

Broadband Network Gateway Overview

This chapter provides an overview of the Broadband Network Gateway (BNG) functionality implemented on the Cisco ASR 9000 Series Router.

For details on Cisco IOS XR 64-bit BNG, see BNG on Cisco IOS XR 64-bit ASR 9000 Series Routers, on page 14

Table 1: Feature History for Broadband Network Gateway Overview

Release	Modification
Release 4.2.0	Initial release of BNG.
Release 5.3.3	RSP-880 support was added.
Release 6.1.2	Added BNG support for these hardware: • A9K-8X100G-LB-SE • A9K-8X100GE-SE • A9K-4X100GE-SE • A9K-MOD200-SE • A9K-MOD400-SE • A9K-MPA-1x100GE • A9K-MPA-2x100GE • A9K-MPA-20x10GE
Release 6.1.2	Added BNG support for the use of Cisco NCS 5000 Series Router as a satellite.
Release 6.1.2	Added BNG smart licensing feature.
Release 6.2.2	Added the support for BNG Geo Redundancy over Cisco NCS 5000 Series Router satellite.

Release	Modification
Release 6.2.2	Added BNG support for the following hardware: • A9K-48X10GE-1G-SE • A9K-24X10GE-1G-SE
Release 6.3.1	Added the support for Cisco IOS XR 64-bit BNG functionality.
Release 6.6.3	Added Cisco IOS XR 64-bit BNG support on RSP5 route switch processor.
Release 7.3.1	Addded BNG support on Cisco ASR 9000 5th Generation line cards.
Release 7.3.2	Addded BNG support on Cisco ASR 9000 5th Generation line cards for the following features: • BNG over PWHE access • PPPoE LAC subscribers • PPPoE keepalive offload • nV Satellite support
Release 7.3.2	Addded BNG support on Cisco ASR 9903 Router.

• Understanding BNG, on page 2
• BNG Architecture, on page 3
• BNG Role in ISP Network Models, on page 5
• BNG Packaging, on page 6
• BNG Configuration Process, on page 8
• Hardware Requirements for BNG, on page 8
• BNG Interoperability, on page 10
• BNG Smart Licensing, on page 12
• BNG on Cisco IOS XR 64-bit ASR 9000 Series Routers, on page 14

Understanding BNG

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 Provide (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 of subscriber sessions
- Address assignment
- Security
- Policy management
- Quality of Service (QoS)

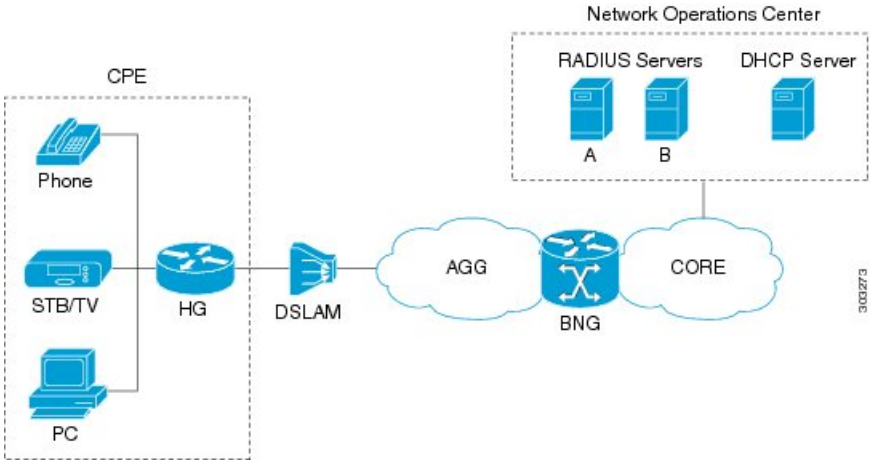
Some benefits of using BNG are:

- The BNG router not only performs the routing function but also communicates with authentication, authorization, and accounting (AAA) server to perform session management and billing functions. This makes the BNG solution more comprehensive.
- Different subscribers can be provided different network services. This enables the service provider to customize the broadband package for each customer based on their needs.

BNG Architecture

The goal of the BNG architecture is to enable the BNG router to interact with peripheral devices (like CPE) and servers (like AAA and DHCP), in order to provide broadband connectivity to subscribers and manage subscriber sessions. The basic BNG architecture is shown in this figure.

Figure 1: BNG Architecture



The BNG architecture is designed to perform these tasks:

- Connecting with the Customer Premise Equipment (CPE) that needs to be served broadband services.
- Establishing subscriber sessions using IPoE or PPPoE protocols.
- Interacting with the AAA server that authenticates subscribers, and keeps an account of subscriber sessions.
- Interacting with the DHCP server to provide IP address to clients.
- Advertising the subscriber routes.

The five BNG tasks are briefly explained in the following sections.

Connecting with the CPE

BNG connects to the CPE through a multiplexer and Home Gateway (HG). The CPE represents the triple play service in telecommunications, namely, voice (phone), video (set top box), and data (PC). The individual subscriber devices connect to the HG. In this example, the subscriber connects to the network over a Digital Subscriber Line (DSL) connection. Therefore, the HG connects into a DSL Access Multiplexer (DSLAM).

Multiple HGs can connect to a single DSLAM that sends the aggregated traffic to the BNG router. The BNG router routes traffic between the broadband remote access devices (like DSLAM or Ethernet Aggregation Switch) and the service provider network.

Establishing Subscriber Sessions

Each subscriber (or more specifically, an application running on the CPE) connects to the network by a logical session. Based on the protocol used, subscriber sessions are classified into two types:

- PPPoE subscriber session—The PPP over Ethernet (PPPoE) subscriber session is established using the point-to-point (PPP) protocol that runs between the CPE and BNG.
- IPoE subscriber session—The IP over Ethernet (IPoE) subscriber session is established using IP protocol that runs between the CPE and BNG; IP addressing is done using the DHCP protocol.

Interacting with the RADIUS Server

BNG relies on an external Remote Authentication Dial-In User Service (RADIUS) server to provide subscriber Authentication, Authorization, and Accounting (AAA) functions. During the AAA process, BNG uses RADIUS to:

- authenticate a subscriber before establishing a subscriber session
- authorize the subscriber to access specific network services or resources
- track usage of broadband services for accounting or billing

The RADIUS server contains a complete database of all subscribers of a service provider, and provides subscriber data updates to the BNG in the form of attributes within RADIUS messages. BNG, on the other hand, provides session usage (accounting) information to the RADIUS server. For more information about RADIUS attributes, see RADIUS Attributes.

