Cloud Native BNG User Plane Configuration Guide for Cisco ASR 9000 Series Routers, IOS XR Release 7.6.x

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Preface

The Cisco IOS XR Software Release 7.3.1 introduces the support for cloud native broadband network gateway (cnBNG) user plane for the Cisco IOS XR platform. cnBNG is an architectural evolution that is based on Control and User Plane Separation (CUPS), where the control plane (CP) and user plane (UP) run in distinct and independent environments. This book describes the cnBNG user plane functionality and related configurations on Cisco ASR 9000 Series Routers.

For details on the commands related to the cnBNG user plane, see the Cloud Native Broadband Network Gateway User Plane Command Reference for Cisco ASR 9000 Series Routers.

For details on cnBNG deployment, the control plane functionality and the related configurations, see the *Cloud Native Broadband Network Gateway Control Plane Configuration Guide*.

To know more about physical BNG on the Cisco IOS XR platform, see the *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Configuration Guide*.

This preface contains these sections:

Changes to This Document

Date	Summary
March 2022	Initial release of this document.

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New and Changed Cloud Native BNG User Plane Features

This table summarizes the new and changed feature information for the *Cloud Native BNG User Plane Configuration Guide for Cisco ASR 9000 Series Routers*, and tells you where they are documented.

Cloud Native BNG User Plane Features Added or Modified in IOS XR Release 7.6.x

Feature	Description	Changed in Release	Where Documented
Multiple Loopback Interfaces for Cloud Native BNG	You can now configure multiple loopbacks under the same VRF.	Release 7.6.2	Configure Loopback Interface, on page 28

Cloud Native BNG Overview

The Cloud Native Broadband Network Gateway (cnBNG) redefines the traditional physical BNG by decoupling the subscriber management and forwarding functions of the control plane (CP) and user plane (UP) to give better flexibility and scalability for the service providers. The cnBNG architecture is based on Control and User Plane Separation (CUPS), where the CP performs the policy and charging rule function (PCRF), whereas the UP performs policy enforcement function (PEF) of the overall BNG subscriber management solution. The cnBNG solution provides optimum scale dimensioning in terms of the number of subscriber sessions and forwarding capacity and aims at rapid deployment of multi-access services for the users. It also acts as a step forward towards converging the fixed line and mobile networks at all network layers.

Overview

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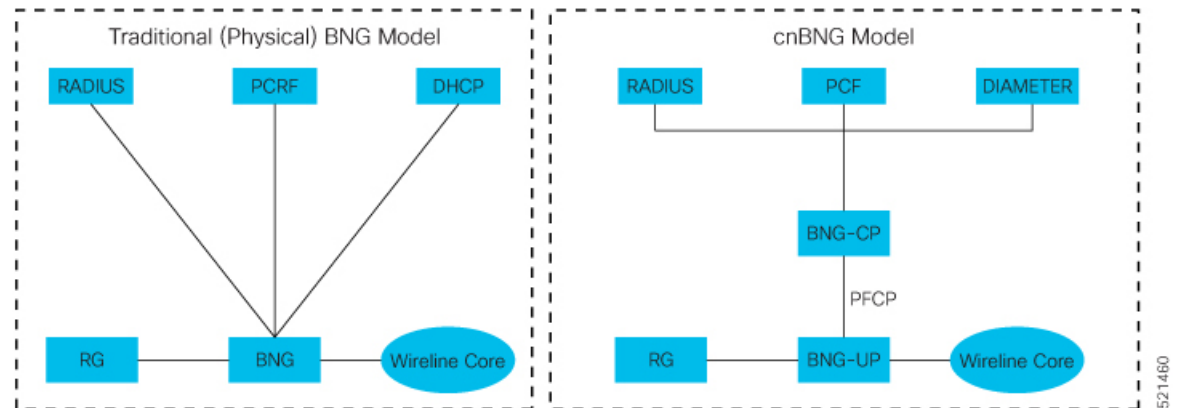
The architectural change is an evolution from an integrated traditional BNG running on a single router to a disaggregated solution, where the centralized subscriber management runs on an elastic and scalable Cloud Native Control Plane (CP) and the User Plane (UP) delivers the forwarding functionality.

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
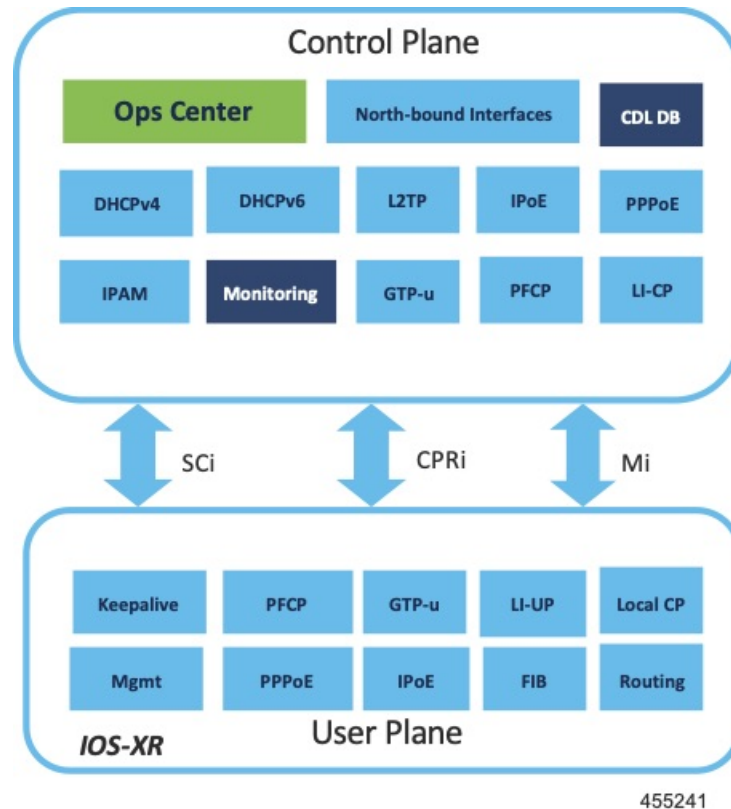
Features and Benefits

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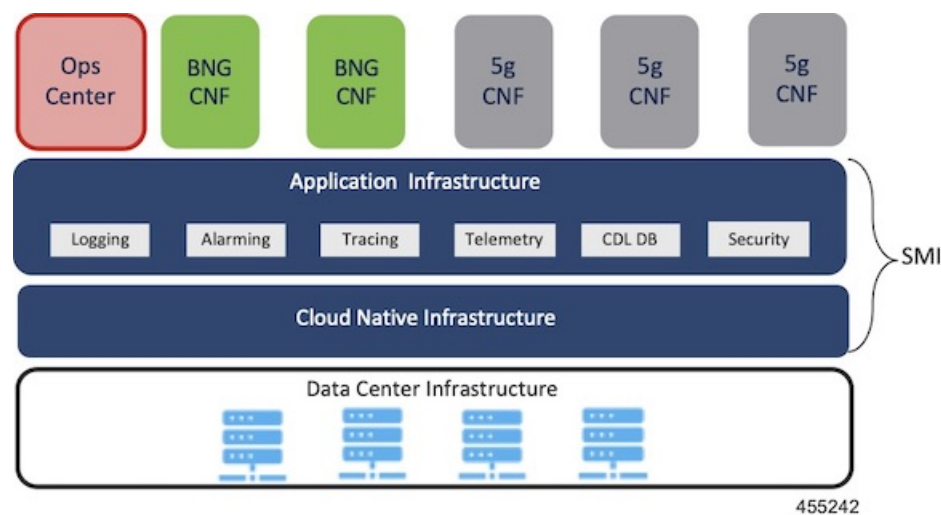
The CP runs as a Virtual Machine (VM) to adapt to existing service provider-deployed virtual infrastructure. It is built ground-up on a clean-slate architecture with a view on 'Converged Subscriber Services' and is aligned to 3gpp and BBF standards.

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.

For more information about the cnBNG control plane, refer to the *Cloud Native Broadband Network Gateway Control Plane Configuration Guide.*

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 Overview* chapter.

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.

Cloud Native BNG User Plane Overview

In the cnBNG architecture, which is based on Control and User Plane Separation (CUPS), the CP handles the subscriber management functionality and the UP handles the forwarding functionality of the entire BNG solution. This chapter focuses on the functionality and architecture of the cnBNG user plane.

For more details on the cnBNG control plane, see the *Cloud Native Broadband Network Gateway Control Plane Configuration Guide*.

Control and User Plane Separation

cnBNG is an architectural evolution that is based on Control and User Plane Separation (CUPS), where the CP and UP run in distinct and independent environments. cnBNG redefines the traditional physical BNG by decoupling the BNG CP and UP functions to give better flexibility and scalability for the service providers. In cnBNG, the centralized subscriber management functionality of BNG runs on CP infrastructure and the user plane delivers the forwarding functionality.
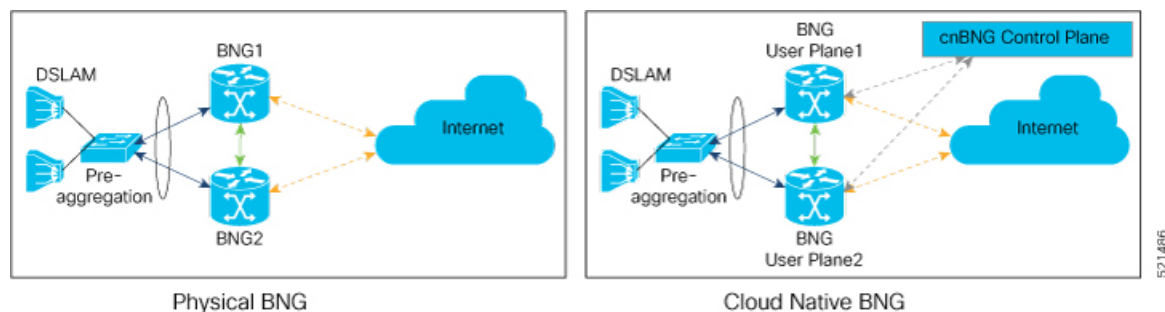
In Cisco cnBNG solution, a physical Cisco IOS XR platform like Cisco ASR 9000 Series Routers provides the UP functionality. Whereas Cisco Ultra Cloud Core Subscriber Microservices Infrastructure (SMI)—a container-based microservice cloud environment, provides the CP functionality.

Why CUPS?

