



Junos[®] OS

Designing an IPv6 Architecture and Implementing IPv4 and IPv6 Dual Stack for Subscriber Access Networks

Release

11.4



Published: 2012-05-03

Juniper Networks, Inc.
1194 North Mathilda Avenue
Sunnyvale, California 94089
USA
408-745-2000
www.juniper.net

This product includes the Envoy SNMP Engine, developed by Epilogue Technology, an Integrated Systems Company. Copyright © 1986-1997, Epilogue Technology Corporation. All rights reserved. This program and its documentation were developed at private expense, and no part of them is in the public domain.

This product includes memory allocation software developed by Mark Moraes, copyright © 1988, 1989, 1993, University of Toronto.

This product includes FreeBSD software developed by the University of California, Berkeley, and its contributors. All of the documentation and software included in the 4.4BSD and 4.4BSD-Lite Releases is copyrighted by the Regents of the University of California. Copyright © 1979, 1980, 1983, 1986, 1988, 1989, 1991, 1992, 1993, 1994. The Regents of the University of California. All rights reserved.

GateD software copyright © 1995, the Regents of the University. All rights reserved. Gate Daemon was originated and developed through release 3.0 by Cornell University and its collaborators. Gated is based on Kirton's EGP, UC Berkeley's routing daemon (routed), and DCN's HELLO routing protocol. Development of Gated has been supported in part by the National Science Foundation. Portions of the GateD software copyright © 1988, Regents of the University of California. All rights reserved. Portions of the GateD software copyright © 1991, D. L. S. Associates.

This product includes software developed by Maker Communications, Inc., copyright © 1996, 1997, Maker Communications, Inc.

Juniper Networks, Junos, Steel-Belted Radius, NetScreen, and ScreenOS are registered trademarks of Juniper Networks, Inc. in the United States and other countries. The Juniper Networks Logo, the Junos logo, and JunosE are trademarks of Juniper Networks, Inc. All other trademarks, service marks, registered trademarks, or registered service marks are the property of their respective owners.

Juniper Networks assumes no responsibility for any inaccuracies in this document. Juniper Networks reserves the right to change, modify, transfer, or otherwise revise this publication without notice.

Products made or sold by Juniper Networks or components thereof might be covered by one or more of the following patents that are owned by or licensed to Juniper Networks: U.S. Patent Nos. 5,473,599, 5,905,725, 5,909,440, 6,192,051, 6,333,650, 6,359,479, 6,406,312, 6,429,706, 6,459,579, 6,493,347, 6,538,518, 6,538,899, 6,552,918, 6,567,902, 6,578,186, and 6,590,785.

Junos® OS Designing an IPv6 Architecture and Implementing IPv4 and IPv6 Dual Stack for Subscriber Access Networks

Release 11.4

Copyright © 2012, Juniper Networks, Inc.

All rights reserved.

Revision History

May 2012—R2 Junos OS 11.4

The information in this document is current as of the date on the title page.

END USER LICENSE AGREEMENT

The Juniper Networks product that is the subject of this technical documentation consists of (or is intended for use with) Juniper Networks software. Use of such software is subject to the terms and conditions of the End User License Agreement ("EULA") posted at <http://www.juniper.net/support/eula.html>. By downloading, installing or using such software, you agree to the terms and conditions of that EULA.

Table of Contents

Part 1	Introduction to IPv4 and IPv6 Dual Stack for Broadband Edge	
Chapter 1	Introduction to IPv4 and IPv6 Dual Stack	3
	Audience for IPv4 and IPv6 Dual Stack	3
	Why Use IPv4/IPv6 Dual Stack?	3
	Basic Architecture of a Subscriber Access Dual-Stack Network	4
	Terms Used in IPv4/IPv6 Dual-Stack Documentation	4
Part 2	Overview of IPv6 Addressing in a Dual-Stack Network	
Chapter 2	Introduction to IPv6 Addresses	9
	IPv6 Addressing Overview	9
	IPv6 Notation	9
	IPv6 Prefixes	10
	IPv6 Address Types	10
	Unicast Addresses	10
	Multicast Addresses	11
	Anycast Addresses	11
Chapter 3	IPv6 Addressing Requirements in a Dual-Stack Network	13
	IPv6 Addressing Requirements for a Dual-Stack Network	13
	Alternatives to Using a Global IPv6 Address on the CPE WAN Link	14
Chapter 4	Using ND/RA to Provide IPv6 WAN Link Addressing in a Dual-Stack Network	15
	Overview of Using ND/RA to Provide IPv6 WAN Link Addressing	15
	IPv6 Neighbor Discovery Protocol Overview	15
	Neighbor Discovery Messages	16
	How ND/RA Works in a Subscriber Access Network	16
	Methods for Obtaining IPv6 Prefixes for ND/RA	17
	Using AAA RADIUS Server to Obtain IPv6 Prefixes for ND/RA	17
	Duplicate Prefix Protection for ND/RA	17
Chapter 5	Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing in a Dual-Stack Network	19
	Overview of Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing	19
	Methods for Obtaining IPv6 Global Addresses for DHCPv6 IA_NA	19
	Using a AAA RADIUS Server to Obtain IPv6 Addresses for DHCPv6 IA_NA	19

Chapter 6	Using DHCPv6 Prefix Delegation for Subscriber Addressing in a Dual-Stack Network	21
	DHCPv6 Prefix Delegation Overview	21
	Using a Delegated Prefix on the CPE Loopback Interface	22
	DHCPv6 Prefix Delegation over PPPoE	22
	Methods for Obtaining IPv6 Prefixes for DHCPv6 Prefix Delegation	23
	Using a AAA RADIUS Server to Obtain IPv6 Prefixes for Prefix Delegation	23
Chapter 7	Using Both DHCPv6 IA_NA and DHCPv6 Prefix Delegation in a Dual-Stack Network	25
	Using DHCPv6 IA_NA with DHCPv6 Prefix Delegation to Provide IPv6 Addressing	25
	Junos OS Predefined Variable for Multiple DHCPv6 Address Assignment	25
	Lease Times and Session Timeouts for DHCPv6 IA_NA and DHCPv6 Prefix Delegation	26
	Methods for Obtaining Addresses for Both DHCPv6 Prefix Delegation and DHCPv6 IA_NA	26
	Address Pools for DHCPv6 Prefix Delegation and DHCPv6 IA_NA	26
	Using a AAA RADIUS Server to Obtain IPv6 Addresses and Prefixes	27
Part 3	Planning an IPv6 Implementation for Use in a Dual-Stack Network	
Chapter 8	IPv6 Dual-Stack Planning Overview	31
	Steps to Planning an IPv6 Implementation for a Dual-Stack Network	31
	Platform Considerations for a Dual-Stack Implementation	31
Chapter 9	Designs for IPv6 Addressing in a Dual-Stack Network	33
	Design 1: IPv6 Addressing with DHCPv6 IA_NA and DHCPv6 Prefix Delegation	34
	Design 2: IPv6 Addressing with ND/RA and DHCPv6 Prefix Delegation	35
	Design 3: IPv6 Addressing with ND/RA	36
	Design 4: IPv6 Addressing with DHCPv6 Prefix Delegation and No ND/RA Prefix	37
Chapter 10	Selecting the Methods of Assigning IPv6 Addresses	39
	Selecting the Type of Addressing Used on the CPE	39
	Selecting the Method of Provisioning a Global IPv6 Address for the WAN Link	40
	Selecting the Method of Assigning Global IPv6 Addresses to Subscribers	40
	Selecting the Method of Obtaining IPv6 Prefixes	40
	Using a AAA RADIUS Server to Obtain Global IPv6 Addresses and IPv6 Prefixes	41

Part 4	Implementing IPv4 and IPv6 Dual Stack	
Chapter 11	Dual-Stack Access Models in a PPPoE Network	45
	IPv4 and IPv6 Dual Stack in a PPPoE Access Network	45
	Determining the Status of CPE in a PPPoE Access Network	46
	IPv6 Address Provisioning in the PPPoE Access Network	46
	Authentication in a PPPoE Access Network	47
	AAA Service Framework in a Dual Stack over a PPPoE Access Network	47
	Collection of Accounting Statistics in a PPPoE Access Network	48
	Change of Authorization (CoA)	48
Chapter 12	Dual-Stack Access Models in a DHCP Network	49
	IPv4 and IPv6 Dual Stack in a DHCP Access Network	49
	AAA Service Framework in a Dual Stack over a DHCP Access Network	49
	Collection of Accounting Statistics in a DHCP Access Network	50
	Change of Authorization (CoA)	50
	Dual-Stack Interface Stack in a DHCP Wholesale Network	50
Chapter 13	Best Practices for Configuring IPv4 and IPv6 Dual Stack in a PPPoE Access Network	53
	Dynamic Profiles for IPv4 and IPv6 Services	53
	Static PPPoE Interfaces with ND/RA	53
	DHCPv6 Prefix Delegation over a PPPoE Access Network	54
	IPv6 Addressing for Logical Interfaces in PPPoE Dynamic Profiles with ND/RA	54
	IPv6 Addressing for Logical Interfaces in PPPoE Dynamic Profiles with DHCPv6	55
	IPv4 Addressing for Logical Interfaces in PPPoE Dynamic Profiles	55
Chapter 14	Configuration Tasks for IPv4 and IPv6 Dual Stack	57
	Overview of Configuration Tasks for IPv4 and IPv6 Dual-Stack in Subscriber Access Networks	58
	Configuring a Loopback Interface	59
	Configuration Tasks for a PPPoE Access Network in Which DHCP Is Used	59
	Configuring a DHCPv6 Local Server for DHCPv6 over PPPoE	59
	Configuring a PPPoE Dynamic Profile for Use with DHCP Addressing in a Dual-Stack Network	60
	Configuration Tasks for PPPoE Access Networks in which ND/RA Is Used	62
	Configuring a PPPoE Dynamic Profile for Use with ND/RA in a Dual-Stack Network	62
	Configuring a Static PPPoE Logical Interface for ND/RA	64
	Configuring an Address-Assignment Pool Used for Router Advertisements	65
	Configuring Duplicate Prefix Protection for Router Advertisement	66
	Configuration Tasks for DHCP Address Assignment Pools	66
	Configuring an Address-Assignment Pool for Use by DHCPv6 Prefix Delegation	66
	Configuring an Address-Assignment Pool for Use by DHCPv6 IA_NA	67