BNG supports connections with more than one RADIUS server to have fail over redundancy in the AAA process. For example, if RADIUS server A is active, then BNG directs all messages to the RADIUS server A. If the communication with RADIUS server A is lost, BNG redirects all messages to RADIUS server B.

During interactions between the BNG and RADIUS servers, BNG performs load balancing in a round-robin manner. During the load balancing process, BNG sends AAA processing requests to RADIUS server A only if it has the bandwidth to do the processing. Else, the request is send to RADIUS server B.

Interacting with the DHCP Server

BNG relies on an external Dynamic Host Configuration Protocol (DHCP) server for address allocation and client configuration functions. BNG can connect to more than one DHCP server to have fail over redundancy in the addressing process. The DHCP server contains an IP address pool, from which it allocates addresses to the CPE.

During the interaction between BNG and the DHCP server, BNG acts as a DHCP relay or DHCP proxy.

As the DHCP relay, BNG receives DHCP broadcasts from the client CPE, and forwards the request to the DHCP server.

As the DHCP proxy, BNG itself maintains the address pool by acquiring it from DHCP server, and also manages the IP address lease. BNG communicates on Layer 2 with the client Home Gateway, and on Layer 3 with the DHCP server.

The DSLAM modifies the DHCP packets by inserting subscriber identification information. BNG uses the identification information inserted by the DSLAM, as well as the address assigned by the DHCP server, to identify the subscriber on the network, and monitor the IP address lease.

Advertising Subscriber Routes

For optimal performance in design solutions where the Border Gateway Protocol (BGP) advertises the subscriber routes, the BNG advertises the entire subnet designated to the subscribers using the **network** command in the BGP configuration.

The BNG redistributes the individual subscriber routes only in scenarios where the Radius server assigns the IP address to a subscriber and there is no way to know to which BNG that particular subscriber will connect.

BNG Role in ISP Network Models

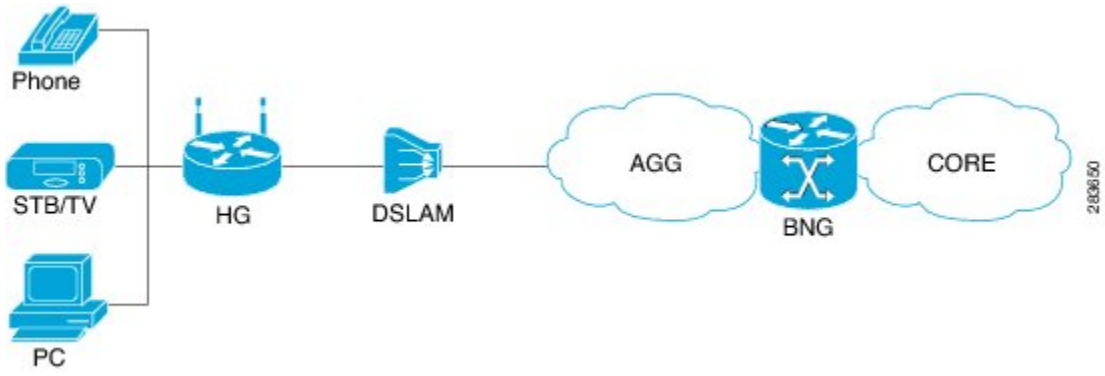
The role of BNG is to pass traffic from the subscriber to the ISP. The manner in which BNG connects to the ISP depends on the model of the network in which it is present. There are two types of network models:

- Network Service Provider, on page 5
- Access Network Provider, on page 6

Network Service Provider

The following figure shows the topology of a Network Service Provider model.

Figure 2: Network Service Provider Model

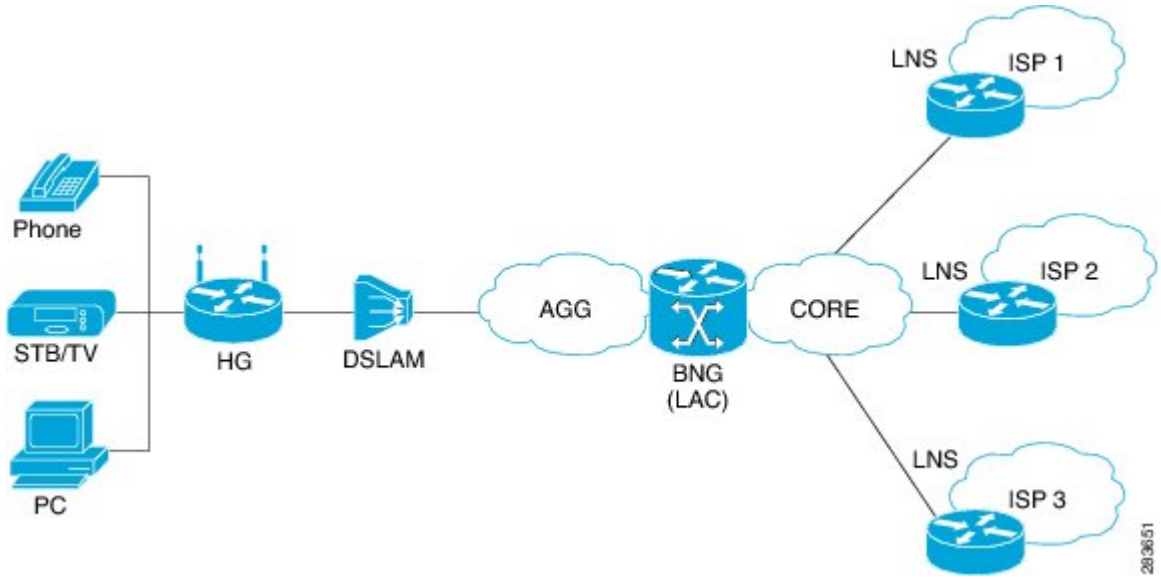


In the Network Service Provider model, the ISP (also called the retailer) directly provides the broadband connection to the subscriber. As shown in the above figure, BNG is at the edge router, and its role is to connect to the core network through uplinks.

Access Network Provider

The following figure shows the topology of a Access Network Provider model.

Figure 3: Access Network Provider Model



In the Access Network Provider model, a network carrier (also called the wholesaler) owns the edge network infrastructure, and provides the broadband connection to the subscriber. However, the network carrier does not own the broadband network. Instead, the network carrier connects to one of the ISPs that manage the broadband network.

