-node-type** { **broadcast-node** | **hexadecimal** | **hybrid-node** | **mixed-node** | **peer-to-peer-node** }: Configures the NetBIOS node as a broadcast, hexadecimal, hybrid, mixed, or peer-to-peer node. The valid values for each of these nodes are:
 - **broadcast-node**: 0x1 B-node
 - **hexadecimal**: Operator provided custom 1 byte hex value
 - **hybrid-node**: 0x8 H-node
 - **mixed-node**: 0x4 M-node
 - **peer-to-peer-node**: 0x2 P-node
- **next-server** *ipv4_address*: Specifies the TFTP-server IP address for the client to use.
- **pool-name** *ipam_pool_name*: Specifies the IP Address Management (IPAM) assigned pool name.
- **option-codes** **option_codes_range** { **ascii-string** *value* | **force insert** { **true** | **false** } | **hex-string** *value* | **ip-address** *ip_address* }: Specifies the values for the ASCII string of length 128, force insert, hex string of length 128, or IP address (IPv4 IP address).
- **lease** { **days** *value* | **hours** *value* | **minutes** *value* }: Specifies the lease time duration in the number of days, hours, and minutes. The number of lease days supported is from 0 to 365. The number of leave hours supported ranges from 0 to 23 and minutes from 0 to 59.

Configuring the IPv4 DHCP Class

Use the following commands to configure the IPv4 DHCP class.

```

configure
  profile dhcp dhcp_profile_name
  ipv4
    class dhcp_class_name
      matches { match { dhcpv4-circuit-id { ascii value | hex value } |
```

NOTES:

- **profile** **dhcp** *dhcp_profile_name*: Specifies the DHCP profile name.
- **ipv4**: Enters IPv4 configuration mode.
- **class** *dhcp_class_name*: Creates a proxy profile class (DHCP), which can be used to enter the proxy profile class sub-configuration mode.
- **matches** { **match** { **dhcpv4-circuit-id** { **ascii** *value* | **hex** *value* } | **dhcpv4-remote-id** { **ascii** *value* | **hex** *value* } } | **dhcpv4-vendor-class** { **ascii** *value* | **hex** *value* } | **dhcpv4-user-class** { **ascii** *value* | **hex** *value* } } | **match-type** { **all** *match_key_value* | **any** *match_key_value* } }: Specifies the list of match keys

and values. The match values supported are DHCPv4 circuit ID, DHCPv4 remote ID, DHCPv4 vendor class, and DHCPv4 user class. Each of the values must specify either an ASCII or hexadecimal value.

match-type { all | any }: Specifies if the match value should apply to any of the specified keys or to all the keys.

Configuring the IPv6 DHCP Server Profile

Use the following commands to configure the IPv6 DHCP server profile.

```
configure
  profile dhcp  dhcp_profile_name
    ipv6
      server { aftr-name value | dns-servers dns_server
        | domain-name domain_name | iana-pool-name ipam_pool_name
        | iapd-pool-name ipam_pool_name | lease { days value | hours value |
minutes value }
        | preference value }
```

NOTES:

- **profile dhcp dhcp_profile_name**: Specifies the DHCP profile name.
- **ipv6**: Enters IPv6 configuration mode.
- **server { aftr-name value | dns-servers dns_server | domain-name domain_name | iana-pool-name ipam_pool_name | iapd-pool-name ipam_pool_name | lease { days value | hours value | minutes value } | preference value }**: Specifies the IPv6 server details.
 - **aftr-name value**: Specifies the FQDN string.
 - **dns-servers dns_server**: Specifies the Domain Name System (DNS) IPv4 servers available to a DHCP for an IPv4 client.
 - **domain-name domain_name**: Specifies the domain name for the IPv4 client.
 - **iana-pool-name ipam_pool_name**: Specifies the Internet Assigned Numbers Authority (IANA) pool name.
 - **iapd-pool-name ipam_pool_name**: Specifies the Identity Association for Prefix Delegation (IAPD) pool name.
 - **lease { days value | hours value | minutes value }**: Specifies the lease time duration in the number of days, hours, and minutes. The number of lease days supported is from 0 to 365. The number of leave hours supported ranges from 0 to 23 and minutes from 0 to 59.
 - **preference value**: Specifies the DHCP server preference. The preference value ranges from 1 to 255.

Configuring the IPv6 DHCP Class

Use the following commands to configure the IPv6 DHCP class.

```
configure
  profile dhcp  dhcp_profile_name
```

```

ipv6
  class dhcp_class_name
    server { aftr-name value | dns-servers dns_server | domain-name
domain_name |
    iana-pool-name ipam_pool_name | iapd-pool-name ipam_pool_name | lease {
days value |
    hours value | minutes value } preference value
    end

```

NOTES:

- **profile dhcp** *dhcp_profile_name*: Specifies the DHCP profile name.
- **ipv6**: Enters IPv6 configuration mode.
- **class** *dhcp_class_name*: Creates a proxy profile class (DHCP), which can be used to enter the proxy profile class sub-configuration mode.
- **server** { **aftr-name** *value* | **dns-servers** *dns_server* | **domain-name** *domain_name* | **iana-pool-name** *ipam_pool_name* | **iapd-pool-name** *ipam_pool_name* | **lease** { **days** *value* | **hours** *value* | **minutes** *value* } | **preference** *value* }: Specifies the IPv6 class server details.
 - **aftr-name** *value*: Specifies the FQDN string.
 - **dns-servers** *dns_server*: Specifies the Domain Name System (DNS) IPv6 servers available to a DHCP for an IPv6 client.
 - **domain-name** *domain_name*: Specifies the domain name for the IPv6 client.
 - **iana-pool-name** *ipam_pool_name*: Specifies the Internet Assigned Numbers Authority (IANA) pool name.
 - **iapd-pool-name** *ipam_pool_name*: Specifies the Identity Association for Prefix Delegation (IAPD) pool name.
 - **lease** { **days** *value* | **hours** *value* | **minutes** *value* }: Specifies the lease time duration in the number of days, hours, and minutes. The number of lease days supported is from 0 to 365. The number of leave hours supported ranges from 0 to 23 and minutes from 0 to 59.
 - **preference** *value*: Specifies the DHCP server preference. The preference value ranges from 1 to 255.



CHAPTER 9

End-to-End Flow Control

- [Feature Summary and Revision History, on page 129](#)
- [Feature Description, on page 129](#)
- [Configuring End-to-End Flow Control, on page 132](#)

Feature Summary and Revision History

Summary Data

Table 22: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Documentation	Not Applicable

Revision History

Table 23: Revision History

Revision Details	Release
First introduced.	2021.04.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

The Cloud Native Broadband Network Gateway (cnBNG) manages residential subscribers from different access planes in a centralized way. It accepts and identifies subscriber Control Plane (CP) traffic coming from multiple User Planes (UPs) associated with the CP. When the number of UPs scale, the amount of CP traffic coming from each UP, multiplies.

There are various scenarios where the traffic flow between the CP and UP must be regulated. This is to ensure that the CP attends all the service requests without service interruption. The scenarios that create burstiness or higher flow rates in the traffic flows are as follows:

- Power outage in a residential area
- Access network outage for a specific period
- UP catastrophic events like process crash, route processor reboots, chassis reload are some of the examples.

These scenarios generate sudden spike in traffic going to the CP. To handle these spikes in traffic, it is necessary to flow control and rate limit the CP ingress to ensure that service applications are not overwhelmed with these bursts. The End-to-End Flow Control feature optimizes flow control and rate limit of the traffic toward the CP ingres.

How it Works

This section describes how End-to-End Flow Control works in cnBNG.

There are two types of traffic that enter or exit the CP:. The control traffic that is responsible for subscriber session creation and the other type of traffic is , control traffic on already provisioned subscriber session.

- Control traffic that is responsible for subscriber session creation
- Control traffic that is already provisioned for a subscriber session

The following application infrastructure (App-Infra) features facilitates the cnBNG CP ingress packet flow control:

- Dispatcher
- Overload Control

Dispatcher

In the dispatcher, if the right dequeue rate is configured, the packets do not pile up in the PFCP queue. Also, the dequeue rate should be higher than the incoming rate from the UP. Because there is no packet segregation, all PFCP packets land into a single queue. Any rate control applied on this queue is per UPF PFCP packet rate control. It is not possible to control a particular type of packet per UPF. For example, DHCP release, PPPoE PADT, or keepalive failure notification packet cannot be controlled per UPF at the dispatcher queue.

The dispatcher queue size is configured to handle burst of packets. This functionality supports the following:

- Dedicated queue for each PFCP or N4 interface and GTPu interface for each UPF connected to the CP
- Configuration of size and flow control rate limits

Overload Control

Overload control is applied to a packet after it is released from a dispatcher. This creates a queue based on the packet type at the aggregate level across all UPF data. Because the overload control enables packet type based queues, rate control is applied for that type of packet at the aggregate level of all UPFs.

Special treatment of the packet is indirectly achieved by having different queue for a packet at overload control feature and aggregate of all UPF level.

The dispatcher supports the following categories of virtual message groups:

- PFCP Keepalive messages between CP and UPF
- PFCP LCP keepalive failure notification messages
- PFCP response messages
- Session Report messages
- Other message types, which includes all GTPu and other messages which are not listed in different categories

The Overload Control feature provides aggregate queues for a message type coming from UPF functions. Group ids are supported for each message group and the message type is configurable for each group. When configured, a virtual queue is created for that message and treated based on the configured attributes for that group.

Example configuration

```
bng(config)# endpoint udp-proxy interface n4 overload-control msg-type ?
```

Possible completions:

all | lcpkeepalive | pfckeepalive | pfcresponse | sessionreport

In the preceding configuration, for each message type, one virtual message queue is supported. For each queue, the size and rate limit can be configured. Based on the configuration, queue sizes and threshold is allocated for each queue.

For each message, the configured rate of packets are dequeued and sent to the CPF. For priority packets like, PFCP keepalives, dedicated queues are allocated such that they are not impacted with other queue sizes.

Based on the cluster capacity, specific values for each queue and message type must be configured. The values are adjusted based on capacity.

Limitations and Restrictions

The End-to-End Flow Control feature has the following limitations and restrictions:

- Flow control on the CP cannot prioritise packets. Therefore, if there is a congestion, critical packets like PFCP keepalive processing can get delayed.
- Session bring-down rate (DHCP release, PPPOE PADT, L2TP, CDN rate control) cannot be enforced using the CP flow control configuration. Also, UP does not have flow control of these packets. Therefore, solution level flow control for session disconnect triggers for all session types is not supported.
- Packet level flow control for DHCPv4 and DHCP/v6 Renew and DHCPv6 Relay forwarded messages is not supported.

- L2TP LAC and LNS FSOL rate control are not supported on the ASR 9000 UP in this release. The CP does not have rate control based on FSOL. Because PPPoE bring-up controls LAC, PPPoE FSOL rate control on ASR 9000 can be used to control LAC session bring-up.
- Dispatcher configuration changes implementation would require restarting of the CP.
- Flow control must be configured at the UP level for the following packets at the UPF. This ensures that the packet rate from UP to CP is controlled because CP cannot provide per packet rate control, per UPF.
 - FSOL
 - Session delete notifications
 - LCP keepalive failure notifications
 - Session statistics report

Configuring End-to-End Flow Control

This section describes how to configure the End-to-End Flow Control features on Control Plane (CP).

The configuration involves the following procedures:

- [Configuring Dispatcher for GTPu Interface, on page 133](#)
- [Configuring Dispatcher for N4 Interfaces, on page 132](#)
- [Configuring Overload Control for Message Types, on page 135](#)

Configuring Dispatcher for N4 Interfaces

Use the following commands to configure the Dispatcher feature for N4 interfaces.

```

config
  instance instance_id
    endpoint udp-proxy
      interface n4 dispatcher { cache { true | false } |
        capactiy queue_capacity | count count |
        outbound { true | false } | rate-limit value |
        threshold value }
      commit

```

NOTES:

- **instance** *instance_id*: Configures multiple instances for the specified instance and enters instance sub-mode.
- **endpoint udp-proxy**: Configures parameters for the UDP-proxy endpoint and enters endpoint sub-mode.
- **interface n4 dispatcher** { **cache** { **true** | **false** } | **capactiy** *queue_capacity* | **count** *count* | **outbound** { **true** | **false** } | **rate-limit** *value* | **threshold** *threshold* }: Specifies dispatcher parameters for the N4 interface.
 - **cache** { **true** | **false** }: Enables (false) or disables (true) cache retransmission support. The default is **false**, which indicates that the cache retransmission support is enabled.

- **capacity** *queue_capacity* : Specifies the number of packets this queue holds.



Note Ensure that there is sufficient memory when configuring higher capacity queues.

- **count** *count* : Specifies the number of N4 queues to be created. Each queue is associated or dedicated to an UPF. For example, if the count is 2, two N4 queues are created and two UPs can be connected. One UP per queue.
- **outbound** { **true** | **false** } : Enables (true) or disables (false) queue support for outbound messages. The default is **false** for BNG.



Note Outbound flow control for BNG is not supported.

- **rate-limit** *per_second* : Specifies rate limit for each queue, that is, when packets are dequeued. The rate limit is defined in seconds.
- **threshold** *threshold* : Specifies size of the queue before packets are dropped.

Example

The following is a configuration example.

```
endpoint udp-proxy
  replicas 1
  nodes 2
  vip-ip 201.201.201.51
  interface n4
    sla response 150000
    dispatcher
      count 1
      capacity 500000
      outbound true
      rate-limit 300
      cache false
      threshold 950000
    exit
```

Configuring Dispatcher for GTPu Interface

Use the following commands to configure the Dispatcher feature for GTPu interfaces.

config

```
instance instance_id
  endpoint udp-proxy
    interface gtpu dispatcher { cache { true | false } |
      capactiy queue_capacity | count count |
      outbound { true | false } | rate-limit value |
      threshold value }
    commit
```

NOTES:

- **instance** *instance_id* : Configures multiple instances for the specified instance and enters instance sub-mode.
- **endpoint udp-proxy** : Configures parameters for the UDP-proxy endpoint and enters endpoint sub-mode.
- **interface gtpu dispatcher { cache { true | false } | capacity queue_capacity | count count | outbound { true | false } | rate-limit value | threshold threshold }**: Specifies dispatcher parameters for the GTPu interface.
 - **cache { true | false }**: Enables (false) or disables (true) cache retransmission support. The default is **false**, which indicates that the cache retransmission support is enabled.
 - **capacity queue_capacity** : Specifies the number of packets this queue holds.



Note Ensure that there is sufficient memory when configuring higher capacity queues.

- **count count** : Specifies the number of N4 queues to be created. Each queue is associated or dedicated to an UPF. For example, if the count is 2, two N4 queues are created and two UPs can be connected. One UP per queue.
- **outbound { true | false }**: Enables (true) or disables (false) queue support for outbound messages. The default is **false** for BNG.



Note Outbound flow control for BNG is not supported.

- **rate-limit per_second** : Specifies rate limit for each queue, that is, when packets are dequeued. The rate limit is defined in seconds.
- **threshold threshold** : Specifies size of the queue before packets are dropped.

Example

The following is a configuration example.

```
interface gtpu
  sla response 150000
  dispatcher
    count      1
    capacity   1000000
    outbound   true
    rate-limit 500
    cache      true
    threshold  950000
  exit
exit
exit
exit
```

Configuring Overload Control for Message Types

Use the following commands to configure the Overload Control feature for all message types.

```
config
  overload-control msg-type { all | lcpkeepalive | pfckeepalive |
    pfcprresponse | sessionreport}
    msg-priority msg_priority | rate-limit value|
    queue-size queue_size | reject-threshold reject_threshold |
    pending-request pending_request | discard-behavior { drop | true }
  commit
```

NOTES:

- **msg-type { all | lcpkeepalive | pfckeepalive | pfcprresponse | sessionreport }**: Configures overload control for the specified message type. The valid values are all, lcpkeepalive, pfckeepalive, and pfcprresponse, and sessionreport.
- **msg-priority *msg_priority***: Specifies message priority. This keyword is not applicable in the BNG context.
- **rate-limit *per_second***: Specifies rate limit for each queue, that is, when packets are dequeued.. The rate limit is defined in seconds.
- **queue-size *queue_size***: Specifies the size of the queue to be created.
- **reject-threshold *threshold_limit***: Specifies the percentage of the pending-request value.
- **pending-request *pending_request***: Specifies the number of packets present in the queue at any time.
- **discard-behavior { drop | true }**: Specifies whether to drop or process the packets. In BNG, the default is **drop**.

Example

The following is a configuration example.

```
overload-control msg-type all
  rate-limit 13000 queue-size 200000 reject-threshold 95 pending-request 200000
  exit
overload-control msg-type lcpkeepalive
  rate-limit 1100 queue-size 25000 reject-threshold 95 pending-request 25000
  exit
overload-control msg-type sessionreport
  rate-limit 1000 queue-size 25000 reject-threshold 95 pending-request 25000
  exit
overload-control msg-type pfckeepalive
  rate-limit 100 queue-size 1000 reject-threshold 95 pending-request 1000
  exit
overload-control msg-type pfcprresponse
  rate-limit 4000 queue-size 25000 reject-threshold 95 pending-request 25000
  exit
exit
```




CHAPTER 10

High Availability and CP Reconciliation

- [Feature Summary and Revision History, on page 137](#)
- [Feature Description, on page 137](#)
- [Configuring High Availability and CP Reconciliation, on page 142](#)

Feature Summary and Revision History

Summary Data

Table 24: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Documentation	Not Applicable

Revision History

Table 25: Revision History

Revision Details	Release
First introduced.	2021.04.0

Feature Description

The High Availability (HA) and Control Plane (CP) Reconciliation feature support is available for all cnBNG specific service pods. HA has the following impact on pod services:

- CPU or memory spike can occur if there is a churn of sessions during pod restart. For example, if SM has two replicas, instance 1 and instance 2 and if instance 1 restarts, there will be spike in the CPU or memory in instance 2.
- Service pod IPCs can timeout if the destination service pod restarts before responding to the ongoing IPCs.
- CDL updates of ongoing sessions can fail and may result in desynchronization of the sessions between the pods.
- Subscriber sessions can desynchronize across all the pods in the CP due to mismatch of session count or session data. The solution is to run reconciliation (that is, CP audit) for sessions across pods.
 - Reconciliation between SM and DHCP for IPOE sessions
 - Reconciliation between SM, DHCP, and PPP for PTA and LNS sessions
 - Reconciliation between SM and PPP for LAC sessions.
 - Reconciliation between Node Manager (NM) and FSOLs for all session types



Note High availability and CP reconciliation is available only for IPOE and PTA session types. LAC and LNS session types are not supported.

- Subscriber sessions can desynchronize between the CP and UP. The solution for this is to run CP to UP reconciliation for sessions between the CP and UP.
- IP address leaks can occur in IPAM. To address this, run the IPAM reconciliation CLI command, **reconcile ipam**.
- ID leaks (CP SubscriberID and PPPoE Session ID) can occur in the NM.
- Grafana metrics can reset for the restarted pods.

How it Works

This section provides a brief about the High Availability and CP Reconciliation feature works.

Subscriber sessions desynchronize across pods in the CP during HA and similar churn scenarios. The solution for these is to manually run the CLI command to synchronize sessions across pods.



Note CP reconciliation is also referred to as CP audit in this document.

Reconciliation Process

This section describes the reconciliation scenarios and processes:

On issuing the manual CP Audit CLI command, FSOL services (DHCP and PPPoE) start reconciling their respective sessions with the SM service to check if the session exists and if the Audit-ID matches. When this check is passed, it proceeds to the next step, else, FSOL disconnects the session.

In the next step, FSOLs tries to audit the session with the Node Manager (NM) to check if the IP address and ID resources are matching. This is to ensure the IP and ID resource consistency across the session database and NM.

After this reconciliation from FSOLs, SM triggers the final reconcile to remove any extra sessions. At the end of this step, all services are expected to have consistent session database.

- The CP reconciliation deletes the session in the following scenarios:
 - Extra sessions in DHCP or PPP compared to the SM
 - Extra sessions in SM compared to DHCP or PPP
 - Mismatch in session data between DHCP, PPP, and SM
 - Mismatch between IP and ID resources between FSOLs and NM
- When a session is deleted in the CP or UP because of a mismatch, the same deleted session could be present in the CPE. This causes traffic loss for the deleted subscriber until subscriber is recreated after lease expiry for an IPoE session.
- A maximum of 5 CP reconciliations in parallel for different UPs are supported.
- Configure the mandatory **cdl datastore session slot notification max-concurrent-bulk-notifications** CLI command to run CDL bulk notifications in parallel for multiple bulk notification requests. Without this configuration, the CP reconciliation process can be slow.

For information, see the [Configuring CDL Bulk Notifications, on page 143](#).

New bulk notification requests are put in queue and these requests are dequeued one at a time when the ongoing request is complete.

Each CP reconciliation request invokes 3 bulk notification requests to the CDL. Hence, 5 CP reconciliation requests invoke a maximum 15 bulk notifications. With this configuration, the **clear subscriber** CLI command is executed in parallel.

Each **clear subscriber** CLI command invokes one CDL bulk notification request to the CDL. Executing more than 5 **clear subscriber** and **show subscriber** CLI commands slows down the CP reconciliation process. Therefore, it is recommended to avoid these commands while CP reconciliation is in progress.

**Note**

- If any pod (SM, DHCP, or PPP) restarts while CP reconciliation is in progress, there may still be a session mismatch across pods even after completing the CP reconciliation.
- CP reconciliation without churn or HA events in CP or UP:
If CP reconciliation is executed within the supported TPS limits, sessions across pods in the CP synchronize after completing CP reconciliation.
- CP audit with churn (session bring-up or bring-down, CoA) but no HA events in CP and UP.
 - If CP audit is executed within TPS limits, sessions across pods in CP synchronize after completing CP audit.
 - CP audit should reconcile sessions that are created before starting CP reconciliation and should not reconcile sessions that are created after starting CP reconciliation.
 - CP audit should not reconcile sessions that are updated 60 seconds before Audit start time. For example, session update time is T1 and audit start time is T2, if T2 - T1 is less than or equal to 60 seconds, then that session is not audited.

Automatic Session Mismatch Detection

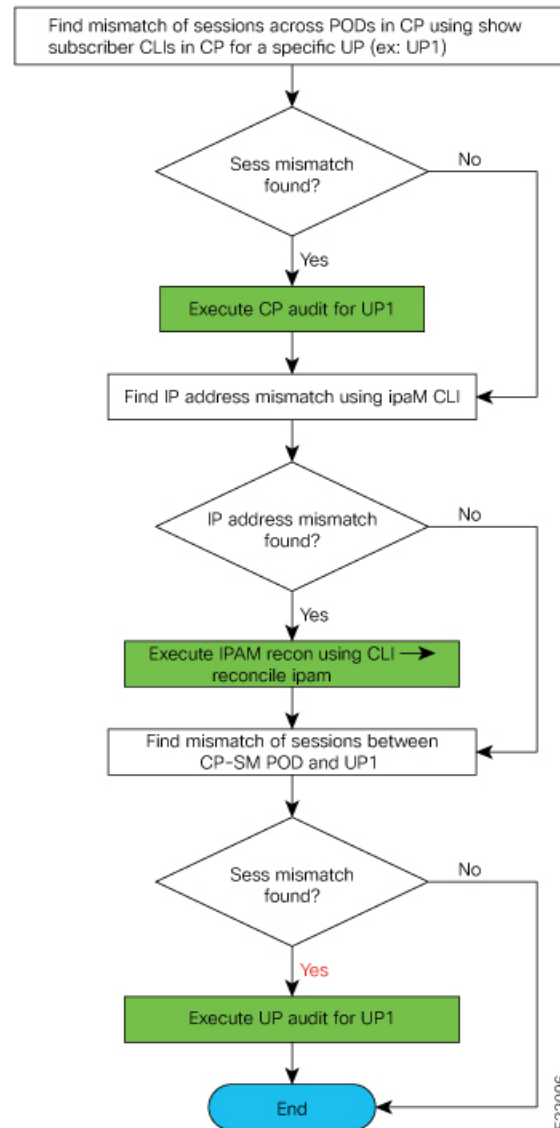
An existing Audit ID is incremented and sent to the SM for every new transaction initiated from the DHCP or PPP to the SM. This Audit ID is stored in DHCP or PPP and in the SM CDL records if the transaction is successful.

The SM validates the Audit ID received in every request from the DHCP or PPP. When a received Audit ID is not incremental to the Audit ID present in the SM, the SM discards the transaction and responds to the DHCP or PPP with an Audit ID mismatch error. The SM then initiates a new transaction to disconnect the session in the CP and UP.

Synchronizing Sessions Across CP Pods and UP

CP reconciliation or UP reconciliation (that is, reconciliation between CP-SM pod and UP) is executed for a specific UP.

The following figure depicts the procedure to synchronize sessions across CP pods and UP, for a specific UP.

Figure 9: Synchronizing Sessions Across CP Pods and UP

Limitations and Restrictions

The High Availability and CP Reconciliation feature has the following limitations and restrictions in this release:

- Only IPoE and PPPoE sessions are supported for High Availability and CP reconciliation.
- Only one BNG specific service pod restart with a gap of minimum 10 minutes between pod restarts, is supported .
- Double fault is not supported for Infrastructre pods (cache, CDL, and Node Manager). System goes to "bad" state with double faults.
- One VM restart with a gap of minimum 30 minutes between VM restarts, is supported.

Configuring High Availability and CP Reconciliation

This section describes how to configure the High Availability and CP Reconciliation feature.

Configuring the High Availability and CP Reconciliation feature involves the following steps:

- [Reconciling Sessions Across CP Pods and UP, on page 142](#)
- [Configuring CDL Bulk Notifications, on page 143](#)

Reconciling Sessions Across CP Pods and UP

Use the following commands to reconcile subscriber sessions across PPP, DHCP, and SM pods in the CP with the specified UP.

```
subscriber session-synchronize-cp upf upf_name { abort |
  timeout timeout_value | tps tps_value }
```

NOTES:

- **upf upf_name** : Configures CP reconciliation for this UPF.



Note The maximum number of CP reconciliations supported is 5.

- { **abort** | **timeout** *timeout_value* | **tps** *tps_value* } : Specifies the following parameters for subscriber session reconciliation:

abort : Aborts the ongoing CP reconciliation for only the specified UPF.

timeout *timeout_in_seconds* : Specifies the number of seconds the reconciliation can run. If it runs longer than the specified timeout, the reconciliation process is aborted. The valid values range from 2 to 100 minutes. The default value is 60 minutes.

tps *tps_value* : Specifies the number of notifications sent from the CDL to Node Manager per second. The valid values range from 40 to 1000. The default is 40.



Note Set this value based on the scale and churn of sessions during the CP reconciliation.

Verifying High Availability and CP Reconciliation

Use the following **show** command to verify ongoing or completed CP audit details for the specified UPF.



Note Only one CP audit detail is stored per UPF.

```
show subscriber synchronize-cp upf upf_name
```

Example

The following is a configuration example.

```
[cnbng-smi-40g-tb03/bng] bng# show subscriber synchronize-cp upf lps_asr9k-1
subscriber-details
{
  "Audit ID": 1634722199,
  "Session Audit Statistics": {
    "DHCP": {
      "Audit State": "Completed",
      "Session Count": 430,
      "Notifications Received": 430
    },
    "LNS": {
      "Audit State": "N/A",
      "Session Count": 0,
      "Notifications Received": 0
    },
    "PTA & LAC": {
      "Audit State": "N/A",
      "Session Count": 0,
      "Notifications Received": 0
    },
    "Session Manager": {
      "Audit State": "Completed",
      "Session Count": 404,
      "Notifications Received": 404
    }
  },
  "Audit State": "Completed",
  "Notifications/Sec": 40,
  "Timeout": 6000,
  "Audit Started": "2021-10-20 09:29:59 +0000 UTC",
  "Fsol Audit Started": "2021-10-20 09:29:59 +0000 UTC",
  "SM Audit Started": "2021-10-20 09:30:10 +0000 UTC",
  "Audit Ended": "2021-10-20 09:30:22 +0000 UTC",
  "Total Time Taken": "23 Seconds"
}
```

Configuring CDL Bulk Notifications

Use the following commands to run CDL bulk notifications in parallel for multiple bulk notification requests.



Note This is a mandatory configuration for CP reconciliation.

```
config
  cdl datastore session slot notification max-concurrent-bulk-notifications
  value
```

NOTES:

- **max-concurrent-bulk-notifications value:** Specifies the maximum number of bulk task notifications that CDL can process concurrently. The valid values range from 1 to 20.

Configure this value to 20 for CP reconciliation.