CUPS provides the capability to independently scale the CP and UP in an efficient and dynamic manner. CUPS enables network operators to optimize data center costs by hosting the CP and UP in different geographic locations. CUPS thus saves on backhaul (the access to core connection) costs by terminating data at the edge of the network. The network operators can then easily adapt to the evolving demands of mobile networks without incurring extra capital expenditures (CapEx) and operating expenditures (OpEx). The CUPS solution thus promotes a more cost-effective approach to core mobile architecture and future-proofs the network for 5G.

cnBNG User Plane Overview

Sample Network Topology for Cloud Native BNG using CUPS
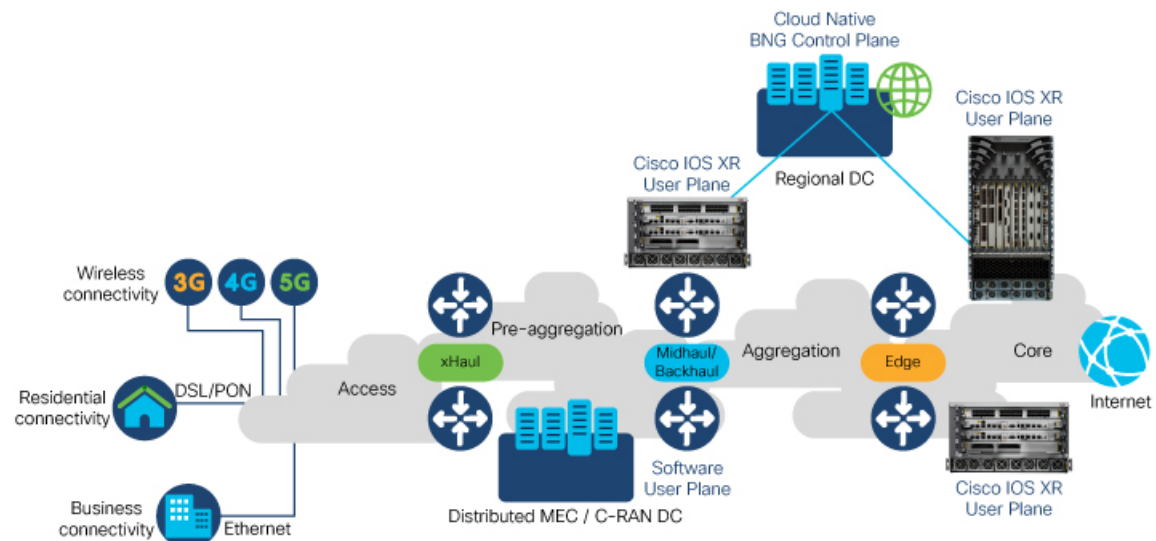
In cloud native BNG (cnBNG), the CP provides the service policies that are sourced from the north-bound systems such as the RADIUS server or the policy and charging rules function (PCRF) node. Whereas the UP performs policy enforcement function (PEF) of the overall BNG subscriber management solution. The BNG CP protocols: RADIUS, DHCPv4, DHCPv6, PPPoE, PPP, and IP address pool management run on the CP. Whereas the non-BNG-specific protocols: IPv6 neighbor discovery (ND), ARP, routing protocols (like ISIS or BGP) that export subscriber subnet routes, and UDP or IP protocols that transport DHCPv4 or DHCPv6 payloads run on the UP.

The cnBNG UP models each subscriber as a unique flow. The system applies the subscriber features like quality of service (QoS), Hierarchial Quality of Service (HQoS),access control list (ACL), policy-based routing (PBR), lawful intercept (LI), accounting, and so on, on this flow. The DHCPv4, DHCPv6, PPPoE, and PPP protocols trigger the BNG subscriber flow. The UP presents these protocol packets to the cnBNG CP for

authentication and authorization, and for evaluating policy and charging rules. Once the subscriber is accepted, the UP creates the subscriber flow and applies features on this flow. The subscriber flow can also have multiple sub-flows, and you can apply specific features to these sub-flows.

Key Features and Benefits of cnBNG User Plane

The key features and benefits of the cnBNG user plane are:

- **Distributed**: With reduced operational complexity and minimal integration efforts with centralized CP, you can distribute the UPs closer to end users. This feature helps to offload the traffic to the nearest peering points and content delivery networks (CDNs) and reduces the core transport costs.

- **Cost-effective and leaner**: With the subscriber management functions moved to cloud, you can choose cost-effective UP models for optimized deployment requirements.

cnBNG User Plane Architecture

The Cisco IOS XR platforms have a distributed hardware architecture that uses a switch fabric to interconnect a series of chassis slots. Each slot can hold one of several types of line cards (LCs). Each line card in these routers has integrated input-output and forwarding engines. The system can identify and handle the subscriber flow either on the route processor (RP) or on the LC. This architecture thereby provides multiple levels of redundancy and scalability for the subscriber management functionality in cnBNG.

The cnBNG UP architecture is designed to interoperate with cnBNG CP with minimal integration efforts. The main components of cnBNG user plane on the Cisco IOS XR platform are:

• **Subscriber Provisioning Agent (SPA)**—is the common interface to the control plane that is bundled with the existing Cisco IOS XR image. This interface helps to have a minimal configuration requirement to transform from an integrated physical BNG router to a cnBNG user plane. SPA consists of a transport layer at the top that interfaces with the CP, and an API layer at the bottom that isolates the network operating system (NOS) and the CP. This isolation from the NOS helps to make the control plane hardware-agnostic and portable across multicloud environments.

The functionality of SPA includes:

> • The support for standard PFCP port for a single UP connection.

> • The support for nonstandard ports for both PFCP and GTPv1-U for multiple connections.

> • UP to CP keep alive (KA) to detect any communication channel faults between CP-UP.

• **NOS Adaptation Layer (NAL)**—translates the CP instructions or messages coming to the UP to Cisco IOS XR-defined format. It is the Cisco IOS XR implementation of cnBNG APIs that interfaces with Cisco IOS XR infra components for various functions. These functions include input-output of packets, interface creation and deletion, subscriber feature provisioning, route operations, subscriber interface statistics and notifications. NAL also manages the subscriber flow on the Cisco IOS XR platform and handles the high availability (HA) requirements of Cisco IOS XR infrastructure.

The **cnbng-nal** is the internal process that provisions all the above NAL functionalities. For details on commands that are related to NAL, see the *Configuring Cloud Native BNG User Plane* chapter and the *Verifying Cloud Native BNG User Plane Configurations* chapter.

- **Platform-specific Layer**—is the API adaptation layer that helps to plug-in different types of hardware architectures to the common Cisco IOS XR infrastructure. This layer in turn helps to extend the user plane functionality to other Cisco IOS XR platforms without altering the basic infrastructure.

Platform-specific layer defines the forward API calls that each underlying platform of the user plane has to implement. The system uses these APIs to provision the following BNG functions:

- IPoE subscriber traffic classification—for L2-connected subscribers that are based on port, MAC, and VLAN.

- PPPoE subscriber traffic classification—for L2-connected subscribers that are based on port and PPPoE session-ID.

Software and Hardware Requirements

The support for cnBNG user plane functionality on Cisco ASR 9000 Series Routers is compatible with the following line card (LC), route switch processors (RSPs), and modular port adapters (MPAs).

Note   The Cisco IOS XR Software Release 7.3.1 supports cnBNG UP only on Cisco ASR 9000 High Density 100GE Ethernet line cards. See the table for the list of supported PIDs.

Table 1: Software and Hardware Requirements for cnBNG User Plane

Cisco IOS XR Software Release	LC	RSP	MPA
Cisco IOS XR Software Release 7.3.1	• A9K-24X10GE-1G-SE • A9K-48X10GE-1G-SE • A9K-4X100GE-SE • A9K-MOD200-SE • A9K-MOD200-CM • A9K-MOD400-SE • A9K-MOD400-CM	• A9K-RSP880-SE • A9K-RSP880-LT-SE • A99-RP-SE and A99-RP2-SE (on the Cisco ASR 9912 and the Cisco ASR 9922 chassis) • A99-RSP-SE (on the Cisco ASR 9910 and the Cisco ASR 9906 chassis) • A9K-RSP5-SE	• A9K-MPA-1X100GE • A9K-MPA-2X100GE • A9K-MPA-4X10GE • A9K-MPA-8X10GE • A9K-MPA-20X10GE • A9K-MPA-20X1GE • A9K-MPA-1X40GE • A9K-MPA-2X40GE

Access Types and Subscriber Types

Access Types

The cnBNG user plane on Cisco IOS XR platform supports sub-interface Bundle-Ethernet access type with these encapsulations:

- **Single Dot1q**—which is the IEEE 802.1Q networking standard to support VLANs on an Ethernet network.

- **Double-tagged VLANs**—where two VLAN ID tags (inner tag and outer tag) are inserted into a single data frame. This encapsulation enables users to use their own VLANs inside the VLAN provided by the service provider.

- **Ambiguous VLANs**—that use a range or group of VLAN IDs that enables you to create multiple sessions on a single access-interface.

Subscriber Types

The IP subscriber sessions that connect through a Layer-2 aggregation network are called **L2-connected** sessions. Subscriber sessions where an IPv4 address and an IPv6 address co-exist for the same subscriber are called **dual-stack** subscriber sessions.

The cnBNG UP on Cisco IOS XR platform supports two types of **L2-connected dual-stack** subscriber sessions:

- **IPoE-DHCP dual-stack sessions**: In IP over Ethernet (IPoE) sessions, subscribers run IPv4 or IPv6 on the CPE device and connect to the BNG through an L2 aggregation network. These sessions rely on the DHCP protocol for assigning IP address for the subscriber.

- **PPPoE-DHCPv6 dual-stack PTA sessions**: The PPP over Ethernet (PPPoE) subscriber session is established using the point-to-point protocol (PPP) that runs between the CPE and BNG. These sessions rely on the standard PPP negotiations for subscriber authentication and IP address assignment.

  In a PPP Termination and Aggregation (PTA) session, the PPP encapsulation terminates on BNG. After that the BNG routes the traffic to the service provider using IP routing.

Subscriber Features

Table 2: Feature History Table

Feature Name	Release Information	Feature Description
Increased Granularity for Cloud Native BNG Traffic Management with Hierarchical QoS (H-QOS)	Release 7.4.2	This feature allows you to specify QoS behavior at multiple policy levels for Internet Protocol over Ethernet (IPoE), Point-to-Point Protocol over Ethernet (PPPoE), PPP Termination and Aggregation (PTA), and LNS (L2TP Network Server) sessions and provides a high degree of granularity in traffic management. Use the first level of the traffic policy, the parent traffic policy, to control the traffic at the main interface or sub-interface level. Use the second level, the child traffic policy, for additional control over a specific traffic stream or class.
Multiple Framed IPv4 and IPv6 Routes for Customer PremisesEquipment (CPE)	Release 7.4.2	You can configure multiple framed routes for IPv4 and IPv6 traffic across CPE. This functionality allows you to route multiple customer networks through a single customer broadband connection, thus enabling the LAN network subscriber to use a different subnet from WAN.

Feature Name	Release Information	Feature Description
Cloud Native BNG feature extension to 5th Generation Line Card	Release 7.4.2	The A99-32X100GE-X-SE, A9K-20HG-FLEX-SE , and A9K-8HG-FLEX-SE line cards now support the following Cloud Native BNG functionalities: • IPoE subscriber sessions that run both IPv4, IPv6 on the CPE device. • PPP over Ethernet PPP Termination and Aggregation (PPPoE PTA) sessions • DHCPv6 support for PPPoE sessions • Cloud Native BNG over Bundle Ether interface • Quality of Service (QoS) • Policy-based Routing (PBR) • Access Control List (ACL) • ICMP unreachable • Lawful Intercept (LI) This enhancement enables BNG features to leverage the higher throughput of the 5th generation of line cards.