BNG is implemented by the network carrier and its role is to hand the subscriber traffic off to one of several ISPs. The hand-off task, from the carrier to the ISP, is implemented by Layer 2 Tunneling Protocol (L2TP) or Layer 3 Virtual Private Networking (VPN). L2TP requires two distinct network components:

- L2TP Access Concentrator (LAC)—The LAC is provided by the BNG.
- L2TP Network Server (LNS)—The LNS is provided by the ISP.

BNG Packaging

The BNG pie, **asr9k-bng-px.pie** can be installed and activated on the Cisco ASR 9000 Series Router to access the BNG features. The install, uninstall, activate and deactivate operations can be performed without rebooting the router.

It is recommended that the relevant BNG configurations be removed from the running configuration of the router, before uninstalling or deactivating the BNG pie.

Installing and Activating the BNG Pie on Cisco ASR 9000 Series Router

Perform this task to install and activate the BNG pie on the Cisco ASR 9000 Series Router:

SUMMARY STEPS

1. **admin**
2. **install add** {*pie_location* | **source** | **tar**}
3. **install activate** {*pie_name* | **id**}

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**admin** **Example:** `RP/0/RSP0/CPU0:router# admin`	Enters the administration mode.
Step 2	**install add** {*pie_location*	**source**	**tar**} **Example:** `RP/0/RSP0/CPU0:router(admin)# install add tftp://223.255.254.254/softdir/asr9k-bng-px.pie`	Installs the pie from the tftp location, on to the Cisco ASR 9000 Series Router.
Step 3	**install activate** {*pie_name*	**id**} **Example:** `RP/0/RSP0/CPU0:router(admin)# install activate asr9k-bng-px.pie`	Activates the installed pie on the Cisco ASR 9000 Series Router.

What to do next

Note During upgrade from Release 4.2.1 to Release 4.3.0, it is recommended that the Cisco ASR 9000 base image pie (asr9k-mini-px.pie) is installed prior to installing the BNG pie (asr9k-bng-px.pie).

After BNG pie is installed, you must copy BNG related configurations from the flash or tftp location to the router. If BNG pie is deactivated and activated again, then load the removed BNG configurations by executing the **load configuration removed** command from the configuration terminal.

Note Most of the BNG feature configurations are moved to a new namespace partition, and hence BNG features are not available by default now. To avoid inconsistent BNG configurations before, or after installing the BNG pie, run the **clear configuration inconsistency** command, in EXEC mode.

BNG Configuration Process

Configuring BNG on the Cisco ASR 9000 Series Router involves these stages:

- Configuring RADIUS Server—BNG is configured to interact with the RADIUS server for authentication, authorization, and accounting functions. For details, see Configuring Authentication, Authorization, and Accounting Functions.
- Activating Control Policy—Control policies are activated to determine the action that BNG takes when specific events occur. The instructions for the action are provided in a policy map. For details, see Activating Control Policy.
- Establishing Subscriber Sessions—Configurations are done to set up one or more logical sessions, from the subscriber to the network, for accessing broadband services. Each session is uniquely tracked and managed. For details, see Establishing Subscriber Sessions.
- Deploying QoS—Quality of Service (QoS) is deployed to provide control over a variety of network applications and traffic types. For example, the service provider can have control over resources (example bandwidth) allocated to each subscriber, provide customized services, and give priority to traffic belonging to mission-critical applications. For details, see Deploying the Quality of Service (QoS).
- Configuring Subscriber Features—Configurations are done to activate certain subscriber features that provide additional capabilities like policy based routing, access control using access list and access groups, and multicast services. For details, see Configuring Subscriber Features.
- Verifying Session Establishment—Established sessions are verified and monitored to ensure that connections are always available for use. The verification is primarily done using "show" commands. Refer to the *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Command Reference* guide for the list of various "show" commands.

To use a BNG command, you must be in a user group associated with a task group that includes the proper task IDs. The *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Command Reference* guide includes the task IDs required for each command. If you suspect that the user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Important

The Select VRF Download (SVD) must be disabled, when BNG is configured. For more information about SVD, see the *Cisco IOS XR Routing Configuration Guide for the Cisco XR 12000 Series Router*.

Hardware Requirements for BNG

For specific hardware requirements for Cisco IOS XR 64-bit BNG, see Hardware Support for Cisco IOS XR 64-bit BNG, on page 15.

These hardwares support BNG:

- The Satellite Network Virtualization (nV) system.
- The route switch processors, RSP-440, RSP-880 and RSP-880-LT-SE.
- The route processor, A99-RP-SE, A99-RP2-SE, on the Cisco ASR 9912 and the Cisco ASR 9922 chassis.

- The route switch processor, A99-RSP-SE, on the Cisco ASR 9910 and the Cisco ASR 9906 chassis.
- The below table lists the Line Cards and Modular Port Adapters that support BNG.

Table 2: Line Cards and Modular Port Adapters Supported on BNG

Product Description	Part Number
24-Port 10-Gigabit Ethernet Line Card, Service Edge Optimized	A9K-24X10GE-SE
36-Port 10-Gigabit Ethernet Line Card, Service Edge Optimized	A9K-36X10GE-SE
40-Port Gigabit Ethernet Line Card, Service Edge Optimized	A9K-40GE-SE
4-Port 10-Gigabit Ethernet, 16-Port Gigabit Ethernet Line Card, 40G Service Edge Optimized	A9K-4T16GE-SE
Cisco ASR 9000 High Density 100GE Ethernet line cards: • Cisco ASR 9000 8-port 100GE "LAN-only" Service Edge Optimized Line Card, Requires CPAK optics • Cisco ASR 9000 8-port 100GE “LAN/WAN/OTN” Service Edge Optimized Line Card, Requires CPAK optics • Cisco ASR 9000 4-port 100GE “LAN/WAN/OTN” Service Edge Optimized Line Card, Requires CPAK optics	A9K-8X100G-LB-SE A9K-8x100GE-SE A9K-4x100GE-SE
Cisco ASR 9000 Series 24-port dual-rate 10GE/1GE service edge–optimized line cards	A9K-24X10-1GE-SE
Cisco ASR 9000 Series 48-port dual-rate 10GE/1GE service edge–optimized line cards	A9K-48X10-1GE-SE
80 Gigabyte Modular Line Card, Service Edge Optimized	A9K-MOD80-SE
160 Gigabyte Modular Line Card, Service Edge Optimized	A9K-MOD160-SE
20-Port Gigabit Ethernet Modular Port Adapter (MPA)	A9K-MPA-20GE
ASR 9000 200G Modular Line Card, Service Edge Optimized, requires modular port adapters	A9K-MOD200-SE
ASR 9000 400G Modular Line Card, Service Edge Optimized, requires modular port adapters	A9K-MOD400-SE