Sample Configuration

The following is a sample configuration of the CDL bulk notification where a maximum of 20 bulk notifications are executed in parallel for multiple bulk notification requests.

```
configure
cdl datastore session slot notification max-concurrent-bulk-notifications
20
```



CHAPTER 11

IP Address Management

- [Feature Summary and Revision History, on page 145](#)
- [Feature Description, on page 146](#)
- [Configuring IPAM Feature, on page 153](#)
- [IPAM Enhancements, on page 160](#)
- [Static IP Support, on page 162](#)

Feature Summary and Revision History

Summary Data

Table 26: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 27: Revision History

Revision Details	Release
Enhancement Introduced: The IPAM feature is NSO-integrated.	2021.04.0

Revision Details	Release
The following sections were added: <ul style="list-style-type: none"> • Configuration Recommendations • IPAM Enhancements • Static IP Pool Enhancements 	2021.03.0
First introduced.	2021.01.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

IP Address Management (IPAM) is a method of tracking and managing IP addresses of a network. IPAM is one of the core components of the subscriber management system. Traditional IPAM functionalities are insufficient in Cloud-Native network deployments. Hence, IPAM requires additional functionalities to work with the Cloud-Native subscriber management system. The Cloud-Native IPAM system is used in various network functions, such as Session Management function (SMF), Policy Charging function (PCF), and Broadband Network Gateway (BNG).

The IPAM system includes the following functionalities to serve the Cloud Native and Control and User Plane Separation (CUPS) architecture:

- **Centralized IP Resource Management**—Based on the needs of the Internet Service Provider (ISP), the Control Plane (CP) is deployed either on a single (centralized) cluster or multiple (distributed) clusters. For multiple cluster deployments, the IPAM automatically manages the single IP address space across the multiple CPs that are deployed in the distributed environment.
- **IP Address-Range Reservation per User Plane**—For subscribers connecting to the Internet core, the User Plane (UP) provides the physical connectivity. The UP uses the summary-routes to advertise subscriber routes to the Internet core. For CPs that are managing multiple UPs, the CP reserves a converged IP subnet to the UPs. In such a scenario, the IPAM splits the available address space into smaller address-ranges and assigns it to different UPs.
- **IP Address Assignment from Pre-Reserved Address-Ranges**—When subscribers request for an IP address, the IPAM assigns addresses from the pre-reserved address range of their respective UP.

IPAM Components

This section describes the different components of the IPAM system.

IPAM Sub-Modules

The IPAM functionalities are categorized in the following sub-modules:

IPAM Server

This module manages the complete list of pools and address-space configurations. It splits the configured address-ranges into smaller address-ranges (statically or dynamically) to distribute it to the IPAM Cache modules. The IPAM server can be deployed as a centralized entity to serve a group of CN clusters or as an integrated entity within a single cluster.

IPAM Cache

This module acquires the free address-ranges from the IPAM server and allocates individual IP addresses to the IPAM clients. The IPAM cache is generally deployed in the Distributed mode running within each cluster, to communicate with the co-located or remotely located IPAM server. It is also responsible for address-range reservation per UP and pool threshold monitoring. The IPAM server and cache modules can also run in an integrated mode.

IPAM Client

This module is tightly coupled with its respective network-function, responsible for handling request and release of individual IP address from the IPAM cache for each IP managed end-device.

Unlike the IPAM server and cache module, the IPAM client caters to use-cases specific to network-functions such as BNG, SMF, PCF, and so on.

IPAM Integration in cnBNG

The Cloud-Native Broadband Network Gateway (cnBNG) function comprises of loosely coupled microservices that provide the functionality of the BNG. The decomposition of these microservices is based on the following three-layered architecture:

1. Layer 1: Protocol and Load Balancer Services (Stateless)
2. Layer 2: Application services (Stateless)
3. Layer 3: Database Services (Stateful)

The IPAM and cnBNG integration occurs in the Application Services layer.

BNG Node Manager Application—The BNG Node Manager application is responsible for the User Plane function (UPF) management, ID and resource management, and IP address management. Therefore, the IPAM Cache is integrated as part of this microservice.

Also, the UPF uses the IPAM Client module for address-range-reservation per UPF.

BNG DHCP and PPPOE Application—The BNG-DHCP and BNG-PPOE pods are responsible for providing IP addresses to the BNG subscriber session. During session bring-up, the IP address is requested and during session bring-down, the IP address is released back. These First Sign of Life (FSOL) applications send the inter-process communications (IPC) to the Resource Manager (RMGR) component in the NodeMgr. The NodeMgr receives the IPC and invokes the IPAM component.

IPAM Server Application—Based on the deployment model, the IPAM Server runs as an independent microservice as part of the same cluster or in a remote cluster.

In standalone deployments, the IPAM Server functionality is an integral part of the IPAM Cache, that is, it runs as part of the Node Manager microservice itself.

Configuration Recommendations

This section provides the following configuration recommendations.

Pool-Size Configuration

While configuring the pool-size, the recommendation is to keep additional buffer of IPs for undisturbed subscriber churn. Consider the following recommendations:

- Released IPs become part of the quarantine queue depending on the quarantine configuration. These IPs cannot be reused until they are free.
- Due to the threshold logic, the CP automatically reserves additional chunks to the User Plane function (UPF) when required. It based on a first-come-first-server basis.

In a multiple UPF sharing a pool use case, whichever UPF hits the threshold first is given a chunk. Therefore, free chunks may not be available for other UPFs. That is, 100% pool utilization may not occur for a given pool in certain conditions. In this scenario, configure additional IPs accordingly or split into multiple pools per UPF.

Split-Size Configuration

While configuring the split-size of a dynamic pool, consider the following recommendations:

- Number of IPs in pool
- Total number of subscribers. That is, the number of IPs versus the percentage of the number of sessions
- Number of UPFs sharing the pool
- Number of sessions per UPF. That is, the number of sessions versus the percentage of the number of UPFs
- Quarantine time of the pool
- Churn rate. That is CPS of IP allocation, CPS of IP release
- Max routes a UPF can support (example: ASR9k supports 32 routes per loopback in Release 7.4.x/7.5.x)

Each Node Manager (nodemgr) uses per-cache as the split-size of the chunk.

Each UPF is assigned per-dp as the split-size of chunk.

Each Node Manager reserves chunks of per-cache size and further splits (if-applicable) and assigns them to a UPF.

A chunk can be in one of the following states:

- <upf-name> (means, this chunk is assigned to an UPF)
- Free:CP (means, it is free in the cache-pod, any Node Manager can use it)
- Free:NM0 (means, it is free in the Node Manager instance-0. Only this Node Manager can use it)
- Free:NM1 (means, it is free in the Node Manager instance-1. Only this Node Manager can use it)
- QT:NM0 (means, it is in quarantine in the Node Manage instance-0. This is moved to free after quarantine timer expiry)

- QT:NM1 (means, it is in quarantine the Node Manage instance-1. This is moved to free after quarantine timer expiry)

Threshold Configuration

Changing threshold configuration on-the-fly takes effect only after the next event, such as address-allocation or address-delete. On an idle-system, there may not be any immediate action.

How it Works

This section describes the call flow pertaining to the integration of the IPAM in the cnBNG.

Call Flows

This section describes the following IPAM call flows in cnBNG:

- IPAM initial sequence call flow
- IPAM call flow
- IPAM static-pool call flow

IPAM Initial Sequence Call Flow

This section describes the cnBNG initial sequence call-flow.

Figure 10: IPAM Initial Sequence Call Flow

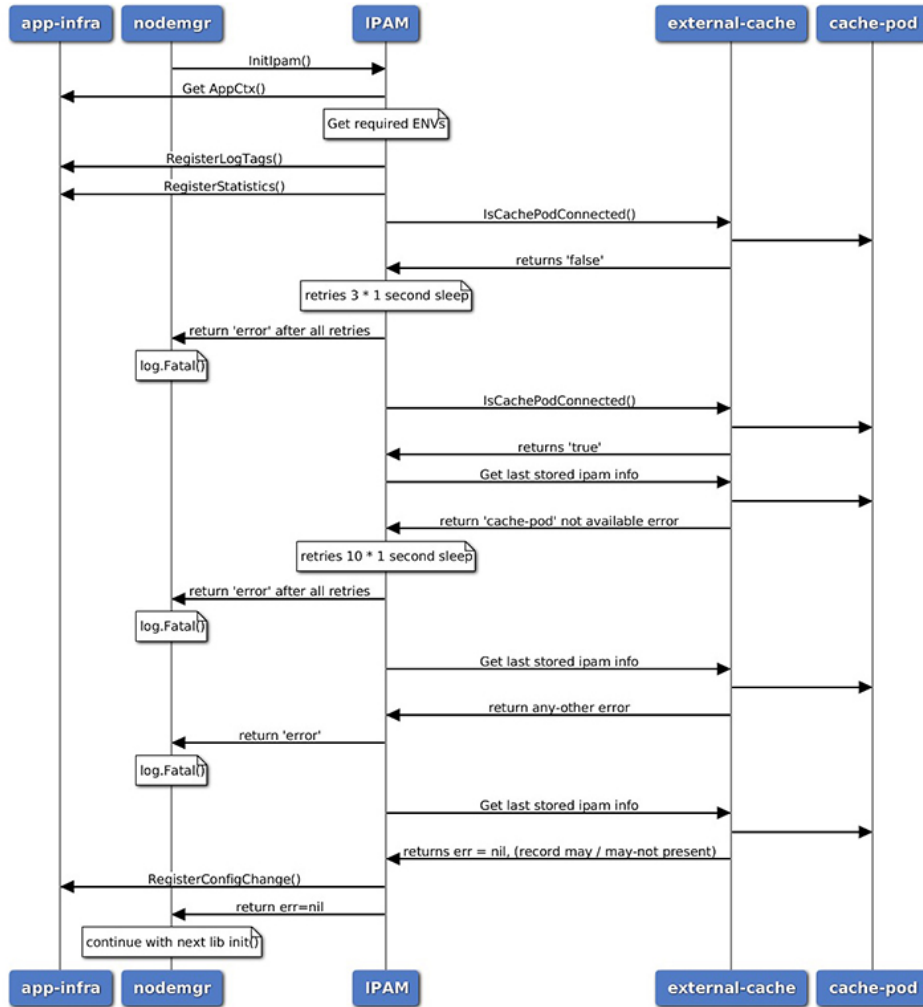


Table 28: IPAM Initial Sequence Call Flow Description

Step	Description
1	IPAM reads the required environments, registers with the application infrastructure for log-tags, metrics, and database connection.
2	IPAM restores the previous state from the cache-pod, if present.
3	IPAM registers for configuration change and applies the new configuration change, if any. -change, apply new config-changes if any

IPAM Call Flow

This section describes the cnBNG IPAM call-flow.

Figure 11: IPAM Call Flow

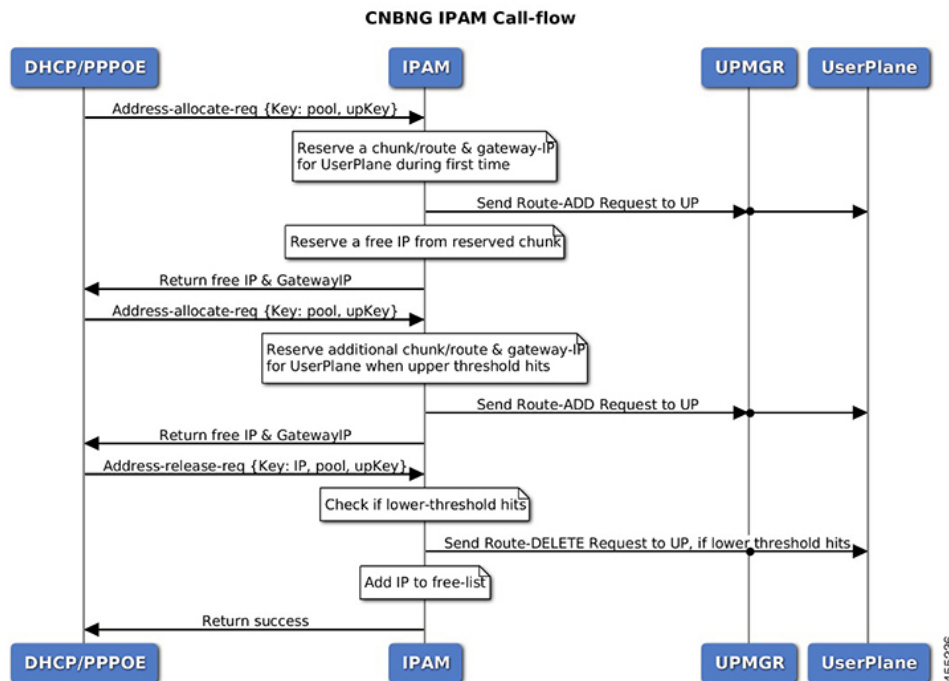


Table 29: IPAM Call Flow Description

Step	Description
1	IPAM receives the ‘addr-alloc’ request from the DHCP or PPPoE pod with pool-name, addr-type and user plane function (UPF) as input.
2	IPAM reserves a new address-range (if not already present for UPF) and sends a ROUTE-ADD message to the UPF. It waits for a success or failure response. If the receives a failure response, it removes the chunk and repeats this step.
3	IPAM reserves a free-IP from the assigned address-range and returns to the DHCP or PPPoE.
4	IPAM monitors the ‘upper-threshold’ for each UPF during each IP address-allocation and also has a background thread that monitors. It then assigns new address-ranges to the UPF and repeats the ROUTE-ADD flow.
5	IPAM receives the ‘addr-free’ request from the DHCP or PPPoE pod with pool-name, addr-type, addr or pfx, and UPF as input.
6	IPAM moves the addr or pfx first to the quarantine-list until the quarantine timer and later moves it to the free-list.
7	IPAM monitors the ‘lower-threshold’ (currently 0%) of the address-range of each UPF, removes the address-range from the UPF, and sends the ROUTE-DELETE message.

IPAM Static-Pool Call Flow

This section describes the IPAM static-pool call flow.

Figure 12: IPAM Static Pool Call Flow

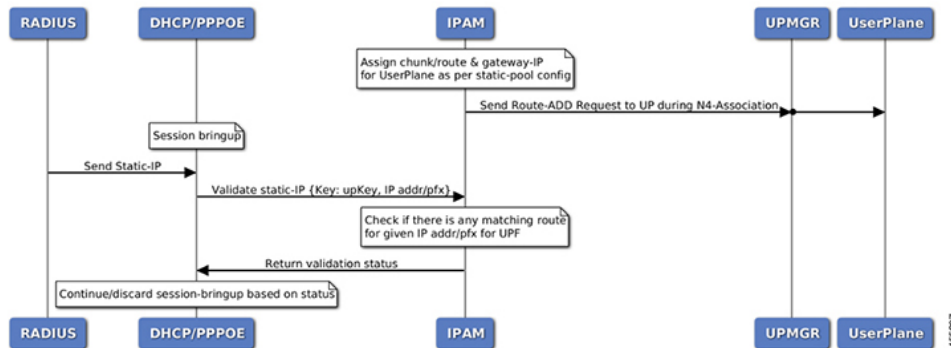


Table 30: IPAM Call Flow Description

Step	Description
1	IPAM receives the 'addr-alloc' request from the DHCP or PPPoE pod with pool-name, addr-type and user plane function (UPF) as input.
2	IPAM reserves a new address-range (if not already present for UPF) and sends a ROUTE-ADD message to the UPF. It waits for a success or failure response. If the receives a failure response, it removes the chunk and repeats this step.
3	IPAM reserves a free-IP from the assigned address-range and returns to the DHCP or PPPoE.
4	IPAM monitors the 'upper-threshold' for each UPF during each IP address-allocation and also has a background thread that monitors. It then assigns new address-ranges to the UPF and repeats the ROUTE-ADD flow.
5	IPAM receives the 'addr-free' request from the DHCP or PPPoE pod with pool-name, addr-type, addr or pfx, and UPF as input.
6	IPAM moves the addr or pfx first to the quarantine-list until the quarantine timer and later moves it to the free-list.
7	IPAM monitors the 'lower-threshold' (currently 0%) of the address-range of each UPF, removes the address-range from the UPF, and sends the ROUTE-DELETE message.

Limitations

The IPAM feature has the following limitations:

- Duplicate IP address is not supported within a pool.
- Duplicate IP address is not supported across pools, that belong to same VRF.
- Removal of 'pool' is not supported while addresses are already assigned.

- Removal or modification of IP-address-ranges is not supported while addresses are already assigned.
- Change of 'source' field is not supported while address or prefixes are already assigned.
- Change of 'vrf-name' of pool is not supported while address or prefixes are already assigned.
- Start-address should be less than the End-address.
- Configuring addr-range split-size in wrong manner, that is, size of address-range < size-of-per-cache < size-of-dp, is not supported.
- Configuring IPv6 Address (IANA) and Prefix (IAPD) values interchangeably is not supported.
- Configuring invalid 'prefix-length' for Prefix (IAPD) range is not supported.

Configuring IPAM Feature

This section describes how to configure the IPAM feature.

Configuring the IPAM feature involves the following steps:

1. Configuring IPAM source
2. Configuring the global threshold
3. Configure IPAM address pool
4. Configuring IPv4 address ranges
5. Configuring IPv6 address ranges
6. Configuring IPv6 prefix ranges
7. Configuring the IPv4 threshold
8. Configuring the IPv6 threshold
9. Configuring IPv4 address range split
10. Configuring IPv6 address and prefix address-range split

Configuring IPAM Source

Use the following configuration to configure the IPAM source.

```
configure
  ipam
    source local
      threshold { ipv4-add percentage | ipv6-address percentage | ipv6-prefix
percentage }
    commit
```

NOTES:

- **ipam**: Enters the IPAM Configuration mode.
- **source local**: Enters the local datastore as the pool source.

- **threshold** { **ipv4-add** *percentage* | **ipv4-address** *percentage* | **ipv6-prefix** *percentage* }: Specifies the threshold in percentage for the following:
 - **ipv4-add** *percentage*: Specifies the IPv4 threshold. The valid values range from 1 to 100. The default value is 80.
 - **ipv6-add** *percentage*: Specifies the IPv4 threshold. The valid values range from 1 to 100. The default value is 80.
 - **ipv6-prefix** *percentage*: Specifies the IPv6 threshold prefix. The valid values range from 1 to 100. The default value is 80.

Configuring Global Threshold

Use the following configuration to configure the global threshold.

```
configure
  ipam
    threshold
      ipv4-addr percentage
      ipv6-addr percentage
      ipv6-prefix percentage
    commit
```

NOTES:

- **ipam**: Enters the IPAM Configuration mode.
- **threshold**: Enters the threshold sub-mode.
- **ipv4-add** *percentage*: Specifies the IPv4 threshold. The valid values range from 1 to 100. The default value is 80.
- **ipv6-add** *percentage*: Specifies the IPv4 threshold. The valid values range from 1 to 100. The default value is 80.
- **ipv6-prefix** *percentage*: Specifies the IPv6 threshold prefix. The valid values range from 1 to 100. The default value is 80.

Configuring IPAM Address Pool

Use the following configuration to configure the IPAM address pool.

```
configure
  ipam
    address-pool pool_name [ address-quarantine-timer ] [ offline ] [
static user_plane_name ] [ vrf-name string ]
    commit
```

NOTES:

- **ipam**: Enters the IPAM configuration mode.
- **address-pool** *pool_name* [**address-quarantine-timer**] [**offline**] [**static** *user_plane_name*] [**vrf-name** *string*]: Configures the address pool configuration. *pool_name* must be the name of the address pool.

This command configures the following parameters:

- **address-quarantine-timer** : Specifies the address quarantine time in seconds. The valid values range from 4 to 60. The default is 4.
- **address-quarantine-timer** : Specifies the address quarantine time in seconds. The valid values range from 4 to 3600. The default is 4.
- **offline**: Sets the address pool to offline mode.
- **static user_plane_name** : Specifies the 'user-plane' name associated to this static-pool.
- **vrf-name string**: Configures the Virtual routing and forwarding (VRF) name of the pool.

Configuring IPAM Quarantine Timer

This section describes how to configure the IPAM quarantine timer.

```
config
  ipam instance instance_id
    address-pool pool_name
      address-quarantine-timer quarantine_timer_value
      vrf-name vrf_name_value
    ip4
      address-range start_ipv4_address end_ipv4_address
      address-range start_ipv4_address end_ipv4_address
    !
  !
!
```

NOTES:

- **ipam**—Enter the IPAM configuration.
- **address-pool pool_name**—Specifies the name of the pool to enter the pool configuration. *pool_name* must be the name of the address pool.
- **address-quarantine-timer quarantine_timer_value**—Specifies the value of the quarantine timer in seconds. *quarantine_timer_value* must be in the range of 4-3600 seconds. The default value is 4.
- **vrf-name vrf_name_value**—Specifies the name of the VPN routing and forwarding (VRF) for the pool.
- **ip4**—Enters the IPv4 mode.
- **address-range start_ipv4_address end_ipv4_address**—Specifies the IP addresses for start and end IPv4 address-range.

Configuring IP Address Reservation

Use the following configuration to reserve the minimum number of addresses for each User Plane function (UPF), Node Manager, and pool.

pool.

```

configure
  ipam
    instance instance_id
      min-dp-addr-size { ipv4-addr | ipv6-addr | ipv6-prefix }
      commit

```

NOTES:

- **ipam**: Enters the IPAM configuration mode.
- **instance *instance_id***: Specifies the IPAM instance and enters the instance sub-mode. *instance_id* must be an integer. The valid value ranges from 1 to 8.
- **min-dp-addr-size { ipv4-addr | ipv6-addr | ipv6-prefix }**: Specifies the minimum number of addresses to reserve for each UPF, Node Manager, and pool.
 - **ipv4-addr**: Specifies the minimum number of IPv4 addresses to reserve.
 - **ipv6-addr**: Specifies the minimum number of IPv6 addresses to reserve.
 - **ipv6-prefix**: Specifies the minimum number of IPv6 prefixes to reserve.

Configuring IPv4 Address Ranges

Use the following configuration to configure the IPv4 address ranges.

```

configure
  ipam
    address-pool pool_name
      ipv4
        address-range start_ipv4_address end_ipv4_address [ default-gateway
ipv4_address ] [ offline ]
      commit

```

NOTES:

- **ipam**: Enters the IPAM configuration mode.
- **address pool *pool_name*** -: Configures the address pool configuration. *pool_name* must be the name of the address pool.
- **ipv4**: Enters the IPv4 mode of the pool.
- **address-range *start_ipv4_address end_ipv4_address* [default-gateway *ipv4_address*] [offline]**: Configures the IPv4 address range with the starting and ending IPv4 address.
 - **default-gateway *ipv4_address***: Specifies the IPv4 address of the default gateway.
 - **offline**: Sets the address pool to offline mode.

Configuring IPv6 Address Ranges

Use the following configuration to configure the IPv6 address ranges:

```

configure
  ipam
    address-pool pool_name
      ipv6
        address-range start_ipv6_address end_ipv6_address [ offline ]
      commit

```

NOTES:

- **ipam**: Enters the IPAM configuration mode.
- **address -pool** *pool_name*: Configures the address pool configuration. *pool_name* must be the name of the address pool.
- **ipv6**: Enters the IPv6 mode of the pool.
- **address-range** *start_ipv6_address end_ipv6_address* [**offline**]: Configures the IPv6 address range with the starting and ending IPv6 address.
- [**offline**]: Sets the address pool to offline mode.

Configuring IPv6 Prefix Ranges

Use the following configuration to configure the IPv6 prefix ranges:

```

configure
  ipam
    address-pool pool_name
      ipv6
        prefix-ranges
          prefix-range prefix_value prefix-length prefix_length
        commit

```

NOTES:

- **ipam**: Enters the IPAM configuration mode.
- **address pool** *pool_name*: Configures the address pool configuration. *pool_name* must be the name of the address pool.
- **ipv6**: Enters the IPv6 mode of the pool.
- **prefix-ranges**: Enters the prefix ranges mode.
- **prefix-range** *prefix_value* **prefix-length** *length* : Configures the IPv6 prefix range. *prefix_value* specifies the IPv6 prefix range.
- prefix-length** *length* specifies the IPv6 prefix length.

Configuring IPv4 Threshold

Use the following configuration to configure the IPv4 threshold:

```

configure
  ipam
    address-pool pool_name

```

```

    ipv4
      threshold
        upper-threshold percentage
      commit

```

NOTES:

- **ipam**: Enters the IPAM Configuration mode.
- **address -pool** *pool_name*: Configures the address pool configuration. *pool_name* must be the name of the address pool.
- **ipv4** : Enters the IPv4 mode of the pool.
- **threshold** : Enters the threshold sub-mode.
- **upper-threshold** *percentage*: Specifies the IPv4 upper threshold value in percentage. The valid values range from 1 to 100. The default value is 80.

The following is a sample configuration:

```

configure
  ipam
    address-pool pl
      ipv4
        threshold
          upper-threshold 80

```

Configuring IPv6 Prefix-Range Threshold

Use the following configuration to configure the IPv6 prefix-range threshold.

```

configure
  ipam
    address-pool pool_name
      ipv6
        prefix-ranges
          threshold
            upper-threshold percentage
          commit

```

NOTES:

- **ipam**: Enters the IPAM configuration mode.
- **address -pool** *pool_name*: Configures the address pool configuration. *pool_name* must be the name of the address pool.
- **ipv6** : Enters the IPv6 mode of the pool.
- **prefix ranges**: Enters the IPv6 prefix ranges sub-mode.
- **threshold** : Enters the threshold sub-mode.
- **upper-threshold** *percentage*: Specifies the IPv6 upper-threshold value in percentage.

The following is an example configuration:

```

configure
 ipam
  address-pool p3
  ipv6
    prefix-ranges
    threshold
    upper-threshold 78

```

Configuring IPv4 Address Range Split

Use the following configuration to configure the IPv4 address range split.

```

configure
 ipam
  address-pool pool_name
  ipv4
    [ no ] split-size { per-cache value | per-dp value }
  commit

```

NOTES:

- **ipam**: Enters the IPAM configuration mode.
- **-address-pool** *pool_name*: Configures the address pool configuration. *pool_name* must be the name of the address pool.
- **ipv4** : Enters the IPv4 mode of the pool.
- **[no] split-size { per-cache value | per-dp value }**: Specifies the size of the IPv4 range to be split for each IPAM cache allocation. The IPAM server consumes this configuration. The **no** form of this command disables the splitting of the address-ranges into smaller chunks.
 - per-cache value** : Specifies the size of the IPv4 range to be split for each Data-Plane (User-Plane) allocation. The valid values range from 2 to 262144. The default value is 1024.
 - The IPAM cache consumes this configuration.
 - per-dp vaue**: Specifies the size of the IPv4 range to be split for each Data-Plane (User-Plane) allocation. The valid values range from 2 to 262144 The default value is 256.
 - The IPAM cache consumes this configuration.

Configuring IPv6 Address and Prefix Address-Range-Split

Use the following configuration to configure the IPv6 address and prefix address range split.

```

configure
 ipam
  address-pool pool_name
  ipv6
    address-ranges
      [ no ] spilt-size { per-cache value | per-dp value }
    commit
  prefix-ranges
    [ no ] spilt-size { per-cache value | per-dp value }
  commit

```

NOTES:

- **ipam**: Enters the IPAM configuration mode.
- **address-range pool** *pool_name*: Configures the address pool. *pool_name* must be the name of the address pool.
- **ipv6** : Enters the IPv6 mode of the pool.
- **[no] spilt-size { per-cache value | per-dp value }**: Specifies the size of the IPv6 range to be split for each IPAM cache allocation. The IPAM server consumes this configuration. The **no** form of this command disables the splitting of the address-ranges into smaller chunks.
per-cache value : Specifies the size of the IPv6 range to be spilt for each Data-Plane (User-Plane) allocation. The valid values range from 2 to 262144. The default value is 1024.
The IPAM cache consumes this configuration.
- **per-dp vaue**: Specifies the size of the IPv6 range to be spilt for each Data-Plane (User-Plane) allocation. The valid values range from 2 to 262144 The default value is 256.
The IPAM cache consumes this configuration.

IPAM Enhancements

This section lists the following IPAM enhancements.

IPAM Quarantine Timer

The IP quarantine logic enhancements are as follows:

- The maximum quarantine configuration is increased to 1 hour (Range: 4 to 3600 seconds).
- If the configured quarantine time is ≤ 15 min, additional buffer of 60 seconds is added to the configured quarantine time.
- If the configured quarantine time is > 15 min, additional buffer of 5 minutes is added to the configured quarantine time.
- Default quarantine time processing thread interval is changed from 5 to 60 seconds.
- The IP is moved to the free-list after $\sim(\text{configured-qTime} + \text{buffer} + \text{delay-from-qt-thread-processing})$.
- Upon Node Manager pod restart, quarantine time of all older IPs in the quarantine time-queue is reset and will restart from beginning.
- After Node Manager pod restart, all IPs released as part of reconciliation are moved to the quarantine-queue before moving to the free-bitmap (this includes pre-reserved IPs).

Address-Range Level Quarantine

If an address-range is removed from the UPF after releasing all the IPs in a proper manner (that is, each released IP went through quarantine time) then the address-range is moved directly to free-list.

If an address-range is removed from the UPF due to the UPF-release with some of the addresses allocated, then the complete address-range is put under quarantine for the configured time and then moved to free-list.

The **show ipam pool** command displays quarantine-chunks with a special 'alloc-context'.