This section lists the set of subscriber features that cnBNG user plane on the Cisco IOS XR platform supports.

- **IPv4 or IPv6**:

    - **Maximum Transmission Unit (MTU)**—that defines the maximum size of each packet that you can transmit during the subscriber session.

    - **Unicast Reverse Path Forwarding (URPF)**—that ensures that the system does not accept any traffic on the subscriber interface from malformed or forged IP source addresses.

    - **Internet Control Message Protocol (ICMP)**—a supporting protocol that networking devices use to send error messages and operational information to the originator of transmission.

- **Access Control List (ACL)**—that performs packet filtering to control the traffic flow into and out of network interfaces. It helps to define the access rights such as, filtering the content, blocking access to various resources and so on, for a subscriber .

    Supported ACL types are:

    - Input ACL (IPv4 or IPv6)

- Output ACL (IPv4 or IPv6)

- **QoS**:

  - **Policing (input and output)**—that allows you to control the maximum rate of traffic sent or received on an interface. It also allows to partition a network into multiple priority levels or class of service (CoS).

  - **Shaping (output)**—that allows you to control the traffic flow that exits an interface to match its transmission to the speed of the remote target interface. It also ensures that the traffic conforms to policies contracted for it.

  - **Policy Merging**—that merges multiple QoS policies on a single subscriber. The UP supports a maximum of 6 policy-maps and 10 class-maps, including the default ones.

- **Hierarchical QoS (H-QoS)**—that allows you to specify QoS behavior at multiple policy levels, which provides a high degree of granularity in traffic management. cnBNG supports the following two-level hierarchical policy for deploying QoS:

  - Parent policy:

  - Child policy

  H-QoS is applied on the router interface using nested traffic policies. The first level of traffic policy, the parent traffic policy, is used for controlling the traffic at the main interface or sub-interface level. The second level of traffic policy, the child traffic policy, is used for additional control over a specific traffic stream or class. The child traffic policy, is a previously defined traffic policy, that is referenced within the parent traffic policy. Two-level H-QoS is supported on both ingress and egress directions on all line cards and on physical or bundle main interfaces and sub-interfaces.

  To know more about H-QOS, refer the *Configuring Hierarchical Modular QoS* chapter in the *Modular QoS Configuration Guide for Cisco ASR 9000 Series Routers*

- **HTTP Redirect using PBR** (for input policy)—that redirects subscriber traffic to a destination other than to its original destination. Policy-based Routing (PBR) makes packet forwarding decisions based on the policy configurations, instead of routing protocols.

- **Accounting:** cnBNG UP supports periodic accounting for these accounting types:

  - **Session Accounting**—which is the statistics of a subscriber session.

  - **Service Accounting:**—which is the statistics for each service (collection of features) that is enabled for a subscriber.

> **Note**
> - You cannot enable service accounting without session accounting.
> - You cannot have different periodicity for session and service accounting.

- **Lawful Intercept** (for mediation device in default or non-default VRF)—that allows Law Enforcement Agencies (LEA) to conduct electronics surveillance as authorized by judicial or administrative order.

- **Multiple Framed Route**—allows a large number of customer networks to reach through framed routes through a single broadband connection. Framed Route is supported on both IPoE and PPPoE sessions. There's no limit enforced to the number of framed routes per session. You don't have to configure or enable Framed Route through command line interface as it is downloaded from RADIUS.

Read more about these features in the *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Configuration Guide*.

Supported Parameter Limit for Subscriber Features

The cnBNG user plane on Cisco IOS XR platform supports a maximum of:

- 32 IP subnet pools

- 32 secondary IP addresses

- Eight QoS services

- Eight class-maps

- Six actions for multi-action change-of-authorization (MA-CoA)

  (MA-CoA is a feature which enables the service providers to activate and deactivate multiple subscriber services using a single CoA request).

High Availability

High Availability (HA) enables network-wide protection by providing fast recovery from faults that may occur in any part of the network. The cnBNG user plane does not delete the subscriber state, summary subnet route state, subscriber route state, and so on, in a stable system except in a few scenarios. These scenarios can be either explicit execution of CLI commands to clear the session, process restart of peer process, mark and sweep procedure (an internal clean-up process which detects and reclaims the memory that is used by unused objects) of *cnbng-nal* process, route processor fail over (RPFO), or deletion of parent interface.

This section describes the expected behavior if a high availability event such as a router reload or RPFO occurs on the cnBNG user plane:

- NAL restores the last stable (check-pointed) session state with best effort after the HA event.

- To ensure data and session integrity between NAL and peer processes, the system triggers a mark and sweep procedure during *cnbng-nal* process restart. During this process, the NAL might not be able to restore the sessions due to unforeseen issues from the feature or from the IOS XR infra components. In that case, the system deletes those sessions and sends a notification to the CP.

- The *cnbng-nal* process restart does not initiate automatic reconciliation procedure between the CP and the UP. The CP triggers this explicitly using a CLI configuration.

- The Cisco IOS XR platform has active and standby hardware level support (active RSP and standby RSP) on logical interface subscriber. The data sync between these nodes is not real time. The *cnbng-nal* process periodically syncs for various internal data on a best-effort basis. There can be a few cases where session data is out of sync between route processors which leads to session recreate failure after RFPO. These cases maybe for recently created sessions or inflight sessions. The system deletes those sessions at UP and sends a notification to the CP.

- The CP acts on these notification events to make sure that the subscriber state is in sync. If not, it leads to out of sync sessions between the UP and the CP in such scenarios.

- During process restart or RPFO, mark and sweep procedure might lead to subscriber session deletion on UP.

- The UP might not push the final statistics if a process restart or RPFO happens while a subscriber or service deletion is in progress. In that case, the CP considers the last collected statistics PCRF or back-end statistics as the final statistics.

Usage Guidelines

These guidelines apply to using the cnBNG user plane functionality on the Cisco IOS XR platform:

- You must not perform these actions on the fly while active subscriber sessions are present on the router:

    - Removal of configurations

    - Enabling or disabling service accounting

    - Deletion or modification of parent interface properties (such as IPv4 or IPv6 address, MTU, DHCPv4 initiator, PPPoE, DHCPv6 initiator, enable L2TP and LNS, and so on)

    - Deactivation of cnBNG package

    - Deletion or modification of VRF and loopback

    - Modification of service profile, and IPv4 or IPv6 address

- PPP keep alive (KA)—the user plane generates the PPP KA messages to the CPE to make packet transport more efficient between the CP and the UP. You must ensure that the duration of PPP keep alive is large enough (in tens of minutes) to have better CPU performance in scenarios with large subscriber scale.

- If an update request having service deactivation fails, the UP reactivates the service as part of rollback and starts the statistics afresh from zero.

- The CP-UP communication loss might cause the CP and UP to be in out of sync. There is no automated recovery mechanism for such scenarios.

Restrictions

The cnBNG user plane functionality on the Cisco IOS XR platform does not support these functionalities:

- Standalone PPP use case with cnBNG enabled

- Per pool or VRF tag support for IP pool subnet routes installed with a specific tag for the entire UP

- Back-to-back RPFO or switchover without graceful shutdown

- LC-based subscribers

- Subscriber redundancy group (SRG) for Bundle-Ethernet

- Enabling service accounting without session accounting

- Different periodicity for session and service accounting

C H A P T E R **4**

Installing Cloud Native BNG User Plane Packages

This chapter describes the procedure for installing cloud native BNG user plane packages on Cisco IOS XR platform.

Installing and Activating the cnBNG Package on the User Plane

Before you begin:

You must follow these guidelines before installing cnBNG package on the user plane:

- The cnBNG user plane functionality requires two packages to be installed on the router—the BNG support package (**asr9k-bng-supp-x64-*.rpm**) and the cnBNG package (**asr9k-cnbng-x64-*.rpm**).

- You can install cnBNG as an optional package on the router. The standard Cisco Golden ISO (GISO) image does not contain the cnBNG package.

- The physical BNG package (**asr9k-bng-x64*.rpm**) and the cnBNG package (**asr9k-cnbng-x64*.rpm**) are mutually exclusive. You cannot install both the packages on the router. The install operation fails if tried.

- You must uninstall and remove the physical BNG package and reboot the router prior to installing the cnBNG package on a router which is already being used as a physical BNG.

- You can either activate the BNG support package and the cnBNG package together as a single step or activate the BNG support package first and then activate the cnBNG package.

- The system does not support standalone PPP use case with cnBNG enabled. You must remove any PPP configuration before activating cnBNG on the router.

Installing and Activating the cnBNG Package on the User Plane

- **Step 1**: Install both the BNG support package and the cnBNG package from the RPM location to the router

  Use the **install add source** command.

```
Router#install add source tftp://209.165.200.225/test-path/
asr9k-bng-supp-x64-1.0.0.0-r73105I.x86_64.rpm asr9k-cnbng-x64-1.0.0.0-r73105I.x86_64.rpm
```

This step adds the BNG support package (**asr9k-bng-supp-x64-1.0.0.0-r73105I.x86_64.rpm**) and the cnBNG package (**asr9k-cnbng-x64-1.0.0.0-r73105I.x86_64.rpm**) from the source location of the RPMs (**tftp://209.165.200.225/test-path/**) to the router.

- **Step 2:** Activate the packages

  Use the **install activate** *activate-id* command.

  Where, *activate-id* is the ID that you see on the router console once the **install add** operation in the previous step is completed.

  ```
  Router#install activate 1
  ```

  This step activates both the BNG support package and the cnBNG package which were installed as part of step 1.

- **Step 3:** Verify the activated packages.

  Use the **show install active** command.

  ```
  Router#show install active
  Sun Apr 19 09:49:34.041 UTC
  Node 0/RSP0/CPU0 [RP]
    Boot Partition: xr_lv0
    Active Packages: 5
          asr9k-xr-7.3.1.05I version=7.3.1.05I [Boot image]
          asr9k-bng-supp-x64-1.0.0.0-r73105I
          asr9k-cnbng-x64-1.0.0.0-r73105I

  Node 0/0/CPU0 [LC]
    Boot Partition: xr_lv0
    Active Packages: 5
          asr9k-xr-7.3.1.05I version=7.3.1.05I [Boot image]
          asr9k-bng-supp-x64-1.0.0.0-r73105I
          asr9k-cnbng-x64-1.0.0.0-r73105I

  Node 0/1/CPU0 [LC]
    Boot Partition: xr_lv0
    Active Packages: 5
          asr9k-xr-7.3.1.05I version=7.3.1.05I [Boot image]
          asr9k-bng-supp-x64-1.0.0.0-r73105I
          asr9k-cnbng-x64-1.0.0.0-r73105I

  Node 0/3/CPU0 [LC]
    Boot Partition: xr_lv0
    Active Packages: 5
          asr9k-xr-7.3.1.05I version=7.3.1.05I [Boot image]
          asr9k-bng-supp-x64-1.0.0.0-r73105I
          asr9k-cnbng-x64-1.0.0.0-r73105I
  ```

  The *Active Packages* parameter in the show command output lists the BNG support package and the cnBNG package. This shows successful activation of the packages.