Product Description	Part Number
2-port 10-Gigabit Ethernet Modular Port Adapter (MPA)	A9K-MPA-2X10GE
4-Port 10-Gigabit Ethernet Modular Port Adapter (MPA)	A9K-MPA-4X10GE
ASR 9000 20-port 10-Gigabit Ethernet Modular Port Adapter, requires SFP+ optics	A9K-MPA-20x10GE
2-port 40-Gigabit Ethernet Modular Port Adapter (MPA)	A9K-MPA-2X40GE
1-Port 40-Gigabit Ethernet Modular Port Adapter (MPA)	A9K-MPA-1X40GE
ASR 9000 1-port 100-Gigabit Ethernet Modular Port Adapter, requires CFP2-ER4 or CPAK optics	A9K-MPA-1x100GE
ASR 9000 2-port 100-Gigabit Ethernet Modular Port Adapter, requires CFP2-ER4 or CPAK optics	A9K-MPA-2x100GE

BNG Interoperability

Table 3: Feature History Table

Feature Name	Release Information	Feature Description

BNG support on satellite interfaces hosted on Cisco ASR 9000 Series routers and line cards	Release 7.3.2	This release enables you to configure BNG services on satellite interfaces hosted on the following hardware:
		• Cisco ASR 9000 5th Generation High Density Ethernet line cards with the following PIDs:
		  • A99-32X100GE-X-SE
		  • A9K-20HG-FLEX-SE
		  • A9K-8HG-FLEX-SE
		• Cisco ASR 9903 Routers
		This feature provides you with extended port scalability and density as each port of the line card/router can host a satellite device.

The BNG interoperability allows BNG to exchange and use information with other larger heterogeneous networks. These are the key features:

- BNG Coexists with ASR9001:

  ASR9001 is a standalone high processing capability router that comprises of a route switch processor (RSP), linecards (LC), and ethernet plugs (EPs). All BNG features are fully supported on the ASR9001 chassis.

- BNG Supports nV Satellite:
  - The only topology that BNG supports with nV Satellite is bundle access on the CPE side with non-bundle ICL links, as shown below:

    CPE --- Bundle --- [Satellite] --- Non Bundle ICL --- ASR9K

    For details on nV Satellite configuration, see *nV System Configuration Guide for Cisco ASR 9000 Series Routers* located here.

  - BNG does not support nV Satellite with bundle ICL and bundle access links, as shown below:

    CPE --- Bundle --- [Satellite] --- Bundle ICL --- ASR9K

  - From Cisco IOS XR Software Release 6.1.2 and later, BNG supports the use of Cisco NCS 5000 Series satellite.
  - From Cisco IOS XR Software Release 6.2.2 and later, Cisco IOS XR 32 bit operating system supports BNG geo redundancy with Cisco NCS 5000 Series satellite. Whereas, it does not support BNG geo redundancy with Cisco ASR 9000v satellite. For details, see *BNG Geo Redundancy* chapter in this guide..
  - From Cisco IOS XR Software Release 7.3.2, satellite interfaces hosted on Cisco ASR 9000 5th Generation High Density Ethernet line cards support BNG with Cisco IOS XR 64-bit operating system.
  - When the Cisco ASR 9903 Router hosts satellite, subscriber sessions over satellite interfaces do not support Port Expansion Card (PEC) OIR.
  - BNG over satellite interfaces do not support PWHE.

- BNG interoperates with Carrier Grade NAT (CGN):

  To address the impending threat from IPv4 address space depletion, it is recommended that the remaining or available IPv4 addresses be shared among larger numbers of customers. This is done by using CGN, which primarily pulls the address allocation to a more centralized NAT in the service provider network. NAT44 is a technology that uses CGN and helps manage depletion issues of the IPv4 address space. BNG supports the ability to perform NAT44 translation on IPoE and PPPoE-based BNG subscriber sessions.



Note For BNG and CGN interoperability, configure the BNG interface and the application service virtual interface (SVI) on the same VRF instance.

BNG Smart Licensing

BNG supports Cisco Smart Software Licensing that provides a simplified way for the customers to purchase licenses and to manage them across their network. Smart licensing provides a customizable consumption-based model that aligns to the network growth of the customer. It also provides the flexibility to quickly modify or upgrade software feature configurations to deploy new services over time.

For more information about this feature, see the *Broadband Network Gateway Overview* chapter in the *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Configuration Guide*. For complete command reference, see the *Subscriber Commands* chapter in the *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Command Reference*.

For more information about configuring and managing Smart Licensing, see the chapter *Smart Licensing* in the *System Management Configuration Guide for Cisco ASR 9000 Series Routers*.

BNG À la carte Licenses

Table 4: Feature History Table

Feature Name	Release Information	Feature Description
BNG À la carte Licenses	Release 7.3.1	This feature allows service-providers to track subscribers and determine license consumption. The ASR 9000 Flexible Consumption Model effectively monetizes a BNG network by providing it as an À la carte license in addition to the Essential and Advanced Right-To-Use per port license.

The ASR 9000 Flexible Consumption Model (FCM) comprises of the following license types:

- The Essential software license for basic transport applications
- The Advanced software license for enhanced applications and network resiliency
- An optional À la carte software license for specialized platform-specific features

The ASR 9000 FCM provides BNG subscriber licenses as an À la carte license where one unit of license supports a maximum of 8000 subscribers.

FCM offers a “pay-as-you-grow” structure that lowers initial set-up costs for the service-providers and provides them the flexibility to add more capacity when needed. Also, the service-providers can use the available capacity across different routers in the FCM network.

Table 5: FCM License PIDs for BNG in the CSSM portal

Product ID	Product Description
S-A9K-BNG-8K-FC	BNG FCM license unit for 8000 subscribers.

Product ID	Product Description
S-A9K-BNG-ADV-FC	ASR 9000 FCM BNG license for advanced features.

For more information about managing ASR 9000 Flexible Consumption Model, see the topic *What is Flexible Consumption Model?* in the *Smart Licensing* chapter of *System Management Configuration Guide for Cisco ASR 9000 Series Routers*.