Pool and UPF Threshold Monitoring

The UPF threshold monitoring enhancements are as follows:

- **Upper threshold:** Default = 80%, configurable. This is used to add new chunks to the pool or UPF.
- **SafeCutOff:** Default = (upper-threshold-5%), not-configurable. After hitting upper-threshold, new chunks are allocated to the pool or UPF to bring down the current-utilization to safecutoff level, that is, upper-threshold – 5%.
- **Lower threshold:** Default = 90% of upper-threshold, not-configurable. This is used to remove a chunk from the pool or UPF.

Each Node Manager runs a pool level threshold monitoring. When a chunk is assigned to the UPF, the Node Manager checks the pool-threshold hit and reserves additional chunks from the cache-pod for future use.

For pool threshold calculation, the total number of IPs left in free-chunks are considered; not the actual number of allocated IPs on an assigned chunk. That is, after a chunk is assigned to the UPF, it is considered as fully used for pool-threshold monitoring purpose. A complete free address-range can be released back to the cache-pod based on lower-threshold calculation.

For UPF threshold monitoring, the actual number of total IPs and allocated IPs are considered; more chunks are reserved for the UPF when the upper-threshold hits. The Node Manager adds the route to the UPF whenever a new chunk is assigned to it due to the threshold hit. For performance reasons, the route is not deleted if it was added in at the last minute.

The upper threshold is configurable (default=80%), when this threshold hits, new chunks are added until the current-utilization falls back to the safe-cutoff level. That is, 75% is safe cutoff if the upper-threshold is 80%.

Lower threshold is 90% of the upper-threshold. That is, if the upper-threshold is 80%, then the lower-threshold is 72%, a chunk can be removed from the UPF only when the remaining threshold is below 72%. Otherwise, the chunk remains in the UPF assigned list. This logic is applied to avoid frequent route-add and route-delete operations around boundary condition. The UPF threshold monitoring is triggered during events such as address-allocate, address-release, and config-change. On idle-system, the behavior may differ, however, in a running system, the threshold calculation occurs regularly.

Marking a pool or address-range as offline overrides the lower-threshold logic. That is, if an offline chunk is completely free, it is removed from the UPF irrespective of the lower-threshold calculation.

Multiple Replica Handling

IPAM is part of the Node Manager (nodemgr) pod. A maximum of two nodemgr pods are supported per BNG cluster.

During UPF-registration, one of the nodemgr pod gets all the static-pool-routes for the UPF and all the dynamic-pool-routes from both the nodemgr pod if anything is allocated earlier and programs it.

During IP-allocation, the IPC request goes to one of the nodemgr pods. If no routes were assigned earlier, a new route is assigned and if successful, an IP is returned to FSOL. Even if one nodemgr pod goes down, the other nodemgr can handle IP-allocations, provided enough IPs are available. Chunks that are reserved by one nodemgr cannot be used by the other nodemgr for address-allocations.

During IP-release, the IPC request should go to the IP owner nodemgr as best-effort. If the IPC fails due, then the IP become stale on the IPAM. During nodemgr bring-up, the CDL reconciliation occurs, which recovers

the stale IPs. In addition, a new CLI is added **reconcile-ipam** to manually trigger IPAM-CDL reconciliation on a need basis. This command should be executed only during maintenance because it is a heavy operation.

During the UPF release, the N4 release comes to one of the nodemgrs. It sends an internal-IPC to the other nodemgr and both clean-up all the routes assigned to the respective UPF. If one of the nodemgr is down during that time, the other nodemgr takes over the content and releases the chunks on behalf of its peer.

Static IP Support

Feature Summary and Revision History

Summary Data

Table 31: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	<i>Cloud Native BNG Control Plane Command Reference Guide</i>

Revision History

Table 32: Revision History

Revision Details	Release
First introduced.	2021.03.0

Feature Description

IPAM is the core component of the subscriber management system. Traditional IPAM functionalities prove insufficient in the Cloud Native network deployments. Therefore, IPAM requires additional functionalities to work with the Cloud Native subscriber management system.

The Static Pool Enhancements provide more functionalities on the cnBNG using IPAM. These functionalities are as follows:

- Supports addition of a new static-pool or static-addr-range dynamically when system is running.
 - Send routes when User Plane function (UPF) is already associated.
- Supports removal of a new static-pool or static-addr-range dynamically when system is running
 - Mark the static-pool or static-addr-range offline.

- Clear subscribers, manually.
- Delete the configuration. IPAM sends the route-delete command to the UPF if it is already associated.



Note Changing the UPF name directly in the static IP pool is not supported. To change the UPF name, gracefully delete the static IP pool and readd the new UPF.

Note the following guidelines while configuring a static IP pool:

- An address pool is marked as 'static' during configuration. A given address pool can be either configured as 'dynamic' or 'static' mode only. It cannot be modified while the system is running.
- Each static pool is associated to an Use Plane function (UPF). The IPAM configures all the address-ranges as routes on the UPF. The recommendation is to use the 'no-split' configuration to avoid having too many splits and routes.
- The IPV4 address ranges must be configured with the 'default-gateway' value, because unlike dynamic address-range, IPAM cannot assign 'default-gateway' on its own. Also, the static address-ranges must not be split further. Therefore, use the 'no-split' configuration.

Configuring Static IP Support

This section describes how to configure the Static IP support feature.

Configuring the Static IP Support involves the following step.

[Configuring Static IPv4 Address Ranges, on page 163](#)

Configuring Static IPv4 Address Ranges

Use the following configuration to configure the Static IPv4 address ranges.

```
configure
ipam
  instance instance_id
    source { local | external }
    address-pool pool_name
    vrf-name vrf_name
    static enable user_plane_name
  ipv4
    split-size no-split
  exit
  ipv4
    address-range start_ipv4_address end_ipv4_address
    default-gateway ipv4_address
  exit
exit
exit
```

NOTES:

- **ipam**: Enters the IPAM configuration mode.

- **address pool** *pool_name*: Configures the address pool configuration. *pool_name* must be the name of the address pool.
- **vrf-name** *vrf_name* : Specifies the name of the VPN routing and forwarding (VRF) for the pool.
- **static enable** *user_plane_name*: Configures static IP details. Sets the specified User Plane (UP) as static. *user_plane_name* is the specified UP for this static pool.
- **ipv4**: Enters the IPv4 mode of the pool.
- **split-size no-split**: Specifies that the address-ranges should not be into smaller chunks.
- **address-range** *start_ipv4_address end_ipv4_address*: Configures the IPv4 address range with the starting and ending IPv4 address.
- **default-gateway** *ipv4_address*: Specifies the IPv4 address of the default gateway.
- IPAM does only route-validation for Static IP. Validate if UPF has a route for a given static IP address or prefix. Individual address-management is not performed.



CHAPTER 12

L2TP Subscriber Management

- [Feature Summary and Revision History, on page 165](#)
- [Feature Description, on page 166](#)
- [Configuring the L2TP Subscriber Management Feature, on page 178](#)

Feature Summary and Revision History

Summary Data

Table 33: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 34: Revision History

Revision Details	Release
First introduced.	2021.04.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

Majority of the digital subscriber line (DSL) broadband deployments use PPPoE sessions to provide Subscriber services. These sessions terminate the PPP link and provide all the features, service, and billing on the same node. These sessions are called PPP Terminated (PTA) sessions .

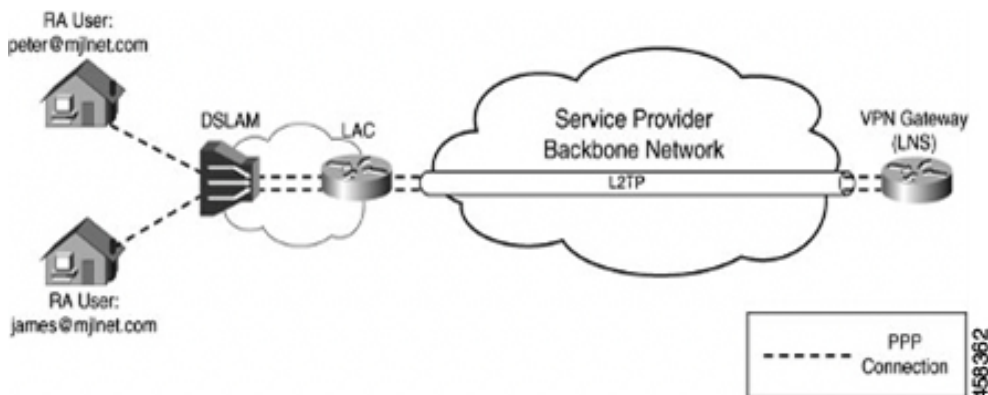
There are some wireline subscriber deployments are in wholesale-retail model where some ISPs work with others to provide the access and core services separately. In such cases, the subscribers are tunneled between wholesale and retail ISPs using the Layer 2 Tunneling Protocol (L2TP) protocol.

L2TP Overview

In cnBNG, the L2TP performs the hand-off task of the subscriber traffic to the Internet service provider (ISP). To do this, L2TP uses two network components:

- L2TP Access Concentrator (LAC)—The L2TP enables subscribers to dial into the L2TP access concentrator (LAC), which extends the PPP session to the LNS. cnBNG provides LAC.
- L2TP Network Server—The L2TP extends PPP sessions over an arbitrary network to a remote network server that is, the L2TP network server (LNS). The ISP provides LNS.

The overall network deployment architecture is also known as Virtual Private Dial up Network (VPDN). The overall topology of LAC and LNS is depicted as follows:



The CP for LAC and LNS depend on the L2TP session termination. Developing these two control planes in a single cnBNG microservice has the following benefits:

Simplified Single L2TP Control Plane

- Enables a single Control Plane (CP) to handle both LAC and LNS services
- Reduces the configuration complexity of the current XR L2TP
vpdn-groups, vpdn-templates, l2tp-class and so on are simplified.

- Supports LC subscriber (not supported on the physical BNG)
- Avoids Ns/Nr checkpointing issues of pBNG to support RPFO

Collocated LAC and LNS

- Supports LAC and LNS in the same cnBNG CP, with different User Plane (UPs)
- Enables sharing of the same AAA and Policy Plane
- Simplifies management and troubleshooting

Flexible Deployment Options

The integration of LAC and LNS into a centralized cnBNG CP provides highly flexible deployments options to suit different customer use-cases and needs. For example, the cnBNG CP can host the CP functionality either for a LAC or LNS UP. Also, the same CP cluster can act as a CP for both LAC and LNS UPs from different data centers (or even from the same user-plane, if the user-plane supports it) except for the same session at the same time.

L2TP Features

The cnBNG supports the following Layer 2 Tunneling Protocol (L2TP) features:

- Tunnel authentication
- L2TP congestion control
- AVP encryption
- Tunnel Hello interval
- IP ToS value for tunneled traffic
- IPv4 don't fragment bit
- DSL line information attributes
- IPv4 tunnel source address
- IPv4 tunnel destination address
- IPv4 destination load balancing
- Tunnel mode
- MTU for LCP negotiation
- TCP maximum support
- Start-Control-Connection-Request (SCCRQ) timeout
- SCCRQ retries
- Control packet retransmission
- Control packet retransmission retries
- Receive window size for control channel

- Rx and Tx connect speed
- Tunnel VRF
- Tunnel session limit
- Weighed and Equal Loadbalancing
- Tunnel password for authentication
- Domain name and tunnel assignment
- LCP and Authentication renegotiation
- LAC hostnames for tunnelling requests

How it Works

This section provides a brief of how the L2TP Subscriber Management feature works.

L2TP Handling

Both LAC and LNS sessions use L2TP protocol for negotiation and creation of L2TP sessions. However for LAC sessions, there is additional PPPoE handling. This section focuses on the L2TP protocol handling.

LAC Sessions

For LAC sessions, the PPP sessions are terminated on a different network node from where the PPPoE sessions are terminated. The PPPoE sessions are terminated on the LAC, but the PPP session is terminated on an LNS upstream, over an L2TP tunnel. Initial PPP negotiations are done on the LAC to determine the appropriate LNS to tunnel the session. When the tunnel has been established, all PPP handling is handed off to the LNS.

- The PPPoE protocol is negotiated in the same way as a PTA session.
- PPPoE service handles all PPPoE packets and the nitial LCP and authorization packets.
- After authentication , if the user-profile contains service=outbound, PPPoE service decides to tunnel the sessions.
- It reaches out the L2TP pod to initiate a L2TP tunnel . The L2TP tunnel pod creates the tunnel and returns the L2TP session ID.
- The PPPoE service continues to handle the L2TP session FSM and bring-up the LAC session and program the UP via the Subscriber Manager.

LNS Sessions

LNS sessions are similar to PTA sessions in the overall functionality. Instead of PPPoE protocol, here the First-Sign-Of-Life (FSOL) packets are the L2TP Incoming-Call-Request (ICRQ) messages. When the L2TP session protocol is up, then the existing PPP protocol finite state machines (FSM) is triggered to bring up and program the session on the UP.

- L2TP Tunnel pod receives tunnel-create request from the remote LAC.
- After Tunnel is up, PPPoE Pod receives ICRQ to create a session.

- PPPoE pod communicates with the L2TP to get L2TP session-id for the given tunnel ID.
- L2TP generates the session ID and checks the session count.
- PPPoE pod checks if there is forced renegotiation configured for the session. Else, it proceeds with the session programming to the UP.

AAA Attributes for L2TP

The following is the list of AAA attributes for L2TP LAC and LNS sessions.

IETF Attribute: AAA_TUNNEL_PASSWORD (69)

Tunnel-Password=<16byte-encrypted-value>

The value of this attribute is defined as an "encrypted-string". RADIUS decrypts the value and sends a plain-text password to the Subscriber Manager (SM).

For more L2TP IETF Attributes, see [IETF Tagged Attributes on LAC, on page 250](#).

CISCO-VSA: AAA_AT_L2TP_TUNNEL_PASSWORD

Cisco-AVPair += "l2tp-tunnel-password=<plain-text>"

The value of this attribute is defined in "plain-text". RADIUS passes the value to SM in the respective Access-accept request.

If required, the RADIUS server can this as an "encrypted-cisco-visa(36)", which is similar to the Layer1 vendor-specific attributes (VSAs).

In that case, RADIUS-Ep decrypts the complete VSA and sends the plain-text value.

For more L2TP VSA attributes, see [RADIUS Vendor-Specific Attributes, on page 251](#).

Call Flows

This section includes the following high-level call flows.

LAC Session Bringup Call Flow

The LAC Session Bringup call flow is as follows.

Figure 13: LAC Session Bringup Call Flow

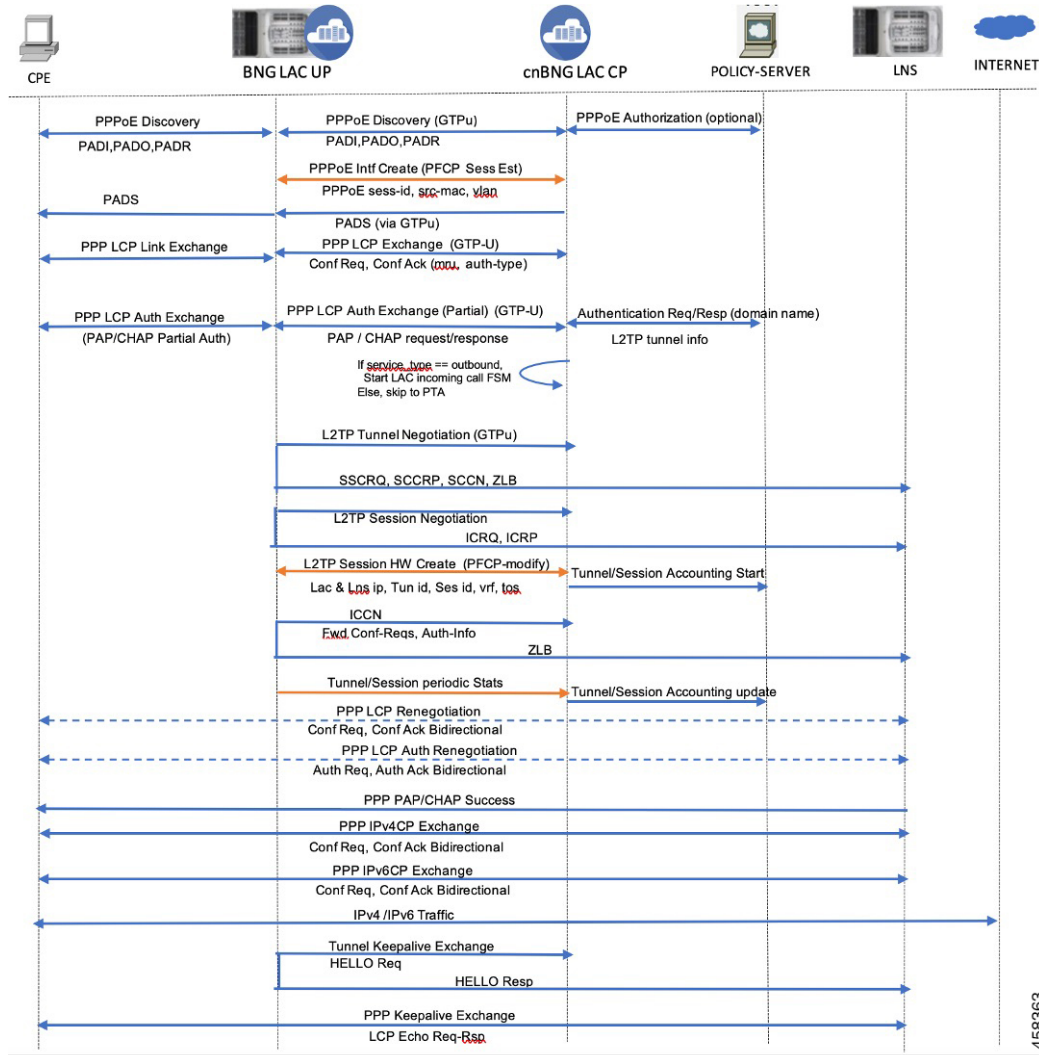


Table 35: LAC Session Bringup Call Flow Description

Steps	Description
1	<p>On learning the first control packet, the BNG-CP sends a Session Creation request to create a new packet forwarding state for the data packet. This updates the BNG-UP state.</p> <p>Note At this step, it is possible to create a session from the redirected control packet. By doing so, resources are consumed on the BNG-UP to allow individual subscriber control packet management such as blocking, rate limiting, and specific packet filtering. It is also possible to postpone the session creation. By doing so, additional resources BNG-UP are not consumed, but individual subscriber control packet management is not possible.</p>

Steps	Description
2	The BNG-UP sends the following response to the BNG-CP: <ul style="list-style-type: none"> • Informs that the states are installed. • Informs that it (BNG-UP) is ready to forward the subscriber PPP control packets.
3	The BNG-CP sends the PADO message back to the CPE through the BNG-UP using the control packet redirect interface.
4	The PADR message is sent from the CPE through the BNG-UP using the control packet redirect interface.
5	The BNG-CP sends the PADS message back to the CPE through the BNG-UP using the control packet redirect interface.
6	The LCP configuration request is sent from the CPE through the BNG-UP using the control packet redirect interface.
7	The BNG-CP sends the LCP configuration acknowledgement back to the CPE through the BNG-UP using the control packet redirect interface. The LCP configuration acknowledgement indicates either a PAP or CHAP authentication challenge. Options: <ul style="list-style-type: none"> • Option 1: If the client chooses PAP, the CPE sends a PAP request to the BNG-CP through the BNG-UP using the control packet redirect interface. The PAP password is sent as an Access request to the AAA server. • Option 2: If CHAP is required, the BNG-CP initiates a challenge to the CPE through the BNG-UP using the control packet redirect interface. The CPE responds back to the challenge to the BNG-CP. The challenge is sent to the AAA server.
8	The AAA successfully authenticates the CPE and replies to the CPE with a PAP/CHAP success and that this is a L2TP session. Note If the RADIUS profile received in AAA Accept-Ack has the field “service-type” with the value as “outbound-user”, this means that the session must be tunneled to the LNS IP address (either specified in the same profile or available in the Control Plane configuration).
9	The BNG-CP sends a Session Establishment message to the BNG-UP. The BNG-CP programs the BNG-UP control packet redirect rules to do the following: <ul style="list-style-type: none"> • Decapsulate and send the L2TP control message towards the LNS. • Redirect L2TP control message back to the BNG-CP. This session establishment is only on a per-tunnel basis.
10	The BNG-UP sends the following response to the BNG-CP: <ul style="list-style-type: none"> • Informs that the states are installed. • Informs that it (BNG-UP) is ready to forward the L2TP control packets.

Steps	Description
11	The BNG-CP sends Start-Control-Connection-Request (SCCRQ), Start-Control-Connection-Reply (SCCRP), Start-Control-Connection-Connected (SCCCN), and Zero-Length Body (ZLB) to the LNS via the BNG-UP through the control packet redirect interface.
12	The BNG-CP sends Incoming-Call-Request (ICRQ), Incoming-Call-Reply (ICRP), Incoming-Call-Connected (ICCN), and ZLB to the LNS via the BNG-UP through the control packet redirect interface.
13	<p>The BNG-CP sends a Session Modify request if there is a previous session established to allow for data packet forwarding to the LNS (and control packet if not done already). If a previous session was not established, this is a Session Request message to allow for data packet forwarding to the LNS. This updates the User Plane state.</p> <p>Note Subscriber session creation can be performed at any steps prior to this. This step is the last chance for a session creation to avoid subscriber data packets drops. Immediately after this step, the CPE is assigned an address and data packets would be sent immediately.</p>
14	<p>The BNG-UP sends the following response to the BNG-CP:</p> <ul style="list-style-type: none"> • Informs that the states are installed. • Informs that it (BNG-UP) is ready to forward subscribers PPP control and data packets.
15	If the LNS has cached the LCP configuration and there is no negotiation disagreement, this step can be skipped. If LNS has not cached the LCP configuration or the session requires renegotiation, then the LCP negotiation takes place.
16	If the LNS has cached the authentication information and there is no disagreement on authentication, this step can be skipped. If LCP has not cached the authentication information or authentication has failed, then reauthorization occurs.
17	The IP Control Protocol (IPCP) takes place between the CPE and the LNS through the BNG-UP.
18	The PPP LCP echo hello are exchanged between the CPE and the LNS through the BNG-UP.

LAC Session Bringdown Call Flow

The LAC Session Bringdown call flow is as follows.

Figure 14: LAC Session Bringdown Call Flow

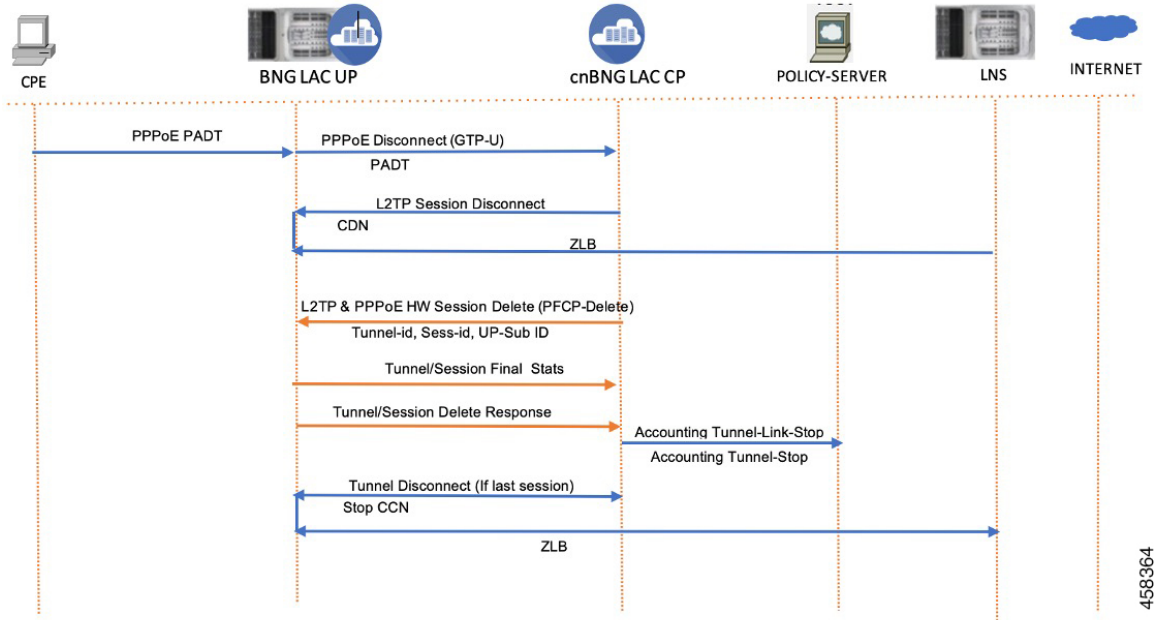


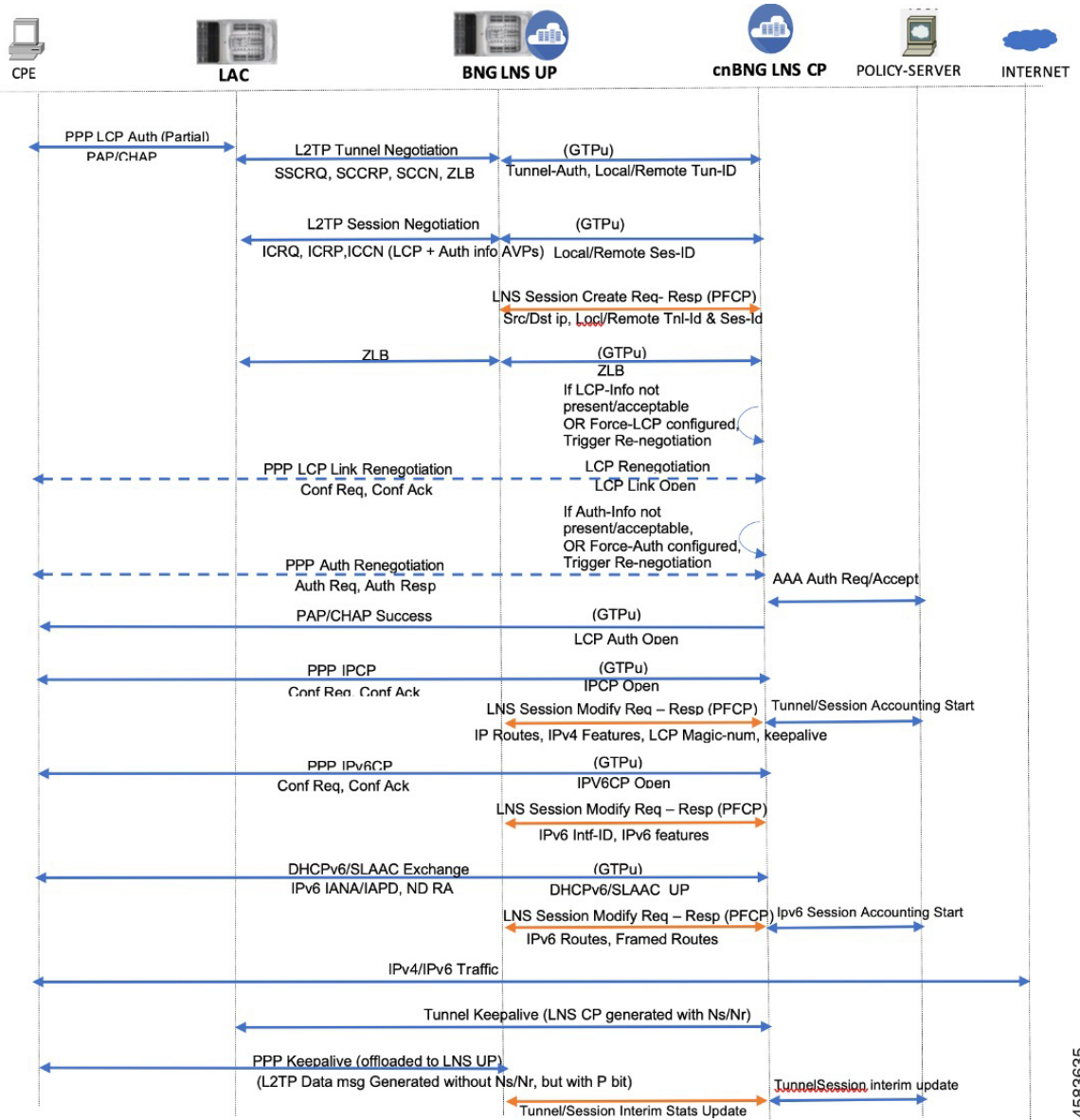
Table 36: LAC Session Bringdown Call Flow Description

Steps	Description
1	The L2TP (LAC) session and tunnel bringdown can occur due to various reasons. For example, CPE can send PADT to gracefully bringdown the subscriber session. This triggers the L2TP session cleanup between LAC and LNS.
2	If it is the last session in the L2TP tunnel, the tunnel is also deleted and the PPPoE session is cleaned up in the LAC. The session or tunnel bringdown occurs in the following scenarios: <ul style="list-style-type: none"> • PPP keepalive failure between CPE and LNS. • Tunnel keepalive failure. In this case, all sessions in the tunnel are removed first. • Admin clear on either LAC or LNS.