This step completes the installation and activation of cnBNG package on the user plane.

Configuring Cloud Native BNG User Plane and Key Features

This chapter describes the configuration procedures to achieve the cnBNG user plane functionality on Cisco ASR 9000 Series Routers.

For details on cnBNG user plane commands, see the *Cloud Native BNG Command Reference for Cisco ASR 9000 Series Routers*.

Configure cnBNG User Plane

Before you begin:

You must follow these guidelines for configuring cnBNG user plane:

- You must perform a complete reimage followed by a reboot of the router if you are switching between physical BNG to cnBNG, or the other way around.

- Ensure that the cnBNG package is installed and activated on the user plane. See the *Installing Cloud Native BNG User Plane Packages* chapter for detailed procedure.

- The system does not support the removal of configurations while active sessions are present. You must delete all active sessions and dissociate the CP-UP connection prior to any configuration change or commit replace procedure.

Configuration Procedure

You must perform the following tasks for the UP to spawn the NAL process, to establish connection with the CP, and to provision the subscriber requests.

Configure Basic User Plane Settings

The basic user plane configuration for cnBNG involves these high-level tasks:

- Configuring the server endpoints of CP to which UP can send PFCP or GTP-U messages to enable cnBNG on the router.

- Configuring a loopback interface for each VRF.

- Configuring a route tag for subscriber summary routes.

- Configuring the access-interface to enable IPoE and PPPoE subscribers.

The cnBNG endpoint configurations on the UP are delivered to the cnBNG SPA component for initiating connection with the CP.

Configuration Procedure

This section describes the steps for the basic user plane configuration, which include certain mandatory and optional configurations.

Mandatory Configurations:

- Specifying a unique name for the UP-server instance.

- Specifying the details of the UP server (such as IP address, GTP port, and PFCP port) to which the CP can send PFCP or GTP-U messages.

- Specifying the details of CP server to which the UP can send PFCP or GTP-U messages.

- Specifying the retry count for CP-UP association.

- Enabling secondary address programming.

- Specifying a name for the auto-loopback VRF.

- Configuring a loopback interface to associate with the above VRF.

- Specifying a primary address for the loopback interface.

Optional Configuration:

- Configuring a route summary tag for the routes to add in the routing table

Configuration Example

```
Router#configure
Router(config)#cnbng-nal location 0/RSP0/CPU0
Router(config-cnbng-nal-local)#hostidentifier asr9k-1
Router(config-cnbng-nal-local)#cp-server primary ipv4 198.51.100.1
Router(config-cnbng-nal-local)#up-server ipv4 192.0.2.1 gtp-port 15002 pfcp-port 15003 vrf
 default
Router(config-cnbng-nal-local)#secondary-address-update-enable
Router(config-cnbng-nal-local)#cp-association retry-count 10
Router(config—cnbng-nal-local)#auto-loopback vrf test
Router(config—cnbng-nal-local-auto-loopback-vrf)#interface Loopback2
Router(config—cnbng-nal-local-auto-loopback-vrf-int)#primary-address 127.0.0.1
Router(config—cnbng-nal-local-auto-loopback-vrf-int)#exit
Router(config—cnbng-nal-local-auto-loopback-vrf)#exit
/* Auto-loopback configuration for default VRF */
Router(config—cnbng-nal-local)#auto-loopback vrf default
Router(config—cnbng-nal-local-auto-loopback-vrf)#interface Loopback1
Router(config—cnbng-nal-local-auto-loopback-vrf-int)#primary-address 10.0.0.1
```

```
Router(config—cnbng-nal-local-auto-loopback-vrf-int)#exit
Router(config—cnbng-nal-local-auto-loopback-vrf)#exit
Router(config-cnbng-nal-local)#route-summary tag 4
Router(config-cnbng-nal-local)#commit
```

Running Configuration

```
Router#show running-config cnbng-nal location 0/RSP0/CPU0
cnbng-nal location 0/RSP0/CPU0
 hostidentifier asr9k-1
 up-server ipv4 192.0.2.1 vrf default
  gtp-port 15002
  pfcp-port 15003
 cp-server primary ipv4 198.51.100.1
 secondary-address-update-enable
cp-association retry-count 10
auto-loopback vrf test
 interface Loopback2
  primary-address 127.0.0.1
 !
!
auto-loopback vrf default
 interface Loopback1
  primary-address 10.0.0.1
 !
!
route-summary tag 4
!
```

Configure Access-Interface

This section describes how to configure the access-interface and to enable PPPoE on the cnBNG user plane.

Configuration Example

```
Router#configure
Router(config)#interface Bundle-Ether1.1
Router(config-subif)#ipv4 point-to-point
Router(config-subif)#ipv4 unnumbered Loopback1
Router(config-subif)#ipv6 enable
Router(config-subif)#encapsulation dot1q 1
Router(config-subif)#ipsubscriber
Router(config-cnbng-nal-ipsub)#ipv4 l2-connected
Router(config-cnbng-nal-ipsub-l2conn)#initiator dhcp
Router(config-cnbng-nal-ipsub-l2conn)#exit
Router(config-cnbng-nal-ipsub)#ipv6 l2-connected
Router(config-cnbng-nal-ipsub-ipv6-l2conn)#initiator dhcp
Router(config-cnbng-nal-ipsub-ipv6-l2conn)#exit
Router(config-cnbng-nal-ipsub)#exit

/* Enable PPPoE */
Router(config-subif)#pppoe enable
Router(config-subif)#commit
```

Running Configuration

```
Router#show running-config interface be1.1
interface Bundle-Ether1.1
 ipv4 point-to-point
 ipv4 unnumbered Loopback1
 ipv6 enable
 encapsulation dot1q 1
 ipsubscriber
  ipv4 l2-connected
   initiator dhcp
  !
  ipv6 l2-connected
   initiator dhcp
  !
 !
 pppoe enable
!
```

Configure Loopback Interface

This section describes how to configure the loopback interface for cnBNG user plane.

> **Note** You must not configure any IP address under loopback interface.

Configuration Example

```
Router#configure
Router(config)#interface loopback 2
Router(config-if)#ipv6 enable
Router(config-if)#commit
```

Running Configuration

```
Router#show running-config interface loopback 2
interface Loopback2
 ipv6 enable
!
```

Enable Multiple Loopback Interfaces for Cloud Native BNG

Table 3: Feature History Table

Feature Name	Release Information	Feature Description
Multiple Loopback Interfaces for Cloud Native BNG	Release 7.6.2	By configuring multiple loopbacks under the same VRF and splitting a large network into smaller chunks, you can increase the number of IP addresses using IP subnet pools, thus improving address allocation and managing network bandwidth efficiently. In earlier releases, Cloud Native BNG supported only a single loopback for a given VRF.

You can configure multiple loopback interfaces under *cnbng-nal* configuration mode for default and non-default VRF.

> **Note** A maximum of 47 loopback interfaces are supported under the *cnbng-nal* configuration mode.

Configuration for default VRF

```
Router#configure
Router(config)#cnbng-nal location 0/rsp0/CPU0
Router(config-cnbng-nal-local)#auto-loopback vrf default
Router(config-cnbng-nal-auto-loopback-vrf)#interface loopback 0
Router(config-cnbng-nal-auto-lb-vrf-int)#primary-address 10.0.0.1
Router(config-cnbng-nal-auto-lb-vrf-int)#exit
Router(config-cnbng-nal-auto-loopback-vrf)#interface loopback 1
Router(config-cnbng-nal-auto-lb-vrf-int)#primary-address 10.0.0.2
Router(config-cnbng-nal-auto-lb-vrf-int)#exit
Router(config-cnbng-nal-auto-loopback-vrf)#interface loopback 2
Router(config-cnbng-nal-auto-lb-vrf-int)#primary-address 10.0.0.3
Router(config-cnbng-nal-auto-lb-vrf-int)#
```

Running Configuration

```
/* Configuration for default VRF */
cnbng-nal location 0/rsp0/CPU0
 auto-loopback vrf default
  interface loopback 0
    primary-address 10.0.0.1
    !
  interface loopback 1
    primary-address 10.0.0.2
    !
  interface loopback 2
    primary-address 10.0.0.3
    !
```

Configuration for non-default VRF

```
Router(config)#cnbng-nal location 0/RSP0/CPU0
Router(config-cnbng-nal-local)# hostidentifier cnBNG-SRG1
Router(config-cnbng-nal-local)# up-server ipv4 10.1.1.1 vrf default
Router(config-cnbng-nal-local)# cp-server primary ipv4 201.201.201.65
Router(config-cnbng-nal-local)# auto-loopback vrf vrftwo
Router(config-cnbng-nal-auto-loopback-vrf)# interface Loopback16
Router(config-cnbng-nal-auto-lb-vrf-int)# primary-address 10.0.0.1
Router(config-cnbng-nal-auto-lb-vrf-int)# interface Loopback17
Router(config-cnbng-nal-auto-lb-vrf-int)# primary-address 10.0.0.2
Router(config-cnbng-nal-auto-lb-vrf-int)# interface Loopback18
Router(config-cnbng-nal-auto-lb-vrf-int)# primary-address 10.0.0.3
Router(config-cnbng-nal-auto-lb-vrf-int)#
```

Running Configuration

```
cnbng-nal location 0/RSP0/CPU0
 hostidentifier cnBNG-SRG1
 up-server ipv4 19.1.1.1 vrf default
 cp-server primary ipv4 201.201.201.65
 auto-loopback vrf RJIL-VRF-OLT-MGMT
  interface Loopback16
   primary-address 1.1.0.1
  !
  interface Loopback17
   primary-address 2.1.0.1
  !
  interface Loopback18
   primary-address 3.1.0.1
```

Verification

```
/* Verification for default VRF */
Router#show cnbng-nal dynamic-routes summary

Location: 0/RSP0/CPU0
---------------------

Counter Name          Value
--------------------------------
V4 OC Entries         64
V6 OC Entries         0
V4 Primary Entries    0
V4 Secondary Entries  64      <<< This the total secondary addresses pushed from CP for
each subnet
V4 RIB Entries        64      <<< This is the total number of v4 subnets pushed from CP
V6 RIB Entries        128     <<< This is the total number of v4 subnets pushed from CP
OC replay entry count 96
```