Configuring Flexible Consumption Model

You can enable FCM using the configuration command **license smart flexible-consumption enable** as shown:

```
Router#conf t
Router(config)#license smart flexible-consumption enable
Router(config)#commit
```

Verification

You can verify the status of the licenses using the **show license all** command. The BNG license is highlighted in the following command output:

Note On the ASR 9000 router, the FCM license with Product ID **S-A9K-BNG-8K-FC** is displayed as **A9K-BNG-LIC-FC** and the FCM license with Product ID **S-A9K-BNG-ADV-FC** is displayed as **A9K-BNG-ADV-FC**.

```
Router#show license all
Smart Licensing Status
Smart Licensing is ENABLED

Registration:
Status: REGISTERED
Smart Account: BU Production Test 1
Virtual Account: NCS550 Testing
Export-Controlled Functionality: ALLOWED
Initial Registration: SUCCEEDED on Feb 09 2021 15:13:22 UTC
Last Renewal Attempt: None
Next Renewal Attempt: Aug 08 2021 15:13:19 UTC
Registration Expires: Feb 09 2022 15:08:18 UTC

License Authorization:
Status: AUTHORIZED on Feb 09 2021 17:31:09 UTC
Last Communication Attempt: SUCCEEDED on Feb 09 2021 17:31:09 UTC
Next Communication Attempt: Mar 11 2021 17:31:08 UTC
Communication Deadline: May 10 2021 17:26:07 UTC
Export Authorization Key:
Features Authorized:
<none>
Utility:
Status: DISABLED
Data Privacy:
Sending Hostname: yes
Callhome hostname privacy: DISABLED
Smart Licensing hostname privacy: DISABLED
Version privacy: DISABLED
Transport:
```

```
Type: Smart
URL: https://smartreceiver.cisco.com/licservice/license
Proxy:
Not Configured
Miscellaneous:
Custom Id: <empty>
License Usage
ASR 9000 3rd Generation MOD400 Hardware Tracking PID (A9K-MOD400-TRK):
Description: ASR 9000 3rd Generation MOD400 Hardware Tracking PID
Count: 2
Version: 1.0
Status: AUTHORIZED
Export status: NOT RESTRICTED

Essentials Software RTU License (per 100G) for Edge (ESS-SE-100G-RTU-1):
Description: Essentials Software RTU License (per 100G) for Edge
Count: 1
Version: 1.0
Status: AUTHORIZED
Export status: NOT RESTRICTED
Essential Edge SIA per 100G Subscription (ESS-ED-100G-SIA3):
Description: Essential Edge SIA per 100G Subscription
Count: 1
Version: 1.0
Status: AUTHORIZED
Export status: NOT RESTRICTED

ASR 9K Flexible Consumption Model License for BNG 8000 Sessions (A9K-BNG-LIC-FC):
Description: ASR 9K Flexible Consumption Model License for BNG 8000 Sessions
Count: 2
Version: 1.0
Status: AUTHORIZED
Export status: NOT RESTRICTED

Product Information
UDI: PID:ASR-9904,SN:FOX2051GFGZ
HA UDI List:
0/RSP0/CPU0: Active:PID:ASR-9904,SN:FOX2051GFGZ
0/RSP1/CPU0: Standby:PID:ASR-9904,SN:FOX2051GFGZ
Agent Version
Smart Agent for Licensing: 5.1.8_rel/25
Reservation Info
License reservation: DISABLED
```

BNG on Cisco IOS XR 64-bit ASR 9000 Series Routers

The Broadband Network Gateway (BNG) functionality is supported on Cisco IOS XR 64-bit ASR 9000 Series Routers, in addition to the Cisco IOS XR 32-bit ASR 9000 Series Routers. This functionality is available on Cisco ASR 9000 Series Routers with RSP880, RSP 880-LT and Cisco ASR 9000 High Density 100GE Ethernet line cards (LCs) having more CPU cycles and per-process virtual memory, which in turn increases the scale and performance of the Cisco ASR 9000 Series Router as a BNG.

For more information about this feature, see the *Broadband Network Gateway Overview* chapter in the *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Configuration Guide*. For complete command reference, see *Cisco ASR 9000 Series Aggregation Services Router Broadband Network Gateway Command Reference*.

Hardware Support for Cisco IOS XR 64-bit BNG

Supported Hardware for Cisco IOS XR 64-bit BNG

- The Satellite Network Virtualization (nV) system.
- Cisco IOS XR 64-bit BNG is supported only on the following Route Switch Processors (RSPs) and families of Cisco ASR 9000 High Density 100GE Ethernet line cards.

  Supported RSPs for Cisco IOS XR 64-bit BNG are:

  - 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-RSP5-X-SE: Starting from Cisco IOS XR Release 24.4.1, support for the A9K-RSP5-X-SE has been introduced.

Table 6: Supported Line Cards and Chassis for Cisco IOS XR 64-bit BNG

Line Cards / Chassis	Description
A9K-8X100G-LB-SE	Cisco ASR 9000 8-port 100GE “LAN-only” Service Edge Optimized Line Card.
A9K-8X100GE-SE	Cisco ASR 9000 8-port 100GE “LAN/WAN/OTN” Service Edge Optimized Line Card.
A9K-4X100GE-SE	Cisco ASR 9000 4-port 100GE “LAN/WAN/OTN” Service Edge Optimized Line Card.
A9K-MOD200-SE	ASR 9000 200G Modular Line Card, Service Edge Optimized, requires modular port adapters
A9K-MOD400-SE	ASR 9000 400G Modular Line Card, Service Edge Optimized, requires modular port adapters.
A99-8X100GE-SE	Cisco ASR 9900 8-port 100GE “LAN/WAN/OTN” Service Edge Optimized Line Card
A9K-8X100GE-CM	Cisco ASR 9000 8-Port 100GE Consumption Model line card.
A9K-MOD400-CM	Cisco ASR 9000 Modular 400G Consumption Model line card.
A9K-MOD200-CM	Cisco ASR 9000 Modular 200G Consumption Model Line Card.