LNS Session Bringup Call Flow

The LNS Session Bringup call flow is as follows.

Figure 15: LNS Session Bringup Call Flow



4583635

Table 37: LNS Session Bringup Call Flow Description

Steps	Description
1	The Start Control Connection Request (SCCRQ) message is received through the control packet redirect interface following the common packet redirect rule.
2	The BNG-CP sends a Session Establishment request message to the BNG-UP. The BNG-CP programs the DBNG-UP control packet redirect rules to send L2TP control message towards the BNG-CP to only accept particular tunnels.

Steps	Description
3	<p>The BNG-UP sends the following response back to the BNG-CP:</p> <ul style="list-style-type: none"> • Informs that the states are installed. • Informs that it (BNG-UP) is ready to forward the L2TP control packets.
4	<p>The BNG-CP exchanges Start Control Connection Reply (SCCRP), Start Control Connection Connected (SCCCN), and Zero Length Body (ZLB) with the LAC using the control packet redirect interface.</p>
5	<p>The BNG-CP receives the Incoming Call Request (ICRQ) message (includes AVP defined in RFC 5515).</p>
6	<p>After receiving the ICRQ message, the BNG-CP has the L2TP session ID information. The BNG-CP can send a Session Establishment request to the BNG-UP to ensure only known L2TP sessions are accepted.</p> <p>1</p> <p>Note At this step, it is possible to create a session from the redirected control packet. By doing so, resources are consumed on the DBNG-UP in order to allow individual subscriber control packet management such as blocking, rate limiting, and specific packet filtering. It is also possible to postpone the session creation. By doing so, additional resources DBNG-UP are not consumed, but individual subscriber control packet management is not possible</p>
7	<p>The BNG-UP sends the following response back to the BNG-CP:</p> <ul style="list-style-type: none"> • Informs that the states are installed. • Informs that it (BNG-UP) only accepts L2TP control packet from known sessions.
8	<p>The BNG-CP exchanges ICRP, ICCN, and ZLB with the LAC using the control packet redirect interface.</p>
9	<p>If the LNS has cached the LCP configuration and there is no negotiation disagreement, this step can be skipped. If the LCP has not cached the LCP configuration or the session requires renegotiation, then the LCP negotiation takes place.</p>
10	<p>If the LNS has cached the authentication information and there is no disagreement on authentication, this step can be skipped. If LCP has not cached the authentication information or authentication has failed, then reauthorization occurs.</p>

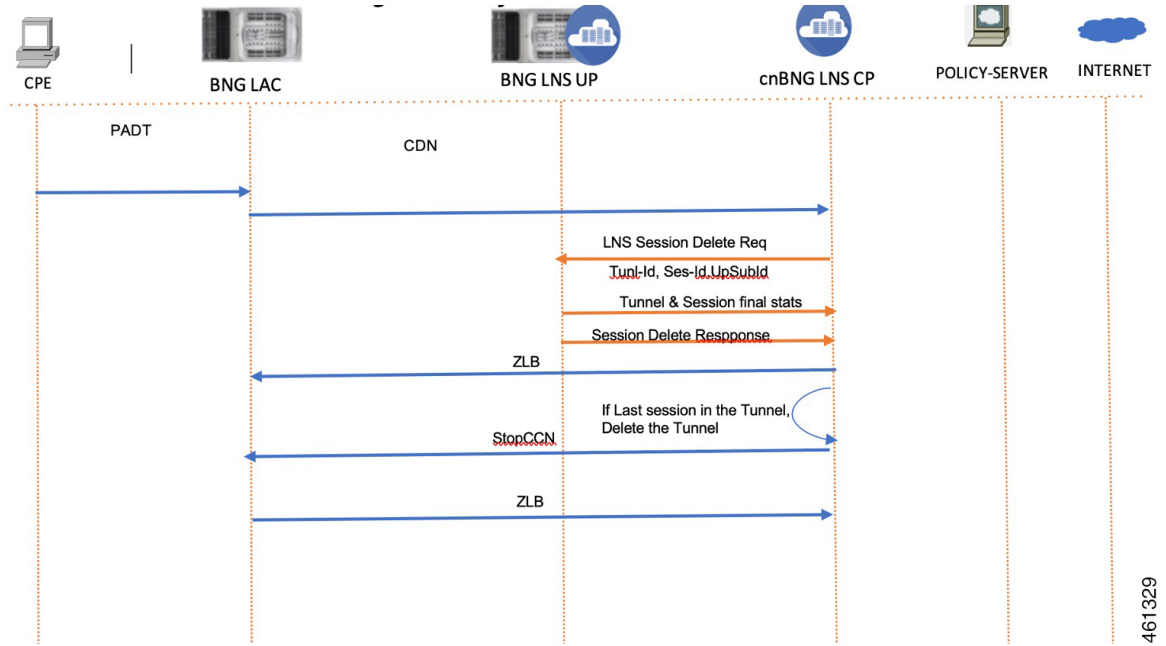
Steps	Description
11	<p>After authentication, the BNG-CP knows the IP address or prefix (or both) for the subscriber either through the local address server or from the AAA returned VSAs. The BNG-CP sends a Session Modify request if there is already an established session to update the User Plane (UP) state. If there are no prior sessions, this requires a Session Establishment request to update the UP.</p> <p>Note Subscriber session creation can be performed at any steps prior to this. This step is the last chance for a session creation to avoid subscriber data packets drops. Immediately after this step, the CPE is assigned an address and data packets would be sent immediately.</p>
12	<p>The BNG-UP sends the following response back to the BNG-CP:</p> <ul style="list-style-type: none"> • Informs that the states are installed. • Informs that it (BNG-UP) is ready to forward subscribers PPP control and data packets.
13	The IPCP takes place between the CPE and the LNS through the BNG-UP.
14	The PPP LCP echo hello are exchanged between the CPE and the LNS through the BNG-UP.

¹ At this step, it is possible to create a session from the redirected control packet. By doing so, resources are consumed on the BNG-UP to allow individual subscriber control packet management such as blocking, rate limiting, and specific packet filtering. It is also possible to postpone the session creation. By doing so, additional resources BNG-UP are not consumed, but individual subscriber control packet management is not possible.

LNS Session Bringdown Call Flow

The LNS Session Bringdown call flow is as follows.

Figure 16: LNS Session Bringdown Call Flow



461329

Table 38: LNS Session Bringdown Call Flow Description

Steps	Description
1	LAC sends a Call-Disconnect-Notify (CDN) message to release the session on the LNS.
2	cnBNG CP deletes the session on UP. It releases all the resources and collects the final statistics from the UP and sends the Accounting-Stop message.
	cnBNG CP sends ZLB as acknowledgement.
	If it is the last session on the tunnel, cnBNG CP sends a Stop-Control-Connection-Notification (Stop-CCN) message to bring down the tunnel.

Standard Compliance

The L2TP Subscriber Management feature is aligned with the following standard:

- RFC 2661: Layer Two Tunneling Protocol "L2TP"

Limitations

The LT2P Subscriber Management feature has the following limitations:

- LAC and LNS Control Plane (CP) functionality is not supported on the same cluster at the same time.
- On-the-fly changes to L2TP profile is not supported.
- L2TP attributes should be configured only for session-activate event.

- Tunnel load balancing with Tunnel-Assignment-ID is not supported.
- Weighted Tunnel load balancing can be configured only in the profile.
- The TCP maximum segment size (TCP-MSS) is supported at the global User Plane Function (UPF) chassis level and not at the tunnel or session level. It must be configured on the ASR 9000 UPF.

Configuring the L2TP Subscriber Management Feature

This section describes how to configure the L2TP Subscriber Management feature.

Configuring the L2TP Subscriber Management feature involves the following step:

Creating the L2TP profile

Creating the L2TP Profile

Use the following commands to create the Layer2 Tunnelling Protocol (L2TP) profile and provide the L2TP specific parameters.

```

configure
  profile l2tp l2tp_profile_name
    authentication
    congestion-control
    encrypt-avp
    hello-interval interval_in_seconds
    hostname local_hostname
    ip-tos { ip_tos_value | reflect }
    ipv4 { df-bit { reflect | set } | source ip_address }
    mode lac
      domain domain_name [ tun-assign-id tunnel_id ]
      dsl-info-forwarding
      ipv4 { destination ip_address | df-bit { reflect | set } |
        source ip_address }
      rx-connect-speed kbps
      tunnel-load-balancing { equal | weighted }
      tx-connect-speed kbps
    mode lns
      force-lcp-renegotiation
      mtu mtu_value
      terminate-from remote_hostname
    password password
    receive-window number_of_packets
    retransmit { retries number_of_retries |
    timeout { max max_timeout | min min_timeout }
    tcp adjust-mss mss_value
    tunnel { session-limit number_of_sessions |
    timeout { no-session | timeout_value }
    vrf vrf_name
    exit

```


NOTES:

- **profile l2tp** *l2tp_profile_name*: Specifies the PPPoE profile name and enters the Profile L2TP mode.
- **authentication** : Enables L2TP tunnel authentication.
- **congestion-control**: Enables L2TP congestion control.
- **encrypt-avp**: Hides attribute-value pair (AVPs) in outgoing control messages.
- **hello-interval** *interval_in_seconds*: Sets the hello interval in seconds. The valid values range from 10 to 1000 seconds.
- **hostname** *local_hostname*: Specifies the local hostname of the tunnel. The valid value is an alphanumeric string ranging from 1 to 256. The name of the Control Plane (CP) is the default local hostname.
- **ip-tos** { *ip_tos_value* | **reflect** }: Sets the IP Type of Service (ToS) value for tunneled traffic. The ToS valid values range from 1 to 255. (The control packets use 0xC0 as the default value.)
- **ipv4** { **destination** *ip_address* | **df-bit** { **reflect** | **set** } | **source** *ip_address* }
: Specifies the IPv4 settings for the tunnel:
 - **df-bit** { **reflect** | **set** } : Specifies the IPv4 Don't Fragment (DF) bit.
 - reflect** : Reflects the DF bit from the specified inner IP address.
 - set** : Sets the DF bit.
 - **source** *ip_address* : Specifies the source IP address of the tunnel.
- **mode** { **lac** | **lns** } : Configures LAC or LNS.
 - **mode lac** { **domain** *domain_name* [**tun-assign-id** *tunnel_id*] | **dsl-info-forwarding** | **ipv4** { **destination** *ip_address* | **df-bit** { **reflect** | **set** } | **source** *ip_address* } | **rx-connect-speed** *kbps* | **tunnel-load-balancing** { **equal** | **weighted** } | **tx-connect-speed** *kbps* : Configures a L2TP Access Concentrator (LAC) to request the establishment of an L2TP tunnel to an L2TP Network Server (LNS).
 - **domain** *domain_name* [**tun-assign-id** *tunnel_id*]: Specifies the domain name to match. The valid values range from 1 to 255. (The control packets use 0xC0 as the default value.)
 - tun-assign-id** *tunnel_id* : Specifies the domain name with a tunnel ID.
 - **dsl-info-forwarding**: Forwards DSL line information attributes.
 - **ipv4** { **destination** *ip_address* | **df-bit** { **reflect** | **set** } | **source** *ip_address* } : Specifies the IPv4 settings for the tunnel:
 - **destination** *ip_address* : Specifies the destination IP address of the tunnel.
 - **df-bit** { **reflect** | **set** } : Specifies the IPv4 Don't Fragment (DF) bit.
 - reflect** : Reflects the DF bit from the specified inner IP address.
 - set** : Sets the DF bit.
 - **source** *ip_address* : Specifies the source IP address of the tunnel.
 - **rx-connect-speed** *kbps* : Specifies the receiving (Rx) connection speed in kbps. The valid values range from 9 to 100000000 kbps.

- **tunnel-load-balancing { equal | weighted }** : Specifies equal or weighted load sharing of the tunnel.
- **tx-connect-speed *kbps*** : Specifies the transmitting (Tx) connection speed in kbps. The valid values range from 9 to 100000000 kbps.
- **mode lns { force-lcp-renegotiation | mtu | terminate-from *remote_hostname* }** : Configures a LNS to accept requests from LAC to establish L2TP tunnel:
 - **force-lcp-renegotiation** : Forces Link Control Protocol (LCP) and Authorisation renegotiation.
 - **mtu *mtu_value*** : Specifies the MTU for LCP negotiation. The *mtu_value* valid values range from 500 to 2000. The default is 1492.
 - **terminate-from *remote_hostname*** : Specifies the hostname of the remote peer to accept tunnels.
- **password *password*** : Specifies the password for tunnel authentication.
- **receive-window *number_of_packets*** : Specifies the receive window size for the tunnel. The valid values range from 1 to 5000 packets. The default value is 4.
- **retransmit { retries *number_of_retries* | timeout { max *max_timeout* | min *min_timeout* }** : Specifies the control message retransmission parameters.
 - **retries *number_of_retries*** : Specifies the maximum number of retries for control packets.
 - **timeout { max *max_timeout* | min *min_timeout* }** : Specifies the control packet retransmission timeout parameters.
 - **max *max_timeout*** : Specifies the control packet retransmission maximum timeout parameters. The valid values range from 1 to 8 seconds. The default is 8.
 - **min *min_timeout*** : Specifies the control packet retransmission minimum timeout parameters. The valid values range from 1 to 8 seconds. The default is 1.
- **tcp adjust-mss *mss_value*** : Adjusts the TCP Maximum Segment Size (MSS) value of TCP SYN (synchronize) packets. The valid values range from 500 to 1500 packets.
- **tunnel { session-limit *number_of_sessions* | timeout { no-session | *timeout_value* }** : Limits the sessions for a tunnel or deletes the tunnel after timeout
 - **session-limit *number_of_sessions*** : Specifies the maximum number of L2TP sessions per tunnel. The valid values range from 1 to 64000 sessions.
 - **timeout { no-session | *timeout_value* }** : Specifies the following parameters :
 - **timeout no-session** : No-session timeout for the tunnel. The default is 0 seconds.
 - **timeout *timeout_value*** : Timeout value in seconds. The valid values range from 1 to 86400 seconds.
- **vrf *vrf_name*** : Specifies the Virtual routing and forwarding (VRF) name of the tunnel.



CHAPTER 13

Log Generation Support

- [Feature Summary and Revision History](#), on page 181
- [Feature Description](#), on page 181

Feature Summary and Revision History

Summary Data

Table 39: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Enabled -Always-on
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 40: Revision History

Revision Details	Release
First introduced.	2021.01.0

Feature Description

The Cloud Native Broadband Network Gateway utilizes the common logging framework to generate logs from its microservices.

The supported logging levels are:

- Error
- Warn
- Info
- Debug
- Trace



CHAPTER 14

Monitor Protocol and Subscriber

- [Feature Summary and Revision History, on page 183](#)
- [Feature Description, on page 184](#)
- [Configuring Monitor Subscriber and Protocol, on page 184](#)

Feature Summary and Revision History

Summary Data

Table 41: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Documentation	<i>Cloud Native BNG Control Plane Command Reference Guide</i>

Revision History

Table 42: Revision History

Revision Details	Release
Enhancement Introduced: The Monitor Subscriber and Protocol feature is NSO-integrated.	2021.04.0
First introduced.	2021.03.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

The Monitor Subscriber and Protocol feature supports the debugging functionality.

Monitor Subscriber

The Monitor Subscriber feature captures all the transactional logs for a given subscriber over a specified period of time across all the Kubernetes pods. It also supports the simultaneous monitoring of multiple subscribers on a given cluster. This information allows to track all the events that had occurred for a given subscriber when the subscriber was coming up or going down.

To configure Monitor Subscriber, see [Configuring Monitor Subscriber, on page 184](#)

Monitor Protocol

The Monitor Protocol feature replicates the packets from different protocol endpoints of cnBNG and sends it to the OAM pod. There two levels of packet replication that occur:

- First replication dumps only the basic packet information
- Second replication dumps the full packet with details like headers, keys of subscriber, and so on.

This feature captures all ingress and egress packets on the cnBNG protocol pods.

To configure Monitor Protocol, see [Configuring Monitor Protocol, on page 195](#)

Configuring Monitor Subscriber and Protocol

This section describes how to configure subscriber and protocol monitoring.

Configuring the Monitor Subscriber and Protocol feature involves the following procedures:

- Configuring Monitor Subscriber
- Configuring Monitor Protocol
- Copying Log Files
- Viewing Log Files

Configuring Monitor Subscriber

Use the following commands to enable the monitoring of a subscriber.

```
monitor subscriber supi subscriber_id capture-duration duration_in_seconds
```

NOTES:

- **supi subscriber_id** : Enables monitoring of subscribers based on the subscriber identifier (supi). For example: 0000.4096.3e4a.

The subscriber-id format supported is as follows:

<mac-adress>@<upf>: This specifies a particular subscriber with the given MAC address from a specific User Plane function (UPF).

Wildcard subscriber-id is also supported. For example:

- *@<upf>: This specifies all subscribers from a specific UPF.
 - <mac>@*: This specifies all subscribers having the given MAC and from any UPF.
 - *: This specifies all subscribers from all UPFs.
- **capture-duration** : Specifies the duration in seconds during which the monitor subscriber is enabled. The *duration_in_seconds* can range from 1 to 2147483647 seconds. The default is 300.
 - Other sub-options that are present in the CLI command are not supported

Example

```

bng# monitor subscriber supi aabb.0000.0001@automation-userplane
supi: aabb.0000.0001@automation-userplane
captureDuration: 300
enableInternalMsg: false
enableTxnLog: false
namespace(deprecated. Use nf-service instead.): none
nf-service: none
gr-instance: 0
  % Total      % Received % Xferd  Average Speed   Time    Time       Time  Current
                                 Dload  Upload   Total     Spent    Left     Speed
100  337  100    119  100    218   10818   19818  --:--:--  --:--:--  --:--:--  30636
Command: --header Content-type:application/json --request POST --data
{"command": "mon_sub", "params": {"supi": "aabb.0000.0001@automation-userplane", "duration": 300, "enableTxnLog": false, "enableInternalMsg": false, "nf-service": "none", "gr-instance": 0}}
http://oam-pod:8879/commands
Result start mon_sub, fileName
->logs/monsublogs/none.aabb.0000.0001@automation-userplane_TS_2021-06-09T12:17:33.838574118.txt
Starting to tail the monsub messages from file:
logs/monsublogs/none.aabb.0000.0001@automation-userplane_TS_2021-06-09T12:17:33.838574118.txt
Defaulting container name to oam-pod.
Use 'kubectl describe pod/oam-pod-0 -n bng' to see all of the containers in this pod.
Subscriber Id: aabb.0000.0001@automation-userplane
Timestamp: 2021/06/09 12:19:30.194843
Message: BNGN4UdpProxyMessage
Description: Received Packet IPOE, IPC Message from udp-proxy
Source: bng.udp-proxy.DC.Local.0
Destination: bng.bng-n4-protocol.DC.Local.0
PAYLOAD:
  BNGN4UdpProxyMessage:
    BNGN4UdpProxyMessage:
      Type: 6
      L2Data:
        SrcMac: aabb.0000.0001
        DstMac: ffff.ffff.ffff
        Outervlan: 100
        Innervlan: 200
        OuterCos: 0
        InnerCos: 0
      IpAddr:

```

```

        AfType: 1
        SrcIpv4:
        SrcIpv6:
        DstIPv4: 8.8.8.8
        DstIPv6:
        LinkLocal:
        Port: 8000
    UpData:
        AccessInterface: GigabitEthernet0/0/0/1
        CpSubscriberId: 0
        UpSubscriberId: 0
        USubInterfaceId: 0
        RouterName: automation-userplane
        AccessVrf: access-vrf-1
        NASID: NAS-ID-1
    NasInfo:
        Port: 4
        Slot: 2
        Adapter: 5
        Subslot: 3
        Chassis: 1
        InterfaceType: 1
    L2TPData:
        PuntPoliceRate: 0
        L2TPTos: 0
        TunnelID: 0
    Packet:
        Payload:
            BaseLayer:
                Operation: 1
                HardwareType: 1
                HardwareLen: 6
                HardwareOpts: 0
                Xid: 1
                Secs: 0
                Flags: 32768
                ClientIP: 0.0.0.0
                YourClientIP: 0.0.0.0
                NextServerIP: 0.0.0.0
                RelayAgentIP: 0.0.0.0
                ClientHWAddr: aa:bb:00:00:00:01
                ServerName:
                File:
                Options: {
    Option(MessageType:Discover)
    Option(ClientID:[1 170 187 0 0 0 1])
}
}

```

```

-----
Subscriber Id: aabb.0000.0001@automation-userplane
Timestamp: 2021/06/09 12:19:30.205174
Message: RadiusUdpProxyMsg
Description: Send Auth/Acct Request Message to UDP-Proxy
Source: bng.radius-ep.DC.Local.0
Destination: bng.udp-proxy.DC.Local.0
PAYLOAD:
    RadiusUdpProxyMsg:
        RadiusUdpProxyMsg:
            SrcIp: 10.105.254.113
            SrcPort: 16384
            DestIp: 10.105.254.114
            DestPort: 1812
            Payload:

```



```

Code = AccessRequest
Id = 2
Authenticator = [148 88 241 197 50 83 83 156 105 245 107 167 117 131 237 165]
User-Name = "cnbng"
User-Password = 0x30b19d11f96401290b6410e8alb324eb
NAS-IP-Address = 10.105.254.113
NAS-Port = 16384
Service-Type = 5
Called-Station-Id = "1"
Calling-Station-Id = "1"
Nas-Identifier = "bng"
Acct-Session-Id = "Local_DC_16777218"
Event-Timestamp = 1623241161
NAS-Port-Type = 41
NAS-Port-Id = "124536"
NAS-IPv6-Address = ::/0
Cisco-Vsa_cisco-nas-port = "124536"
Cisco-Vsa_cisco-dhcp-client-id = 0x01aabb00000001
Cisco-Vsa_Cisco AVpair = "client-mac-address=aabb.0000.0001"
Cisco-Vsa_Cisco AVpair = 0x646863702d636c69656e742d69643d01aabb00000001
    PayloadLen: 231
    SubscriberID: aabb.0000.0001@automation-userplane

```

```

-----
Subscriber Id: aabb.0000.0001@automation-userplane
Timestamp: 2021/06/09 12:19:30.206778
Message: RadiusUdpProxyMsg
Description: Received Auth/Acct Response Message from UDP-Proxy
Source: bng.udp-proxy.DC.Local.0
Destination: bng.radius-ep.DC.Local.0
PAYLOAD:

```

```

    RadiusUdpProxyMsg:
        RadiusUdpProxyMsg:
            SrcIp: 10.105.254.114
            SrcPort: 1812
            DestIp: 10.105.254.113
            DestPort: 16384
            Payload:
Code = AccessAccept
Id = 2
Authenticator = [127 214 195 68 205 142 58 23 126 138 11 70 241 169 153 92]
    PayloadLen: 20

```

```

-----
Subscriber Id: aabb.0000.0001@automation-userplane
Timestamp: 2021/06/09 12:19:30.216130
Message: DHCPpacketTx
Description: Sending Packet IPOE, IPC Message to udp-proxy
Source: bng.bng-n4-protocol.DC.Local.0
Destination: bng.udp-proxy.DC.Local.0
PAYLOAD:

```

```

    DHCPpacketTx:
        DHCPpacketTx:
            Type: 6
            L2Data:
                DstMac: ff:ff:ff:ff:ff:ff
                Outervlan: 100
                Innervlan: 200
                OuterCos: 0
                InnerCos: 0
            IpAddr:
                AfType: 1

```

```

SrcIpv4: 33.0.0.1
SrcIpv6:
DstIPv4: 255.255.255.255
DstIPv6:
LinkLocal:
Port: 68
UpData:
  AccessInterface: GigabitEthernet0/0/0/1
  CpSubscriberId: 16777218
  UpSubscriberId: 0
  USubInterfaceId: 0
  RouterName: automation-userplane
  AccessVrf: access-vrf-1
  NASID: NAS-ID-1
Packet:
  Payload:
    BaseLayer:
      Operation: 2
      HardwareType: 1
      HardwareLen: 6
      HardwareOpts: 0
      Xid: 1
      Secs: 0
      Flags: 32768
      ClientIP: 0.0.0.0
      YourClientIP: 33.0.0.3
      NextServerIP: 0.0.0.0
      RelayAgentIP: 0.0.0.0
      ClientHWAddr: aa:bb:00:00:00:01
      ServerName:
      File:
      Options: {
Option(MessageType:Offer)
Option(ClientID:[1 170 187 0 0 0 1])
Option(SubnetMask:255.255.224.0)
Option(LeaseTime:90060)
Option(Timer1:45030)
Option(Timer2:78802)
Option(ServerID:33.0.0.1)
}

```

```

-----
Subscriber Id: aabb.0000.0001@automation-userplane
Timestamp: 2021/06/09 12:19:30.293167
Message: BNGN4UdpProxyMessage
Description: Received Packet IPOE, IPC Message from udp-proxy
Source: bng.udp-proxy.DC.Local.0
Destination: bng.bng-n4-protocol.DC.Local.0
PAYLOAD:
  BNGN4UdpProxyMessage:
    BNGN4UdpProxyMessage:
      Type: 6
      L2Data:
        SrcMac: aabb.0000.0001
        DstMac: ffff.ffff.ffff
        Outervlan: 100
        Innervlan: 200
        OuterCos: 0
        InnerCos: 0
      IpAddr:
        AfType: 1
        SrcIpv4:
        SrcIpv6:

```

```

        DstIPv4: 8.8.8.8
        DstIPv6:
        LinkLocal:
        Port: 8000
    UpData:
        AccessInterface: GigabitEthernet0/0/0/1
        CpSubscriberId: 0
        UpSubscriberId: 0
        USubInterfaceId: 0
        RouterName: automation-userplane
        AccessVrf: access-vrf-1
        NASID: NAS-ID-1
    NasInfo:
        Port: 4
        Slot: 2
        Adapter: 5
        Subslot: 3
        Chassis: 1
        InterfaceType: 1
    L2TPData:
        PuntPoliceRate: 0
        L2TPtos: 0
        TunnelID: 0
    Packet:
        Payload:
            BaseLayer:
            Operation: 1
            HardwareType: 1
            HardwareLen: 6
            HardwareOpts: 0
            Xid: 1
            Secs: 0
            Flags: 32768
            ClientIP: 0.0.0.0
            YourClientIP: 0.0.0.0
            NextServerIP: 0.0.0.0
            RelayAgentIP: 0.0.0.0
            ClientHWAddr: aa:bb:00:00:00:01
            ServerName:
            File:
            Options: {
    Option(MessageType:Request)
    Option(ClientID:[1 170 187 0 0 0 1])
    Option(ServerID:33.0.0.1)
    Option(RequestIP:33.0.0.3)
}

```

```

-----
Subscriber Id: aabb.0000.0001@automation-userplane
Timestamp: 2021/06/09 12:19:30.301343
Message: BNGN4SessionEstablishmentReq
Description: Sending N4 Session Establishment Request, IPC Message to udp-proxy
Source: bng.bng-n4-protocol.DC.Local.0
Destination: bng.udp-proxy.DC.Local.0
PAYLOAD:
    BNGN4SessionEstablishmentReq:
        BNGN4SessionEstablishmentReq:
            PfcpsessionHeader:
                Version: 1
                SeidSet: true
                MessageType: 50
                MessageLen: 413
                SequenceNumber: 5

```

```

    Seid: 0
    Priority: 1
NodeID:
    Valid: true
    Ip: Afi=v4 Ip=10.105.254.113
Fseid:
    Valid: true
    Seid: 16777218
    Ipv4: 0.0.0.0
    Ipv6:
CreatePdrList:
    CreatePdrList[0]:
        Valid: true
        PdrId:
            Valid: true
            RuleId: 1
        Precedence:
            Valid: true
            Val: 1
        Pdi:
            Valid: true
            SrcIface:
                Valid: true
                Value: 1
            TrafficEndptId:
                Valid: true
                Val: 1
        FarId:
            Valid: true
            Val: 1
        OuterHeaderRemoval:
            Valid: false
            Description: 0
        UrrId:
            Valid: true
            Val: 1
    CreatePdrList[1]:
        Valid: true
        PdrId:
            Valid: true
            RuleId: 2
        Precedence:
            Valid: true
            Val: 1
        Pdi:
            Valid: true
            SrcIface:
                Valid: true
                Value: 2
            TrafficEndptId:
                Valid: false
                Val: 0
        FarId:
            Valid: true
            Val: 2
        OuterHeaderRemoval:
            Valid: false
            Description: 0
        UrrId:
            Valid: false
            Val: 0
CreateFarList:
    CreateFarList[0]:
        Valid: true