The following example shows the details of each route entry:

```
/* Verification for non-default VRF */
Router#show cnbng-nal dynamic-routes afi ipv4

Location: 0/RSP0/CPU0
---------------------

Index                 : 1
Interface             : Loopback24
VRF                   : vrfone
AFI                   : IPv4
Prefix                : 10.0.0.0/20
Secondary address     : 10.0.0.1
Route tag             : 41
```

```
State                   : RIB_REQ_COMPLETE
SRG group name          :
Route metric            : 0


[Event History]
| Event Name                              | Time Stamp

| Route OC request sent                   | Jun 15 15:29:10.144
| Added secon V4 addrs on lb              | Jun 15 15:29:10.144
| Route update succeed                    | Jun 15 15:29:10.144
| V4 route add success                    | Jun 15 15:29:10.144
=============================================

Router#show cnbng-nal dynamic-routes afi ipv6
Thu Jun 16 08:06:25.312 GMT

Location: 0/RSP0/CPU0
----------------------

Index                   : 1
Interface               : Loopback20
VRF                     : vrfone
AFI                     : IPv6
Prefix                  : 4001::/52
Secondary address       : NA
Route tag               : 31
State                   : RIB_REQ_COMPLETE
SRG group name          :
Route metric            : 0


[Event History]
| Event Name                              | Time Stamp

| Added secon V6 addrs on lb              | Jun 15 15:29:05.152
| Skip V6 rt install (standby)            | Jun 15 15:29:05.152
| Route update succeed                    | Jun 15 15:29:05.152
=============================================

/* Verification for non-default VRF */
Router#nshow cnbng-nal dynamic-routes afi ipv4
Mon Aug  8 05:13:59.576 GMT

Location: 0/RSP0/CPU0
----------------------

Index                   : 1
Interface               : Loopback16
VRF                     : vrftwo
AFI                     : IPv4
Prefix                  : 10.0.0.0/20
Secondary address       : 10.0.0.1
Route tag               : 32
State                   : RIB_REQ_COMPLETE
SRG group name          : group32
Route metric            : 0


[Event History]
| Event Name                              | Time Stamp

| Route OC request sent                   | Aug  4 15:39:24.288
| Added secon V4 addrs on lb              | Aug  4 15:39:24.288
```

```
| Route update succeed                  | Aug  4 15:39:24.416
| V4 route add success                  | Aug  4 15:39:24.416
===========================================

Index                 : 2
Interface             : Loopback17
VRF                   : vrftwo
AFI                   : IPv4
Prefix                : 10.0.0.0/20
Secondary address     : 10.0.0.1
Route tag             : 32
State                 : RIB_REQ_COMPLETE
SRG group name        : group32
Route metric          : 0


[Event History]
| Event Name                            | Time Stamp

| Route OC request sent                 | Aug  4 15:39:26.976
| Added secon V4 addrs on lb            | Aug  4 15:39:26.976
| Route update succeed                  | Aug  4 15:39:26.976
| V4 route add success                  | Aug  4 15:39:26.976
===========================================
```

Configure DHCP

This section describes the steps to configure DHCP for cnBNG BNG user plane.

The basic DHCP configurations include these steps:

- Creating a cnBNG profile
- Assigning the cnBNG profile to access-interfaces

Configuration Example

```
Router(config)#dhcp ipv4
/* Create a cnBNG profile */
Router(config-dhcpv4)#profile cnbng_1 cnbng
Router(config-dhcpv4-cnbng-profile)#exit
/* Assign the cnBNG profile to access-interfaces */
Router(config-dhcpv4)#interface bundle-Ether 1.1 cnbng profile cnbng_1
Router(config-dhcpv4)#interface bundle-Ether 2.1 cnbng profile cnbng_1
Router(config-dhcpv4)#commit
```

Similarly, you can configure the DHCP IPv6 profiles.

Running Configuration

```
Router#show run dhcp ipv4
Wed Oct 14 16:48:56.814 UTC
dhcp ipv4
 profile cnbng_1 cnbng
 !
 interface Bundle-Ether1.1 cnbng profile cnbng_1
 interface Bundle-Ether2.1 cnbng profile cnbng_1
```

```
 !


Router#show run dhcp ipv6
Wed Oct 14 16:49:19.095 UTC
dhcp ipv6
 profile cnbng_1 cnbng
 !
 interface Bundle-Ether1.1 cnbng profile cnbng_1
 interface Bundle-Ether2.1 cnbng profile cnbng_1
!
```

Configure Subscriber Gateway Address and Subnet Route

Table 4: Feature History Table

Feature Name	Release Information	Feature Description
Disable Notifications for Dynamic Programming of Subscriber Gateway Address	Release 7.4.2	This feature allows you to disable the notifications exchanged internally between software components when the user plane (UP) of a cloud-native BNG (cnBNG) network programs the gateway address for its subscriber. It prevents excessive notifications when many active subscribers are on the UP, thus reducing the overhead on UP resources. The feature introduces the following command: • **disable-secondary-address-notification**

In cnBNG, the IP address management is more dynamic. Hence, the loopback interface for IPoE or PPPoE subscribers isn't provisioned in the user profile of the subscriber with static configuration. cnBNG user plane selects the loopback based on the subnet allocated to a loopback dynamically at cnBNG user plane.

Note For every VRF, one loopback must be present on the UP.

Consider this example,

```
On RSP0:
Tue Jul 28 05:55:13.015 UTC
cnbng-nal location 0/RSP0/CPU0
hostidentifier asr9k-1
up-server ipv4 192.0.2.1 vrf default
cp-server primary ipv4 198.51.100.1
auto-loopback vrf default
  interface Loopback1
   primary-address 10.0.0.1
```

```
    !
!
On RSP1:
Tue Jul 28 05:56:13.015 UTC
cnbng-nal location 0/RSP1/CPU0
hostidentifier asr9k-1
up-server ipv4 192.0.2.1 vrf default
cp-server primary ipv4 198.51.100.1
auto-loopback vrf default
  interface Loopback1
   primary-address 10.0.0.1
  !
!
```

In this example, the CP assigns 10.11.12.0/24 as subnet, and 10.11.12.1/32 as gateway address to subscribers under the default VRF. This gateway address serves as the DHCPv4 server address for DHCPv4 OFFER or ACK messages. The *cnbng-nal* process uses Operations Center (OC) to configure this gateway address as secondary IP address on the loopback and route provision APIs to program the entry in the L3 routing table.

Note   The system supports a maximum of 32 secondary IP addresses under an interface.

```
Router#show ipv4 interface loopback 1
Tue Jul 28 05:29:58.741 UTC
Loopback1 is Up, ipv4 protocol is Up
  Vrf is default (vrfid 0x60000000)
   Internet address is 10.0.0.1/32
   Secondary address 10.11.12.1/32


Router#show route vrf all ipv4 subscriber
A    10.11.12.0/24 [1/0] via 0.0.0.0, 00:10:29
```

Note   The dynamic programming of the subnet (secondary gateway) under the loopback causes a major churn on the UP if large scale of active subscribers is present on the node. Hence, the secondary address programming is disabled, by default.

Enable Secondary Address Programming

It's mandatory to enable the secondary address programming on cnBNG user plane. To enable that, use the **secondary-address-update enable** command under the cnbng-nal configuration mode.

Configuration Example

```
Router#configure
Router(config)#cnbng-nal location 0/RSP0/CPU0
Router(config-cnbng-nal)#secondary-address-update enable
Router(config-cnbng-nal)#commit
```

Running Configuration

```
Router#show running-config cnbng-nal location 0/RSP0/CPU0
cnbng-nal location 0/RSP0/CPU0
 secondary-address-update enable
!
```

✎

Note From Release 7.4.2 onwards, you can disable internal notifications on the UP while it programs the
secondary address on the loopback interface by configuring the command
disable-secondary-address-notification.

Disable Notifications for Dynamic Programming of Subscriber Gateway Address

In a cnBNG network, the CP assigns the gateway address for each subscriber. The UP dynamically programs
gateway address assigned to each subscriber as a secondary IP address on its loopback interface. During this
configuration, UP internally exchanges notification messages between various software components. The
more the number of active subscribers on the UP, the more the notifications. To preserve valuable time and
resources of the UP, you can disable notifications using the command **disable-secondary-address-notification**
in the **cnbng-nal-local** config mode.

Configuration Example

```
Router#configure
Router(config)#cnbng-nal location 0/RSP0/CPU0
Router(config-cnbng-nal-local)#disable-secondary-address-notification
Router(config-cnbng-nal-local)#commit
```

Running Configuration

The following running configuration on cnBNG UP includes basic UP configuration as well:

```
Router#show running-config cnbng-nal location 0/RSP0/CPU0
cnbng-nal location 0/1/CPU0
 hostidentifier RTR1
 auto-loopback vrf test
  interface Loopback1
   primary-address 10.1.1.1
  !
 !
 auto-loopback vrf default
  interface Loopback0
   primary-address 10.30.30.1
  !

 !

 up-server ipv4 10.11.11.1 gtp-port 15002 pfcp-port 15003 vrf default
 cp-server primary ipv4 10.11.11.2
 enable-test-server
 disconnect-history file-logging-enable
 secondary-address-update enable
 disable-secondary-address-notification
 route-summary tag 111
```

```
    cp-association retry-count 5
!
```

Configure Route Summary

This section describes the steps to configure route summary for the cnBNG user plane.

The NAL handles the following routes:

- Individual subscriber routes

- Summary routes for subscriber pool subnet

The subscriber routes are part of the subscriber provisioning message, which includes:

- WAN IP address (/32 or /128 subnet)

- LAN IP (prefix delegation)

The summary routes are for the subscriber pool subnet which are exported to the core network to download traffic towards the subscriber. On physical BNG, the subscriber pool subnets were configured as static routes and redistributed through BGP or IGP. With cnBNG and auto-loopback selection, these subnets for the subscribers are added dynamically to the loopback. Every time a new subscriber pool subnet is added to the loopback, the same is added to the RIB with the tag that is provided by the CP. If tag is '0', the NAL uses the tag configured under the cnbng-nal. Routes with this tag can be exported to the core using the Routing Protocol for Low-Power and Lossy Networks (RPLs).

To configure route summary, use the **route-summary** command under the cnbng-nal configuration mode.

Configuration Example

```
Router#configure
Router(config)#cnbng-nal location 0/RSP0/CPU0
Router(config-cnbng-nal)#route-summary tag 10
Router(config-cnbng-nal)#commit
```

Running Configuration

```
Router#show running-config cnbng-nal location 0/RSP0/CPU0
cnbng-nal location 0/RSP0/CPU0
 route-summary tag 10
!
```

After the first subnet is installed on NAL, the following routes are added to the system:

```
A 10.11.12.0/24 [1/0] via 0.0.0.0, 0d01h
```

Export Routes to Core Network

This section describes how to export routes to core network as part of enabling cnBNG user plane functionality.

Configuration Example

```
Router#configure
Router(config)#route-policy test-policy-cnbng
Router(config-rpl)#if tag eq 10 then
Router(config-rpl-if)#set community (123:100)
Router(config-rpl-if)#done
Router(config-rpl-if)#endif
Router(config-rpl)#end-policy
Router(config)#commit

Router(config)#router ospf 10
Router(config-ospf)#vrf test-vrf-cnbng
Router(config-ospf-vrf)#redistribute subscriber route-policy test-policy-cnbng
Router(config-ospf-vrf)#commit
```

Running Configuration

```
Router#show running-config route-policy test-policy-cnbng
route-policy test-policy-cnbng

    if tag eq 10  then

      set community (123:100)

      done

    endif

  end-policy
  !

Router#show running-config router ospf
router ospf 10
 vrf test-vrf-cnbng
  redistribute subscriber route-policy test-policy-cnbng
  !
```

Configure ARP Scale Mode

This section describes the steps to configure ARP scale mode for the cloud-native BNG user plane.