Line Cards / Chassis	Description
A9K-24X10-1GE-SE	Cisco ASR 9000 Series 24-port dual-rate 10GE/1GE service edge–optimized line cards.
A9K-48X10-1GE-SE	Cisco ASR 9000 Series 48-port dual-rate 10GE/1GE service edge–optimized line cards.
A99-48X10GE-1G-SE	Cisco ASR 9000 48-port dual-rate 10G/1G service edge line card.
A99-32X100GE-X-SE	Cisco ASR 9900 3.2T Service Edge 5th Generation line card.
A99-32X100GE-X-FC	Cisco ASR 9000 32X100GE Flexible Consumption line card (1.3T out of 3.2T).
A9K-20HG-FLEX-SE	Cisco ASR 9000 2T Service Edge Combo 5th Generation line card.
A9K-20HG-FLEX-FC	Cisco ASR 9000 2T Service Flexible Consumption line card.
A9K-8HG-FLEX-SE	Cisco ASR 9000 800G Service Edge Combo 5th Generation line card.
A9K-8HG-FLEX-FC	Cisco ASR 9000 800G Service Edge Combo Flexible Consumption line card.
A9K-4HG-FLEX-SE	Cisco ASR 9000 400GE Combo Service Edge Line Card 5th Generation line card.
A9K-4HG-FLEX-FC	Cisco ASR 9000 400GE Combo Service Flexible Consumption line card.
ASR 9902	Cisco ASR 9903 fixed chassis.
ASR 9902-FC	ASR 9902, 2RU, Flexible Consumption Chassis.
ASR-9903	Cisco ASR 9903 Chassis. BNG supports both A9903-20HG-PEC and A9903-8HG-PEC cards in the ASR-9903 chassis.
ASR 9903-FC	Cisco ASR 9903 Chassis. BNG supports both A9903-20HG-PEC and A9903-8HG-PEC cards in the ASR-9903 chassis.
A9903-20HG-PEC	ASR 9903 2T Multirate Port Expansion Card.
A9903-20HG-PEC-FC	ASR 9903 2T Flexible Consumption Port Expansion Card.
A9903-8HG-PEC	ASR 9903 800G Multirate Port Expansion Card.

Line Cards / Chassis	Description
A9903-8HG-PEC-FC	ASR 9903 800G Flexible Consumption Port Expansion Card.
A99-4HG-FLEX-X-SE	Cisco ASR 9000 400GE Combo Service Edge 5th Generation line card.
A9K-4HG-FLEX-X-FC	Cisco ASR 9000 400GE Flexible Consumption Enhanced 5th Generation line card.

Table 7: Supported Modular Port Adapters for Cisco IOS XR 64-bit BNG

Modular Port Adapters (MPA)	Part Number
MOD400	• A9K-MPA-1X100GE • A9K-MPA-2X100GE • A9K-MPA-4X10GE • A9K-MPA-8X10GE • A9K-MPA-20X10GE • A9K-MPA-20X1GE • A9K-MPA-1X40GE • A9K-MPA-2X40GE
MOD200	The support list is same as that for MOD400.

Restrictions and Unsupported Hardware for Cisco IOS XR 64-bit BNG

- Cisco IOS XR 64-bit BNG is not supported on these hardwares:
  - Packet Transport Optimised (TR) families of Cisco ASR 9000 High Density 100GE Ethernet line cards.
  - A9K-RSP880-TR
  - A9K-MPA-2X10GE
- The A9903-20HG-PEC PEC OIR is not supported with BNG subscribers.

Feature Support on Cisco IOS XR 64-bit BNG

Table 8: Feature History Table

Feature Name	Release Information	Feature Description
BNG on ASR 9000 5th Generation 400G Ethernet Enhanced Line Cards	Release 25.2.1	The Broadband Network Gateway (BNG) enhances subscriber management, traffic optimization, and service delivery by acting as a central point for managing subscriber sessions, aggregating traffic, and ensuring secure and reliable broadband access. BNG support is now available on these line cards: A99-4HG-FLEX-X-SE A9K-4HG-FLEX-X-SE
Subscriber Redundancy Group for IPoE-LC based Subscribers	Release 7.11.1	You can now enable fast switchover using subscriber redundancy group (SRG) for the IPoE-LC based subscribers on the following: • A99-32X100GE-X-SE • A9K-20HG-FLEX-SE • A9K-8HG-FLEX-SE • A9K-4HG-FLEX-SE • Cisco ASR 9902 Router • Cisco ASR 9903 Router • Cisco ASR 9000 Series Route Switch Processor 5 (RSP5)

Feature Name	Release Information	Feature Description
Line Card based IPoE Subscriber Sessions on Cisco ASR 9000 5th Generation High Density Ethernet Line Cards	Release 7.9.1	We now support Line card based Internet over Ethernet (IPoE) subscriber sessions on the following : • Cisco ASR 9902 Router • Cisco ASR 9903 Router • Cisco ASR 9000 Series Route Switch Processor 5 (RSP5) Also on the following Cisco ASR 9000 5th Generation High Density Ethernet line cards: • A99-32X100GE-X-SE • A9K-20HG-FLEX-SE • A9K-8HG-FLEX-SE • A9K-4HG-FLEX-SE

Feature Name	Release Information	Feature Description
Subscriber Redundancy Group on Cisco ASR 9903 Router, ASR 9902 Router, and Cisco ASR 9006 Route Switch Processor	Release 7.9.1	You can now configure subscriber redundancy group (SRG) for the IPoE subscribers over bundle and PWHE access interfaces on the following: • Cisco ASR 9902 Router • Cisco ASR 9903 Router • Cisco ASR 9000 Series Route Switch Processor 5 (RSP5) Also on the following Cisco ASR 9000 5th Generation High Density Ethernet line cards: • A99-32X100GE-X-SE • A9K-20HG-FLEX-SE • A9K-8HG-FLEX-SE • A9K-4HG-FLEX-SE SRG offers the advantage of enabling planned switch over or failover for all subscriber groups in case of a failure, proving especially advantageous for subscribers requiring high availability and geo-redundancy as part of their service level agreement (SLA).
BNG on ASR 9903 800G Multirate Port Expansion Card	Release 7.8.1	BNG, the access point for subscribers connecting to the broadband network, is now supported on the Cisco ASR 9903 800G Multirate Port Expansion Card (A9903-8HG-PEC) line card, which offers 48 physical ports with maximum 800G data bandwidth capacity.