```

```
FarId:
  Valid: true
  Val: 1
ApplyAction:
  Valid: true
  Drop: false
  Forward: true
  Buffer: false
  NotifyCP: false
  Duplicate: false
ForwParams:
  Valid: true
  DestIface:
    Valid: true
    Value: 2
  OuterHeaderCreation:
    Valid: true
    CprNSH: false
    TfEndpt: true
    L2tp: false
    Ppp: false
    TunnelID: 0
    SessionID: 0
DuplParams:
  Valid: false
  DestIface:
    Valid: false
    Value: 0
  OuterHeaderCreation:
    Valid: false
    Teid: 0
    Ipv4:
    Ipv6:
    PortNum: 0
  IntrInfo:
    Valid: false
    InterceptId:
      Valid: false
    Dscp:
      Valid: false
      Dscp: 0
CreateFarList[1]:
  Valid: true
  FarId:
    Valid: true
    Val: 2
  ApplyAction:
    Valid: true
    Drop: false
    Forward: true
    Buffer: false
    NotifyCP: false
    Duplicate: false
  ForwParams:
    Valid: true
    DestIface:
      Valid: true
      Value: 1
    OuterHeaderCreation:
      Valid: true
      CprNSH: false
      TfEndpt: true
      L2tp: false
      Ppp: false
```

```

        TunnelID: 0
        SessionID: 0
DuplParams:
    Valid: false
    DestIface:
        Valid: false
        Value: 0
    OuterHeaderCreation:
        Valid: false
        Teid: 0
        Ipv4:
        Ipv6:
        PortNum: 0
    IntrInfo:
        Valid: false
        InterceptId:
            Valid: false
        Dscp:
            Valid: false
            Dscp: 0
CreateTrafficEndptList:
    CreateTrafficEndptList[0]:
        Valid: true
        Tfid:
            Valid: true
            Val: 1
        AccessPortID:
            Valid: true
            Value: GigabitEthernet0/0/0/1
        UeIPAddr:
            Valid: true
            Flags: 2
            Ipv4Addr: Afi=v4 Ip=33.0.0.3
            Ipv6Addr:
            IPv6PrefixLen: 0
            Ipv6PAddr:
            Ipv6LLAddr:
        UeMacAddress: aa:bb:00:00:00:01
        PppoeSessId:
            Valid: false
            Value: 0
        AddressFamily:
            Valid: true
            Value: 3
        Cvlan:
            Valid: true
            Pcp: 0
            Dei: 0
            VlanId: 200
        Svaln:
            Valid: true
            Pcp: 0
            Dei: 0
            VlanId: 100
        L2tpTunnel:
            Valid: false
            TunnelEndpoint:
                Valid: false
                Choose: false
                LocalID: 0
                RemoteID: 0
            SessionID:
                Valid: false
                SessionID: 0

```

```

        RemoteSessionID: 0
    TunnelFeatures:
        Valid: false
        SetTOS: false
        ReflectTOS: false
        SetDF: false
        ReflectDF: false
        TcpMssAdjust: false
        TunnelStatsEnabled: false
        SessStatsEnabled: false
        TSI: false
        SSI: false
        TosVal: 0
        TcpMssVal: 0
        TunnelStatsInterval: 0
        SessStatsInterval: 0
SubParams:
    Valid: true
    Stype:
        Valid: true
        Value: 1
    SrgIntfId:
        Valid: false
        Value: 0
    SrgGrpId:
        Valid: false
        Value: 0
    Vrf:
        Valid: true
        Value: automation-vrf
    AccessVrf:
        Valid: false
CreateURR:
    CreateURR[0]:
        Valid: true
        UrrID:
            Valid: true
            Val: 1
        MeasurementMethod:
            Valid: true
            Event: false
            Volume: true
            Duration: false
        Trigger:
            Valid: true
            PeriodicReporting: true
            VolumeThreshold: false
            TimeThreshold: false
            QuotaHoldingTime: false
            StartOfTraffic: false
            StopOfTraffic: false
            DroppedDlTrafficThreshold: false
            ImmediateReport: false
            VolumeQuota: false
            TimeQuota: false
            LinkedUsageReporting: false
            TerminationReport: true
            MonitoringTime: false
            EnvelopeClosure: false
            MacAddressReporting: false
            EventThreshold: false
            EventQuota: false
            TerminationByUP: false
    MeasurementPeriod:

```

```

        Valid: true
        Val: 1940
Keepalive:
  Valid: false
  Tfid:
    Valid: false
    Val: 0
  Timer:
    Valid: false
    TimeInterval: 0
    RetryCount: 0
  MagicNum:
    Valid: false
    LocalMagicNum: 0
    PeerMagicNum: 0
CreateQspList:
  CreateQspList[0]:
    Valid: true
    Service:
      Valid: true
      Length: 0
      Value: automation-feature-template-accounting
    QosIngress:
      Valid: true
      Length: 0
      Name: inpolicy
      Priority: 0
    QosEgress:
      Valid: true
      Length: 0
      Name: outpolicy
      Priority: 0
    Stats:
      Valid: true
      Value: true
    Spi:
      Valid: false
      Value: 0
    PlainQos: false
CreateACL:
  Valid: false
  Ipv4InACL:
    Valid: false
  Ipv4OutACL:
    Valid: false
  Ipv6InACL:
    Valid: false
  Ipv6OutACL:
    Valid: false
CreatePBR:
  Valid: false
  PbrIngress:
    Valid: false
    Length: 0
CreateuRPF:
  Valid: false
  Strictv4: false
  Strictv6: false
  Loosev4: false
  Loosev6: false
CreateICMP:
  Valid: false
  V4: false
  V6: false

```



```

RemoveICMP:
  Valid: false
  V4: false
  V6: false
CreateMTU:
  Valid: true
  V4Mtu: 1400
  V6Mtu: 0
  PPPMtu: 0
TransactionIdentifier:
  Valid: true
  Value: 1
-----

```

Configuring Monitor Protocol

Use the following commands to enable protocol monitoring for a subscriber.

```
monitor protocol interface pcap_interface capture-duration duration_in_seconds
```

NOTES:

- **interface** *pcap_interface* : Specifies the packet capture (PCAP) interface. The valid PCAP interfaces are: Packet Forwarding Control Protocol (PFCP), GPRS Tunnelling Protocol User Plane (GTP-U), and Remote Authentication Dial-In User Service (RADIUS).
- **capture-duration** *duration_in_seconds* : Specifies the duration in seconds during which the monitor protocol is enabled. The *duration_in_seconds* can range from 1 to 2147483647 seconds. The default is 300.
- cnBNG uses a custom GTPU packet format. Therefore, packet decode errors are displayed on the screen because the standard decode plugin does not support the cnBNG format. Capture the packet to PCAP and use the cnBNG specific LUA plugin during Wireshark decode.
- Interface names must be entered manually and must match the name mentioned in the description, else the packet capture may fail.
- Only one physical-interface (NIC) packet capture is supported. For PFCP and GTPU this limitation is not applicable as they always run-on a single interface (VIP). However for RADIUS, certain deployments may use different VIPs for Auth/Acct/COA, leading to different physical NICs. Due to the infrastructure limitation, packet-capture can run on only one of the physical-NICs.

Example

```
monitor protocol interface pfcp
```

```

InterfaceName = N4:10.86.73.161:8805 | InterfaceIP = 10.86.73.161 | Filter = (tcp or udp)
and (port 8805)
<<<<OUTBOUND
from 10.86.73.161:8805 to 10.86.73.162:8805
Protocol: UDP | Sequence Number: 0
Packet Metadata: {Timestamp:2019-10-22 09:22:34.029363 +0000 UTC CaptureLength:72 Length:72
InterfaceIndex:2 AncillaryData:[]}

```

Packet Raw Bytes:

```
0050569c14610050569c8f5c08004500003a76c5400040111bfff0a5649a10a5649a2226522650026a8262006001a00000004003c0005000a5649a1001300010100600004e159480e
```

Packet Dump:

```

-- FULL PACKET DATA (72 bytes) -----
00000000 00 50 56 9c 14 61 00 50 56 9c 8d 5c 08 00 45 00
00000010 00 3a 76 c5 40 00 40 11 1b ff 0a 56 49 a1 0a 56
00000020 49 a2 22 65 22 65 00 26 a8 26 20 06 00 1a 00 00
00000030 00 04 00 3c 00 05 00 0a 56 49 a1 00 13 00 01 01
00000040 00 60 00 04 e1 59 48 0e
--- Layer 1 ---
Ethernet {Contents=[..14..] Payload=[..58..] SrcMAC=00:50:56:9c:8d:5c DstMAC=00:50:56:9c:14:61
  EthernetType=IPv4 Length=0}
00000000 00 50 56 9c 14 61 00 50 56 9c 8d 5c 08 00
--- Layer 2 ---
IPv4 {Contents=[..20..] Payload=[..38..] Version=4 IHL=5 TOS=0 Length=58 Id=30405 Flags=DF
  FragOffset=0 TTL=64 Protocol=UDP Checksum=7167 SrcIP=10.86.73.161 DstIP=10.86.73.162
  Options=[] Padding=[]}
00000000 45 00 00 3a 76 c5 40 00 40 11 1b ff 0a 56 49 a1
00000010 0a 56 49 a2
--- Layer 3 ---
UDP {Contents=[..8..] Payload=[..30..] SrcPort=8805(pfcp) DstPort=8805(pfcp) Length=38
  Checksum=43046}
00000000 22 65 22 65 00 26 a8 26 |"e".e.&.&|
--- Layer 4 ---
Payload 30 byte(s)
00000000 20 06 00 1a 00 00 00 04 00 3c 00 05 00 0a 56 49
00000010 a1 00 13 00 01 01 00 60 00 04 e1 59 48 0e

```

Copying Log Files

Use the following commands to copy the stored log files externally or on the BNG Ops Center.

These files either can be copied outside or dumped on the bng-opscenter using the following CLI command.

```
monitor subscriber-dump filename <file path got from monitor
subscriber-list CLI>
```

Example:

```

monitor subscriber dump filename
/opt/workspace/logs/monsublogs/none.aabb.0000.0001@automation-userplane_TS_2021-06-09T12:17:33.838574118.txt.sorted
RELEASE_NAMESPACE: 'bng'
Dumping file
'/opt/workspace/logs/monsublogs/none.aabb.0000.0001@automation-userplane_TS_2021-06-09T12:17:33.838574118.txt.sorted'
**** Received 19 messages ****
Subscriber Id: aabb.0000.0001@automation-userplane
Timestamp: 2021/06/09 12:19:30.194843
Message: BNGN4UdpProxyMessage
Description: Received Packet IPOE, IPC Message from udp-proxy
Source: bng.udp-proxy.DC.Local.0
Destination: bng.bng-n4-protocol.DC.Local.0
PAYLOAD:
  BNGN4UdpProxyMessage:
    BNGN4UdpProxyMessage:
      Type: 6
      L2Data:
        SrcMac: aabb.0000.0001
        DstMac: ffff.ffff.ffff
        Outervlan: 100
        Innervlan: 200
        OuterCos: 0
        InnerCos: 0
      IpAddr:
        AfType: 1
        SrcIpv4:
        SrcIpv6:

```

```

        DstIPv4: 8.8.8.8
        DstIPv6:
        LinkLocal:
        Port: 8000
    UpData:
        AccessInterface: GigabitEthernet0/0/0/1
        CpSubscriberId: 0
        UpSubscriberId: 0
        USubInterfaceId: 0
        RouterName: automation-userplane
        AccessVrf: access-vrf-1
        NASID: NAS-ID-1
    NasInfo:
        Port: 4
        Slot: 2
        Adapter: 5
        Subslot: 3
        Chassis: 1
        InterfaceType: 1
    L2TPData:
        PuntPoliceRate: 0
        L2TPos: 0
        TunnelID: 0
    Packet:
        Payload:
            BaseLayer:
            Operation: 1
            HardwareType: 1
            HardwareLen: 6
            HardwareOpts: 0
            Xid: 1
            Secs: 0
            Flags: 32768
            ClientIP: 0.0.0.0
            YourClientIP: 0.0.0.0
            NextServerIP: 0.0.0.0
            RelayAgentIP: 0.0.0.0
            ClientHWAddr: aa:bb:00:00:00:01
            ServerName:
            File:
            Options: {
                Option(MessageType:Discover)
                Option(ClientID:[1 170 187 0 0 0 1]).

```

```

-----
Subscriber Id: aabb.0000.0001@automation-userplane
Timestamp: 2021/06/09 12:19:30.205174
Message: RadiusUdpProxyMsg
Description: Send Auth/Acct Request Message to UDP-Proxy
Source: bng.radius-ep.DC.Local.0
Destination: bng.udp-proxy.DC.Local.0
PAYLOAD:
    RadiusUdpProxyMsg:
        RadiusUdpProxyMsg:
            SrcIp: 10.105.254.113
            SrcPort: 16384
            DestIp: 10.105.254.114
            DestPort: 1812
            Payload:

```

```

-----
Subscriber Id: aa11.0000.0003@asr9k-1
Timestamp: 2021/06/03 06:26:26.796023
Message: RadiusUdpProxyMsg
Description: Send Auth/Acct Request Message to UDP-Proxy
Source: BNG.radius-ep.DC.Local.0
Destination: BNG.udp-proxy.DC.Local.0
PAYLOAD:
  RadiusUdpProxyMsg:
    RadiusUdpProxyMsg:
      SrcIp: 10.1.4.150
      SrcPort: 16384
      DestIp: 10.1.4.151
      DestPort: 1813
      Payload:
        Code = AccountingRequest
        Id = 31
        Authenticator = [88 13 251 114 225 205 9 68 52 194 48 231 234 226
226 184]
        User-Name = "cnbng"
        NAS-IP-Address = 10.1.4.150
        NAS-Port = 16384
        Service-Type = 5
        Framed-IP-Address = 1.0.3.13
        Nas-Identifier = "CISCO-BNG-ACCT"
        Acct-Status-Type = 1
        Acct-Delay-Time = 0
        Acct-Session-Id = "Local_DC_16777230"
        Event-Timestamp = 1622701602
        NAS-Port-Type = 41
        Acct-Interim-Interval = 300
        NAS-Port-Id = "asr9k-1/2/3/4/100.200"
        NAS-IPv6-Address = ::/0
        Cisco-Vsa_cisco-nas-port = "asr9k-1/2/3/4/100.200"
        Cisco-Vsa_cisco-dhcp-client-id = 0x01aa1100000003
        Cisco-Vsa_Cisco AVpair = "client-mac-address=aa11.0000.0003"
        Cisco-Vsa_Cisco AVpair = "dhcp-class=RJIL_DHCPV4_CLASS_2"
        Cisco-Vsa_Cisco AVpair = "dhcp-class=RJIL_DHCPV6_CLASS_1"
        Cisco-Vsa_Cisco AVpair = "accounting-list=aaa-prof1"
        Cisco-Vsa_Cisco AVpair =
0x646863702d636c69656e742d69643d01aa1100000003
        Cisco-Vsa_Cisco AVpair = "vrf=ISP"
      PayloadLen: 396
      SubscriberID: aa11.0000.0003@asr9k-1
-----

```

```

-----
Subscriber Id: aa11.0000.0003@asr9k-1
Timestamp: 2021/06/03 06:26:26.800776
Message: RadiusUdpProxyMsg
Description: Received Auth/Acct Response Message from UDP-Proxy
Source: BNG.udp-proxy.DC.Local.0
Destination: BNG.radius-ep.DC.Local.0
PAYLOAD:
  RadiusUdpProxyMsg:
    RadiusUdpProxyMsg:
      SrcIp: 10.1.4.151
      SrcPort: 1813
      DestIp: 10.1.4.150
      DestPort: 16384
      Payload:
        Code = AccountingResponse

```

```

                                Id = 31
                                Authenticator = [168 192 147 70 117 31 151 16 237 80 68 105 42 191
23 186]
                                PayloadLen: 20

```

bng#



Note

- While receiving CoA or DM packets, the RADIUS pod does not have the subscriber-information, instead the information is available only with the BNG-SM pod. Therefore, the packet related session programming N4-SESS-UPDATE TX and RX is dumped on the screen first followed by the CoA or DM TX and RX dump.
- Packet dumps are not captured for PFCP session report request and response.

Viewing Log Files

Use the following commands to view the stored log files for a monitor protocol or subscriber.

```

monitor subscriber list
monitor protocol list

```

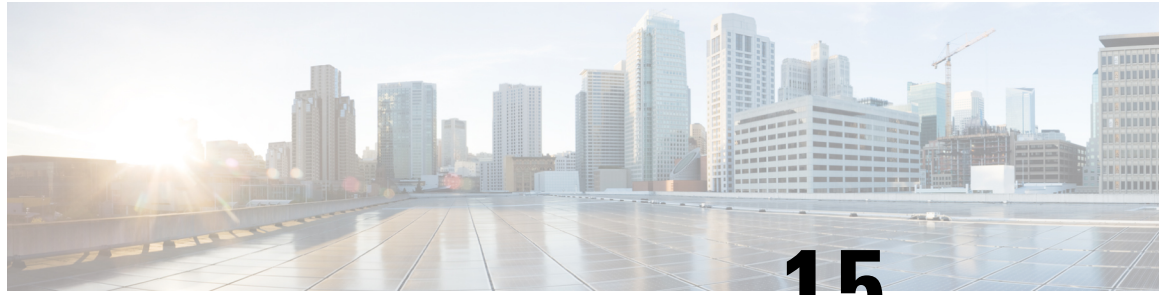
The following is a sample output for the **monitor subscriber list**.

Example:

```

bng# monitor subscriber list
none.aal1.0000.0004*_TS_2021-06-03T06:28:13.564009704.txt.sorted
none.aal1.0000.0003@asr9k-1_TS_2021-06-03T06:26:20.627655233.txt.sorted
none.*_TS_2021-06-03T06:25:04.176857711.txt.sorted
bng#

```

CHAPTER 15

Multiple Replica Support for cnBNG Services

- [Feature Summary and Revision History, on page 201](#)
- [Feature Description, on page 202](#)
- [Configuring Multiple Replica Support for cnBNG Services, on page 203](#)

Feature Summary and Revision History

Summary Data

Table 43: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Documentation	<i>Cloud Native BNG Control Plane Command Reference Guide</i>

Revision History

Table 44: Revision History

Revision Details	Release
Enhancement Introduced: The Multiple Replica Support for cnBNG Services feature is NSO-integrated.	2021.04.0
First introduced.	2021.03.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

The Multiple Replica Support for cnBNG Services is designed to support multiple instances of the cnBNG services and load balance the session transactions to address the following requirements:

- Higher scalability
- Calls per Second (CPS) [CEPS - Call Events per Second (CEPS), TPS - Transactions per Second (TPS)]
- Redundancy

The following services must be configured to support multiple instances for load-balancing the session transactions.

- bng-dhcp
- bng-pppoe
- bng-l2tp-tunnel
- bng-sm
- bng-n4-protocol
- radius-ep
- udp-proxy
- bng-node-manager

To configure Multiple Replica Support, see [Configuring Multiple Replica Support for cnBNG Services](#), on page 203.

How it Works

In a microservices architecture, a service mesh refers to a network of microservices that make up an application and the interactions they have among them. Istio is an open source service mesh that layers transparently on existing distributed applications.

Istio makes it easy to create a network of deployed services with load balancing, service-to-service authentication, monitoring, and so on. Therefore, Istio support is added to the cnBNG services, which intercepts all network communication between the microservices. The CP functionality is used to configure and manage Istio.

The cnBNG pod layout ensures that instances of a service are distributed across virtual machines (VMs) to ensure VM level redundancy.

Configuring Multiple Replica Support for cnBNG Services

This section describes how to configure Multiple Replica Support for cnBNG Services.

Configuring Multiple Replica Support for cnBNG Services involves the following procedure:

Replicating Multiple cnBNG Service Instances

Replicating Multiple cnBNG Service Instances

Use the following commands to replicate multiple cnBNG service instances.

```
config
  instance instance_id
    endpoint { dhcp | geo | l2tp-tunnel | n4-protocol | nodemgr | pppoe
              | radius | sm | udp-proxy }
    nodes node_replicas_for_resiliency
    replicas replicas_per_node
  commit
```

NOTES:

- **instance** *instance_id* : Configures multiple instances for the specified instance and enters instance sub-mode.
- **endpoint** { **dhcp** | **geo** | **l2tp-tunnel** | **n4-protocol** | **nodemgr** | **pppoe** | **radius** | **sm** | **udp-proxy** } : Configures parameters for the selected endpoint. The endpoint options are dhcp, geo, l2tp-tunnel, n4-protocol, nodemgr, pppoe, radius, sm, and udp-proxy.
- **nodes** *node_replicas_for_resiliency* : Specifies the number of node replicas for resiliency. *node_replicas_for_resiliency* must be an integer. The minimum number of nodes supported per replica is one and the maximum is 2. The default value is 1.
- **replicas** *replicas_per_node* : Specifies the number of replicas per node. *replicas_per_node* must be an integer. The minimum number of replicas supported is one and the maximum is 2. The default value is 1.



Note

- The number of replicas depend on the cluster resources and number of nodes assigned to bring up the service pods.
- Currently one replica is supported per node. Therefore, for two nodes the total number of replicas supported are 2 * 1.



CHAPTER 16

PPPoE Subscriber Management

- [Feature Summary and Revision History, on page 205](#)
- [Feature Description, on page 206](#)
- [Configuring the PPPoE Subscriber Management Feature, on page 212](#)

Feature Summary and Revision History

Summary Data

Table 45: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	Not Applicable

Revision History

Table 46: Revision History

Revision Details	Release
Enhancement Introduced: The PPPoE is NSO-integrated.	2021.04.0
First introduced.	2021.01.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

Point-to-Point Protocol (PPP) over Ethernet (PPPoE) is a point-to-point link with the subscriber over an Ethernet network where the standard PPP negotiations are used for authentication and IPv4 address assignment. The basic PPPoE is defined in RFC-2516. This RFC defines two distinct stages:

- **Discovery stage:** This sets up a point-to-point session over which PPP can run between two points. For example, between the CPE and Broadband Network Gateway (BNG). This is the PPPoE protocol itself.

Unlike PPP, the PPPoE discovery protocol defines a client-server relationship with the client initiating the discovery of the server and the subsequent setup of the point-to-point link.

- **Session stage:** This runs over the established point-to-point connection, negotiating the PPP protocols (LCP, Authentication, IPCP) as required for a standard PPP interface.

The session stage carries the data packets from the PPPoE (this includes PPP protocol negotiation) and the actual data packets to and from the subscriber.

PPPoE Overview

The cnBNG CP supports the standard PPPoE protocol, as defined in RFC-2516. It implements the PPPoE server functionality, that is, providing PPPoE sessions to subscribers who request them. More specifically, it supports the following functionality:

- Handling incoming PPPoE Active Discovery Initiation (PADI) packets and replying with a PPPoE Active Discovery Offer (PADO) packet when the PADI is valid.
- Handling incoming PPPoE Active Discovery Request (PADR) packets and setting up a PPPoE session for the subscriber when the PADR is valid. It also replies with a PPPoE Active Discovery Session (PADS) with an allocated session-id. When the PADR is not valid (or session setup fails), a PADS is sent containing a zero session-id and an error tag.
- Handling incoming PPPoE Active Discovery Termination (PADT) packets and terminating the corresponding PPPoE sessions.
- Sending a PADT packet to the subscriber when terminating a PPPoE session.

PPPoE Features

The cnBNG supports the following PPPoE features.

PPPoE Tag Support

cnBNG supports the following PPPoE tags as defined in RFC-2516.

- Service-Name
- AC-Name tag

- AC-Cookie
- Host-Uniq tag
- Relay-Session-Id tag
- End-Of-List tag
- Vendor-Specific tags
- Error tags
- Max-payload tag

Interface types

PPPoE is generally supported on all types of Ethernet interfaces. The cloud-native CP supports PPPoE if the configuration is present either on the port identifier, NAS level, or at the router level. The UP is responsible for the interfaces where the PPPoE punt inject towards CP can be enabled.

CoS Bits

The cnBNG allows configuration of the Class-of-Service (CoS) bits value used in the Ethernet header of PADx packets. This ensure that the PPPoE control packets get treated at a higher priority. The cnBNG CP passes these values in the inject packet and the UP places these CoS values in the PADx packets it forwards towards the CPE.

Service Selection

The PPPoE Service Selection feature uses service tags to enable a PPPoE server to offer PPPoE clients a selection of different services in the PADO. Then the client chooses one of the services offered and then sends the desired service name in a PADR. This feature enables service providers to offer a variety of services and to charge customers according to the chosen services.

Whenever a PADI is received containing one of the locally configured service-names, the PADO response contains all the configured service-names.

A configuration is also provided to allow the user to disable Service Selection. In this case, the PADO only contains the service-name that was in the original PADI.

Session Limits

- Mac-limit – max sessions per MAC address.
- Circuit-id-limit – max sessions per circuit Id.
- Outer-vlan-limit – max sessions per outer VLAN.
- Max-limit – total max sessions per UP.

PPP Overview

The Point-to-Point Protocol provides a standard method for transporting multiprotocol datagrams over point-to-point links. It defines an encapsulation scheme, a link layer control protocol (LCP) and a set of network control protocols (NCPs) for different network protocols that can be transmitted over the PPP link.

The LCP is used to configure and maintain the data link. PPP peers use the LCP to negotiate various link layer properties or characteristics.

An NCP is used to establish and configure the associated network protocol before data packets for the protocol are transmitted. For example, IP Control Protocol (IPCP) is used to negotiate IPv4 addresses between peers.

Between LCP and NCP negotiation phases there is an optional authentication phase that the LCP exchanges are agreed upon. Several different authentication schemes are selected with Challenge Handshake Authentication Protocol (CHAP) being the most prevalent one. The basic PPP protocol is defined in RFC 1661 and there are extensions to it for various features.

PPP Features

The cnBNG supports the following point-to-point protocols required for bringing up a PPPoE session.

- Link Control Protocol (LCP): This is used for PPP link configuration.
- IP Control Protocol (IPCP): This is used to negotiate IPv4 addresses between peers.
- IPv6 Control Protocol (IPv6CP): This is used to negotiate IPv6 interface ID.
- Password Authentication Protocol (PAP): This is used to verify the identity of the peer by means of a two-way handshake
- Challenge Handshake Authentication Protocol (CHAP): This is used to verify the identity of the peer by means of a three-way handshake.

For more information about the protocols and their negotiation, refer the respective RFCs.

Address Assignment Strategies

The IPv4 address assignment occurs as part of the IPCP negotiation. The address can be part of the RADIUS profile. Often it is the RADIUS profile that specifies the pool to use and the Control Plane (CP) selects an address from that pool. If neither the address nor pool comes from the RADIUS, the PPP profile configuration (on the box) specifies which pool name to use. This profile is attached to the port identifier where the PPP packets are received.

The IPv6 address assignment occurs in two phases:

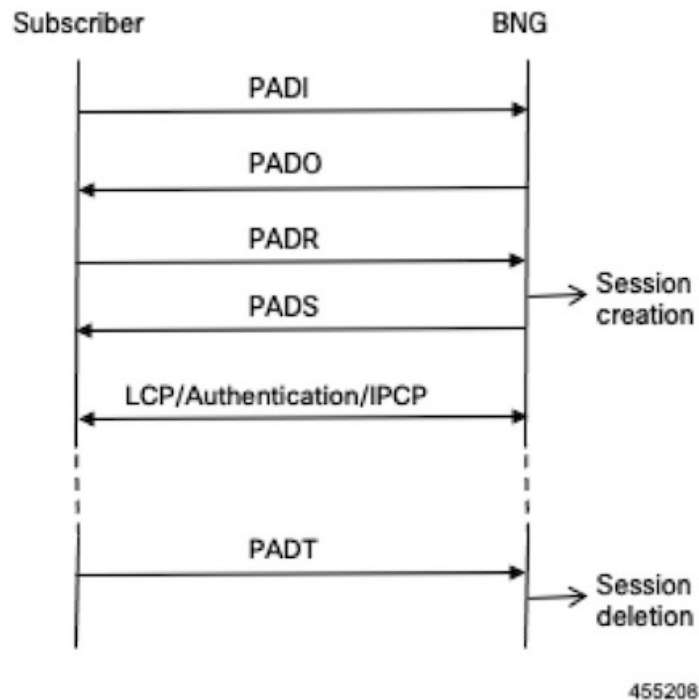
- First, as part of the IPv6CP, the interface-ID is negotiated with the CPE, which is used for link local negotiation.
- Second, after the CPE initiates the DHCPv6 protocol to get IPV6 IANA or IAPD (or both) address allocation, it gets the IPv6 address from either the RADIUS or from a pool.

How it Works

This section provides a brief of how the PPPoE Subscriber Management feature works.

PPPoE Handling

The PPPoE discovery-stage protocol consists of basic packet exchange between the subscriber and server (cnBNG). The following illustration displays the flow of events.