To disable interface entry creation by ARP for each subscriber interface on the data plane (line cards), you must enable ARP scale mode for the subscriber using the **arp scale-mode-enable** command in subscriber configuration mode.

Configuration Example

```
Router#configure
Router(config)#subscriber
Router(config-subscriber)#arp scale-mode-enable
Router(config-subscriber)#commit
```

Running Configuration

```
Router#show running-config subscriber
Sat Aug 22 06:36:21.422 UTC
subscriber
arp scale-mode-enable
!
```

Configure Cloud Native BNG over Pseudowire Headend

Table 5: Feature History Table

Feature Name	Release Information	Feature Description
Establishing Cloud Native BNG Sessions over Pseudowire Headend (PWHE)	Release 7.4.2	This feature establishes Cloud Native BNG subscriber sessions on PWHE interfaces. PWHE enables an easy and scalable mechanism for tunneling cnBNG traffic into a common IP, MPLS, or L2 network.

Cloud Native BNG provides subscriber support over Pseudowire Headend (PWHE). PWHE provides L3 connectivity to customer edge nodes through a pseudowire connection. PWHE terminates the L2VPN circuits that exist between the access-provide edge (A-PE) nodes, to a virtual interface, and performs routing on the native IP packet. Each virtual interface can use one or more physical interfaces towards the access cloud to reach customer Router through the A-PE nodes.

This figure shows a sample topology for Cloud Native BNG over Pseudowire Headend:

Figure 5: Sample Topology for Cloud Native BNG over Pseudowire Headend:
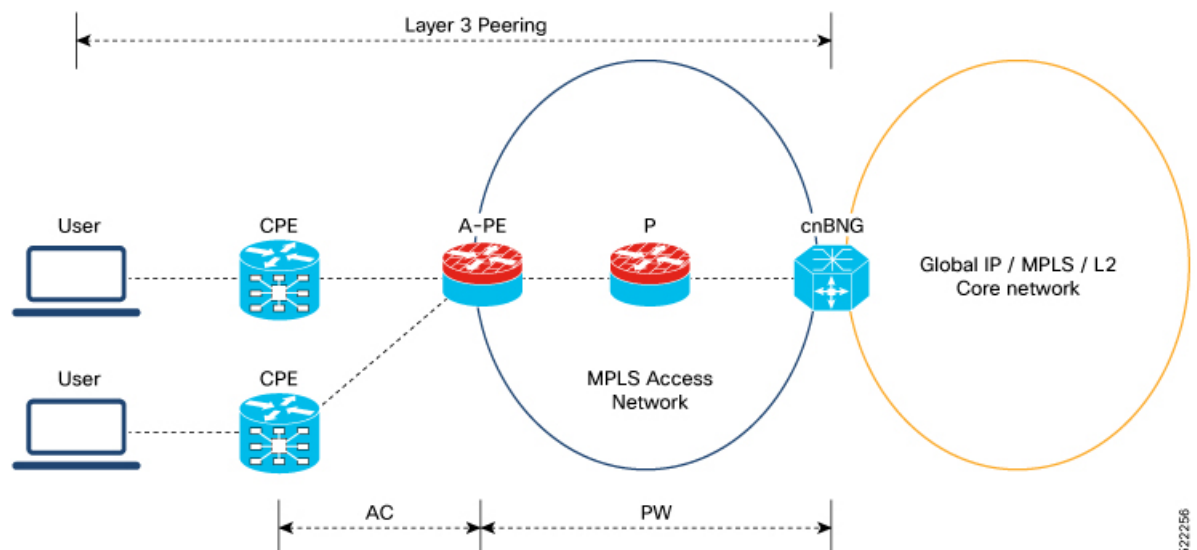
Restrictions

You can not configure eight ECMP links on the same PE device.

Configuration Example

This section provides the sample configurations for BNG over Pseudowire Headend:

The following is the sample configuration to allow IPOE or PPPOE subsciber to bring up from the PWHE access interface on the cnBNG:

```
Router#configure
Router(config)#interface PW-Ether100.102
Router(config-subif)#ipv4 unnumbered Loopback100
Router(config-subif)#ipv6 enable
Router(config-subif)#load-interval 30
Router(config-subif)#ipsubscriber
Router(config-cnbng-nal-ipsub)#ipv4 l2-connected
Router(config-cnbng-nal-ipsub-l2conn)#initiator dhcp
Router(config-cnbng-nal-ipsub-l2conn)#exit
Router(config-cnbng-nal-ipsub)#ipv6 l2-connected
Router(config-cnbng-nal-ipsub-ipv6-l2conn)#initiator dhcp
Router(config-cnbng-nal-ipsub-ipv6-l2conn)#exit
Router(config-cnbng-nal-ipsub)#exit
Router(config-subif)#pppoe enable
Router(config-subif)#encapsulation ambiguous dot1q any second-dot1q 102
Router(config-subif)#commit
```

This example shows the configuration of DHCPv4 on PWHE interfaces:

```
Router#configure
Router(config)#dhcp ipv4
Router(config-dhcpv4)#profile cn4 cnbng
Router(config-dhcpv4-cnbng-profile)#exit
Router(config-dhcpv4)#interface PW-Ether100.102 cnbng profile cn4
Router(config-dhcpv4)#interface PW-Ether100.103 cnbng profile cn4
Router(config-dhcpv4)#interface PW-Ether100.104 cnbng profile cn4
Router(config-dhcpv4)#commit
```

This example shows the configuration of DHCPv6 on PWHE interface:

```
Router#configure
Router(config)#dhcp ipv6
Router(config-dhcpv6)#profile cn4 cnbng
Router(config-dhcpv6-cnbng-profile)#exit
Router(config-dhcpv6)#interface PW-Ether100.102 cnbng profile cn6
Router(config-dhcpv6)#interface PW-Ether100.103 cnbng profile cn6
Router(config-dhcpv6)#commit
```

Running Configuration

The following example displays the running configuration of pw-ether interface.

```
Router#show running-config interface PW-Ether 100.102
Thu Feb  3 11:33:58.450 IST
interface PW-Ether100.102
 ipv4 unnumbered Loopback100
 ipv6 enable
 load-interval 30
 ipsubscriber
  ipv4 l2-connected
   initiator dhcp
  !
  ipv6 l2-connected
```

```
  initiator dhcp
 !
 !
 pppoe enable
 encapsulation ambiguous dot1q any second-dot1q 102
!
```

Configure DHCPv4 on PWHE interface:

```
Router#show run dhcp ipv4
Thu Feb  3 11:55:01.903 IST
dhcp ipv4
 profile cn4 cnbng
 !
 interface PW-Ether100.102 cnbng profile cn4
 interface PW-Ether100.103 cnbng profile cn4
 interface PW-Ether100.104 cnbng profile cn4
!
```

Configure DHCPv6 on PWHE interface:

```
Router#show run dhcp ipv6
Thu Feb  3 11:55:07.906 IST
dhcp ipv6
 profile cn6 cnbng
 !
 interface PW-Ether100.102 cnbng profile cn6
 interface PW-Ether100.103 cnbng profile cn6
!
```

Verify cnBNG User Plane Configuration

This section describes the show commands to be executed on the router to verify cloud native BNG user plane configuration.

For details on cnBNG commands, see the *Cloud Native BNG Command Reference for Cisco ASR 9000 Series Routers*.

Verify cnBNG NAL Process Information

You can use the following commands to verify the NAL process information on cnBNG user plane.

-
  ```
  Router#show cnbng-nal process-info location 0/RSP0/CPU0
  Mon Aug  3 00:12:42.080 UTC

  Location: 0/RSP0/CPU0

   HA Pre_Init Role        : PRIMARY
   HA Role                 : PRIMARY
   Restart-flag            : FALSE
   card_type               : 0
   Node-Id                 : 0
   Disc-Hist File-logging  : FALSE
   Test-server config-enabled: FALSE

   Proc-flags     : 8000FFBF
  ```

```
            OT Connection Status: UP
            IM Connection Status: UP
            IPv4 RIB Connection Status: UP
            IPv6 RIB Connection Status: UP
            SUBDB Connection Status: UP
```

-
  ```
  Router#show cnbng-nal process-readiness
  Mon Aug  3 00:12:00.778 UTC

  Location: 0/RSP1/CPU0

  NAL resync pending flags:
          Service Resync Pending
          Interface Resync Pending
          IPv4 Route Resync Pending
          IPv6 Route Resync Pending

  SIR status: not ready

  Location: 0/RSP0/CPU0
  NAL resync pending flags:
          NONE

  SIR status: ready
  ```

-
  ```
  Router#show processes cnbng_nal
  Fri Sep 11 09:22:45.139 UTC
                  Job Id: 456
                     PID: 1543

  Router#show processes memory 1543
  Fri Sep 11 09:24:12.398 UTC
  JID      Text(KB)   Data(KB)   Stack(KB) Dynamic(KB) Process
  ------ ---------- ---------- ---------- ----------- -------------------------------
  456          992    1700604        200       19999 cnbng_nal
  ```

Verify Control Plane Connection Status

You can use the following command to verify the connection status of cnBNG control plane.

-
  ```
  Router#show cnbng-nal cp connection status
  Fri Feb 19 11:27:31.178 UTC

  Location: 0/RSP0/CPU0


  User-Plane configurations:
  ------------------------
  IP              : 10.105.227.96
   GTP Port       : 2152
  PFCP Port       : 8805
  VRF             : default


  Control-Plane configurations:
  ```

```
----------------------------
PRIMARY IP     : 10.84.102.235
 GTP Port      : 2152
PFCP Port      : 8805

 Association retry count: 10

Connection Status: Up
Connection Status time stamp: Thu Feb 11 12:46:19 2021

Connection Prev Status : Down
Connection Prev Status time stamp: Thu Feb 11 12:44:55 2021

Association status: Active
Association status time stamp: Thu Feb 11 12:46:18 2021
```

Verify Subscriber Information

You can use the following commands to verify subscriber information on the cnBNG user plane.

-
```
Router#show cnbng-nal subscriber access-interface bundle-Ether 1.1
Mon Aug  3 00:04:42.558 UTC
====================
Location: 0/RSP0/CPU0
====================

               Type          PPPoE          IPoE
               ====          =====          ====

Session Counts by State:
        initializing         0              0
        connecting           0              0
        connected            0              0
        activated            0              8000
        idle                 0              0
    disconnecting            0              0
            Total:           0              8000


Session Counts by Address-Family:
        none                 0              0
        ipv4                 0              0
        ipv6                 0              8000
        dual                 0              0
            Total:           0              8000


====================
Location: 0/RSP1/CPU0
====================

               Type          PPPoE          IPoE
               ====          =====          ====

Session Counts by State:
        initializing         0              0
        connecting           0              0
        connected            0              0
        activated            0              8000
            idle             0              0
```

```
       disconnecting            0                0
              Total:            0             8000


Session Counts by Address-Family:
              none              0                0
              ipv4              0                0
              ipv6              0             8000
              dual              0                0
              Total:            0             8000
```