Feature Name	Release Information	Feature Description
BNG on A9903-20HG-PEC Multirate Port Expansion Card	Release 7.8.1	BNG, the access point for subscribers connecting to the broadband network, is now supported on the Cisco ASR 9903 2T Multirate Port Expansion Card (A9903-20HG-PEC) line card, which offers 20 physical ports with maximum 2T data bandwidth capacity.
BNG on Cisco ASR 9902 Routers	Release 7.6.2	BNG, the access point for subscribers connecting to the broadband network, is now supported on the Cisco ASR 9902 Router. All BNG features supported on the Cisco ASR 9000 5th Generation High Density Ethernet Line Cards are supported on Cisco ASR 9902 Routers from this release. See BNG Support on Cisco ASR 9000 5th Generation High Density Ethernet Line Cards, on page 24 for details.
Subscriber Redundancy Group on Cisco ASR 9903 Router and specific Cisco ASR 9000 High-Density Ethernet line cards	Release 7.6.1	Configuring redundancy for a subscriber group makes it a subscriber redundancy group (SRG). SRG offers the advantage of enabling planned switch over or failover for all subscriber groups in case of a failure, proving especially advantageous for subscribers requiring high availability and geo-redundancy as part of their service level agreement (SLA). SRG is now supported on PPPoE subscribers over bundle and PWHE access interfaces on Cisco ASR 9903 Router and on the following Cisco ASR 9000 5th generation High Density Ethernet line cards: • A99-32X100GE-X-SE • A9K-20HG-FLEX-SE • A9K-8HG-FLEX-SE • A9K-4HG-FLEX-SE

Feature Name	Release Information	Feature Description
BNG feature support extension	Release 7.3.2	This release extends the support of certain BNG functionalities on these Cisco ASR 9000 5th generation High Density Ethernet line cards: • A99-32X100GE-X-SE • A9K-20HG-FLEX-SE • A9K-8HG-FLEX-SE • A9K-4HG-FLEX-SE Features now available on these line cards are: • Provisioning PPP LAC Session • PPPoE keep alive offload. See Provisioning PPP PTA Session. • BNG over Pseudowire Headend This enhancement enables BNG features to leverage the higher throughput that the 5th generation of line cards provide.
BNG on Cisco ASR 9903 Router	Release 7.3.2	BNG, which is the access point for subscribers through which they connect to the broadband network, is now supported on the Cisco ASR 9903 Router. This is a compact, high-performance router that delivers up to 3.6 Tbps of nonblocking, full-duplex capacity in a Three-Rack-Unit (3RU) form factor. All features supported on the Cisco ASR 9000 5th Generation High Density Ethernet Line Cards are supported on Cisco ASR 9903 Router from this release. See *BNG Support on Cisco ASR 9000 5th Generation High Density Ethernet Line Cards* for details.

Feature Name	Release Information	Feature Description
BNG support on the Cisco ASR 9000 Series 5th Generation Line Cards	Release 7.3.1	The support of BNG functionality is extended on the following ASR 9000 5th generation High Density Ethernet line cards: • A99-32X100GE-X-SE • A9K-20HG-FLEX-SE • A9K-4HG-FLEX-SE

The following section describes the folllowing :

- Supported Features on Cisco IOS XR 64-bit BNG
- Unsupported Features on Cisco IOS XR 64-bit BNG

Supported Features on Cisco IOS XR 64-bit BNG

The Cisco IOS XR 64-bit BNG functionality maintains parity with Cisco IOS XR 32-bit BNG. This section lists the BNG functionality and features supported on Cisco IOS XR 64-bit ASR 9000 Series Routers.

- RADIUS server interface - RADIUS server interaction to authorize the subscriber session and to download RADIUS attributes from the AAA server
- Access control lists (ACLs) or access control elements (ACEs)
- Routed subscriber sessions
- QoS features:
  - Shared policy instance (SPI)
  - Shared policy database (SPD)
  - Parameterized QoS (pQoS)
  - Policy-map merge
  - Hierarchical QoS (HQoS)
- Session accounting
- Services and service accounting – The limitations on the number of services enabled on subscriber sessions remain the same as that on Cisco IOS XR 32-bit BNG.
- Session timeout and static timeout in control policy
- SNMP, NetConf or Yang, XML
- RADIUS dynamic authorization
  - RADIUS change-of-authorization (CoA) for service-activation (SA), service-deactivation (SD), service-update (SU), accounting-query, session-query, and so on.
  - RADIUS packet of disconnect (PoD) feature for disconnecting subscriber session

- Stateful switchover (SSO) - Process restart and RP failover (RPFO)
- Subscriber redundancy group (SRG)
- Licensing
- Static sessions
- HTTP redirect (HTTPR) using policy-based routing (PBR)
- Pseudowire headend (PWHE)
- Ingress Lawful Intercept (LI) for all interface types (bundle and PWHE interfaces)
- Egress Lawful Intercept for all interface types (bundle and PWHE interfaces)
- DIAMETER-based Gx and Gy interfaces

Unsupported Features on Cisco IOS XR 64-bit BNG

This section lists the BNG functionality and features that are currently not supported on Cisco IOS XR 64-bit ASR 9000 Series Routers.

- PPPoE LAC SSO
- In-service software upgrade (ISSU)
- Multicast passive, QoS correlation
- Port Expansion Card is not supported with ASR 9903 800G card when BNG subscribers are up.

BNG Support on Cisco ASR 9000 5th Generation High Density Ethernet Line Cards

Starting from Release 7.3.1 onwards, BNG features are supported on Cisco ASR 9000 5th generation High Density Ethernet line cards.

The following features are not supported on Cisco ASR 9000 5th generation High Density Ethernet line cards:

Table 9: Unsupported Features for Cisco ASR 9000 5th generation High Density Ethernet line cards

Release	Unsupported Features
Release 7.6.1	• Subscriber redundancy group (SRG) for IPoE sessions • Static sessions • HTTP Header Enrichment • LC subscribers • DIAMETER-based Gx and Gy interfaces • Group-based Grandparent Shaping is not supported

Release	Unsupported Features
Release 7.3.2	• Subscriber redundancy group (SRG) • Static sessions • HTTP Header Enrichment • LC subscribers • DIAMETER-based Gx and Gy interfaces • Group-based Grandparent Shaping is not supported
Release 7.3.1	• Subscriber redundancy group (SRG) • Static sessions • HTTP Header Enrichment • LC subscribers • Pseudowire headend (PWHE) • LAC over bundle and PWHE • BNG over satellite interfaces • Support for Keep Alive • DIAMETER-based Gx and Gy interfaces • Group-based Grandparent Shaping is not supported

Packaging of Cisco IOS XR 64-bit BNG

Unlike the Cisco IOS XR 32-bit BNG, the Cisco IOS XR 64-bit BNG does not use the BNG pie, **asr9k-bng-px.pie**. Instead, it uses the **mini.iso** or the **full.iso** image that combines all service packages including the BNG service package for the Cisco IOS XR 64-bit ASR9000 Series Router. Also, a **.rpm** package is available separately for the BNG services.