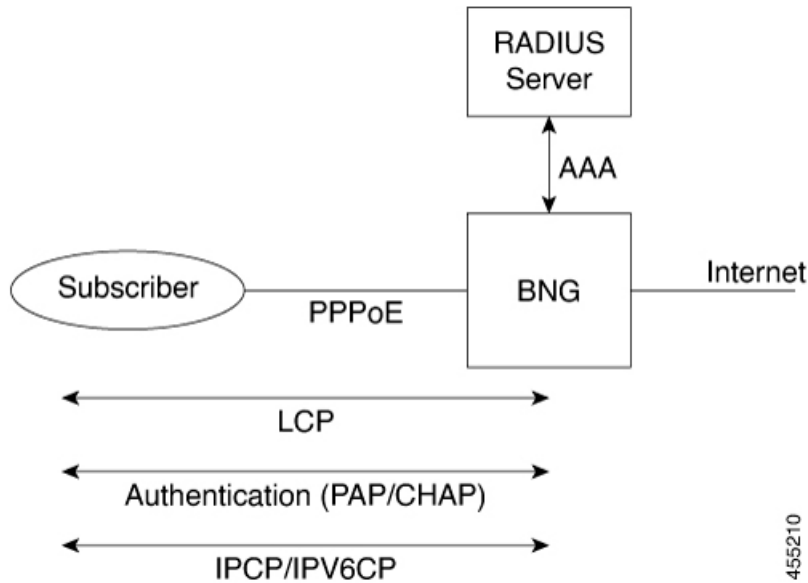
In brief, the protocol can be summarized as follows:

- When the subscriber wishes to establish a PPPoE session, it sends PADI message to the server.
 - The PADI may be multicast, if the subscriber tries to find out if any servers are available.
 - The PADI contains a Service-Name tag, which indicates the service that it wants the server to provide.
- When a server receives a PADI message, it checks if it can provide the service requested to the subscriber. If it can, it replies with a PADO message.
 - The PADO message is unicast to the peer. It contains the Service-Name the client requested.
- When the subscriber receives the PADO messages from the servers, it selects the server to connect to and sends a PADR message.
 - The PADR message is unicast, directed to the specific server with which it wants to establish a session.
 - The PADR message also contains the Service-Name tag.
- When the server receives a PADR message, it checks if it can provide the service to the subscriber.
 - If it can, it chooses a 16-bit Session-Id to identify the session of the subscriber and sets up the necessary state for the subscriber. It then replies with a PADS confirmation, which contains the Session-Id to indicate to the subscriber that the session is established.
 - If it cannot provide a session, it replies with a PADS containing an Error-tag, which indicates the reason it cannot. This PADS contains a zero Session-id.

- After the PADS is sent, the subscriber and server negotiate PPP in the standard way.
 - When either the subscriber or the server wants to terminate the session, it sends PADT message to the peer with the Session-Id. This clears up all the states associated with the session.
- This completes the PPPoE discovery stage. the peers can now start the PPP negotiation.

PPP Handling

The network topology of the PPP is the point-to-point link between the BNG and the subscriber (this link is established during the PPPoE Discovery phase):



The PPPoE subscriber is viewed like any other PPP peer – LCP, Authentication and IPv4CP or IPv6CP (or both) are negotiated to establish the PPP link.

The standard scenario where the BNG terminates both the PPPoE and PPP subscriber session is referred to as PPP Termination and Aggregation (PTA). This distinguishes it from the more complex L2TP Access Concentrator (LAC) and L2TP Network Server (LNS) scenarios where the PPPoE is terminated locally on the BNG but the PPP session is terminated on a separate node from over L2TP to an upstream box known as an LNS.

Call Flows

This section includes the following high-level call flow.

PPPoE Bring-Up Call Flow

In cnBNG, the PPPoE and PPP Control Plane runs the overall PTA session bring-up, which includes the PPPoE and PPP negotiation as shown in the following call-flow.

Figure 17: cnBNG PPPoE Bring-Up Call Flow

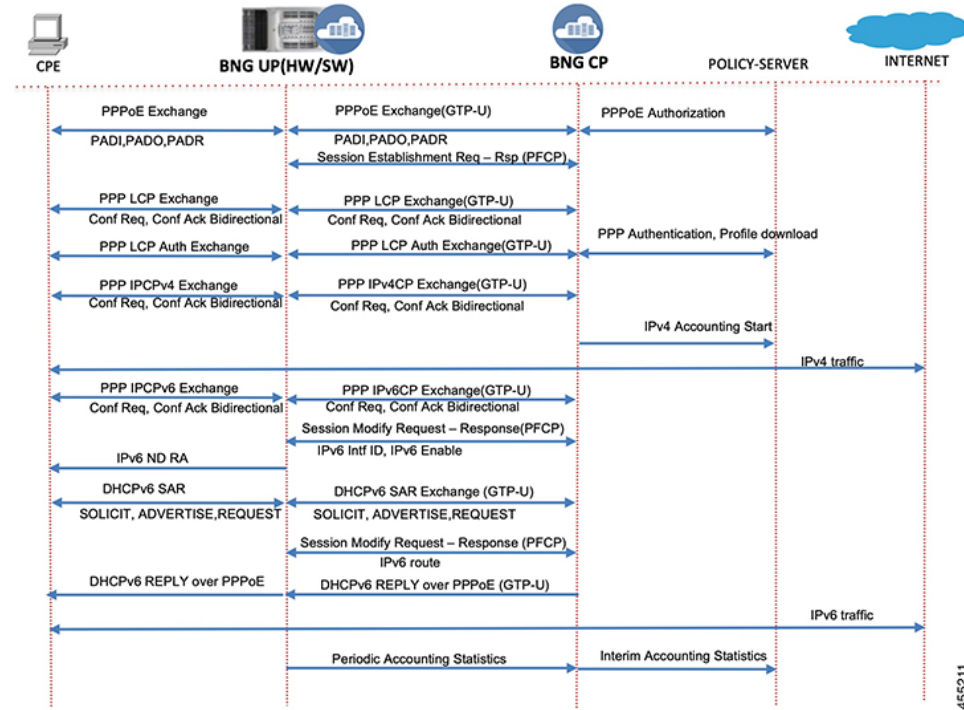


Table 47: cnBNG PPPoE Call Flow Description

Steps	Description
1	The CPE initiates the PPPoE packet exchange. The BNG-CP verifies the tags, session limits, service name, and so on and creates a PPPoE interface.
2	The BNG-CP sends a Success PADS message with an assigned PPPoE session ID.
3	The CPE and BNG-CP negotiate the LCP link parameters and authorization methods to use.
4	The BNG-CP authenticates the CPE with the provided username and password via AAA and downloads the network level parameters.
5	The CPE starts the IPv4CP and gets the IPv4 address. The BNG-CP programs the IPv4 route and features on the BNG-UP. Accounting start is initiated for IPv4.
6	Now bidirectional IPv4 traffic is enabled for the subscriber with the applied features.
7	Optionally, the CPE starts IPv6CP in case of dual stack. The local and peer interface ID are negotiated and the BNG-UP is programmed to allow link local negotiation to occur.
8	The BNG-UP completes the link local addressing with the IPv6 ND router advertisement.

Steps	Description
9	The CPE starts the DHCPv6 packet exchange on the negotiated PPPoE session to get the global IPv6 address assignment.
10	The BNG-CP programs the IPv6 routes and features into the BNG-UP and responds to the CPE with the DHCPv6 Reply packet to acknowledge that the IPv6 is up. At this stage, the session is converted into a dual stack in the CP.
11	The subscriber can now send and receive IPv6 traffic from the Internet.
12	The BNG-UP collects and pushes the interim statistics to the BNG-CP. The BNG-CP pushes these statistics to the Policy Plane for billing.

Standard Compliance

The PPPoE Subscriber Management feature is aligned with the following standards:

- RFC 1661 Point-to-Point Protocol
- RFC 2516. A Method for Transmitting PPP Over Ethernet (PPPoE)

Limitations

The PPPoE Subscriber Management feature has the following limitations:

- Session throttling is not supported
- The PPPoE profile and PPP feature template configuration changes are applied only to the new sessions. These changes are not applied to the existing sessions.
- Update of PPP features via CoA is not supported.
- In deployment, it is not expected that one address family interface (AFI) of session goes down and another AFI bring-up is inflight. This is not supported. For example, the following sequence is not supported.
 1. Dual-stack is UP.
 2. IPv4 release is received (Session becomes IPv6 only).
 3. IPv4 Discover is received (Session is IPv6 only but IPv4 is inflight).
 4. IPv6 release is received (Session becomes IPv4 is inflight).
 5. IPv4 Request is receive (Session is IPv4 only).

In Step 3, IPv4 session is inflight and in step 4, IPv6 is going down, and in step 5, IPv4 session bring-up is complete. Such sequence of events is not expected in deployment and is not supported.

Configuring the PPPoE Subscriber Management Feature

This section describes how to configure the PPPoE Subscriber Management feature.

Configuring the PPPoE Subscriber Management feature involves the following steps:

1. Creating the PPPoE profile
2. Creating the PPP Feature template

Creating PPPoE Profile

Use the following commands to create a PPPoE profile and provide the PPPoE protocol specific parameters.

```
configure
profile pppoe pppoe_profile_name
mtu mtu
service-selection-disable [ true | false ]
max-payload minimum { payload_value } maximum { payload_value }
service-name service_name
ac-name ac_name
ac-cookie ac-cookie_name
session max limit { count } threshold { count }
session mac limit { count } threshold { count }
session circuit-id limit { count } threshold { count }
session outer-vlan limit { count } threshold { count }
timeout-completion period
control-packets priority cos_value
exit
```

NOTES:

- **profile pppoe** *pppoe_profile_name*: Specifies the PPPoE profile name.
- **mtu** *mtu*: Specifies the default PPP maximum transmission unit (MTU) value to use if the Max-Payload tag is not provided. The valid values range from 500 to 2000. The default value is 1492.
- **service-selection-disable** [**true** | **false**]: Enables or disables the advertising of extra service names in the PADO packets. True enables the service and false disables the service. The default value is false.
- **max-payload minimum** { *payload_value* } **maximum** { *payload_value* }: Specifies the supported PPPoE service name. Multiple service names can be configured simultaneously. The valid value is an alphanumeric string ranging from 1 to 256. All service names are accepted.
- **service-name** *service_name*: Specifies the supported PPPoE service name. Multiple service names can be configured simultaneously. The valid value is an alphanumeric string ranging from 1 to 256. All service names are accepted.
- **ac-name** *ac_name*: Specifies the access concentrator (AC) to use in the PADO packets. The valid value is an alphanumeric string ranging from 1 to 256. The default ac-name is the router hostname.
- **ac-cookie** *ac-cookie_name*: Specifies the AC-Cookie to use in the PADO packets. The valid value is an alphanumeric string ranging from 1 to 256.
- **session max limit** { *count* } **threshold** { *count* }: Specifies the total maximum number of sessions and threshold allowed per User Plane per profile. The valid values range from 1 to 65535. The default value is 65535.
- **session mac limit** { *count* } **threshold** { *count* }: Specifies the maximum number of sessions and threshold allowed per UP per peer profile. The valid values range from 1 to 65535. The default value is 65535.

When the threshold is passed, a syslog is printed as a warning.

- **session circuit-id limit { count } threshold { count }** : Specifies the maximum number of sessions and threshold allowed per circuit-id. The valid values range from 1 to 65535. The default value is 65535.

When the threshold is passed, a syslog is printed as a warning.

- **session outer-vlan limit { count } threshold { count }** : Specifies the maximum number of sessions and threshold allowed per UP per peer profile. The valid values range from 1 to 65535. The default value is 65535.

When the threshold is passed, a syslog is printed as a warning.

- **timeout-completion period**: Specifies the maximum time to wait for the session to be completed (an NCP to come up for PTA sessions or the L2TP tunnel to be setup for LAC sessions) before terminating the session. The valid values range from 30 to 600 seconds. The default value is 120 seconds.
- **control-packets priority cos_value**: Specifies the CoS to use in the PADx packets. The valid values range from 0 to 7. The default CoS bits are used.

Creating the PPP Feature Template

Use the following commands to create a PPP feature template.



Note The PPP feature template allows per subscriber PPP parameters.

```

configure
  profile feature-template feature_template_name
  ppp
    authentication { chap | pap }
    chap hostname chap_hostname
    chap password chap_password
    ipcp dns ipv4_address
    ipcp peer-address-pool ipam_pool_name
    ipcp renegotiation ignore
    ipcp wins ipv4_address
    ipcpv6 renegotiation ignore
    ipcp wins ipv4_address
    max-bad-auth count
    max-configure count
    max-failure count
    pap accept-null-password
    timeout absolute seconds
    timeout authentication seconds
    timeout retry seconds
    keepalive interval seconds retryseconds [ disable ]
  exit

```

NOTES:

- **profile feature-template feature_template_name**: Specifies the profile feature template name.

- **ppp**: Enters the PPP Configuration mode to configure the PPP feature.
- **authentication { chap | pap }**: Specifies the authentication type as CHAP or PAP.
- **chap hostname *chap_hostname***: Specifies the hostname to use for CHAP authentication. The valid values range from 1 to 64. The default is the router hostname.
- **chap password *chap_password***: Specifies the password to use for CHAP authentication.
- **ipcp dns *ipv4_address***: Specifies the DNS address to use for the peer.
- **ipcp peer-address-pool *ipam_pool_name***: Specifies the address pool to use to obtain an IPv4 address for the peer.
- **ipcp renegotiation ignore**: Specifies to ignore the attempts of the peer to renegotiate IPCP. The entire PPPoE session is terminated on renegotiation.
- **ipcp wins *ipv4_address***: Specifies the Windows Internet Name Service (WINS) address to use for the peer.
- **max-bad-auth *count***: Specifies the maximum authentication failures to allow. The valid values range from 0 to 10. The default is 0.
- **max-configure *count***: Specifies the maximum number of Conf-Reqs to send without a response. The valid values range from 4 to 20. The default is 10.
- **max-failure *count***: Specifies the maximum number of Conf-Naks to send. The valid values range from 2 to 10. The default is 5.
- **pap accept-null-password**: Accepts the null password feature for PAP.
- **max-failure *count***: Specifies the maximum number of Conf-Naks to send. The valid values range from 2 to 10. The default is 5.
- **timeout absolute *seconds***: Specifies the absolute timeout for a PPP session. The valid values range from 0 to 70000000 minutes.
- **timeout authentication *seconds***: Specifies the total time to allow for authentication to complete. The valid values range from 3 to 30 seconds. The default is 10.
- **timeout retry *seconds***: Specifies the maximum time to wait for a response to a Conf-Req. The valid values range from 1 to 10 seconds. The default is 3.
- **keepalive interval *seconds* retry *seconds* [disable]**: Specifies the keepalive interval and the retry attempts for the subscribers. The valid values range from 10 to 120 seconds for the keepalive interval. The default is 60 seconds. The valid values range from 1 to 255 for the retry attempt. The default value is 5 counts.



CHAPTER 17

Rolling Software Update

- [Feature Summary and Revision History, on page 217](#)
- [Feature Description, on page 217](#)
- [Installing the Rolling Software Update, on page 220](#)

Feature Summary and Revision History

Summary Data

Table 48: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Documentation	<ul style="list-style-type: none">• Multiple Replica Support for cnBNG Services• High Availability and CP Reconciliation

Revision History

Table 49: Revision History

Revision Details	Release
First introduced.	2021.04.0

Feature Description

The cnBNG Rolling Software Update feature enables incremental update of pod instances with minimal downtime. In Kubernetes, this implementation is possible only with rolling updates.

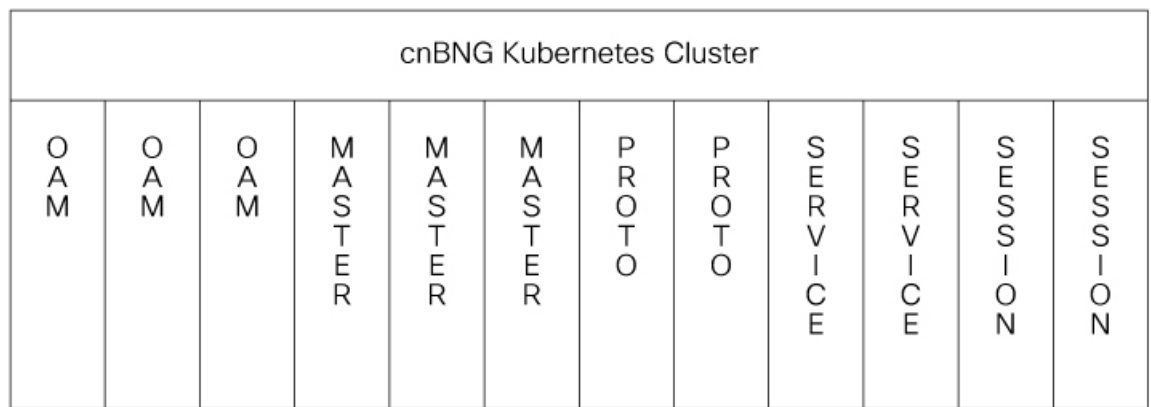
Subscriber Microservices Infrastructure (SMI) platform supports rolling software upgrade for cnBNG pods. The “Pod Restart and Reconciliation” and “Multiple Replica Support for cnBNG Services” features depend on this feature. For more information, see [Multiple Replica Support for cnBNG Services](#) and [High Availability and CP Reconciliation](#).

The cnBNG has a three-tier architecture consisting of Protocol, Service, and Session tiers. Each tier includes a set of microservices (pods) for a specific functionality. Within these tiers, there exists a Kubernetes Cluster comprising of Kubernetes (K8s) master and worker nodes (including Operation and Management nodes).

For high availability (HA) and fault tolerance, a minimum of two K8s worker nodes are required for each tier. Each worker node can have multiple replicas. Kubernetes orchestrates the pods using the StatefulSets controller. The pods require a minimum of two replicas for fault tolerance.

The following figure depicts the cnBNG K8s Cluster with 12 nodes – three Master nodes, three Operations and Management (OAM) worker nodes, two Protocol worker nodes, two Service worker nodes, and two Session (data store) worker nodes.

Figure 18: cnBNG Kubernetes Cluster



522109



Note

- OAM worker nodes: These nodes host the Ops Center pods for configuration management and metrics pods for statistics and Key Performance Indicators (KPIs).
- Protocol worker nodes: These nodes host the cnBNG protocol related pods for UDP based interfaces like N4, RADIUS, and GTP.
- Service worker nodes: These nodes host the cnBNG application related pods that perform session and FSOL management.
- Session worker nodes: These nodes host the database-related pods that store subscriber session data.

How it Works

This section describes how the cnBNG Rolling Software Update works.

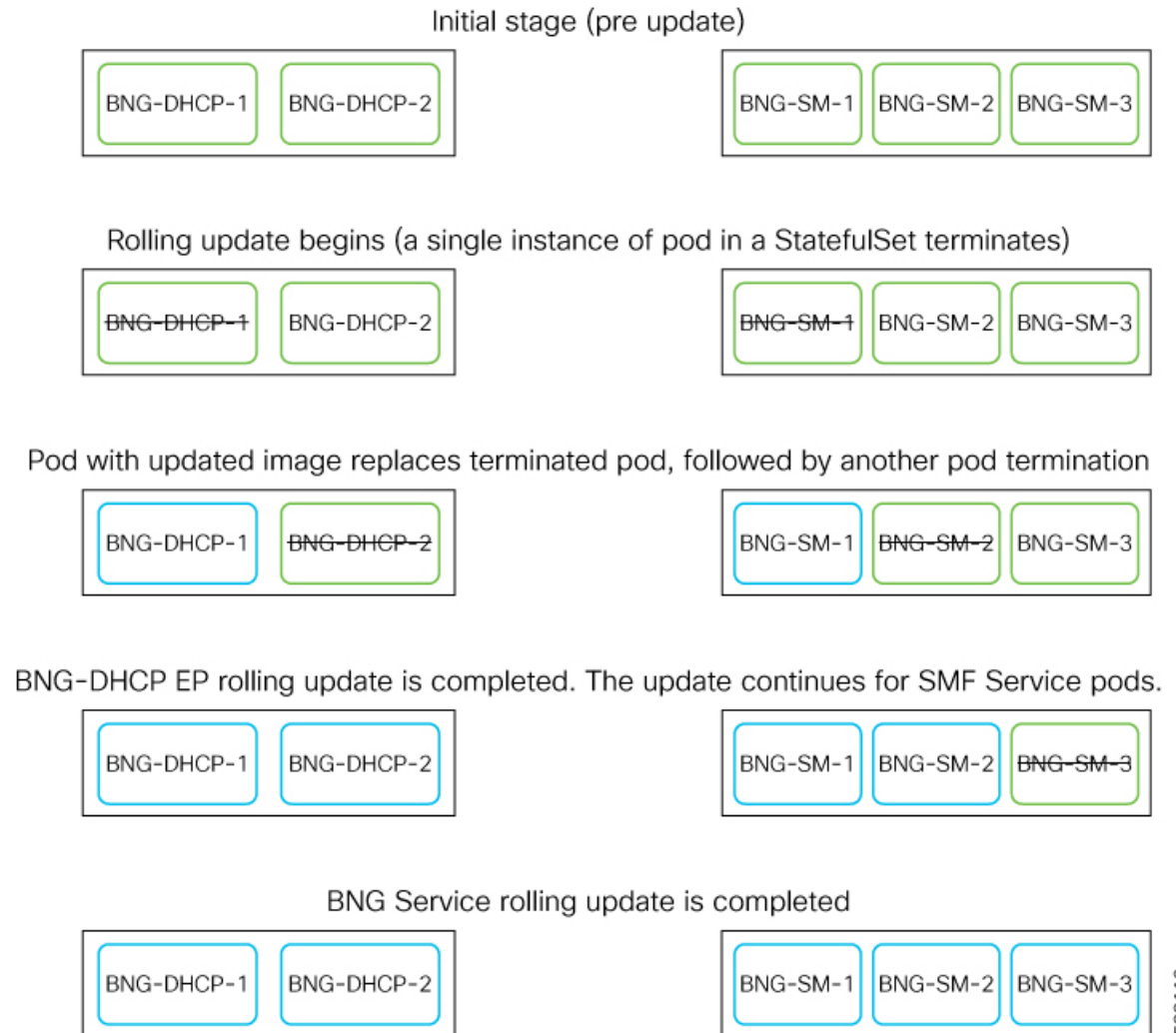
Rolling Software Update Using SMI Cluster Manager

Rolling software upgrade is a process of upgrading or migrating the build from an older to a newer version or upgrading the patch for the prescribed deployment set of application pods.

The cnBNG software update or in-service update procedure utilizes the K8s rolling strategy to update the pod images. In K8s rolling update strategy, the pods of a StatefulSet are updated sequentially to ensure that the ongoing process continues. Initially, a rolling update on a StatefulSet causes a single pod instance to terminate. A pod with an updated image replaces the terminated pod. This process continues until all the replicas of the StatefulSet are updated. The terminating pods exit gracefully after completing all the ongoing processes. Other in-service pods continue to receive and process the traffic with minimal impact. Use the Ops Center CLI to control the software update process.

The following figure illustrates an cnBNG rolling update for bng-dhcp and bng-sm endpoint pods (two replicas) on Protocol worker nodes along with cnBNG Service pods (three replicas) on Service worker nodes.

Figure 19: cnBNG Rolling Update



522110

Installing the Rolling Software Update

This section describes how to install the cnBNG Rolling Software Update feature.

The Rolling Software Update feature involves the following procedures.

Prerequisites

The prerequisites for installing the rolling software update for cnBNG are as follows:

- Ensure that all the nodes, including all the pods in the node, are up and running.
- Perform the cnBNG health check.
- Prepare for the upgrade.
- Backup the Ops Center configuration.
- Backup the CEE and BNG Ops Center configuration.
- Stage a new cnBNG image.



Attention

Trigger rolling upgrade only when the CPU usage of the nodes is less than 50%.

Performing the cnBNG Health Check

Perform the cnBNG health check to ensure that all the services are running and nodes are in ready state. To perform an health check, log in to the master node and use the following configuration:

```
kubectl get pods -n smi
kubectl get nodes
kubectl get pod --all-namespaces -o wide
kubectl get pods -n bng-bng -o wide
kubectl get pods -n cee-global -o wide
kubectl get pods -n smi-vips -o wide
helm list -A
kubectl get pods -A | wc -l
```



Important

Ensure that all the services are running and nodes are in ready state before proceeding further.

**Note**

- Static calls would not be impacted due to rolling upgrade.
- Inflight transactions and events will see failure during the rolling upgrade.
- For about 1-2 minutes downtime (that is, 100% transaction failures) is expected during upgrade with the suggested replica counts for 500K scale & 1000 CPS. Note: We can achieve zero downtime by increasing the number of replicas for each of the pods [dhcp, sm, pppoe], but that comes with the cost of additional resources.

Backing Up Ops Center Configuration

This section describes the procedure involved in creating a backup of the Ops Center configurations. To backup the Ops Center configurations:

1. Log in to SMI Cluster Manager node as an **ubuntu** user.
2. Run the following command to backup the SMI Ops Center configuration to **/home/ubuntu/smiops.backup** file.

```
ssh -p <port_number> admin@$(kubectl get svc -n smi | grep
'.*netconf.*<port_number>' | awk '{ print $4 }') "show run | nomore"
> smiops.backup_$(date +%m%d%Y_T%H%M')
```

3. Run the following command to backup the CEE Ops Center configuration to **/home/ubuntu/ceeops.backup** file.

```
ssh admin@<cee-vip> "show run | nomore" > ceeops.backup_$(date
+%m%d%Y_T%H%M')
```

4. Run the following command to backup the BNG Ops Center configuration to **/home/ubuntu/bngops.backup** file.

```
ssh admin@<bng-vip> "show run | nomore" > bngops.backup_$(date
+%m%d%Y_T%H%M')
```

Backing Up CEE and BNG Ops Center Configuration

This section describes the procedure involved in creating a backup of CEE and BNG Ops Center configuration from the master node. To perform a backup of CEE and BNG Ops Center configuration:

1. Log in to the master node as an **ubuntu** user.
2. Create a directory to backup the configuration files.
3. Backup the BNG Ops Center configuration and verify the line count of the backup files.

```
mkdir backups_$(date +%m%d%Y_T%H%M') && cd "$_"
ssh -p <port_number> admin@$(kubectl get svc -n $(kubectl get namespaces
| grep -oP 'bng-(\d+|\w+)') | grep <port_number> | awk '{ print $3
}') "show run | nomore" > bngops.backup_$(date +%m%d%Y_T%H%M') && wc
-l bngops.backup_$(date +%m%d%Y_T%H%M')
```

Example:

```

ubuntu@pobng-mas01:~/backups_09182019_T2141$ ssh -p 2024 admin@$(kubectl get svc -n
$(kubectl get namespaces | grep -oP 'bng-(\d+|\w+)') | grep <port_number> | awk '{ print
$3 }') "show run | nomore" > bngops.backup_$(date +%m%d%Y_T%H%M') && wc -l
bngops.backup_$(date +%m%d%Y_T%H%M')
admin@<ipv4address>'s password: bng-OPS-PASSWORD
334 bngops.backup

```

4. Backup the CEE Ops Center configuration and verify the line count of the backup files.

```

ssh -p <port_number> admin@$(kubectl get svc -n $(kubectl get namespaces
| grep -oP 'cee-(\d+|\w+)') | grep <port_number> | awk '{ print $3
}') "show run | nomore" > ceeps.backup_$(date +%m%d%Y_T%H%M') && wc
-l ceeps.backup_$(date +%m%d%Y_T%H%M')

```

Example:

```

ubuntu@pobng-mas01:~/backups_09182019_T2141$ ssh -p <port_number> admin@$(kubectl get
svc -n $(kubectl get namespaces | grep -oP 'cee-(\d+|\w+)') | grep <port_number> | awk
'{ print $3 }') "show run | nomore" > ceeps.backup_$(date +%m%d%Y_T%H%M') && wc -l
ceeps.backup_$(date +%m%d%Y_T%H%M')
admin@<ipv4address>'s password: CEE-OPS-PASSWORD
233 ceeps.backup

```

5. Move the SMI Ops Center backup file (from the SMI Cluster Manager) to the backup. directory.

```

scp $(grep cm01 /etc/hosts | awk '{ print $1
}'):/home/ubuntu/smiops.backup_$(date +%m%d%Y_T%H%M') .

```

Example:

```

ubuntu@pobng-mas01:~/backups_09182019_T2141$ scp $(grep cm01 /etc/hosts | awk '{ print
$1 }'):/home/ubuntu/smiops.backup_$(date +%m%d%Y_T%H%M') .
ubuntu@<ipv4address>'s password: SMI-CM-PASSWORD
smiops.backup                               100% 9346      22.3MB/s
00:00

```

6. Verify the line count of the backup files.

Example:

```

ubuntu@pobng-mas01:~/backups_09182019_T2141$ wc -l *
233 ceeps.backup
334 bngops.backup
361 smiops.backup
928 total

```

Staging a New cnBNG Image

The SMI Deployer downloads the new image and verifies it. Provide sha256 details in the "software cnf" section:

```

software cnf bng.2021.04.0.i96
url
https://cisco-maestro.cisco.com/artifactory/role-cnf-data-release/element/builds/2021.04.0/bng/2021.04.0.i96/bng.2021.04.0.i96-offline/bng.2021.04.0.i96.SHA256.txt
user testuser-deployer.gen
password $8$L1KSfQG9oMTkulzRxFjPTRsOH107S9qUVsLgDcFqJ04=
accept-self-signed-certificate true
sha256 d3a440be0e6080f2a83dc3d4e20121f2ceddadd0368a1d1bf41e567a397d35e0
exit

```

Performing Rolling Software Update

The cnBNG uses the SMI Cluster Manager to perform a rolling software update. To update cnBNG using the SMI Cluster Manager:



Important

Ensure that cnBNG is up and running with the current version of the software.