	Specifying the Delegated Address-Assignment Pool to Be Used for DHCPv6 Prefix Delegation	67
	Suppressing Accounting Information That Comes from AAA	68
Chapter 15	Monitoring and Managing IPv6 Subscribers	69
	Monitoring Active Subscriber Sessions	69
	Monitoring Both IPv4 and IPv6 Address in Correct Routing Instance	70
	Monitoring Dynamic Subscriber Sessions	70
	Monitoring Address Pools Used for Subscribers	71
	Monitoring Specific Subscriber Sessions	72
	Monitoring the Status of the PPPoE Logical Interface	72
	Monitoring Service Sessions for Subscribers	73
	Monitoring PPP Options Negotiated with the Remote Peer	75
	Monitoring the RADIUS Attribute Used for ND/RA	75
	Monitoring Address Bindings on the DHCPv6 Local Server	75
Part 5	Examples: IPv4 and IPv6 Dual-Stack Designs	
Chapter 16	Example: Dual-Stack Design That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE	79
	Example: Configuring a Dual Stack That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE	79
Chapter 17	Example: Dual-Stack Design That Uses ND/RA and DHCPv6 Prefix Delegation over PPPoE	103
	Example: Configuring a Dual Stack That Uses ND/RA and DHCPv6 Prefix Delegation over PPPoE	103
Chapter 18	Example: Dual-Stack Design That Uses ND/RA over PPPoE	123
	Example: Configuring a Dual Stack That Uses ND/RA over PPPoE	123

PART 1

Introduction to IPv4 and IPv6 Dual Stack for Broadband Edge

- [Introduction to IPv4 and IPv6 Dual Stack on page 3](#)

CHAPTER 1

Introduction to IPv4 and IPv6 Dual Stack

- [Audience for IPv4 and IPv6 Dual Stack on page 3](#)
- [Why Use IPv4/IPv6 Dual Stack? on page 3](#)
- [Basic Architecture of a Subscriber Access Dual-Stack Network on page 4](#)
- [Terms Used in IPv4/IPv6 Dual-Stack Documentation on page 4](#)

Audience for IPv4 and IPv6 Dual Stack

This guide is intended to assist service providers to design and plan an IPv6 implementation for their subscriber access networks, and then to use the dual-stack feature to deploy IPv6 alongside IPv4 in their networks. We intend the guide to be used by the following:

- Network architects—Responsible for creating the overall design and architecture of the dual-stack network.
- Network planners—Responsible for planning the implementation from a network perspective, including equipment.
- Network operations engineer—Responsible for creating the configuration that implements the overall design. Also responsible for deploying the implementation and actively monitoring the network.
- Sales engineers—Responsible for working with architects, planners, and operations engineers to design and implement the network solution.

Why Use IPv4/IPv6 Dual Stack?

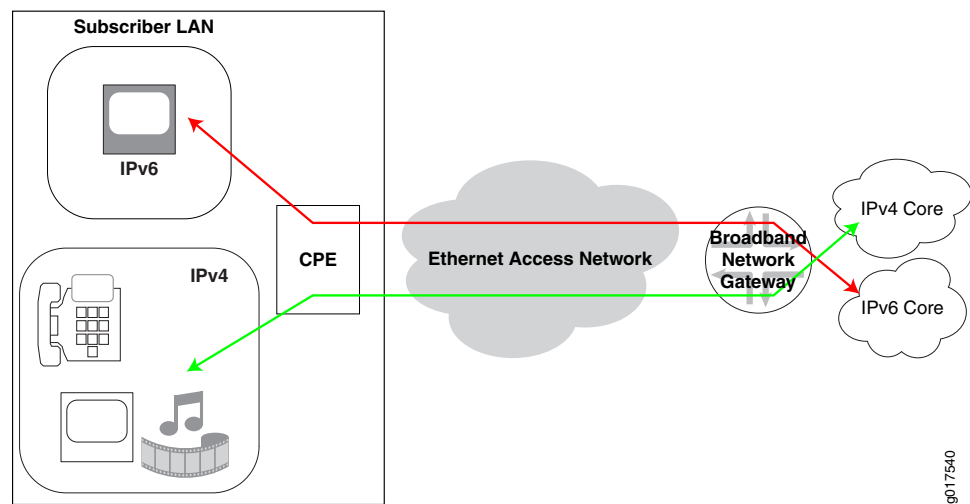
As a service provider, you can use the Junos OS IPv4/IPv6 dual-stack feature to begin your migration from IPv4 to IPv6 by implementing IPv6 alongside IPv4 in your existing subscriber networks. The feature allows you to implement IPv6 so that you can provide the same subscriber services over IPv6—video, voice, high-quality data—that you currently provide in your IPv4 networks. You can then perform incremental upgrades to IPv6 and avoid service disruptions while migrating from IPv4 to IPv6.

Basic Architecture of a Subscriber Access Dual-Stack Network

This Juniper Networks dual-stack architecture is designed for either DHCP-based or PPP/PPPoE-based subscriber access networks. In addition, this design allows you to layer DHCPv6 over PPPoE-based networks.

Figure 1 on page 4 shows the components of a basic subscriber access network in which the subscriber LAN is running both IPv4 and IPv6 and is connected to the IPv4 and IPv6 core using a broadband network gateway (BNG) configured for dual stack. Using IPv4/IPv6 dual stack, the BNG can provide both IPv4 and IPv6 services over the access network to the subscriber LAN. A single interface can operate simultaneously in IPv4 and IPv6 modes.

Figure 1: IPv4 and IPv6 Dual-Stack Architecture in a Subscriber Access Network



Terms Used in IPv4/IPv6 Dual-Stack Documentation

Table 1 on page 4 defines terms used in the IPv4/IPv6 dual-stack documentation.

Table 1: IPv4/IPv6 Dual-Stack Terms

Term	Definition
Access network	Network that connects the subscriber premises directly to the subscriber's service provider.
BNG	Broadband network gateway. An IP edge router in which bandwidth and QoS policies may be applied. The BNG may encompass any or all of the functionality of B-RAS.
CPE	Customer premises equipment on the subscriber network that connects the subscriber network to the BNG.
Delegated addressing	Method of address assignment in which a host uses IPv6 prefixes to delegate IPv6 global addresses. In a dual-stack network, the CPE uses IPv6 prefixes that it receives to delegate global IPv6 addresses to individual subscriber equipment.

Table 1: IPv4/IPv6 Dual-Stack Terms (*continued*)

Term	Definition
Delegating router	Role of the BNG when it delegates IPv6 prefixes to the requesting router (the CPE).
DHCPv6 IA	Identity association. A collection of addresses assigned to a client. Each IA contains one type of address. For example, IA_NA carries assigned addresses that are nontemporary addresses; IA_PD carries a prefix.
DHCPv6 IA_PD	IA for prefix delegation. An IA that carries a prefix that is assigned to the requesting router. Instead of assigning a single address, IA_PD assigns a prefix or a complete subnet. Referred to as DHCPv6 prefix delegation.
DHCPv6 IA_NA	IA for nontemporary addresses. An IA that carries assigned addresses that are not temporary addresses. DHCPv6 IA_NA is used to assign global IPv6 addresses.
Global IPv6 address	Unique IPv6 address that identifies a single interface and allows the interface to access the IPv6 internet.
IPv6 address prefix/prefix length	Combination of an IPv6 prefix (address) and a prefix length. The prefix takes the form <i>ipv6-prefix/prefix-length</i> and represents a block of address space (or a network). The <i>/prefix-length</i> indicates the number of contiguous, higher-order bits of the address that make up the network portion of the address. For example, 2001:DB8::/32 is an IPv6 prefix.
IPCP	IPv4 Control Protocol. A PPP protocol that establishes the IPv4 link between the BNG and the CPE if you are using PPPoE in your access network.
IPv6CP	IPv6 Control Protocol. A PPP protocol that establishes the IPv6 link between the BNG and the CPE if you are using PPPoE in your access network.
Link-local address	Locally derived address that is designed to be used for addressing on a single link for purposes such as automatic address configuration, neighbor discovery, or when no routers are present. It is indicated by the prefix FE80::/10. In your dual-stack network, you can use a link-local address on the interface that connects the CPE and the BNG.
ND/RA	Neighbor Discovery/Router Advertisement. An IPv6 protocol that is used in the dual-stack network to allow automatic addressing on the CPE WAN link.
Neighbor dDiscovery	Protocol in the IPv6 protocol suite that allows nodes on the same link to advertise their existence to their neighbors, and to learn about the existence of their neighbors.
Prefix list	Table that contains IPv6 prefixes.
Requesting router	Role of the CPE when it requests IPv6 prefixes from the delegating router (the BNG).