You should install the following packages for BNG:

- asr9k-bng-supp-x64-1.0.0.0-r781.x86_64.rpm
- asr9k-bng-x64-1.0.0.0-r781.x86_64.rpm
- asr9k-bng-pppoe-x64-1.0.0.0-r781.x86_64.rpm
- asr9k-bng-ipoe-x64-1.0.0.0-r781.x86_64.rpm

Note In order to operate BNG services, it is mandatory to install the respective **.rpm** package for BNG, irrespective of having the **mini.iso** or the **full.iso** image installed on the router.

Install BNG RPM on Cisco ASR 9000 Series Routers

Installing BNG RPM on Cisco ASR 9000 Series Routers involves these steps:

- Download the **.rpm** package for BNG services from the source location to the router
- Activate the service package
- Commit the activated package
- Verify the activated package

Configuration Example

```
/* Download the .rpm file from the source location */
Router# install add source tftp://192.0.2.254
/user1/asr9k-bng-supp-x64-1.0.0.0-r781.x86_64.rpm
Router# install add source tftp://192.0.2.254 /user1/asr9k-bng-x64-1.0.0.0-r781.x86_64.rpm
Router# install add source tftp://192.0.2.254
/user1/asr9k-bng-pppoe-x64-1.0.0.0-r781.x86_64.rpm
Router# install add source tftp://192.0.2.254
/user1/asr9k-bng-ipoe-x64-1.0.0.0-r781.x86_64.rpm

/* Verify if the package is successfully added */
Router# show install inactive summary

/* Activate the inactive package listed in the above command output */
Router# install activate asr9k-bng-supp-x64-1.0.0.0-r781.x86_64.rpm
Router# install activate asr9k-bng-x64-1.0.0.0-r781.x86_64.rpm
Router# install add source tftp://192.0.2.254
/user1/asr9k-bng-pppoe-x64-1.0.0.0-r781.x86_64.rpm
Router# install add source tftp://192.0.2.254
/user1/asr9k-bng-ipoe-x64-1.0.0.0-r781.x86_64.rpm


/* Verify the status of the install operation that proceeds in the background */
Router# show install log

/* Commit the activated package after the install operation is successfully completed */
Router# install commit
```

Verify the Installation of BNG RPM

Use this command to verify if the .rpm for BNG services is successfully installed:

```
Router# show install active summary
Thu Aug 10 21:28:46.484 UTC
    Active Packages: 7
    asr9k-xr-7.9.2 version=7.9.2 [Boot image]
    asr9k-mgbl-x64-1.0.0.0-r781
    asr9k-bng-supp-x64-1.0.0.0-r781
    asr9k-bng-x64-1.0.0.0-r781
```

```
asr9k-bng-ipoe-x64-1.0.0.0-r781
asr9k-bng-pppoe-x64-1.0.0.0-r781
asr9k-mcast-x64-1.0.0.0-r781
```

Related Topics

- BNG on Cisco IOS XR 64-bit ASR 9000 Series Routers, on page 14

Associated Commands

- install add
- install activate
- install commit
- show install {active | inactive} summary

Call-model Support on Cisco IOS XR 64-bit BNG

Supported Call-models on Cisco IOS XR 64-bit BNG

This table lists the call-models supported on Cisco IOS XR 64-bit BNG.

Call-model	Description
RP-based PPPoE PTA IPv4 sessions	Route Processor (RP)-based PPPoE PTA subscriber sessions by allocating IPv4 address for end user, with or without user authentication with the AAA server.
RP-based PPPoE PTA IPv6 or dual-stack sessions	RP-based PPPoE PTA subscriber sessions by allocating IPv6 or dual subscriber address for end-user with or without user authentication with the AAA server. The IPv6 address allocation can be done using any of these: • DHCPv6 procedures (using DHCPv6 server or proxy for address allocation) • IPv6 neighbor discovery (ND) procedures
RP-based PPPoE LAC sessions	RP-based PPPoE LAC subscriber sessions with LNS server interaction for authenticating the user and by providing IPv4, IPv6 or dual-stack address allocation to the user. **Note** PPPoE LAC stateful switchover (SSO) is not supported.

Call-model	Description
RP-based IPoE sessions	RP-based IPoE subscriber sessions by providing IPv4, IPv6 or dual-stack address allocation for end-user with or without user authentication with the AAA server. The IPv4, IPv6 or dual-stack address allocation can be done using any of these: • DHCPv4 procedures (using DHCPv4 server or proxy) • DHCPv6 procedures (using DHCPv6 server or proxy)
LC-based PPPoE PTA IPv4 sessions	Line Card (LC)-based PPPoE PTA subscriber sessions by allocating IPv4 address for end-user with or without user authentication with the AAA server.
LC-based PPPoE PTA IPv6 or dual-stack sessions	LC-based PPPoE PTA Subscriber sessions by allocating IPv6 or dual-stack address for end-user with or without user authentication with the AAA server. The IPv6 address allocation can be done using any of these: • DHCPv6 procedures (using DHCPv6 server or proxy for address allocation) • IPv6 ND procedures
LC-based IPoE sessions	LC-based IPoE subscriber sessions by providing IPv4, IPv6 or dual-stack address allocation for end-user with or without user authentication with the AAA server. The IPv4, IPv6 or dual-stack address allocation can be done using any of these: • DHCPv4 procedures (using DHCPv4 server or proxy) • DHCPv6 procedures (using DHCPv6 server or proxy)
RP PWHE-based PPPoE PTA IPv4 sessions	RP Pseudowire Headend (PWHE)-based PPPoE PTA subscriber sessions by allocating IPv4 address for end-user with or without user authentication with the AAA server.

Call-model	Description
RP PWHE-based PPPoE PTA IPv6 or dual-stack sessions	RP PWHE-based PPPoE PTA subscriber sessions by allocating IPv6 or dual-stack address for end-user with or without user authentication with the AAA server. The IPv6 address allocation can be done using any of these: • DHCPv6 procedures (using DHCPv6 server or proxy for address allocation) • IPv6 neighbor discovery (ND) procedures
RP PWHE-based IPoE sessions	RP PWHE-based IPoE subscriber session by providing IPv4, IPv6 or dual-stack address allocation for end-user with or without user authentication with the AAA server. The IPv4, IPv6 or dual-stack address allocation can be done using any of these: • DHCPv4 procedures (using DHCPv4 server or proxy) • DHCPv6 procedures (using DHCPv6 server or proxy)