1. Log in to SMI Cluster Manager Ops Center.
2. Update the product repository URL with the latest version of the product chart.



Note If the repository URL contains multiple versions, the Ops Center automatically selects the latest version.

configure

```
cluster cluster_name
ops-centers app_name bng_instance_name
repository-local local_repository
exit
exit
```

Example:

```
SMI Cluster Manager# config
SMI Cluster Manager(config)# clusters test2
SMI Cluster Manager(config-clusters-test2)# ops-centers bng bng
SMI Cluster Manager(config-ops-centers-bng/bng)# repository-local <reference to the
locally downloaded image>
SMI Cluster Manager(config-ops-centers-bng/bng)# exit
SMI Cluster Manager(config-clusters-test2)# exit
```

3. Run the **cluster sync** command to update to the latest version of the product chart.

```
clusters cluster_name actions sync run
```

Example:

```
SMI Cluster Manager# clusters test2 actions sync run
```



Important

- The cluster synchronization updates the BNG Ops Center, which in turn updates the application pods (through **helm sync** command) in sequence, automatically.
- When the rolling upgrade is in progress on a specific pod, the cnBNG avoids routing new calls to that pod.
- The cnBNG waits for 30 seconds before restarting the pod where rolling upgrade is initiated. Also, the cnBNG establishes all the in-progress calls completely within 30 seconds during the upgrade period (maximum call-setup time is 10 seconds).

**Note**

- **cluster** –Specifies the K8s cluster.
- **cluster_name** –Specifies the name of the cluster.
- **ops-centers app_name instance_name** – Specifies the product Ops Center and instance. *app_name* is the application name. *instance_name* is the name of the instance.
- **repository url**–Specifies the local registry URL for downloading the charts.
- **actions** –Specifies the actions performed on the cluster.
- **sync run** –Triggers the cluster synchronization.

Monitoring the Rolling Software Update

Use the following sample configuration to monitor the status of the Rolling Software Update using the SMI Cluster Manager Ops Center:

config

```
clusters cluster_name actions sync run debug true
clusters cluster_name actions sync logs
monitor sync-logs cluster_name
clusters cluster_name actions sync status
exit
```

NOTES:

- **clusters cluster_name**–Specifies the information about the nodes to be deployed. *cluster_name* is the name of the cluster.
- **actions**–Specifies the actions performed on the cluster.
- **sync run**–Triggers the cluster synchronization.
- **sync logs**–Shows the current cluster synchronization logs.
- **sync status**–Shows the current status of the cluster synchronization. **debug true**–Enters the debug mode.
- **monitor sync logs**–Monitors the cluster synchronization process.

Example:

```
SMI Cluster Manager# clusters test1 actions sync run
SMI Cluster Manager# clusters test1 actions sync run debug true
SMI Cluster Manager# clusters test1 actions sync logs
SMI Cluster Manager# monitor sync-logs test1
SMI Cluster Manager# clusters test1 actions sync status
```

**Important**

To view the pod details after the upgrade through CEE Ops Center, see [Viewing the Pod Details, on page 225](#).

Viewing the Pod Details

Use the following sample configuration to view the details of the current pods through CEE Ops Center (in CEE Ops Center CLI):

```
cluster pods instance_name pod_name detail
```

NOTES:

- **cluster pods**—Specifies the current pods in the cluster.
- *instance_name*—Specifies the name of the instance.
- *pod_name*—Specifies the name of the pod.
- **detail**—Displays the details of the specified pod.

The following example displays the details of the pod named udp-proxy-0 in the bng-bng instance.

Example:

```
svi-cn-bng-tb4/global] cee# cluster pods bng-bng udp-proxy-0 detail
details apiVersion: "v1"
kind: "Pod"
metadata:
  annotations:
    prometheus.io/port: "8083"
    prometheus.io/scrape: "true"
    sidecar.istio.io/inject: "false"
  creationTimestamp: "2021-10-25T00:19:28Z"
  generateName: "udp-proxy-"
  labels:
    component: "udp-proxy"
    controller-revision-hash: "udp-proxy-5444cc5d74"
    instanceId: "1"
    release: "bng-bng-udp-proxy"
    statefulset.kubernetes.io/pod-name: "udp-proxy-0"
  managedFields:
  - apiVersion: "v1"
    fieldsType: "FieldsV1"
    fieldsV1:
      f:metadata:
        f:annotations:
          .: {}
          f:prometheus.io/port: {}
          f:prometheus.io/scrape: {}
          f:sidecar.istio.io/inject: {}
        f:generateName: {}
        f:labels:
          .: {}
          f:component: {}
          f:controller-revision-hash: {}
          f:instanceId: {}
          f:release: {}
          f:statefulset.kubernetes.io/pod-name: {}
        f:ownerReferences:
          .: {}
          k:{"uid":"914265b3-8b5b-4301-9433-c748e791c332"}:
            .: {}
            f:apiVersion: {}
            f:blockOwnerDeletion: {}
            f:controller: {}
            f:kind: {}
```

```

      f:name: {}
      f:uid: {}
f:spec:
  f:affinity:
    .: {}
    f:nodeAffinity:
      .: {}
      f:requiredDuringSchedulingIgnoredDuringExecution:
        .: {}
        f:nodeSelectorTerms: {}
    f:podAntiAffinity:
      .: {}
      f:requiredDuringSchedulingIgnoredDuringExecution: {}
f:containers:
  k:{"name":"udp-proxy"}:
    .: {}
    f:command: {}
    f:env:
      .: {}
      k:{"name":"APPLICATION_NAME"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"CLUSTER_NAME"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"COVERAGE_BUILD"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"CPS_PATCH"}:
        .: {}
        f:name: {}
      k:{"name":"DATACENTER_NAME"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"ENABLE_ADD_DYNAMIC_BGP_ROUTE"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"ENABLE_RETRY_CONFIG"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"ENABLE_SGW_CACHE"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"ENABLE_TP_FEATURE"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"GOGC"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"GOMAXPROCS"}:
        .: {}
        f:name: {}
        f:value: {}
      k:{"name":"GOTRACEBACK"}:
        .: {}

```



```

      f:name: {}
      f:value: {}
k:{"name":"GR_INSTANCE_ID"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"INFRA_ADMIN_PORT"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"INFRA_DIAG_PORT"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"INFRA_PROMETHEUS_PORT"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"INSTANCE_NODE_ID"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"IPC_EP_PORT"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"MY_POD_IP"}:
  .: {}
  f:name: {}
  f:valueFrom:
    .: {}
    f:fieldRef:
      .: {}
      f:apiVersion: {}
      f:fieldPath: {}
k:{"name":"MY_POD_NAME"}:
  .: {}
  f:name: {}
  f:valueFrom:
    .: {}
    f:fieldRef:
      .: {}
      f:apiVersion: {}
      f:fieldPath: {}
k:{"name":"PPROF_EP_PORT"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"PROTOCOL_POD"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"PROXY_KEEPAIVED_PORT"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"SERVICE_NAME"}:
  .: {}
  f:name: {}
  f:value: {}
k:{"name":"SMF_PROFILE_CONFIGURED"}:
  .: {}
  f:name: {}
  f:value: {}

```

```

f:image: {}
f:imagePullPolicy: {}
f:name: {}
f:readinessProbe:
  .: {}
  f:failureThreshold: {}
  f:initialDelaySeconds: {}
  f:periodSeconds: {}
  f:successThreshold: {}
  f:tcpSocket:
    .: {}
    f:host: {}
    f:port: {}
  f:timeoutSeconds: {}
f:resources:
  .: {}
  f:limits:
    .: {}
    f:cpu: {}
    f:memory: {}
  f:requests:
    .: {}
    f:cpu: {}
    f:memory: {}
f:terminationMessagePath: {}
f:terminationMessagePolicy: {}
f:volumeMounts:
  .: {}
  k:{"mountPath":"/config/udp-proxy/coverage"}:
    .: {}
    f:mountPath: {}
    f:name: {}
    f:readOnly: {}
  k:{"mountPath":"/config/udp-proxy/flowcontrol"}:
    .: {}
    f:mountPath: {}
    f:name: {}
    f:readOnly: {}
  k:{"mountPath":"/config/udp-proxy/logging"}:
    .: {}
    f:mountPath: {}
    f:name: {}
    f:readOnly: {}
  k:{"mountPath":"/config/udp-proxy/system"}:
    .: {}
    f:mountPath: {}
    f:name: {}
    f:readOnly: {}
  k:{"mountPath":"/config/udp-proxy/vip-ip"}:
    .: {}
    f:mountPath: {}
    f:name: {}
    f:readOnly: {}
f:dnsPolicy: {}
f:enableServiceLinks: {}
f:hostNetwork: {}
f:hostname: {}
f:imagePullSecrets:
  .: {}
  k:{"name":"regcredbng"}:
    .: {}
    f:name: {}
f:restartPolicy: {}
f:schedulerName: {}

```

```

f:securityContext: {}
f:subdomain: {}
f:terminationGracePeriodSeconds: {}
f:volumes:
  .: {}
  k:{"name":"coverage-volume"}:
    .: {}
    f:configMap:
      .: {}
      f:defaultMode: {}
      f:items: {}
      f:name: {}
    f:name: {}
  k:{"name":"flowcontrol-volume"}:
    .: {}
    f:configMap:
      .: {}
      f:defaultMode: {}
      f:items: {}
      f:name: {}
      f:optional: {}
    f:name: {}
  k:{"name":"logging-volume"}:
    .: {}
    f:configMap:
      .: {}
      f:defaultMode: {}
      f:items: {}
      f:name: {}
    f:name: {}
  k:{"name":"system-volume"}:
    .: {}
    f:configMap:
      .: {}
      f:defaultMode: {}
      f:items: {}
      f:name: {}
    f:name: {}
  k:{"name":"vip-ip-volume"}:
    .: {}
    f:configMap:
      .: {}
      f:defaultMode: {}
      f:items: {}
      f:name: {}
    f:name: {}
manager: "kube-controller-manager"
operation: "Update"
time: "2021-10-25T00:19:28Z"
- apiVersion: "v1"
  fieldsType: "FieldsV1"
  fieldsV1:
    f:status:
      f:conditions:
        k:{"type":"ContainersReady"}:
          .: {}
          f:lastProbeTime: {}
          f:lastTransitionTime: {}
          f:status: {}
          f:type: {}
        k:{"type":"Initialized"}:
          .: {}
          f:lastProbeTime: {}
          f:lastTransitionTime: {}

```

```

      f:status: {}
      f:type: {}
    k:{"type":"Ready"}:
      .: {}
      f:lastProbeTime: {}
      f:lastTransitionTime: {}
      f:status: {}
      f:type: {}
    f:containerStatuses: {}
    f:hostIP: {}
    f:phase: {}
    f:podIP: {}
    f:podIPs:
      .: {}
      k:{"ip":"208.208.208.21"}:
        .: {}
        f:ip: {}
      f:startTime: {}
    manager: "kubelet"
    operation: "Update"
    time: "2021-10-25T00:19:38Z"
  name: "udp-proxy-0"
  namespace: "bng-bng"
  ownerReferences:
  - apiVersion: "apps/v1"
    kind: "StatefulSet"
    blockOwnerDeletion: true
    controller: true
    name: "udp-proxy"
    uid: "914265b3-8b5b-4301-9433-c748e791c332"
  resourceVersion: "1557892"
  uid: "d519c85b-baae-4131-925b-df46e72757ac"
spec:
  affinity:
    nodeAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        nodeSelectorTerms:
        - matchExpressions:
          - key: "smi.cisco.com/vm-type"
            operator: "In"
            values:
            - "protocol"
    podAntiAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        - labelSelector:
            matchExpressions:
            - key: "component"
              operator: "In"
              values:
              - "udp-proxy"
          topologyKey: "kubernetes.io/hostname"
  containers:
  - command:
    - "/usr/local/bin/run-app"
    env:
    - name: "GOGC"
      value: "200"
    - name: "GOTRACEBACK"
      value: "crash"
    - name: "GOMAXPROCS"
      value: "12"
    - name: "CPS_PATCH"
    - name: "SERVICE_NAME"
      value: "udp-proxy"

```

```

- name: "INFRA_PROMETHEUS_PORT"
  value: "8083"
- name: "INFRA_ADMIN_PORT"
  value: "8879"
- name: "INFRA_DIAG_PORT"
  value: "8979"
- name: "PPROF_EP_PORT"
  value: "8850"
- name: "IPC_EP_PORT"
  value: "9004"
- name: "PROXY_KEEPAIVED_PORT"
  value: "28000"
- name: "ENABLE_RETRY_CONFIG"
  value: "true"
- name: "COVERAGE_BUILD"
  value: "false"
- name: "DATACENTER_NAME"
  value: "DC"
- name: "CLUSTER_NAME"
  value: "Local"
- name: "APPLICATION_NAME"
  value: "BNG"
- name: "INSTANCE_NODE_ID"
  value: "0"
- name: "GR_INSTANCE_ID"
  value: "1"
- name: "SMF_PROFILE_CONFIGURED"
  value: "false"
- name: "ENABLE_TP_FEATURE"
  value: "true"
- name: "ENABLE_ADD_DYNAMIC_BGP_ROUTE"
  value: "true"
- name: "ENABLE_SGW_CACHE"
  value: "true"
- name: "PROTOCOL_POD"
  value: "bng-n4-protocol"
- name: "MY_POD_IP"
  valueFrom:
    fieldRef:
      apiVersion: "v1"
      fieldPath: "status.podIP"
- name: "MY_POD_NAME"
  valueFrom:
    fieldRef:
      apiVersion: "v1"
      fieldPath: "metadata.name"
image:
"docker.10.81.103.113.nip.io/bng.2021.04.0.i105/mobile-cnat-cn/udp-proxy/rel-2021.04/udp_proxy:0.1.1-16b9200-fe3d3ad-27f9489"

imagePullPolicy: "IfNotPresent"
name: "udp-proxy"
readinessProbe:
  failureThreshold: 3
  initialDelaySeconds: 6
  periodSeconds: 5
  successThreshold: 1
  tcpSocket:
    host: "127.0.0.1"
    port: 28000
  timeoutSeconds: 1
resources:
  limits:
    cpu: "3"
    memory: "32Gi"

```

```

    requests:
      cpu: "3"
      memory: "8Gi"
    terminationMessagePath: "/dev/termination-log"
    terminationMessagePolicy: "File"
    volumeMounts:
    - mountPath: "/config/udp-proxy/logging"
      name: "logging-volume"
      readOnly: true
    - mountPath: "/config/udp-proxy/vip-ip"
      name: "vip-ip-volume"
      readOnly: true
    - mountPath: "/config/udp-proxy/system"
      name: "system-volume"
      readOnly: true
    - mountPath: "/config/udp-proxy/flowcontrol"
      name: "flowcontrol-volume"
      readOnly: true
    - mountPath: "/config/udp-proxy/coverage"
      name: "coverage-volume"
      readOnly: true
    - mountPath: "/var/run/secrets/kubernetes.io/serviceaccount"
      name: "kube-api-access-hn2p5"
      readOnly: true
    dnsPolicy: "ClusterFirstWithHostNet"
    enableServiceLinks: true
    hostNetwork: true
    hostname: "udp-proxy-0"
    imagePullSecrets:
    - name: "regcredbng"
    nodeName: "svi-cn-bng-tb4-proto2"
    preemptionPolicy: "PreemptLowerPriority"
    priority: 100000000
    priorityClassName: "default-application"
    restartPolicy: "Always"
    schedulerName: "default-scheduler"
    securityContext: {}
    serviceAccount: "default"
    serviceAccountName: "default"
    subdomain: "udp-proxy-11"
    terminationGracePeriodSeconds: 30
    tolerations:
    - effect: "NoExecute"
      key: "node.kubernetes.io/not-ready"
      operator: "Exists"
      tolerationSeconds: 30
    - effect: "NoExecute"
      key: "node.kubernetes.io/unreachable"
      operator: "Exists"
      tolerationSeconds: 30
    volumes:
    - configMap:
        defaultMode: 420
        items:
        - key: "logging"
          path: "logging.yaml"
        name: "infra-logging-conf"
      name: "logging-volume"
    - configMap:
        defaultMode: 420
        items:
        - key: "endpointIp"
          path: "endpointIp.yaml"
        name: "udp-proxy-vip-ip-conf"

```

```

    name: "vip-ip-volume"
  - configMap:
      defaultMode: 420
      items:
        - key: "system"
          path: "system.yaml"
          name: "infra-system-conf"
      name: "system-volume"
  - configMap:
      defaultMode: 420
      items:
        - key: "flowcontrol"
          path: "flowcontrol.yaml"
          name: "udp-proxy-flowcontrol-conf"
          optional: true
      name: "flowcontrol-volume"
  - configMap:
      defaultMode: 420
      items:
        - key: "coverage"
          path: "coverage.yaml"
          name: "udp-proxy-coverage-conf"
      name: "coverage-volume"
  - name: "kube-api-access-hn2p5"
    projected:
      defaultMode: 420
      sources:
        - serviceAccountToken:
            expirationSeconds: 3607
            path: "token"
        - configMap:
            items:
              - key: "ca.crt"
                path: "ca.crt"
                name: "kube-root-ca.crt"
        - downwardAPI:
            items:
              - fieldRef:
                  apiVersion: "v1"
                  fieldPath: "metadata.namespace"
                path: "namespace"
status:
  conditions:
    - lastTransitionTime: "2021-10-25T00:19:28Z"
      status: "True"
      type: "Initialized"
    - lastTransitionTime: "2021-10-25T00:19:38Z"
      status: "True"
      type: "Ready"
    - lastTransitionTime: "2021-10-25T00:19:38Z"
      status: "True"
      type: "ContainersReady"
    - lastTransitionTime: "2021-10-25T00:19:28Z"
      status: "True"
      type: "PodScheduled"
  containerStatuses:
    - containerID: "docker://9365e5d78de9e7edf427ee92f3aa7e74c4fdf5070874c89045079a1586199358"

      image:
"docker.10.81.103.113.nip.io/bng.2021.04.0.i105/mobile-cnat-cn/udp-proxy/rel-2021.04/udp_proxy:0.1.1-16b9200-fe3d3ad-27f9489"

      imageID:
"docker.10.81.103.113.nip.io/bng.2021.04.0.i105/mobile-cnat-cn/udp-proxy/rel-2021.04/udp_proxy:0.1.1-16b9200-fe3d3ad-27f9489"

```

```
lastState: {}
name: "udp-proxy"
ready: true
restartCount: 0
started: true
state:
  running:
    startedAt: "2021-10-25T00:19:29Z"
hostIP: "208.208.208.21"
phase: "Running"
podIP: "208.208.208.21"
podIPs:
- ip: "208.208.208.21"
qosClass: "Burstable"
startTime: "2021-10-25T00:19:28Z"

[svi-cn-bng-tb4/global] cee#
```




CHAPTER 18

Subscriber Manager

- [Feature Summary and Revision History, on page 235](#)
- [Feature Description, on page 236](#)
- [Configuring Subscriber Manager Features, on page 238](#)
- [Automatic Session Reconciliation, on page 243](#)
- [Framed Route Support, on page 243](#)
- [Subscriber Accounting Functions, on page 245](#)
- [Subscriber QoS Policy, on page 247](#)

Feature Summary and Revision History

Summary Data

Table 50: Summary Data

Applicable Product(s) or Functional Area	cnBNG
Applicable Platform(s)	SMI
Feature Default Setting	Disabled - Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	<i>Cloud Native BNG Control Plane Command Reference Guide</i>

Revision History

Table 51: Revision History

Revision Details	Release
Enhancement Introduced: The Subscriber Manager feature is NSO-integrated.	2021.04.0

Revision Details	Release
The following features are supported: <ul style="list-style-type: none"> • Automatic Session Reconciliation • Framed Route Support • Subscriber QoS Policy 	2021.03.0
First introduced.	2021.01.0

Feature Description



Note This feature is Network Services Orchestrator (NSO) integrated.

In the Subscriber Manager (SM) context, a subscriber is a binding between the cnBNG Control Plane (CP) and a single subscriber end device. The SM is designed to provide a generic mechanism to connect edge subscribers to services enabling features. Subscribers are identified, authenticated, authorized, and accounted for in the SM.



Note The Subscriber Manager is also referred to as the Session Manager.

The following is a high-level list of the SM functionalities:

- Provides a generic mechanism for different Broadband Access Protocols such as DHCP and PPPoE.
- Provides an interface with off-box Radius servers using policy-plane to meet protocol and network provisioning requirements.
- Supports different subscriber lifecycle events such as CoA, idle timeout processing, and periodic reauthorization.
- Provides support for configuring subscriber lifecycle events that help customer define the subscriber behavior for the different subscriber lifecycle events.
- Derives per subscriber configuration from multiple sources.
- Maintains the subscriber state and subscriber configuration in a centralized session database.
- Interacts with the User Plane (UP) for subscriber session creation and subscriber feature configurations.

Subscriber features that are configured on cnBNG enable service providers to deploy certain specific functionalities like restricting the use of certain network resources, allowing Law Enforcement Agencies (LEAs) to conduct electronic surveillance, and so on.

Subscriber Features

The cnBNG supports the following subscriber features on the UP. For details, see the latest version of the Broadband Network Gateway Configuration Guide for Cisco ASR 9000 Series Routers listed here: <https://www.cisco.com/c/en/us/support/routers/asr-9000-series-aggregation-services-routers/products-installation-and-configuration-guides-list.html>.

- IPv4 or IPv6
 - Maximum Transmission Unit (MTU)
 - Unicast Reverse Path Forwarding (URPF)
 - Internet Control Message Protocol (ICMP)
- Access Control List (ACL)
 - Input ACL (IPv4 or IPv6)
 - Output ACL (IPv4 or IPv6)
- QoS (Quality of Service)
 - Input (policing)
 - Output (policing, shaping)
 - Policy merging (up to 6 policy maps and 10 class maps, including the default)
- Policy-based Routing (PBR)
 - Input policy (HTTP redirect)
- Accounting
 - Session Accounting
 - Periodic accounting
 - Service Accounting
 - Periodic accounting

To configure subscriber features, see [Configuring Subscriber Manager Features](#), on page 238.

How it Works

This section provides a brief about how the Subscriber Manager works.

The SM functionality is hosted in a SM pod having one container in it. The SM pod communicates with the BNG Ops Center, policy-plane, and PFCP-EP pods using the APP infrastructure inter-pod communication (IPC).

The Subscriber Microservices Infrastructure (SMI) instantiates the SM pod. There can be more than one SM pod in the cluster. Each SM pod instance is independent. The per subscriber data is stored in a centralized database such that any SM pod can access this data.

Configuring Subscriber Manager Features

This section describes how to configure Subscriber Manager features on the CP.

The configuration of the Subscriber Manager features involves the following procedures:

- [Configuring the HTTPR Policy Name, on page 238](#)
- [Configuring IPv4 Options, on page 238](#)
- [Configuring IPv6 Options, on page 239](#)
- [Configuring QoS Parameters](#)
- [Configuring the VRF Name, on page 240](#)
- [Configuring a Subscriber Profile, on page 240](#)



Note

- To configure PPP feature options, see [Creating the PPP Feature Template, on page 214](#)
 - To configure service accounting, see [Configuring Service Accounting, on page 246](#)
 - To configure session accounting, see [Configuring Session Accounting, on page 247](#)
-

Configuring the HTTPR Policy Name

Use the following commands to configure the Policy Based Routing (PBR) HTTP Redirect (HTTPR) policy name.

```
configure
  profile feature-template feature_template_name
  http-policy http_policy_name
exit
```

NOTES:

- **profile feature-template** *feature_template_name*: Specifies the profile feature template name.
- **http-policy** *http_policy_name*: Specifies the PBR HTTPR policy name. The *http_policy_name* value can range from 1 to 128 characters.

Configuring IPv4 Options

Use the following commands to configure IPv4 options.

```
configure
  profile feature-template feature_template_name
  ipv4
    disable-unreachables
    egress-acl string
    ingress-acl string
```

```

mtu mtu_bytes
verify-unicast-source reachable-via-rx
exit

```

NOTES:

- **profile feature-template** *feature_template_name*: Specifies the profile feature template name.
- **ipv4**: Enters the IPv4 Configuration mode to configure the IPv4 features.
- **disable-unreachables**: Disables sending the Internet Control Message Protocol (ICMP) Unreachable messages.
- **egress-acl** *string*: Specifies the IPv4-based egress Access Control List (ACL) list. The supported length of the *string* ranges from 1 to 128 characters.
- **ingress-acl** *string*: Specifies the IPv4-based ingress ACL list. The supported length of the *string* ranges from 1 to 128 characters.
- **mtu** *mtu_bytes*: Specifies the maximum transmission unit (MTU). The supported *mtu_bytes* value can range from 68 to 65535 bytes.
- **verify-unicast-source reachable-via-rx** : Enables per packet validation for unicast. The source is reachable via the interface on which packet is received.

Configuring IPv6 Options

Use the following commands to configure IPv6 options.

```

configure
profile feature-template feature_template_name
ipv6
  disable-unreachables
  egress-acl string
  ingress-acl string
  mtu mtu_bytes
  verify-unicast-source reachable-via-rx
exit

```

NOTES:

- **profile feature-template** *feature_template_name*: Specifies the profile feature template name.
- **ipv6**: Enters the IPv6 Configuration mode to configure the IPv6 features.
- **disable-unreachables**: Disables sending the Internet Control Message Protocol (ICMP) Unreachable messages.
- **egress-acl** *string*: Specifies the IPv6-based egress Access Control List (ACL) list. The supported length of the *string* ranges from 1 to 128 characters.
- **ingress-acl** *string*: Specifies the IPv6-based ingress ACL list. The supported length of the *string* ranges from 1 to 128 characters.
- **mtu** *mtu_bytes*: Specifies the maximum transmission unit (MTU). The supported *mtu_bytes* value can range from 68 to 65535 bytes.

- **verify-unicast-source reachable-via-rx** : Enables per packet validation for unicast. The source is reachable via the interface on which packet is received.

Configuring QoS Parameters

Use the following commands to configure the Quality of Service (QoS) parameters.

```
configure
  profile feature-template feature_template_name
  qos
    in-policy qos_input_policy_name
    merge-level integer
    out-policy qos_output_policy_name
  exit
```

NOTES:

- **profile feature-template** *feature_template_name*: Specifies the profile feature template name.
- **qos**: Enters the QoS Configuration mode to configure the parameters.
- **in-policy** *qos_input_policy_name*: Specifies the QoS input policy name. The supported length of the *qos_input_policy_name* ranges from 1 to 128 characters.
- **merge-level** *integer* : Enables or disables the merge level. A merge value of 0 disables the merge-level. Any value greater than 0, enables the merge level.
- **out-policy** *qos_output_policy_name*: Specifies the QoS output policy name. The supported length of the *qos_output_policy_name* ranges from 1 to 128 characters.

Configuring the VRF Name

Use the following commands to configure the virtual routing and forwarding (VRF) name.

```
configure
  profile feature-template feature_template_name
  vrf-name vrf_name
  exit
```

NOTES:

- **profile feature-template** *feature_template_name*: Specifies the profile feature template name.
- **vrf-name** *vrf_name*: Specifies the VRF name. The supported length of the *vrf_name* ranges from 1 to 128 characters.