Table 1: IPv4/IPv6 Dual-Stack Terms (*continued*)

Term	Definition
Router Advertisement (RA)	<p>Message that the BNG periodically sends to hosts or sends in response to Router Solicitation (RS) requests from another host. The message includes IPv6 prefixes and other autoconfiguration information.</p> <p>In a dual-stack network, the router sends RAs to CPE devices on its access network.</p>
Router Solicitation (RS)	Message that hosts send to discover the presence of on-link routers. In a dual-stack network, CPE devices send RS messages to the BNG.
Subscriber LAN	Residential or small network.
Unnumbered address	Address that can be used on the router's PPPoE loopback interface that connects to the CPE.

PART 2

Overview of IPv6 Addressing in a Dual-Stack Network

- [Introduction to IPv6 Addresses on page 9](#)
- [IPv6 Addressing Requirements in a Dual-Stack Network on page 13](#)
- [Using ND/RA to Provide IPv6 WAN Link Addressing in a Dual-Stack Network on page 15](#)
- [Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing in a Dual-Stack Network on page 19](#)
- [Using DHCPv6 Prefix Delegation for Subscriber Addressing in a Dual-Stack Network on page 21](#)
- [Using Both DHCPv6 IA_NA and DHCPv6 Prefix Delegation in a Dual-Stack Network on page 25](#)

CHAPTER 2

Introduction to IPv6 Addresses

- [IPv6 Addressing Overview on page 9](#)
- [IPv6 Notation on page 9](#)
- [IPv6 Prefixes on page 10](#)
- [IPv6 Address Types on page 10](#)

IPv6 Addressing Overview

IPv6 uses a 128-bit addressing model compared with the 32-bit addresses used for IPv4. In addition to being larger, IPv6 addresses differ from IPv4 addresses in several ways:

- Notation
- Prefixes
- Address types

These differences give IPv6 addressing greater simplicity and scalability than IPv4 addressing gives.

IPv6 Notation

IPv6 addresses are 128 bits long (expressed as 32 hexadecimal numbers) and consist of eight colon-delimited sections. Each section contains 2 bytes, and each byte is expressed as a hexadecimal number from 0 through FF.

An IPv6 address looks like this:

2001:0db8:0000:0000:0000:0800:200c:7334

By omitting the leading zeroes from each section or substituting contiguous sections that contain zeroes with a double colon, you can write the example address as:

2001:db8:0:0:0:800:200c:7334 or 2001:db8::800:200c:7334

You can use the double-colon delimiter only once within a single IPv6 address. For example, you cannot express the IPv6 address 2001:db8:0000:0000:ea34:0000:71ff:fe01 as 2001:db8::ea34::71ff:fe01.

IPv6 Prefixes

An IPv6 address prefix represents a block of address space or a network. The prefix is a combination of an IPv6 prefix (address) and a prefix length. It takes the form *ipv6-prefix/prefix-length*.

IPv6 addresses can be broken into prefixes of varying length. The prefix length is a decimal value that specifies the number of the leftmost bits in the address that make up the prefix. The prefix length follows a forward slash and, in most cases, identifies the portion of the address owned by an organization. All remaining bits (up to the right-most bit) represent individual nodes or interfaces.

For example, 2001:db8:0000:0000:250:af:34ff:fe26/64 has a prefix length of 64.

The first 64 bits of this address (2001:db8:0000:0000) are the prefix. The rest (250:af:34ff:fe26) identify the interface.

IPv6 Address Types

There are three major categories of IPv6 addresses:

- Unicast—For a single interface.
- Multicast—For a set of interfaces on the same physical medium. A packet is sent to all interfaces associated with the address.
- Anycast—For a set of interfaces on different physical media. A packet is sent to only one of the interfaces associated with this address, not to all the interfaces.

Unicast Addresses

A unicast address identifies a single interface. When a network device sends a packet to a unicast address, the packet goes only to the specific interface identified by that address. Unicast addresses support a global address scope and two types of local address scopes.

A unicast address consists of n bits for the prefix, and $128 - n$ bits for the interface ID.

In the IPv6 implementation for a subscriber access network, the following types of unicast addresses can be used:

- Global unicast address—A unique IPv6 address assigned to a host interface. These addresses have a global scope and essentially the same purposes as IPv4 public addresses. Global unicast addresses are routable on the Internet.
- Link-local IPv6 address—An IPv6 address that allows communication between neighboring hosts that reside on the same link. Link-local addresses have a local scope, and cannot be used outside the link. They always have the prefix FE80::/10.
- Loopback IPv6 address—An IPv6 address used on a loopback interfaces. The IPv6 loopback address is 0:0:0:0:0:0:0:1, which can be notated as ::1/128.
- Unspecified address—An IPv6 unspecified address is 0:0:0:0:0:0:0:0, which can be notated as ::/128.

Multicast Addresses

A multicast address identifies a set of interfaces that typically belong to different nodes. When a network device sends a packet to a multicast address, the device broadcasts the packet to all interfaces identified by that address. IPv6 does not support broadcast addresses, but instead uses multicast addresses in this role.

Multicast addresses support 16 different types of address scope, including node, link, site, organization, and global scope. A 4-bit field in the prefix identifies the address scope.

The following types of multicast addresses can be used in an IPv6 subscriber access network:

- Solicited-node multicast address—Neighbor Solicitation (NS) messages are sent to this address.
- All-nodes multicast address—Router Advertisement (RA) messages are sent to this address.
- All-routers multicast address—Router Solicitation (RS) messages are sent to this address.

Multicast addresses use the prefix FF00::/8.

Anycast Addresses

An anycast address identifies a set of interfaces that typically belong to different nodes. Anycast addresses are similar to multicast addresses, except that packets are sent only to one interface, not to all interfaces. The routing protocol used in the network usually determines which interface is physically closest within the set of anycast addresses and routes the packet along the shortest path to its destination.

There is no difference between anycast addresses and unicast addresses except for the subnet-router address. For an anycast subnet-router address, the low-order bits, typically 64 or more, are zero. Anycast addresses are taken from the unicast address space.

For more information about anycast addresses, see RFC 2526, *Reserved IPv6 Subnet Anycast Addresses*.

CHAPTER 3

IPv6 Addressing Requirements in a Dual-Stack Network

- [IPv6 Addressing Requirements for a Dual-Stack Network on page 13](#)

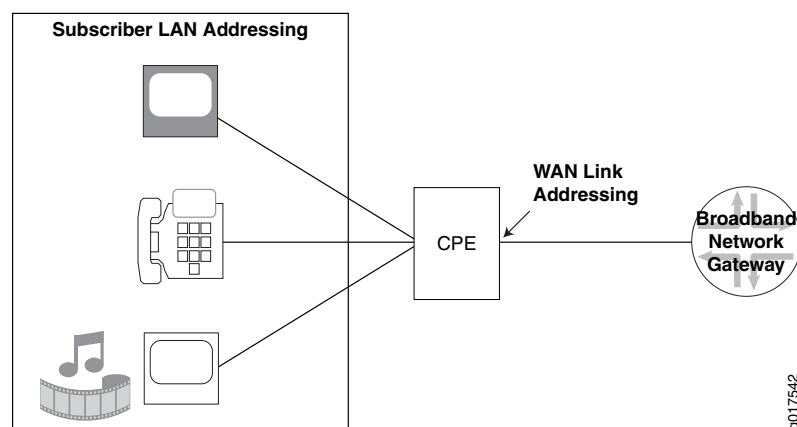
IPv6 Addressing Requirements for a Dual-Stack Network

You need to implement two types of addressing for IPv6 in a subscriber access network:

- WAN link addressing—For the WAN interface on the CPE (CPE upstream interface).
- Subscriber LAN addressing—For devices connected to the CPE on the subscriber LAN (CPE downstream interfaces).

[Figure 2 on page 13](#) shows where WAN link addressing and subscriber addressing are assigned in a dual-stack network.

Figure 2: IPv6 Address Requirements in a Subscriber Access Network



You can use the following methods for assigning IPv6 addresses:

- For WAN link addressing, you can use ND/RA or DHCPv6 IA_NA to provision a global IPv6 address.
- For subscriber LAN addressing, you can use DHCPv6 prefix delegation to provision global IPv6 addresses to subscribers on the LAN.

Alternatives to Using a Global IPv6 Address on the CPE WAN Link

If the CPE is supplied by or recommended by the service provider, you do not need to provision a unique global IPv6 address on the CPE. In this case, the BNG can use the loopback interface to manage the CPE. You can use one of the following methods to provision an address on the loopback interface:

- Link-local IPv6 address—Can be used on PPPoE access networks. The link-local address is provisioned by appending the interface identifier negotiated by IPv6CP with the IPv6 link-local prefix (FE80::/10).
- Address derived from DHCPv6 prefix delegation—Can be used on PPPoE access networks or on DHCP access networks. If you use DHCPv6 prefix delegation for subscriber addressing, the CPE can use the prefix it receives from the BNG to assign an IPv6 address on the loopback interface between the CPE and the BNG. This address can be used to manage the CPE, and the CPE uses it as a source address when it communicates with the BNG.