•
```
Router#show cnbng-nal subscriber all
Fri Sep 11 06:07:52.343 UTC
   Codes: CN - Connecting, CD - Connected, AC - Activated,

        ID - Idle, DN - Disconnecting, IN - Initializing




CPID(hex)Interface           State Mac Address   Subscriber IP Addr / Prefix (Vrf)
Ifhandle
-----------------------------------------------------------------------------------

1005ca0  BE2.500.ip2149474448 AC    0010.942e.3b00 13.0.92.160 (default) 0x225e60

                                                   1:4::5c9f (IANA)

                                                   2003:db0:0:5c9e::/64 (IAPD)

10053b2  BE2.500.ip2149466000 AC    0010.942e.3689 13.0.83.175 (default) 0xfdfe0

                                                   1:4::53b1 (IANA)

                                                   2003:db0:0:53b0::/64 (IAPD)

1004c81  BE2.600.ip2149013936 AC    0010.942e.5230 13.0.76.129 (default) 0x4079a0

                                                   1:4::4c80 (IANA)

                                                   2003:db0:0:4c7f::/64 (IAPD)

1004aaa  BE2.500.ip2149353232 AC    0010.942e.3205 13.0.74.169 (default) 0x5192e0

                                                   1:4::4aa9 (IANA)

                                                   2003:db0:0:4aa8::/64 (IAPD)

1004927  BE2.600.ip2149518576 AC    0010.942e.50b1 13.0.73.116 (default) 0x219ba0

                                                   1:4::4926 (IANA)

                                                   2003:db0:0:4925::/64 (IAPD)

10047e4  BE2.800.ip2149422928 AC    0010.9431.a7c7 13.0.71.228 (default) 0x41ff60

                                                   1:4::47e4 (IANA)

                                                   2003:db0:0:47e2::/64 (IAPD)

1004777  BE2.600.ip2149520224 AC    0010.942e.5021 13.0.71.115 (default) 0x41420
```

```
                                                      1:4::4776 (IANA)

                                                      2003:db0:0:4775::/64 (IAPD)

1003a6d  BE2.800.ip2149369728 AC    0010.9431.a3a1 13.0.58.105 (default) 0x141360

                                                      1:4::3a6d (IANA)

                                                      2003:db0:0:3a6a::/64 (IAPD)

10038b7  BE2.600.ip2149362240 AC    0010.942e.4bb2 13.0.56.178 (default) 0x259aa0

                                                      1:4::38b6 (IANA)

                                                      2003:db0:0:38b5::/64 (IAPD)

10028ba  BE2.500.ip2149210768 AC    0010.942e.2873 13.0.40.185 (default) 0x129620

                                                      1:4::28b9 (IANA)

                                                      2003:db0:0:28b8::/64 (IAPD)

100247b  BE2.600.ip2149396320 AC    0010.942e.46a3 13.0.36.113 (default) 0x4b8e0

                                                      1:4::2471 (IANA)

                                                      2003:db0:0:2470::/64 (IAPD)

100207a  BE2.500.ip2149356496 AC    0010.942e.2663 13.0.32.117 (default) 0x1a9460

                                                      1:4::2079 (IANA)

                                                      2003:db0:0:2078::/64 (IAPD)

1001d3f  BE2.600.ip2149251360 AC    0010.942e.44d4 13.0.29.61 (default) 0xcc760
```

•

```
Router#show cnbng-nal subscriber all summary
Sun Aug  2 16:26:44.281 UTC
=====================
Location: 0/RSP0/CPU0
=====================


                        Type            PPPoE           IPoE
                        ====            =====           ====


Session Counts by State:
         initializing              0               0
          connecting              0               0
           connected              0               0
           activated              0             130
                idle              0               0
       disconnecting              0               0
              Total:              0             130


Session Counts by Address-Family:
                none              0               0
                ipv4              0             130
                ipv6              0               0
                dual              0               0
              Total:              0             130
```

```
====================

Location: 0/RSP0/CPU0

=====================


                      Type        PPPoE        IPoE

                      ====        =====        ====


   Session Counts by State:

            initializing        0            0

             connecting         0            0

              connected         226          0

              activated         31774        0

                   idle         0            0

        disconnecting           0            0

                Total:          32000        0



   Session Counts by Address-Family:

                    none        226          0

                    ipv4        7774         0

                    ipv6        0            0

                    dual        24000        0

                  Total:        32000        0
```

-
```
Router#show cnbng-nal subscriber all detail
Mon Aug  3 00:00:14.624 UTC
Location: 0/2/CPU0
==================
Location: 0/RSP1/CPU0
==================
Interface:              Bundle-Ether1.1.ip2148413040
UPID:                   0x800e2e70
CPID:                   0x0100918f
PPPOE Session Id:       0x0000
Type:                   IPoE
IPv4 Address:           0.0.0.0
IPv4 Framed Route:
  Prefix:               0.0.0.0/0
  Next Hop:             0.0.0.0
  Tag:                  0
```

```
IPv6 IANA Address:          1:5::345c
IPv6 IAPD Prefix:           2004:cd0:0:188d::/64
CPE link local Address:     ::
IPv6 Framed Route:
  Prefix:                   ::/0
  Next Hop:                 ::
  Tag:                      0
IPv6 State:                 UP, Sat Jul 25 02:09:55 2020
Mac Address:                5065.aaab.d864
Inner VLAN ID:              Not Set
Outer VLAN ID:              100
Outer VLAN Cos:             0
Outer VLAN DEI:             1
Created:                    Sat Jul 25 02:09:54 2020
State:                      Activated
Ifhandle:                   0x000b75a0
VRF:                        default
Access-interface:           Bundle-Ether1.1
 Attribute List: 0x5556aed3f878
1:  ipv6-enable     len=  4  value= 1(1)
2:  ipv4-unnumbered len=  9  value= Loopback1
3:  strict-rpf      len=  4  value= 1(1)
4:  ipv6-strict-rpf len=  4  value= 1(1)
5:  ipv4-icmp-unreachable len=  4  value= 1(1)
6:  ipv6-unreachable len=  4  value= 1(1)
7:  ipv4-mtu        len=  4  value= 1500(5dc)
8:  ipv6-mtu        len=  4  value= 1500(5dc)
Session Accounting:         enabled
Interim Interval:           1800 secs
Last interim timestamp:     Sun Aug  2 23:39:46 2020
Interim fail count: None
Last interim failed reason: NA
Last stats:
  BytesIn: 0
  BytesOut: 384570
  BytesInGiga: 0
  BytesOutGiga: 0
Feature IDs activated :
  0x800e2e71
  0x800e2e72
```