Configuring a Subscriber Profile

Use the following commands to create a subscriber profile.

```
configure
  profile subscriber subscriber_profile
    aaa { authenticate aaa_profile_for_authentication
```

```

    | authorize aaa_profile_for_authorization }
activate-feature-template feature_template_name
apply-all-class
class class_name
    aaa aaa_profile_for_authentication | authorize aaa_profile_for_authorization
activate-feature-template feature_template_name
matches
    match { protocol { dhcp | ppp } } | username
        { ascii ascii_string |
          regex reg-exp string } |
    source-mac { ascii ascii_string |
               regex reg-exp string } |
    circuit-id { ascii ascii_string |
               regex reg-exp string } |
    remote-id { ascii ascii_string |
              regex reg-exp string }
    match-type { all match { protocol | username | source-mac |
                           circuit-id | remote-id } | any match { protocol | username |
                           source-mac | circuit-id | remote-id } }
    exit
dhcp-profile dhcp_profile_name
event event_name
pppoe-profile pppoe_profile_name
session-type { ipv4 | ipv4v6 | ipv6 }
exit

```

configure

```

profile subscriber subscriber_profile
    aaa { authenticate aaa_profile_for_authentication |
          authorize aaa_profile_for_authorization }
activate-feature-template feature_template_name
apply-all-class
class class_name
    aaa aaa_profile_for_authentication | authorize aaa_profile_for_authorization
activate-feature-template feature_template_name
matches
    match { protocol { dhcp | ppp } } | username { ascii
        ascii_string | regex reg-exp string}
        | source-mac { ascii ascii_string
                    | regex reg-exp string } |
    circuit-id { ascii ascii_string
               | regex reg-exp string } |
    remote-id { ascii ascii_string
              | regex reg-exp string }
    match-type { all match { protocol | username |
                           source-mac | circuit-id | remote-id } | any match {
        protocol | username | source-mac | circuit-id
        | remote-id } }
    exit
dhcp-profile dhcp_profile_name
event session-activate { aaa { authenticate | authorize } |
                        activate-feature-templates

```

```

feature_templates_list
| apply-all-class | class class_name
| deactivate-feature-templates
feature_templates_list

pppoe-profile pppoe_profile_name
session-type { ipv4 | ipv4v6 | ipv6 }
exit

```

NOTES:

- **profile subscriber** *subscriber_profile_name*: Specifies the profile subscriber name and enters the Profile Subscriber Configuration mode.
- **aaa** { **authenticate** *aaa_profile_for_authentication* | **authorize** *aaa_profile_for_authorization* }: Specifies the AAA profile to associate for authentication and authorization.
- **activate-feature-templates** *feature_template_name*: Specifies the list of feature-templates in sequence for activation.
- **apply-all-class**: Applies all classes that are enabled.
- **class** *class_name* : Specifies the subscriber class name.
- **matches**: Enters the matches Configuration sub-mode to specify the match values.
 - **match** { **protocol** { **dhcp** | **ppp** } | **username** { **ascii** *ascii_string* | **regex** *reg-exp string* } | **source-mac** { **ascii** *ascii_string* | **regex** *reg-exp string* } | { **circuit-id** { **ascii** *ascii_string* | **regex** *reg-exp string* } | **remote-id** { **ascii** *ascii_string* | **regex** *reg-exp string* } }: Specifies the list of match values.
 - **match** { **protocol** { **dhcp** | **ppp** } }: Specifies the match protocol as DHCP or PPP.
 - **username** { **ascii** *ascii_string* | **regex** *reg-exp string* } : Specifies the username in ascii format or regular express (reg-exp) string.
 - **source-mac** { **ascii** *ascii_string* | **regex** *reg-exp string* } : Specifies the source MAC address in ascii format or regular express (reg-exp) string.
 - **remote-id** { **ascii** *ascii_string* | **regex** *reg-exp string* } : Specifies the remote identifier in ascii format or regular express (reg-exp) string.
 - **circuit-id** { **ascii** *ascii_string* | **regex** *reg-exp string* } : Specifies the circuit identifier in ascii format or regular express (reg-exp) string.
 - **match-type** { **all match** { **protocol** | **username** | **source-mac** | **circuit-id** | **remote-id** } | **any match** { **protocol** | **username** | **source-mac** | **circuit-id** | **remote-id** } }: Specifies the match key and value for matching any or all of the options: protocol, username, source-mac, circuit-id, and remote-id.



Note By default **aaa**, **activate-feature-templates**, **apply-all-class**, and **class** are executed as part of the session bring-up. The PPPoE and DHCP access protocols use these events to create a subscriber in the SM. The operator may configure the AAA actions and activate-feature-templates, suitable for a subscriber.

- **dhcp-profile** *dhcp_profile_name*: Associates the DHCP first sign of life (FSOL) profile.
- **event** *event_list_name*: Specifies the event name.
- **event session-activate**: Specifies the subscriber event to activate.

Some Access-Protocols require a two-stage session bring up. For example with PPPoE subscribers, the PPPoE Access protocol will call the Session-Start event for FSOL followed by Session-Activate during PPP negotiation and authentication. The IPoE subscribers created by DHCP will not use this event. The operator may configure authenticate, authorize AAA actions and feature templates as suitable for a subscriber.

- **pppoe-profile** *pppoe_profile_name*: Associates the PPPoE FSOL profile.
- **session-type** { **ipv4** | **ipv4v6** | **ipv6** }: Specifies the allowed session-types as IPv4, IPv4v6, and IPv6.

Automatic Session Reconciliation

Feature Description

The Automatic Session Reconciliation feature enables reconciliation of sessions that are out of synchronization between the Control Plane (CP) and User Plane (UP).

Desynchronization of a session occurs when the transaction is successful in the UP but times out before receiving a response from the UP.

The existing transaction-id increments by 1 in every request initiated from the CP to the UP. The CDL record stores the transaction-id per session when the UP conveys a successful response to the CP. The UP also stores this transaction-id when the transaction is successful in the UP.

How it Works

This section briefly describes how the Automatic Session Reconciliation feature works.

The UP validates the transaction-id received in every request from the CP. When a received transaction-id is not incremental to the transaction-id present in UP, the UP discards the transaction and responds to the CP with a transaction-id mismatch error.

On receiving the transaction-id mismatch error, the CP discards the current transaction and initiates a new transaction to replay the complete session data to the UP. After this session replay, the session reconciles and synchronizes automatically in the CP and UP.

Framed Route Support

Feature Description

The Framed Route Support on subscriber sessions enables framed (dynamic) routes to be added for individual subscribers. Framed route per subscriber support is provided through RADIUS or Change of Authorization (CoA).

A framed route is pushed from the Control Plane (CP) to the User Plane (UP) only when the IP address is allocated for the respective address family indicator (AFI). The UP withdraws the framed route when the respective AFI goes down (for example, when an IP address is deallocated).

The configuration format of the framed route is as follows:

- **IPv4**

```
Framed-Route = "[vrf <prefix VRF>] {<prefix>/<prefix_length>} [vrf <next hop vrf>]
                [<next hop prefix>] [<metric>] [tag <tag-value>] "
Framed-Route = "[vrf <vrf-name>] {<prefix> <netmask>} [vrf <next hop vrf>]
                [<next hop prefix>]
                [<metric>] [tag <tag-value>] "
```

```
cisco-avpair = "[vrf <prefix VRF>] {<prefix>/<prefix_length>} [vrf <next hop vrf>]
                [<next hop prefix>] [<metric>] [tag <tag-value>] "
cisco-avpair = "[vrf <vrf-name>] {<prefix> <netmask>} [vrf <next hop vrf>]
                [<next hop prefix>]
                [<metric>] [tag <tag-value>] "
```

- **IPv6**

```
Framed-IPv6-Route = "[vrf <prefix VRF>] {<prefix>/<prefix_length>}
                    [vrf <next hop vrf>]
                    [<next-hop prefix>] [<metric>] [tag <tag-value>] "
cisco-avpair = "[vrf <prefix VRF>] {<prefix>/<prefix_length>} [vrf <next hop vrf>]
                [<next hop prefix>][<metric>] [tag <tag-value>] "
```

The description of the format of the framed route is as follows:

- [**vrf <prefix VRF>**]: This is an optional parameter. Specifies the virtual routing and forwarding (VRF) prefix.
- {<prefix>/<prefix_length>} or {<prefix> <netmask>}: This is a mandatory parameter. Specifies the prefix and prefix mask or prefix length for the destination.
- [**vrf <next hop vrf>**]: This is an optional parameter. Specifies the next hop VRF name.
- [**<next hop prefix>**]: This is an optional parameter. Specifies that when the next hop is specified as "0.0.0.0" for IPv4 or ":::" for IPv6, the IP address of the session must be used as the next hop prefix.
- [**<metric>**]: This is an optional parameter. Specifies the route metric.
- [**tag <tag-value>**]: This is an optional parameter. Specifies a tag value that can be used as a match for controlling redistribution using route policies.

For information about the framed-route attributes, see Table 1 and Table 2 in the [RADIUS Attributes, on page 249](#) chapter.

Implementing the framed (dynamic) route support depends on the UP. Therefore, check the *UP Cloud Native BNG User Plane Configuration Guide for Cisco ASR 9000 Series Router* for the following before enabling the framed route.

- IPv4 and IPv6 framed route support for PPP Termination and Aggregation (PTA) and IPoE
- VRF and next hop VRF support for PTA and IPoE

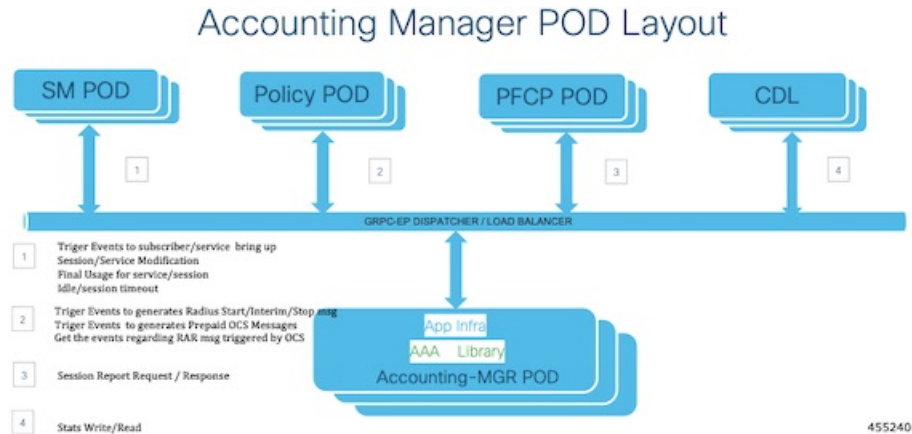
- CoA support for framed route for PTA and IPoE
- Maximum routes supported per subscriber per AFI for PTA and IPoE

Subscriber Accounting Functions

Feature Description

The Accounting Manager handles the Subscriber Accounting functions in the cnBNG CP. The Accounting function includes features that track traffic either in volume or duration. It provides accounting information for subscribers on a session or per service. The Accounting function determines the length and duration of a given service that a subscriber has used. Certain regulations require service providers to account for services they provide to the subscriber.

The following figure illustrates the Accounting Manager external interfaces.



The Accounting Manager in cnBNG supports the following forms of accounting:

Service Accounting

ISPs can offer different tiered services to their subscribers with the ability to move between different tiers. Different tiers could correspond to different bandwidths offered to the subscriber. A subscriber can enable a new service that corresponds to temporarily moving from one tier of service to another. ISPs need to keep track of when a new service is enabled and how long it is active for each subscriber. Often there might be a need to count the number of packets and bytes associated with a service. Both of these forms of accounting are referred to as service accounting. When service accounting is enabled, BNG sends a Service-Start request when service is activated and a Service-Stop request when the service is deactivated. A timestamp is sent with both the actions. Service-Stop can also contain statistics associated with the service.

To configure Service Accounting, see [Configuring Service Accounting, on page 246](#).

Session Accounting

When Session Accounting is activated, an Accounting-Start request is sent to AAA when the session is started. When the session is terminated, an Accounting-Stop request is sent. The Accounting-Stop request contains the final session accounting statistics (packets, bytes in, bytes out). An “interim” session accounting can be

optionally activated that sends Interim-Updates periodically while the session is active. These updates provide the current session statistics accumulated since the start of the session.

Session Accounting is configured directly on the template.

To configure Session Accounting, see [Configuring Session Accounting, on page 247](#).

Limitations and Restrictions

The Subscriber Accounting Function has the following limitation in this release:

- An interim Interval of zero is not supported.
- AAA profile change at service level is not supported.
- Service-level attributes changes are not supported after service bring-up.
- Session accounting is mandatory to enable Service accounting due to User Plane (UP) (asr9k) limitation.
- Session and Service Accounting enable or disable is not supported after session or service is up because of UP limitations. Session Accounting must be enabled only during session bring-up.

Configuring Subscriber Accounting Functions

This section describes how to configure the Subscriber Accounting Functions.

The configuration of the Subscriber Accounting Functions involve the following procedures:

- Configuring Service Accounting
- Configuring Session Accounting

Configuring Service Accounting

Use the following commands to configure service accounting.

```
configure
  profile feature-template feature-template
  service accounting
    aaa-profile aaa_profile_name
    enable
    periodic-interval interval_in_seconds
  exit
```

NOTES:

- **profile feature-template** *feature-template*: Specifies the profile feature template name and enters Feature-Template Configuration mode.
- **service accounting**: Enters the Service Configuration mode to configure service accounting for a AAA profile.
- **aaa-profile** *aaa_profile_name*: Specifies the AAA profile to use for service accounting.
- **enable**: Enables service accounting for the specified AAA profile.

- **periodic-interval** *interval_in_seconds*: Specifies the interim interval in seconds. The valid values range from 60 to 4320000 seconds.

Configuring Session Accounting

Use the following commands to configure session accounting.

```
configure
  profile feature-template feature-template
  session accounting
    aaa-profile aaa_profile_name
    dual-stack-delay delay_in_seconds
    enable
    periodic-interval interval_in_seconds
  exit
```

NOTES:

- **profile feature-template** *feature-template*: Specifies the profile feature template name and enters Feature-Template Configuration mode.
- **session accounting**: Enters the Session Configuration mode to configure session accounting for a AAA profile.
- **aaa-profile** *aaa_profile_name*: Specifies the AAA profile to use for session accounting.
- **dual-stack-delay** *delay_in_seconds*: Specifies the dual stack set delay time in seconds. The valid values range from 1 to 30 seconds.
- **enable**: Enables session accounting for the specified AAA profile.
- **periodic-interval** *interval_in_seconds*: Specifies the interim interval in seconds. The valid values range from 60 to 4320000 seconds.

Subscriber QoS Policy

Feature Description

The Subscriber Quality of Service (QoS) Policy feature uses the following Cisco AVPs to apply the subscriber QoS policy through RADIUS.

```
cisco-avpair = "subscriber:sub-qos-policy-in=<ingress qos policy name>"
cisco-avpair = "subscriber:sub-qos-policy-out=<egress qos policy name>",
```

Example:

```
radius profile
cisco-avpair = "subscriber:sub-qos-policy-in=qos_in_100mbps",
cisco-avpair = "subscriber:sub-qos-policy-out=qos_out_100mbps",
```

"qos_in_100mbps" and "qos_out_100mbps" are the QoS policy maps that are configured in the User Plane (UP). The merge-level and accounting features are not supported through RADIUS. If unsupported features are passed from RADIUS, behaviour is undefined.

Applying QoS from profile feature-template and through RADIUS using sub-qos-policy-in or sub-qos-policy-out is not supported for the same subscriber. When applied, behaviour is undefined.

For information about the sub-qos-policy-in or sub-qos-policy-out attributes, see Table 2 in the [RADIUS Attributes, on page 249](#) chapter.



APPENDIX **A**

RADIUS Attributes

Remote Authentication Dial-In User Service (RADIUS) attributes are used to define specific authentication, authorization, and accounting (AAA) elements in a user profile, which is stored on the RADIUS daemon.

This appendix describes the following types of RADIUS attributes supported in Broadband Network Gateway (BNG):

- [RADIUS IETF Attributes, on page 249](#)
- [RADIUS Vendor-Specific Attributes, on page 251](#)
- [RADIUS ADSL Attributes, on page 256](#)
- [RADIUS ASCEND Attributes, on page 256](#)
- [RADIUS Disconnect-Cause Attributes, on page 256](#)

RADIUS IETF Attributes

IETF Attributes Versus VSAs

RADIUS Internet Engineering Task Force (IETF) attributes are the original set of 255 standard attributes that are used to communicate AAA information between a client and a server. Because IETF attributes are standard, the attribute data is predefined and well known; thus all clients and servers who exchange AAA information via IETF attributes must agree on attribute data such as the exact meaning of the attributes and the general bounds of the values for each attribute.

RADIUS vendor-specific attributes (VSAs) derived from one IETF attribute-vendor-specific (attribute 26). Attribute 26 allows a vendor to create an additional 255 attributes however they wish. That is, a vendor can create an attribute that does not match the data of any IETF attribute and encapsulate it behind attribute 26; thus, the newly created attribute is accepted if the user accepts attribute 26.

Table 52: Supported RADIUS IETF Attributes

Name	Value	Type
Acct-Delay-Time	integer	41
Acct-Input-Giga-Words	integer	52
Acct-Input-Octets	integer	42
Acct-Input-Packets	integer	47

Name	Value	Type
Acct-Interim-Interval	integer	85
Acct-Link-Count	integer	51
Acct-Output-Giga-Words	integer	53
Acct-Output-Octets	integer	43
Acct-Output-Packets	integer	48
Acct-Status-Type	integer	40
Acct-Terminate-Cause	integer	49
CHAP-Challenge	binary	40
CHAP-Password	binary	3
Delegated-IPv6-Prefix	binary	123
Dynamic-Author-Error-Cause	integer	101
Event-Timestamp	integer	55
Framed-Interface-Id	binary	96
Framed-IP-Address	ipv4addr	8
Framed-IPv6-Route	string	99
Framed-Protocol	integer	7
Framed-Route	string	22
Nas-Identifier	string	32
NAS-IP-Address	ipv4addr	4
NAS-IPv6-Address	string	95
NAS-Port	integer	5
Reply-Message	binary	18
Service-Type	integer	6
Stateful-IPv6-Address-Pool	binary	123
X-Ascend-Client-Primary-DNS	ipv4addr	135
X-Ascend-Client-Secondary-DNS	ipv4addr	136

IETF Tagged Attributes on LAC

The IETF Tagged Attributes support on L2TP Access Concentrator (LAC) provides a means of grouping tunnel attributes referring to the same tunnel in an Access-Accept packet sent from the RADIUS server to the LAC. The Access-Accept packet can contain multiple instances of same RADIUS attributes, but with different tags. The tagged attributes support ensures that all attributes pertaining to a given tunnel contain the same value in their respective tag fields, and that each set includes an appropriately-valued instance of the Tunnel-Preference attribute. This conforms to the tunnel attributes that are to be used in a multi-vendor network

environment, thereby eliminating interoperability issues among Network Access Servers (NASs) manufactured by different vendors.

For details of RADIUS Attributes for Tunnel Protocol Support, refer RFC 2868.

These examples describe the format of IETF Tagged Attributes:

```
Tunnel-Type = :0:L2TP, Tunnel-Medium-Type = :0:IP, Tunnel-Server-Endpoint = :0:"1.1.1.1",
Tunnel-Assignment-Id = :0:"1", Tunnel-Preference = :0:1, Tunnel-Password = :0:"hello"
```

A tag value of 0 is used in the above example in the format of :0:, to group those attributes in the same packet that refer to the same tunnel. Similar examples are:

```
Tunnel-Type = :1:L2TP, Tunnel-Medium-Type = :1:IP, Tunnel-Server-Endpoint = :1:"2.2.2.2",
Tunnel-Assignment-Id = :1:"1", Tunnel-Preference = :1:1, Tunnel-Password = :1:"hello"
```

```
Tunnel-Type = :2:L2TP, Tunnel-Medium-Type = :2:IP, Tunnel-Server-Endpoint = :2:"3.3.3.3",
Tunnel-Assignment-Id = :2:"1", Tunnel-Preference = :2:2, Tunnel-Password = :2:"hello"
```

```
Tunnel-Type = :3:L2TP, Tunnel-Medium-Type = :3:IP, Tunnel-Server-Endpoint = :3:"4.4.4.4",
Tunnel-Assignment-Id = :3:"1", Tunnel-Preference = :3:2, Tunnel-Password = :3:"hello"
```

```
Tunnel-Type = :4:L2TP, Tunnel-Medium-Type = :4:IP, Tunnel-Server-Endpoint = :4:"5.5.5.5",
Tunnel-Assignment-Id = :4:"1", Tunnel-Preference = :4:3, Tunnel-Password = :4:"hello"
```

```
Tunnel-Type = :5:L2TP, Tunnel-Medium-Type = :5:IP, Tunnel-Server-Endpoint = :5:"6.6.6.6",
Tunnel-Assignment-Id = :5:"1", Tunnel-Preference = :5:3, Tunnel-Password = :5:"hello"
```

Table 53: Supported IETF Tagged Attributes

IETF Tagged Attribute Name	Value	Type
Tunnel-Type	integer	64
Tunnel-Medium-Type	integer	65
Tunnel-Client-Endpoint	string	66
Tunnel-Server-Endpoint	string	67
Tunnel-Password	string	69
Tunnel-Assignment-ID	string	82
Tunnel-Preference	integer	83
Tunnel-Client-Auth-ID	string	90
Tunnel-Server-Auth-ID	string	91

RADIUS Vendor-Specific Attributes

The Internet Engineering Task Force (IETF) draft standard specifies a method for communicating vendor-specific information between the network access server and the RADIUS server by using the vendor-specific attribute (attribute 26). Attribute 26 encapsulates vendor specific attributes, thereby, allowing vendors to support their own extended attributes otherwise not suitable for general use.

The Cisco RADIUS implementation supports one vendor-specific option using the format recommended in the specification. Cisco's vendor-ID is 9, and the supported option has vendor-type 1, which is named "cisco-avpair." The value is a string of this format:

```
protocol : attribute sep value *
```

"Protocol" is a value of the Cisco "protocol" attribute for a particular type of authorization; protocols that can be used include IP, IPX, VPDN, VOIP, SHELL, RSVP, SIP, AIRNET, OUTBOUND. "Attribute" and "value" are an appropriate attribute-value (AV) pair defined in the Cisco TACACS+ specification, and "sep" is "=" for mandatory attributes and "*" for optional attributes. This allows the full set of features available for TACACS+ authorization to also be used for RADIUS.

For example, the following AV pair causes Cisco's "multiple named ip address pools" feature to be activated during IP authorization (during PPP's IPCP address assignment):

```
cisco-avpair= "ip:addr-pool=first"
```

If you insert an "*", the AV pair "ip:addr-pool=first" becomes optional. Note that any AV pair can be made optional.

IETF Attribute 26 (Vendor-Specific) encapsulates vendor specific attributes, thereby, allowing vendors to support their own extended attributes otherwise not suitable for general use.

```
cisco-avpair= "ip:addr-pool*first"
```

The following example shows how to cause a user logging in from a network access server to have immediate access to EXEC commands:

```
cisco-avpair= "shell:priv-lvl=15"
```

The following example shows how to configure avpair aaa attribute to enable IPv6 router advertisements from an IPv4 subscriber interface:

```
Cisco-avpair= "ipv6:start-ra-on-ipv6-enable=1"
```

Attribute 26 contains these three elements:

- Type
- Length
- String (also known as data)
 - Vendor-ID
 - Vendor-Type
 - Vendor-Length
 - Vendor-Data



Note

It is up to the vendor to specify the format of their VSA. The Attribute-Specific field (also known as Vendor-Data) is dependent on the vendor's definition of that attribute.

Table 54: Supported Cisco Vendor-Specific RADIUS Attributes

Name	Value	Type	Present in AAA message type
accounting-list	string	1	Access-accept, CoA, Accounting-request
acct-input-gigawords-ipv4	integer	1	Accounting-request
acct-input-octets-ipv4	integer	1	Accounting-request
acct-input-packets-ipv4	integer	1	Accounting-request
acct-input-gigawords-ipv6	integer	1	Accounting-request
acct-input-octets-ipv6	integer	1	Accounting-request
acct-input-packets-ipv6	integer	1	Accounting-request
acct-output-gigawords-ipv4	integer	1	Accounting-request
acct-output-octets-ipv4	integer	1	Accounting-request
acct-output-packets-ipv4	integer	1	Accounting-request
acct-output-gigawords-ipv6	integer	1	Accounting-request
acct-output-octets-ipv6	integer	1	Accounting-request
acct-output-packets-ipv6	integer	1	Accounting-request
addrv6	string	1	Access-accept, Accounting-request
circuit-id-tag	string	1	Access-accept, Accounting-request
cisco-dhcp-subscriber-id	string	65	Access-request
cisco-dhcp-user-class	string	47	Access-request
cisco-dhcp-vendor-class	string	48	Access-request
cisco-nas-port	string	2	Access-accept, Accounting-request
cisco-vsa-in-acl	string	57	Access-accept, CoA
cisco-vsa-ipv6-in-acl	string	61	Access-accept, CoA
cisco-vsa-ipv6-out-acl	string	62	Access-accept, CoA
cisco-vsa-out-acl	string	58	Access-accept, CoA
cisco-vsa-service-name	string	51	Access-accept
cisco-vsa-sub-activate-service	string	60	Access-accept, CoA
cisco-vsa-sub-deactivate-service	string	63	Access-accept, CoA
cisco-vsa-sub-pbr-policy-in	string	59	Access-accept, CoA

Name	Value	Type	Present in AAA message type
client-mac-address	string	1	Access-accept, Accounting-request
command	string	1	CoA
connect-progress	string	1	Accounting-request
delegated-ipv6-pool	string	1	Access-accept
dhcp-class	string	1	Access-accept
dhcp-client-id	string	1	Accounting-request
dhcp-vendor-class	string	1	Access-request, Accounting-request
disc-cause-ext	string	1	Accounting-request
disconnect-cause	string	1	Accounting-request
dual-stack-delay	integer	1	Access-accept
inacl	string	1	Access-accept
intercept-id	integer	1	Access-accept
ip-addresses	string	1	Access-request, Accounting-request
ip:route	string	1	Access-accept, CoA
ip:ipv6-route	string	1	Access-accept, CoA
ipv6_inacl	string	1	Access-accept, CoA
ipv6_outacl	string	1	Access-accept, CoA
ipv6-dns-servers-addr	string	1	Access-accept
ipv6-mtu	integer	1	Access-accept
ipv6-strict-rpf	integer	1	Access-accept
ipv6-unreachable	integer	1	Access-accept
l2tp-tunnel-password	string	1	Access-accept
md-dscp	integer	1	Access-accept
md-ip-addr	ipaddr	1	Access-accept
md-port	integer	1	Access-accept
outacl	string	1	Access-accept
parent-session-id	string	1	Accounting-request
pppoe_session_id	integer	1	Accounting-request
primary-dns	ipaddr	1	Access-accept

Name	Value	Type	Present in AAA message type
remote-id-tag	string	1	Access-request, Accounting-request
sa	string	1	Access-accept, CoA
sd	string	1	RADIUS CoA
secondary-dns	ipaddr	1	Access-accept
service-name	string	1	Accounting-request
source-ip	ipv4addr	1	Access-accept
Stateful-IPv6-Address-Pool	string	1	Access-accept
sub-pbr-policy-in	string	1	Access-accept, CoA
subscriber:sub-qos-policy-in	string	1	Access-accept, CoA
subscriber:sub-qos-policy-out	string	1	Access-accept, CoA
tunnel-tos-reflect	string	1	Access-accept
tunnel-tos-setting	string	1	Access-accept
tunnel-type	string	1	Access-accept
username	string	1	Access-request, Accounting-request
vpdn-group	string	1	Access-accept
vrf	string	1	Access-accept
vpn-vrf	string	1	Access-accept

Vendor-Specific Attributes for Account Operations

Table 55: Supported Vendor-Specific Attributes for Account Operations

RADIUS AVP	Value	Type	Action
subscriber:command=account-update	string	1	account update
subscriber:sa=<service-name>	string	1	service activate
subscriber:sd=<service-name>	string	1	service de-activate

RADIUS ADSL Attributes

Table 56: Supported RADIUS ADSL Attributes

Name	Value	Type
Agent-Circuit-Id	string	1
Agent-Remote-Id	string	2

RADIUS ASCEND Attributes

Table 57: Supported RADIUS Ascend Attributes

Name	Value	Type
Ascend-Client-Primary-DNS	ipv4addr	135
Ascend-Client-Secondary-DNS	ipv4addr	136
Ascend-Connection-Progress	integer	196
Ascend-Disconnect-Cause	integer	195

RADIUS Disconnect-Cause Attributes

Disconnect-cause attribute values specify the reason a connection was taken offline. The attribute values are sent in Accounting request packets. These values are sent at the end of a session, even if the session fails to be authenticated. If the session is not authenticated, the attribute can cause stop records to be generated without first generating start records.

lists the cause codes, values, and descriptions for the Disconnect-Cause (195) attribute.



Note The Disconnect-Cause is incremented by 1000 when it is used in RADIUS AVPairs; for example, disc-cause 4 becomes 1004.

Table 58: Supported Disconnect-Cause Attributes

Cause Code	Value	Description
2	Unknown	Reason unknown.
3	Call-Disconnect	The call has been disconnected.
11	Lost-Carrier	Loss of carrier.

Cause Code	Value	Description
21	Idle-Timeout	Timeout waiting for user input. Note Codes 21, 100, 101, 102, and 120 apply to all session types.
28	EXEC-Process-Destroyed	EXEC process destroyed.
33	Insufficient-Resources	Insufficient resources.
40	Timeout-PPP-LCP	PPP LCP negotiation timed out. Note Codes 40 through 49 apply to PPP sessions.
41	Failed-PPP-LCP-Negotiation	PPP LCP negotiation failed.
42	Failed-PPP-PAP-Auth-Fail	PPP PAP authentication failed.
45	PPP-Remote-Terminate	PPP received a Terminate Request from remote end.
47	NCP-Closed-PPP	PPP session closed because there were no NCPs open.
52	Invalid-IP-Address	IP address is not valid for Telnet host.
100	Session-Timeout	Session timed out.
150	RADIUS-Disconnect	Disconnected by RADIUS request.
151	Local-Admin-Disconnect	Administrative disconnect.
170	PPP-Authentication-Timeout	PPP authentication timed out.