CHAPTER 4

Using ND/RA to Provide IPv6 WAN Link Addressing in a Dual-Stack Network

- [Overview of Using ND/RA to Provide IPv6 WAN Link Addressing on page 15](#)
- [IPv6 Neighbor Discovery Protocol Overview on page 15](#)
- [How ND/RA Works in a Subscriber Access Network on page 16](#)
- [Methods for Obtaining IPv6 Prefixes for ND/RA on page 17](#)
- [Duplicate Prefix Protection for ND/RA on page 17](#)

Overview of Using ND/RA to Provide IPv6 WAN Link Addressing

In a dual-stack network, ND/RA provides a lightweight address assignment method for autoconfiguration of global IPv6 address on the CPE WAN link. The CPE device can construct its own IPv6 global address by combining the interface ID that is negotiated by IPv6CP and the prefix obtained through ND/RA.

IPv6 Neighbor Discovery Protocol Overview

Neighbor discovery is a protocol in the IPv6 protocol suite that allows nodes on the same link to advertise their existence to their neighbors and to learn about the existence of their neighbors. Neighbor discovery is built on top of Internet Control Message Protocol version 6 (ICMPv6). It replaces the following IPv4 protocols: router discovery (RDISC), Address Resolution Protocol (ARP), and ICMPv4 redirect.

Neighbor discovery uses router advertisement messages to detect neighbors, advertise IPv6 prefixes, assist in address provisioning, and share link parameters such as MTU, hop limit, advertisement intervals, and lifetime.

Neighbor Discovery Messages

Neighbor discovery uses the following message types:

- Router Advertisement (RA)—Messages sent to announce the presence of the router, advertise prefixes, assist in address configuration, and share other link information such as MTU size and hop limit. The IPv6 nodes on the link can use this information to configure themselves with an IPv6 address and routing information such as the default gateway.
- Router Solicitation (RS)—Messages sent by IPv6 nodes when they come online to solicit immediate router advertisements from the router.
- Neighbor Solicitation (NS)—Messages used for duplicate address detection and to test reachability of neighbors.

A host can verify that its address is unique by sending a neighbor solicitation message destined to the new address. If the host receives a neighbor advertisement in reply, the address is a duplicate.

- Neighbor Advertisement (NA)—Messages used for duplicate address detection and to test reachability of neighbors. Neighbor advertisements are sent in response to neighbor solicitation messages.

You can specify the information that is sent in router advertisements.

How ND/RA Works in a Subscriber Access Network

Before ND/RA can provide IPv6 address information to the CPE, you need to first obtain a link-local address for the CPE WAN link. ND/RA provides address assignment in two phases:

1. Link-local address assignment for local connectivity to the BNG
2. Global address assignment for global connectivity

The process is as follows:

1. During IPv6CP negotiation to establish the PPPoE link between the BNG and the CPE, an interface identifier is negotiated for the CPE.
2. The CPE creates a link-local address by appending the interface identifier with the IPv6 link-local prefix (FE80::/10).



NOTE: When the interface ID is 0, such as for Windows 7 clients, PPP uses the subscriber's session ID in place of the interface ID.

The CPE now has IPv6 connectivity to the BNG, and it can use ND/RA to obtain its global IPv6 address.

3. The CPE sends a router solicitation message to the BNG.

4. The BNG responds with a router advertisement message that includes an IPv6 prefix with a length of /64.

This prefix can come directly from a local ND/RA address pool configured on the BNG.

If you are using AAA, a RADIUS server can specify the prefix in the *Framed-Ipv6-Prefix* attribute, or it can specify an ND/RA pool on the BNG from which the prefix is assigned in the *Framed-Ipv6-Pool* attribute.

5. When the CPE receives the 64-bit prefix, it appends its interface ID to the supplied prefix to form a globally routable 128-bit address.
6. The CPE verifies that the global address is unique by sending a neighbor solicitation message destined to the new address. If there is a reply, the address is a duplicate. The process stops and requires operator intervention.

Methods for Obtaining IPv6 Prefixes for ND/RA

You can set up the BNG to select IPv6 prefixes used for ND/RA through one of the following methods:

- An external source such as a AAA RADIUS server
- Dynamic assignment from a local pool of ND/RA prefixes that is configured on the BNG

Using AAA RADIUS Server to Obtain IPv6 Prefixes for ND/RA

When the BNG needs to obtain a prefix for ND/RA, it uses the values in one of the following RADIUS attributes that it receives in Access-Accept messages from the RADIUS server:

- *Framed-IPv6-Prefix*—The attribute contains an IPv6 prefix that the BNG can send to the CPE in router advertisement messages.
- *Framed-IPv6-Pool*—The attribute contains the name of an ND/RA pool configured on the BNG from which the BNG can select a prefix to include in router advertisements.

Duplicate Prefix Protection for ND/RA

If you are using AAA to supply IPv6 prefixes for ND/RA, you can enable duplicate prefix protection for ND/RA. If enabled, the BNG checks the following attributes received from external servers:

- *Framed-IPv6-Prefix*
- *Framed-IPv6-Pool*

The BNG then takes one of the following actions:

- If a prefix overlaps with a prefix in an address pool, the prefix is taken from the pool if it is available.
- If the prefix is already in use, it is rejected as unavailable.

- If the prefix length requested from the external server does not match the pool's prefix length exactly, the authentication request is denied. If configured, the Acct-Stop message includes a termination cause.

CHAPTER 5

Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing in a Dual-Stack Network

- [Overview of Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing on page 19](#)
- [Methods for Obtaining IPv6 Global Addresses for DHCPv6 IA_NA on page 19](#)

Overview of Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing

You can use DHCPv6 IA_NA to assign a global IPv6 address to the CPE WAN link. If the CPE sends a Solicit message that contains the IA_NA option to the BNG, the BNG acts as a DHCPv6 server and assigns a single IPv6/128 address to the WAN interface of the CPE.

Methods for Obtaining IPv6 Global Addresses for DHCPv6 IA_NA

You can set up the BNG to select global IPv6 addresses to be delegated to the requesting router in one the following ways:

- An external source such as a AAA RADIUS server
- Dynamic assignment from a local pool of addresses that is configured on the BNG

Using a AAA RADIUS Server to Obtain IPv6 Addresses for DHCPv6 IA_NA

When the BNG needs to obtain a global IPv6 for the CPE WAN link and optionally a DHCPv6 prefix, it uses the values in one of the following RADIUS attributes:

- *Framed-IPv6-Prefix*—The attribute contains a global IPv6 address with a prefix length of 128.
- *Framed-IPv6-Pool*—The attribute contains the name of an address-assignment pool configured on the BNG from which the BNG can select a global IPv6 address to send to the CPE.

Both attributes are sent from the RADIUS server to the BNG in RADIUS Access-Accept messages.

CHAPTER 6

Using DHCPv6 Prefix Delegation for Subscriber Addressing in a Dual-Stack Network

- [DHCPv6 Prefix Delegation Overview on page 21](#)
- [Using a Delegated Prefix on the CPE Loopback Interface on page 22](#)
- [DHCPv6 Prefix Delegation over PPPoE on page 22](#)
- [Methods for Obtaining IPv6 Prefixes for DHCPv6 Prefix Delegation on page 23](#)

DHCPv6 Prefix Delegation Overview

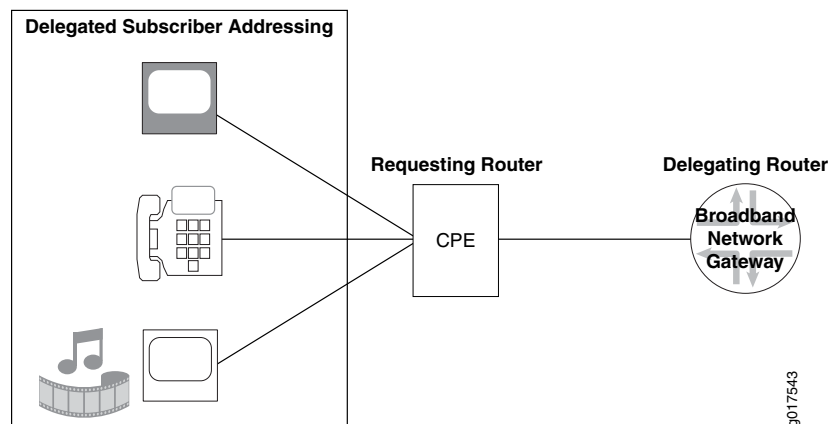
You can use DHCPv6 prefix delegation to automate the delegation of IPv6 prefixes to the CPE. With prefix delegation, a delegating router (the BNG) delegates IPv6 prefixes to a requesting router (the CPE). The requesting router then uses the prefixes to assign global IP addresses to the devices on the subscriber LAN. The requesting router can also assign subnet addresses to subnets on the LAN.