•

```
Router#show cnbng-nal subscriber type ipoe summary
Mon Aug  3 00:06:15.032 UTC
=====================
Location: 0/RSP0/CPU0
====================

              Type          PPPoE         IPoE
              ====          =====         ====

Session Counts by State:
      initializing          0             0
        connecting          0             0
         connected          0             0
         activated          0             8000
              idle          0             0
     disconnecting          0             0
            Total:          0             8000

Session Counts by Address-Family:
              none          0             0
              ipv4          0             0
```

```
                         ipv6              0                8000
                         dual              0                0
                         Total:            0                8000


====================
Location: 0/RSP1/CPU0
====================

                         Type            PPPoE            IPoE
                         ====            =====            ====

Session Counts by State:
         initializing              0                0
          connecting              0                0
           connected              0                0
           activated              0                8000
                idle              0                0
        disconnecting             0                0
                Total:            0                8000

Session Counts by Address-Family:
                none              0                0
                ipv4              0                0
                ipv6              0                8000
                dual              0                0
                Total:            0                8000

Router#


Router#show cnbng-nal subscriber type pppoe summary
Mon Aug  3 00:06:15.032 UTC
====================
Location: 0/RSP0/CPU0
====================

                         Type            PPPoE            IPoE
                         ====            =====            ====

Session Counts by State:
         initializing              0                0
          connecting              0                0
           connected              0                0
           activated          31031                0
                idle              0                0
        disconnecting             0                0
                Total:        31031                0

Session Counts by Address-Family:
                none              0                0
                ipv4          31031                0
                ipv6              0                0
                dual              0                0
                Total:        31031                0

Router#


Router#show cnbng-nal subscriber disconnect-history unique
Mon Aug  3 00:07:22.716 UTC

Location: 0/RSP1/CPU0

| Count|       Last Interface       | Disconnected Reason |         Last Time
```

```
                                                                          Disconnected
    Location: 0/1/CPU0
    Location: 0/RSP0/CPU0

    | Count|        Last Interface      | Disconnected Reason |      Last Time
                                                                      Disconnected
    35494    Bundle-Ether1.1.ip2148328848  Disconnect by CP          Sat Jul 25
                                                                      02:04:55 2020


    14154    Bundle-Ether1.1.ip2148324096  Disconnect by clear CLI    Sat Jul 25
                                                                      02:05:48 2020


     2777    Bundle-Ether1.1.ip2148194512  Disconnect due to create failure Sat Jul 25
                                                                      01:38:29 2020
```

*

```
Router#show cnbng-nal subscriber disconnect-history last location
Mon Aug  3 00:08:42.655 UTC

Disconnect-reason:          Disconnect by clear CLI
Disconnect-timestamp:       Sat Jul 25 02:05:48 2020
  Message Txn ID: 55663
  Session Txn ID: 1
  Failed at: Sat Jul 25 01:57:03 2020
  Feature Mask: 0x0
  SVM State: 0
  IPSUB flags: 0x600a200
  Pending callback: 0x2
  Data:

Interface:                  Bundle-Ether1.1.ip2148324096
UPID:                       0x800cd300
CPID:                       0x01007bd8
PPPOE Session Id:           0x0000
Type:                       IPoE
IPv4 Address:               0.0.0.0
IPv4 Framed Route:
  Prefix:                   0.0.0.0/0
  Next Hop:                 0.0.0.0
  Tag:                      0
IPv6 IANA Address:          1:5::3de5
IPv6 IAPD Prefix:           2004:cd0:0:616::/64
CPE link local Address:     ::
IPv6 Framed Route:
  Prefix:                   ::/0
  Next Hop:                 ::
  Tag:                      0
IPv6 State:                 UP, Sat Jul 25 01:57:03 2020
Mac Address:                5065.aaab.cfbb
Inner VLAN ID:              Not Set
Outer VLAN ID:              100
Outer VLAN Cos:             0
Outer VLAN DEI:             1
Created:                    Sat Jul 25 02:05:48 2020
State:                      Init
Ifhandle:                   0x000323a0
VRF:                        default
Access-interface:           Bundle-Ether1.1
 Attribute List: 0x559125764408
1:  ipv6-enable     len=  4  value= 1(1)
2:  ipv4-unnumbered len=  9  value= Loopback1
3:  strict-rpf      len=  4  value= 1(1)
4:  ipv6-strict-rpf len=  4  value= 1(1)
5:  ipv4-icmp-unreachable len=  4  value= 1(1)
```

```
6:  ipv6-unreachable len=  4  value= 1(1)
7:  ipv4-mtu       len=  4  value= 1500(5dc)
8:  ipv6-mtu       len=  4  value= 1500(5dc)
Session Accounting:        enabled
Interim Interval:          1800 secs
Last interim timestamp:    Sat Jul 25 02:05:47 2020
Interim fail count: None
Last interim failed reason: NA
Last stats:
  BytesIn: 0
  BytesOut: 540
  BytesInGiga: 0
  BytesOutGiga: 0
Feature IDs activated :
  0x800cd301
  0x800cd302

[Event History]
UPID:  0x800cd300

| Event Name              | Time Stamp             | S, M
| Create                  | Jul 25 01:57:02.999679 | 0, 0
| New Session Request     | Jul 25 01:57:02.999686 | 0, 0
| Interface create        | Jul 25 01:57:02.999823 | 0, 0
| SVM create              | Jul 25 01:57:03.018268 | 0, 0
| UP Install(req)         | Jul 25 01:57:03.018321 | 0, 0
| UP Install(CB)          | Jul 25 01:57:03.019220 | 0, 0
| Last Assoc(req)         | Jul 25 01:57:03.019232 | 0, 0
| Last Assoc(CB)          | Jul 25 01:57:03.020160 | 0, 1
| Produce done(req)       | Jul 25 01:57:03.020233 | 0, 0
| IPv4 Caps Up            | Jul 25 01:57:03.188034 | 0, 0
| IPv6 Caps Up            | Jul 25 01:57:03.233210 | 0, 0
| Init data req           | Jul 25 01:57:03.254482 | 0, 1
| Init data cb            | Jul 25 01:57:03.369027 | 0, 1
| Client Session up       | Jul 25 01:57:03.379152 | 0, 0
| Produce done            | Jul 25 01:57:03.977629 | 0, 0
| IPv6 Up                 | Jul 25 01:57:03.977643 | 0, 0
| Session up notified     | Jul 25 01:57:03.977650 | 0, 0
| Stats start             | Jul 25 01:57:03.977841 | 0, 0
| Disconnect notified     | Jul 25 02:05:47.548202 | 0, 0
| Disconnect ack          | Jul 25 02:05:47.550293 | 0, 0
| IPv4 Caps Down          | Jul 25 02:05:47.652232 | 0, 0
| IPv6 Caps Down          | Jul 25 02:05:47.652333 | 0, 0
| Final stats             | Jul 25 02:05:47.753805 | 0, 0
| SVM delete              | Jul 25 02:05:47.780713 | 0, 0
| SVM cleanup             | Jul 25 02:05:48.283050 | 0, 0
Help: S - Sticky Event, M - Multiple Occurrence
```

-

```
Router#show cnbng-nal subscriber fadb
Mon Aug  3 00:03:12.858 UTC

Location: 0/RSP1/CPU0
==================

UPID:      0x800ec810
Service-ID: 0x04000003  Service-Name: JHV_VOICE
Feature-ID: 0x800ec812
 Attribute List: 0x559cba6d0008
1:  feature-acct-bitmask len=  4  value= 805306413(3000002d)
Accounting:              enabled
Interim fail count: None
Last interim failed reason: None
```

```
Last stats:
  BytesIn: 0
  BytesOut: 0
  BytesInGiga: 0
  BytesOutGiga: 0

UPID:      0x800e9470
Service-ID: 0x04000003  Service-Name: JHV_VOICE
Feature-ID: 0x800e9472
 Attribute List: 0x559cba6d0008
1:  feature-acct-bitmask len=  4  value= 805306413(3000002d)
Accounting:             enabled
Interim fail count: None
Last interim failed reason: None
Last stats:
  BytesIn: 0
  BytesOut: 0
  BytesInGiga: 0
  BytesOutGiga: 0

UPID:      0x800e7ee0
Service-ID: 0x04000003  Service-Name: JHV_VOICE
Feature-ID: 0x800e7ee2
 Attribute List: 0x559cba6d0008
1:  feature-acct-bitmask len=  4  value= 805306413(3000002d)
Accounting:             enabled
Interim fail count: None
Last interim failed reason: None
Last stats:
  BytesIn: 0
  BytesOut: 0
  BytesInGiga: 0
  BytesOutGiga: 0

UPID:      0x800e16e0
Service-ID: 0x04000004  Service-Name: LIVE_TV
Feature-ID: 0x800e16e1
 Attribute List: 0x559cba6d0008
1:  feature-acct-bitmask len=  4  value= 0(0)
Accounting:             disabled
Interim fail count: None
Last interim failed reason: None
Last stats:
  BytesIn: 0
  BytesOut: 0
  BytesInGiga: 0
  BytesOutGiga: 0

UPID:      0x800dda90
Service-ID: 0x04000003  Service-Name: JHV_VOICE
Feature-ID: 0x800dda91
 Attribute List: 0x559cba6d0008
1:  feature-acct-bitmask len=  4  value= 805306413(3000002d)
Accounting:             enabled
Interim fail count: None
Last interim failed reason: None
Last stats:
  BytesIn: 0
  BytesOut: 0
  BytesInGiga: 0
  BytesOutGiga: 0

UPID:      0x800dd4e0
Service-ID: 0x04000004  Service-Name: LIVE_TV
```

```
Feature-ID: 0x800dd4e1
 Attribute List: 0x559cba6d0008
1:  feature-acct-bitmask len=  4  value= 0(0)
Accounting:              disabled
Interim fail count: None
Last interim failed reason: None
Last stats:
  BytesIn: 0
  BytesOut: 0
  BytesInGiga: 0
  BytesOutGiga: 0
```

Verify cnBNG NAL Counters

You can use the following commands to verify various NAL counters on the cnBNG user plane:

●

```
Router#show cnbng-nal counters type all
Sun Aug  2 20:42:49.548 UTC

Location: 0/RSP0/CPU0

Subscriber Counters
-------------------

Counter name                  Value
============                  =====
INTF Delete                   500
IPv4 caps down                500
IPv6 caps down                500
IPv4 Rou del                  500
IPv6 Rou del                  500
Blkdis q empty                1
DB cache hit                  17113

Error Counters
--------------

Counter name                  Value
============                  =====

Accounting Counters
-------------------

Counter name                  Value
============                  =====
Sess Stop req                 500
Feat Stop req                 500
Stop req                      3000
Stop cb                       3000
Final cb                      3000
Feat Final cb                 500
Sess Final cb                 2500

SVM Counters
------------

Counter name                  Value
============                  =====
Sess deleted                  500
Delete CB                     500
```

```
        Feat deleted                   1000
        Cleanup                        500
        Sess stats, before svm         500
        Feat stats, before svm         500

        SPA Counters
        ------------

        Counter name                   Value
        =============                  =====
        SPA Delete Req                 500
        SPA Update Req                 500
        Sub Delete Res                 500
        Sub Update Res                 500
        Blkdic adm more                39
        GTPu pkt sent                  1000
        PFCP pkt sent                  1463
        GTPu pkt punt                  500
        PFCP pkt punt                  1463
        DHCPv4 pkt punt                500
        DHCPv6 pkt punt                500
        DHCPv6 pkt inj                 500
        Alloc count                    3463
        Free count                     3463
        Mutex lock                     6741
        Mutex unlock                   6741
        Timer start                    463
        Timer expiry                   463
        Sub Update IPOE OK             500
        Sub Delete IPOE OK             500

        CP Recon Counters
        ------------------

        Counter name                   Value
        =============                  =====

        Histogram/API Performance Stats
        -------------------------------

        API name      1ms      10ms 100ms 1s   5s  10s  20s  50s  100s
        ========      ===      ==== ===== ==   ==  ===  ===  ===  ====
        Per trans     410      90   0     500  0   0    0    0    0
        Sub Create    0        0    0     0    0   0    0    0    0
        Sub Update    445      55   0     0    0   0    0    0    0
        Sub Delete    0        0    0     500  0   0    0    0    0
        IPOE Int Crt  0        0    0     0    0   0    0    0    0
        IPOE Int Upd  0        0    0     0    0   0    0    0    0
        IPOE Int Del  0        0    0     500  0   0    0    0    0
        PPPOE Int Crt 0        0    0     0    0   0    0    0    0
        PPPOE Int Upd 0        0    0     0    0   0    0    0    0
        PPPOE Int Del 0        0    0     0    0   0    0    0    0
        Sess Create   0        0    0     0    0   0    0    0    0
        Sess Update   0        0    0     0    0   0    0    0    0
        Sess Delete   0        0    10    490  0   0    0    0    0
        V4 RT Inst    0        0    0     0    0   0    0    0    0
        V4 RT Del     0        6    320   174  0   0    0    0    0
        V4 FR Inst    0        0    0     0    0   0    0    0    0
        V4 FR Del     0        0    0     0    0   0    0    0    0
        V6 RT Inst    0        0    0     0    0   0    0    0    0
        V6 RT Del     0        6    310   184  0   0    0    0    0
        V6 PD RT Inst 0        0    0     0    0   0    0    0    0
        V6 PD RT Del  0        0    0     0    0   0    0    0    0
        V6 FR Inst    0        0    0     0    0   0    0    0    0
```

```
V6 FR Del      0          0     0     0   0   0   0   0   0
CDM Lookup     0          0     0     0   0   0   0   0   0
CDM Insert     0          0     0     0   0   0   0   0   0
CDM Update     1469       31    0     0   0   0   0   0   0
Eval Lookup    0          0     0     0   0   0   0   0   0
```

-
```
Router#show cnbng-nal counters type all | beg SPA LIB
Sun Aug  2 20:44:07.902 UTC
SPA LIB Counters
----------------

Counter name                  Value
=============                 =====
pfcp_rx_counter               6899
pfcp_tx_counter               6900
gtpu_tx_counter               9048
gtpu_rx_counter               7510
pfcp_keepalive_tx_counter     891
pfcp_keepalive_rx_counter     890

SPA API counters
----------------------
```

-
```
Router#show cnbng-nal counters type spa
Sun Aug 2 20:42:13.703 UTC

Location: 0/RSP0/CPU0

SPA Counters
------------

Counter name                  Value
=============                 =====
SPA Delete Req                500
SPA Update Req                500
Sub Delete Res                500
Sub Update Res                500
Blkdic adm more               39
GTPu pkt sent                 1000
PFCP pkt sent                 1461
GTPu pkt punt                 500
PFCP pkt punt                 1461
DHCPv4 pkt punt               500
DHCPv6 pkt punt               500
DHCPv6 pkt inj                500
Alloc count                   3461
Free count                    3461
Mutex lock                    6727
Mutex unlock                  6727
Timer start                   461
Timer expiry                  461
Sub Update IPOE OK            500
Sub Delete IPOE OK            500
```