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

Configuration example with IPv4 transport.

```
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
!
```

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 1: 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

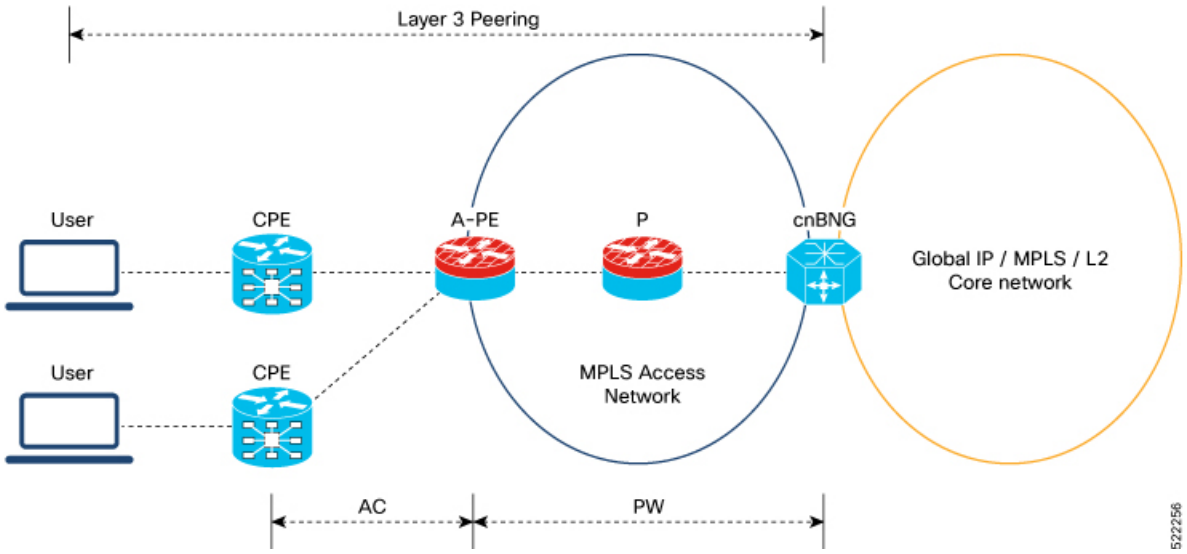
Table 2: Feature History Table

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 1: 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
```