DHCPv6 prefix delegation is useful when the delegating router does not have information about the topology of the networks in which the requesting router is located. In such cases, the delegating router requires only the identity of the requesting router to choose a prefix for delegation.

DHCPv6 prefix delegation replaces the need for NAT in an IPv6 network.

[Figure 3 on page 22](#) shows how DHCPv6 prefix delegation is used in a dual-stack network.

Figure 3: Delegated Addressing in a Dual-Stack Network Using DHCPv6



DHCPv6 prefix delegation operates as follows:

1. A delegating router is provided with IPv6 prefixes to be delegated to requesting routers. These prefixes can come from a local address-assignment pool or an external AAA server.
Each prefix has an associated valid and preferred lifetime, which can be extended.
2. A requesting router requests one or more prefixes from the delegating router.
3. The delegating router chooses prefixes for delegation, and responds with prefixes to the requesting router.
4. The requesting router is then responsible for the delegated prefixes.

The address allocation mechanism in the subscriber network can be performed with ICMPv6 neighbor discovery in router advertisements, DHCPv6, or a combination of these two methods.

Using a Delegated Prefix on the CPE Loopback Interface

For networks in which the service provider directly controls the CPE, a delegated prefix can be used to create an IPv6 address on the loopback interface between the CPE and the BNG. This address can be used to manage the CPE, and the CPE uses it as a source address when it communicates with the BNG.

DHCPv6 Prefix Delegation over PPPoE

The process of DHCPv6 prefix delegation when DHCPv6 is running over a PPPoE access network is as follows:

1. The CPE obtains a link-local address by appending the interface ID that it receives through IPv6CP negotiation to the IPv6 link-local prefix (FE80::/10). The link-local address provides an initial path for protocol communication between the BNG and CPE.
2. The CPE sends a DHCPv6 Solicit message that includes an IA_PD option.

3. The BNG chooses a prefix for the CPE with information from an external AAA server or from a local prefix pool.
4. The BNG sends an Advertise message to the CPE. The message includes the delegated prefix, an IA_PD option, and an IA_PD prefix option. The prefix length in the IA_PD prefix option is 48. The message can also contain other configuration information, such as a maximum lease time.
5. The CPE sends a Request message to the BNG. The message requests the prefix that was advertised.
6. The BNG returns the delegated prefix to the CPE in a Reply message. This message also contains the delegated prefix, an IA_PD option, and an IA_PD prefix option. The prefix length in the IA_PD prefix option is 48. The message can also contain other configuration information, such as a maximum lease time.
7. The CPE uses the delegated prefix to allocate global IPv6 addresses to host devices on the subscriber network. It can use router advertisements, DHCPv6, or a combination of these two methods to allocate addresses on the subscriber LAN.

Methods for Obtaining IPv6 Prefixes for DHCPv6 Prefix Delegation

You can set up the BNG to select IPv6 prefixes to be delegated to the requesting router in one of the following ways:

- An external source such as a AAA RADIUS server
- Dynamic assignment from a local pool of prefixes that is configured on the BNG

You can specify the name of a delegated pool to use for prefix delegation, which means that you do not need to use AAA to obtain the pool name. In this configuration, if you have also specified a pool match order, the specified delegated pool takes precedence.

Using a AAA RADIUS Server to Obtain IPv6 Prefixes for Prefix Delegation

When the BNG needs to obtain a prefix for DHCPv6 prefix delegation, it uses the values in one of the following RADIUS attributes:

- *Delegated-IPv6-Prefix*—The attribute contains an IPv6 prefix that the BNG can send to the CPE.
- *Inpr-IPv6-Delegated-Pool-Name*—The attribute contains the name of an address-assignment pool configured on the BNG from which the BNG can select a prefix to send to the CPE.

Both attributes are sent from the RADIUS server to the BNG in RADIUS Access-Accept messages.

CHAPTER 7

Using Both DHCPv6 IA_NA and DHCPv6 Prefix Delegation in a Dual-Stack Network

- [Using DHCPv6 IA_NA with DHCPv6 Prefix Delegation to Provide IPv6 Addressing on page 25](#)
- [Methods for Obtaining Addresses for Both DHCPv6 Prefix Delegation and DHCPv6 IA_NA on page 26](#)

Using DHCPv6 IA_NA with DHCPv6 Prefix Delegation to Provide IPv6 Addressing

You can use DHCPv6 IA_NA to assign a global IPv6 address to the CPE WAN link and DHCPv6 prefix delegation to provide prefixes for use on the subscriber LAN. DHCPv6 IA_NA and DHCPv6 prefix delegation are done in a single DHCPv6 session. If the CPE sends both the IA_NA and IA_PD options in the same DHCPv6 Solicit message, the BNG returns both a single IPv6/128 address and an IPv6 prefix.

When at least one address is successfully allocated, the router creates a subscriber entry and binds the entry to the assigned address. If both addresses are successfully allocated, the router creates a single subscriber entry and binds both addresses to that entry.

Junos OS Predefined Variable for Multiple DHCPv6 Address Assignment

To configure dynamic DHCPv6 address assignment for both DHCPv6 IA_NA and DHCPv6 prefix delegation, use the **\$junos-subscriber-ipv6-multi-address** variable in your dynamic profile. You use this variable in place of the **\$junos-subscriber-ipv6-address** variable, which supports a single IPv6 address or prefix. The **\$junos-subscriber-ipv6-multi-address** variable is applied as a demultiplexing source address array, and is expanded to include both the host and prefix addresses.

You include the **\$junos-subscriber-ipv6-multi-address** variable at the **[edit dynamic-profile profile-name interfaces interface-name unit logical-unit-number family inet6 demux-source]** hierarchy level.

Lease Times and Session Timeouts for DHCPv6 IA_NA and DHCPv6 Prefix Delegation

When you use DHCPv6 IA_NA together with DHCPv6 prefix delegation, note the following about session timeouts and lease times:

- A session timeout from AAA has the highest precedence and overrides local pool lease times.
- For DHCPv6 local server, the minimum lease time associated with an address pool takes precedence over pools with longer lease times. For example, if a CPE obtains an IA_NA address from a pool with a lease time of 3600, and a prefix from a pool with a lease time of 7200, the lease time returned in the Reply message from the BNG is 3600.
- If AAA does not return a session timeout and the address pool does not have a configured lease time, the default setting of 86,400 (one day) is used.

Methods for Obtaining Addresses for Both DHCPv6 Prefix Delegation and DHCPv6 IA_NA

You can set up the BNG to select global IPv6 addresses to be delegated to the requesting router in one of the following ways:

- An external source such as a AAA RADIUS server
- Dynamic assignment from a local pool of prefixes or global IPv6 addresses that is configured on the BNG

Address assignment for prefix delegation and IA_NA are independent. For example, you can use AAA RADIUS for DHCPv6 IA_NA, and use a local pool for prefix delegation.

Address Pools for DHCPv6 Prefix Delegation and DHCPv6 IA_NA

You need two separate address pools for prefix delegation and IA_NA. The pool used for IA_NA contains /128 addresses, and the pool for prefix delegation contains /56 or /48 addresses.

You can specify the name of a delegated pool to use for prefix delegation, which means that you do not need to use AAA to obtain the pool name. In this configuration, if you have also specified a pool match order, the specified delegated pool takes precedence.

You can configure pool attributes so that the IA_NA pool and the prefix delegation pool can specify different SIP servers for DNS addresses. DHCPv6 options that the BNG returns to the CPE are based on the pool from which the addresses were allocated. These options that are returned are based on the DHCPv6 Option Request option (ORO), which can be configured globally or within the IA_NA and IA_PD request.

Using a AAA RADIUS Server to Obtain IPv6 Addresses and Prefixes

When the BNG needs to obtain a global IPv6 address for the CPE WAN link and a DHCPv6 prefix, it uses the values in one of the following RADIUS attributes:

- *Framed-IPv6-Prefix*—The attribute contains a global IPv6 address and a prefix. A prefix length of 128 is associated with the global IPv6 address. Prefix lengths less than 128 are associated with prefixes.
- *Framed-IPv6-Pool*—The attribute contains the name of an address-assignment pool configured on the BNG, from which the BNG can select a global IPv6 address or an IPv6 prefix to send to the CPE.

Both attributes are sent from the RADIUS server to the BNG in RADIUS Access-Accept messages.

PART 3

Planning an IPv6 Implementation for Use in a Dual-Stack Network

- [IPv6 Dual-Stack Planning Overview on page 31](#)
- [Designs for IPv6 Addressing in a Dual-Stack Network on page 33](#)
- [Selecting the Methods of Assigning IPv6 Addresses on page 39](#)

CHAPTER 8

IPv6 Dual-Stack Planning Overview

- [Steps to Planning an IPv6 Implementation for a Dual-Stack Network on page 31](#)
- [Platform Considerations for a Dual-Stack Implementation on page 31](#)

Steps to Planning an IPv6 Implementation for a Dual-Stack Network

Deciding how to implement IPv6 in your network depends on a combination of existing infrastructure and future needs. We recommend that you follow these steps to plan your IPv6 implementation:

Step 1: Determine the routing platform requirements.

Step 2: Determine the IPv6 addressing requirements.

Step 3: Select the type of IPv6 addressing used on the CPE.

Step 4: Select the method of provisioning a global IPv6 address for the CPE WAN link.

Step 5: Select the method of assigning global IPv6 addresses to subscribers.

Step 6: Select the method of obtaining IPv6 addresses and prefixes.

Platform Considerations for a Dual-Stack Implementation

[Table 2 on page 31](#) shows the combinations of routing hardware that you can use for your dual-stack implementation, along with information about access protocol and accounting support on each of the hardware combinations.

Table 2: Platform Support for a Dual-Stack Implementation

Routing Platform	PIC or MIC Support	Routing Engine Support	Access Protocol Support	Separate IPV4 and IPv6 Accounting Statistics Support	Comments
M120 Multiservice Edge Router	IQ2 PICs	RE-A-2000	PPPoE	No	Supports a static configuration only
	IQ2E PICs	RE-A-1800x2			

Table 2: Platform Support for a Dual-Stack Implementation (*continued*)

Routing Platform	PIC or MIC Support	Routing Engine Support	Access Protocol Support	Separate IPV4 and IPV6 Accounting Statistics Support	Comments
M320 Multiservice Edge Router	IQ2 PICs	RE-A-2000	PPPoE	No	—
	IQ2E PICs	RE-A-1800x2			
MX Series 3D Universal Edge Routers	3D Ethernet MICs	32-bit RE-2000 Series	PPPoE	Yes	—
			DHCPv6		
MX Series 3D Universal Edge Routers	3D Ethernet MICs	RE-1800x2	PPPoE	Yes	Provides the highest level of logical interface scaling
			DHCPv6		

CHAPTER 9

Designs for IPv6 Addressing in a Dual-Stack Network

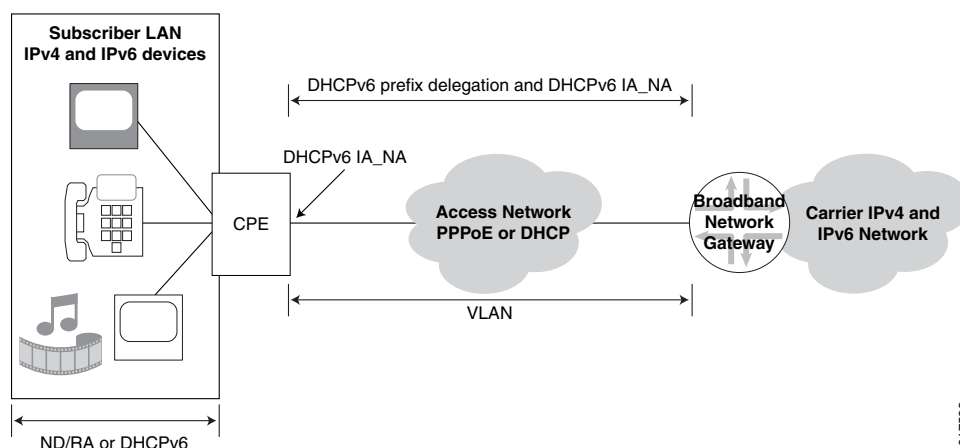
- Design 1: IPv6 Addressing with DHCPv6 IA_NA and DHCPv6 Prefix Delegation on page 34
- Design 2: IPv6 Addressing with ND/RA and DHCPv6 Prefix Delegation on page 35
- Design 3: IPv6 Addressing with ND/RA on page 36
- Design 4: IPv6 Addressing with DHCPv6 Prefix Delegation and No ND/RA Prefix on page 37

Design 1: IPv6 Addressing with DHCPv6 IA_NA and DHCPv6 Prefix Delegation

This design (Figure 4 on page 34) uses DHCPv6 IA_NA and DHCPv6 prefix delegation in your subscriber access network as follows:

- DHCPv6 IA_NA is used to assign a global IPv6 address on the WAN link. The address can come from a local pool or AAA RADIUS.
- DHCPv6 prefix delegation is used for host device addressing. The delegated prefix can come from a local pool or from AAA RADIUS. The CPE uses the delegated prefix for subscriber addressing. The CPE can use ND/RA or DHCPv6 to allocate IPv6 addresses on the LAN.

Figure 4: Subscriber Access Network with DHCPv6 IA_NA and DHCPv6 Prefix Delegation

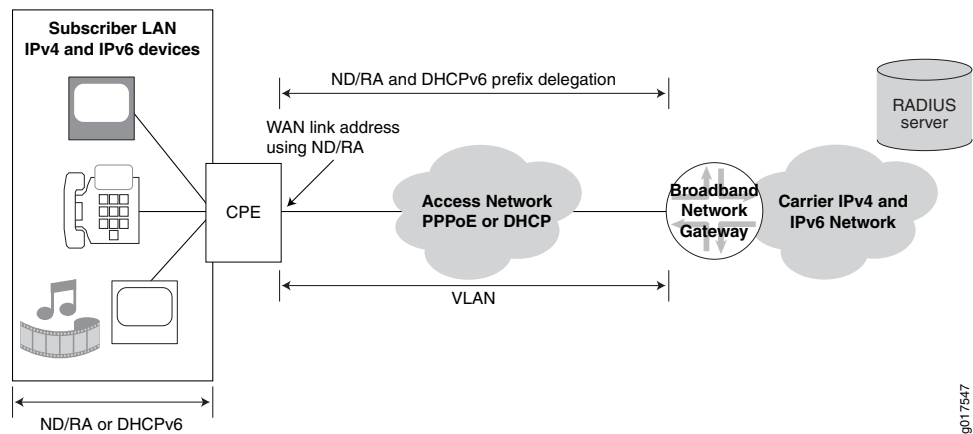


Design 2: IPv6 Addressing with ND/RA and DHCPv6 Prefix Delegation

This design (Figure 5 on page 35) uses ND/RA and DHCPv6 prefix delegation in your subscriber access network as follows:

- ND/RA addressing is used to provision a global IPv6 address on the WAN link. IPv6 prefixes for ND/RA come from a local pool or AAA RADIUS.
- DHCPv6 prefix delegation is used for host device addressing. The delegated prefix can come from a local pool or from AAA RADIUS. The CPE uses the delegated prefix for subscriber addressing. The CPE can use ND/RA or DHCPv6 to allocate IPv6 addresses on the LAN.

Figure 5: Subscriber Access Network with ND/RA and DHCPv6 Prefix Delegation

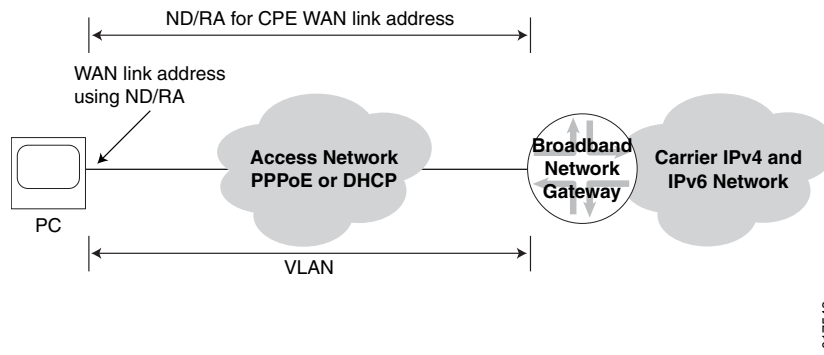


If you have a network with a combination of subscriber LANs and single PCs, you can use a combination of design 2 and design 3.

Design 3: IPv6 Addressing with ND/RA

In this design (Figure 6 on page 36), ND/RA is used for addressing a global IPv6 on the WAN link with prefixes from a local pool or AAA RADIUS. The PC does not need a delegated prefix.

Figure 6: Subscriber Access Network with ND/RA

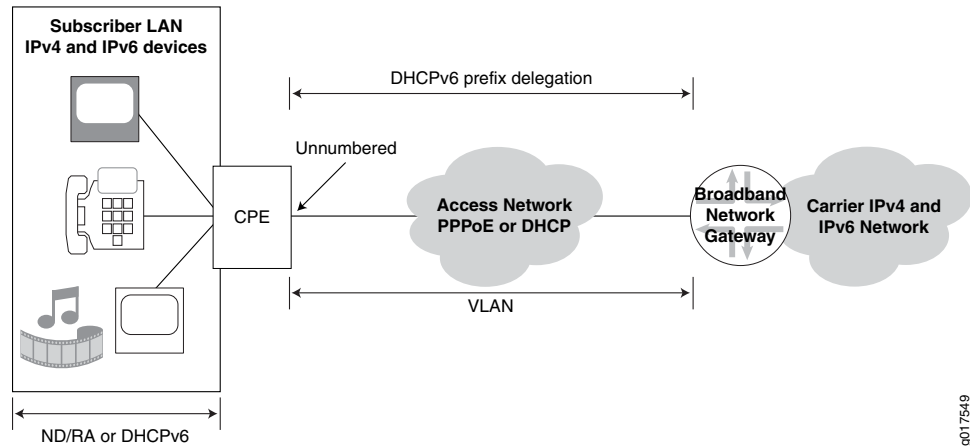


If you have a network with a combination of subscriber LANs and single PCs, you can use a combination of Design 2 and Design 3.

Design 4: IPv6 Addressing with DHCPv6 Prefix Delegation and No ND/RA Prefix

In this design (Figure 7 on page 37), the CPE is a model that is sold by or specified by the service provider. The CPE uses an unnumbered WAN interface. The BNG delegates an IPv6 prefix to the CPE with DHCPv6 prefix delegation. The CPE uses the delegated prefix for subscriber addressing. It can use ND/RA or DHCPv6 to allocate the IPv6 addresses on the LAN.

Figure 7: Subscriber Access Network with DHCPv6 Prefix Delegation



9017549

CHAPTER 10

Selecting the Methods of Assigning IPv6 Addresses

- [Selecting the Type of Addressing Used on the CPE on page 39](#)
- [Selecting the Method of Provisioning a Global IPv6 Address for the WAN Link on page 40](#)
- [Selecting the Method of Assigning Global IPv6 Addresses to Subscribers on page 40](#)
- [Selecting the Method of Obtaining IPv6 Prefixes on page 40](#)

Selecting the Type of Addressing Used on the CPE

In some networks, you do not need to assign a global IPv6 address on the CPE WAN link. Your decision depends on the type of CPE being used:

- If the CPE is purchased by the subscriber, and is not a device specifically recommended by the service provider, you need to assign a global IPv6 address that can be routed on the Internet.
- If the CPE is supplied by or recommended by the service provider, you can use the loopback interface to manage the CPE.

In this case, you can use a link-local address or you can use an address that is derived from DHCPv6 prefix delegation.

Selecting the Method of Provisioning a Global IPv6 Address for the WAN Link

To assign a global IPv6 address to the WAN link of the CPE device, you can choose one of the methods described in [Table 3 on page 40](#).

Table 3: Choosing the Global IPv6 Address Provisioning Method for the WAN Link

ND/RA Features	DHCPv6 IA_NA Features
Provides address autoconfiguration of the WAN link by means of router advertisements.	Provides a single IPv6/128 address to the WAN interface of the CPE by the BNG acting as a DHCPv6 server.
Supported on PPPoE access networks.	Supported on PPPoE and DHCP access networks.
Provides duplicate prefix prevention.	Provides the ability to use one DHCPv6 message to solicit both a global IPv6 address for the WAN link, and a prefix used to provision addresses on the subscriber LAN.
Use if the CPE does not support DHCP.	--

Selecting the Method of Assigning Global IPv6 Addresses to Subscribers



BEST PRACTICE: For addressing on the subscriber LAN, we recommend that you provision a global IP address for each device on the LAN. IPv6 was designed to allow every IP-capable device on a subscriber LAN to obtain a globally unique address, which avoids the use of NAT between the subscriber LAN and the service provider.

DHCPv6 prefix delegation automates the delegation of IPv6 prefixes to the CPE. The CPE can then use these prefixes to assign global IPv6 addresses for use in a subscriber LAN. DHCPv6 prefix delegation is useful when the delegating router (the BNG) does not have information about the topology of the networks in which the requesting router (the CPE) is located. In such cases, the delegating router requires only the identity of the requesting router to choose a prefix for delegation.

Selecting the Method of Obtaining IPv6 Prefixes

You can set up the BNG to select IPv6 prefixes through one of the following methods:

- An external source such as a AAA RADIUS server
- Dynamic assignment from a local pool of global IPv6 addresses or prefixes that is configured on the BNG

Using a AAA RADIUS Server to Obtain Global IPv6 Addresses and IPv6 Prefixes

Table 4 on page 41 describes the RADIUS attributes used in a dual-stack network. These attributes are sent from the RADIUS server to the BNG in RADIUS Access-Accept messages.

Table 4: RADIUS Attributes Used to Obtain Global IPv6 Addresses and IPv6 Prefixes

RADIUS Attribute	Address Assignment Type	Attribute Description
Framed-IPv6-Prefix	ND/RA	IPv6 prefix with a prefix length less than 128.
	DHCPv6 IA_NA	IPv6 prefix with a length of 128.
Framed-IPv6-Pool	ND/RA	Name of an ND/RA pool configured on the BNG from which the BNG selects a prefix.
	DHCPv6 IA_NA	Name of an address-assignment pool configured on the BNG from which the BNG selects a global IPv6 address.
Delegated-IPv6-Prefix	DHCPv6 prefix delegation	IPv6 prefix.
Jnpr-IPv6-Delegated-Pool-Name	DHCPv6 prefix delegation	Name of an address-assignment pool configured on the BNG from which the BNG delegates a prefix.

PART 4

Implementing IPv4 and IPv6 Dual Stack

- [Dual-Stack Access Models in a PPPoE Network on page 45](#)
- [Dual-Stack Access Models in a DHCP Network on page 49](#)
- [Best Practices for Configuring IPv4 and IPv6 Dual Stack in a PPPoE Access Network on page 53](#)
- [Configuration Tasks for IPv4 and IPv6 Dual Stack on page 57](#)
- [Monitoring and Managing IPv6 Subscribers on page 69](#)

Dual-Stack Access Models in a PPPoE Network

- [IPv4 and IPv6 Dual Stack in a PPPoE Access Network on page 45](#)
- [AAA Service Framework in a Dual Stack over a PPPoE Access Network on page 47](#)

IPv4 and IPv6 Dual Stack in a PPPoE Access Network

In a dual-stack architecture with a PPPoE access network that connects the CPE to the BNG, IPv4 and IPv6 connectivity are provided over a single PPP logical link. The PPP IPv4 control protocol (IPCP) and the IPv6 control protocol (IPv6CP) provide independent IPv4 and IPv6 connectivity over the logical link.

The BNG and the CPE handle both IPCP and IPv6CP identically and simultaneously over a single PPP connection. The BNG or the CPE can open and close any Network Control Protocol (NCP) session without affecting the other sessions. This capability allows for a dynamic setup where IPv4 (family inet) and IPv6 (family inet6) sessions can be brought up and down individually. As long as one family is active, the subscriber remains active.

[Figure 8 on page 46](#) shows a dual-stack interface stack in a PPPoE access network. The IPv4 family (inet) and the IPv6 family (inet6) can reside on the same PPPoE logical interfaces. The family inet and family inet6 parts of dynamic profiles are applied, and services are activated when each individual family is negotiated.

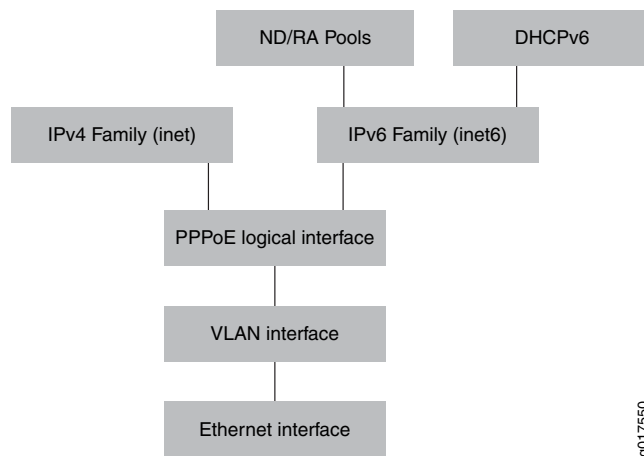
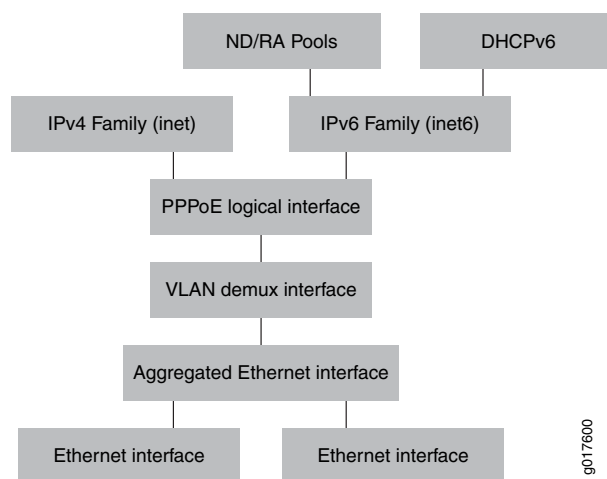
Figure 8: Dual-Stack Interface Stack over a PPPoE Access Network

Figure 9 on page 46 shows a dual-stack interface stack over aggregated Ethernet in a PPPoE access network.

Figure 9: Dual-Stack Aggregated Ethernet Stack over a PPPoE Access Network

Determining the Status of CPE in a PPPoE Access Network

In a PPPoE access network, you can enable keepalives to determine the status of the CPE.

IPv6 Address Provisioning in the PPPoE Access Network

IPv6CP negotiates the interface identifier, which can be used to provision link-local addresses that are used for direct connectivity between the BNG and the CPE. Because PPPoE negotiates only interface IDs and does not negotiate IPv6 addresses, PPPoE relies on other protocols for addressing. The protocols you can use are DHCPv6 and ND/RA.

Authentication in a PPPoE Access Network

In a PPPoE network, you can use PAP and CHAP to identify and authenticate the CPE and subscriber sessions.

You can also use AAA for authentication and authorization through external RADIUS servers.

AAA Service Framework in a Dual Stack over a PPPoE Access Network

You can use the AAA Service Framework for all authentication, authorization, accounting, address assignment, and dynamic request services that the BNG uses for network access. The framework supports authentication and authorization through external RADIUS servers. It also supports accounting and dynamic-request change of authorization (CoA) and disconnect operations through external servers, and address assignment through a combination of local address-assignment pools and RADIUS servers.

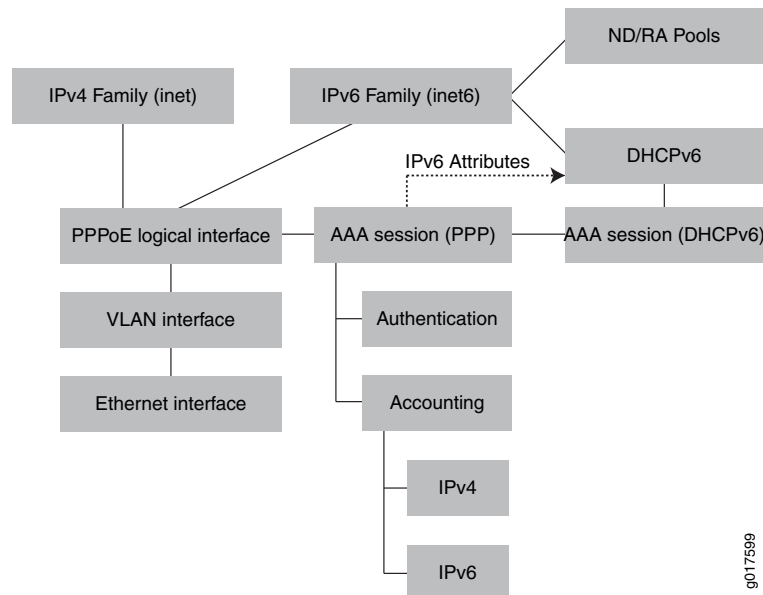
The BNG interacts with external servers to determine how individual subscribers access the broadband network. The BNG can also obtain information from external servers for the following:

- How subscribers are authenticated.
- How accounting statistics are collected and used.
- How dynamic requests, such as CoA, are handled.

As shown in [Figure 10 on page 48](#), implementing a dual stack over a PPPoE access network that uses AAA can have the following characteristics:

- DHCPv6—If used, it runs over the IPv6 family session, and it inherits attributes from the underlying PPPoE session.
- ND/RA—If used, it runs over the IPv6 family session.
- IPv4 and IPv6 accounting—One accounting session handles both IPv4 and IPv6 accounting information.

Figure 10: AAA Service Framework in a Dual Stack over a PPPoE Access Network



Collection of Accounting Statistics in a PPPoE Access Network

AAA provides support for both IPv4 and IPv6 statistics in one accounting session. On MX Series 3D Universal Edge routers AAA also provides support for separate IPv4 and IPv6 accounting statistics.

The following RADIUS attributes are included by default (when available) in Acct-Start, Interim, and Acct-Stop messages:

- Framed-IPv6-Prefix
- Framed-IPv6-Pool
- Delegated-Ipv6-Prefix
- Framed-IPv4-Route
- Framed-IPv6-Route

You can configure the BNG to exclude these attributes in Acct-Start and Acct-Stop messages.

Change of Authorization (CoA)

RADIUS servers can initiate dynamic requests to the BNG. Dynamic requests include CoA requests, which specify vendor-specific attribute (VSA) modifications and service changes.

In your access profile configuration, you specify the IP addresses of RADIUS authentication servers that can initiate dynamic requests to the router. The list of authentication servers also provides RADIUS-based dynamic service activation and deactivation during subscriber login.

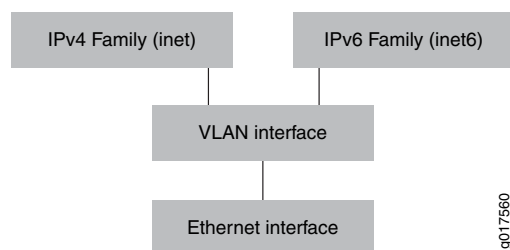
Dual-Stack Access Models in a DHCP Network

- [IPv4 and IPv6 Dual Stack in a DHCP Access Network on page 49](#)
- [AAA Service Framework in a Dual Stack over a DHCP Access Network on page 49](#)
- [Dual-Stack Interface Stack in a DHCP Wholesale Network on page 50](#)

IPv4 and IPv6 Dual Stack in a DHCP Access Network

[Figure 11 on page 49](#) shows a dual-stack interface stack in a DHCP access network. The IPv4 family (inet) and the IPv6 family (inet6) can reside on the same VLAN interface.

Figure 11: Dual-Stack Interface Stack over a DHCP Access Network



AAA Service Framework in a Dual Stack over a DHCP Access Network

You can use the AAA Service Framework for all authentication, authorization, accounting, address assignment, and dynamic request services that the BNG uses for network access. The framework supports authentication and authorization through external RADIUS servers. It also supports accounting and dynamic-request change of authorization (CoA) and disconnect operations through external servers, and address assignment through a combination of local address-assignment pools and RADIUS servers.

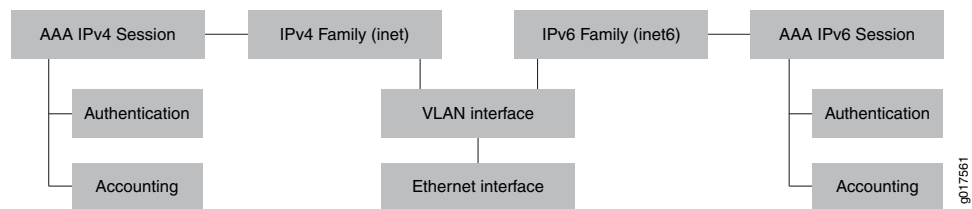
The BNG interacts with external servers to determine how individual subscribers access the broadband network. The BNG can also obtain information from external servers for the following:

- How subscribers are authenticated.
- How accounting statistics are collected and used.

- How dynamic requests, such as CoA, are handled.

As shown in [Figure 12 on page 50](#), an implementation of dual stack over a DHCP access network, there are separate AAA sessions for IPv4 and IPv6 authentication and accounting.

Figure 12: AAA Service Framework in a Dual Stack over a DHCP Access Network



Collection of Accounting Statistics in a DHCP Access Network

AAA provides support for IPv4 and IPv6 statistics in separate accounting sessions.

The following RADIUS attributes are included by default (when available) in Acct-Start, Interim, and Acct-Stop messages:

- Framed-IPv6-Prefix
- Framed-IPv6-Pool
- Delegated-Ipv6-Prefix
- Framed-IPv4-Route
- Framed-IPv6-Route

You can configure the BNG to exclude these attributes in accounting Acct-Start and Acct-Stop messages.

Change of Authorization (CoA)

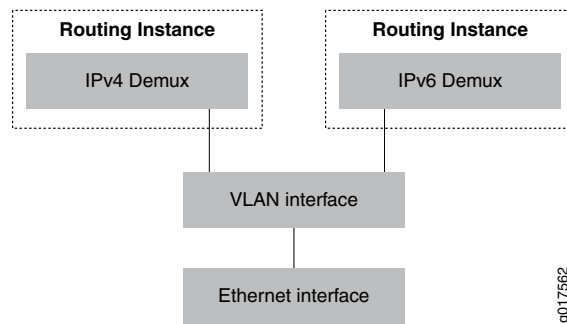
RADIUS servers can initiate dynamic requests to the BNG. Dynamic requests include CoA requests, which specify VSA modifications and service changes.

In your access profile configuration, you specify the IP addresses of RADIUS authentication servers that can initiate dynamic requests to the router. The list of authentication servers also provides RADIUS-based dynamic service activation and deactivation during subscriber login.

Dual-Stack Interface Stack in a DHCP Wholesale Network

[Figure 13 on page 51](#) shows a dual-stack interface stack in a DHCP wholesale network. In this scenario, the IPv4 and IPv6 demux interfaces are configured on the same VLAN interface. The demux interfaces are configured in a separate logical system: routing instance.

Figure 13: Dual-Stack Interface Stack in a DHCP Wholesale Network



9017562

Best Practices for Configuring IPv4 and IPv6 Dual Stack in a PPPoE Access Network

- [Dynamic Profiles for IPv4 and IPv6 Services on page 53](#)
- [Static PPPoE Interfaces with ND/RA on page 53](#)
- [DHCPv6 Prefix Delegation over a PPPoE Access Network on page 54](#)
- [IPv6 Addressing for Logical Interfaces in PPPoE Dynamic Profiles with ND/RA on page 54](#)
- [IPv6 Addressing for Logical Interfaces in PPPoE Dynamic Profiles with DHCPv6 on page 55](#)
- [IPv4 Addressing for Logical Interfaces in PPPoE Dynamic Profiles on page 55](#)

Dynamic Profiles for IPv4 and IPv6 Services

You can use one dynamic profile to allow network access for both IPv4 and IPv6 subscribers. However, we recommend that you create separate dynamic profiles for IPv4 and IPv6 services.

Static PPPoE Interfaces with ND/RA

When you use static PPPoE interfaces with ND/RA, the prefix configured for router advertisement must match the source address specified under family inet6 in the logical pp0 interface configuration. If these values do not match, the prefix is not advertised correctly.

For example:

```
[edit protocols router-advertisement]
interface pp0.2004 {
  prefix 2040:2004::/64;
}

[edit interface pp0]
unit 2004 {
  family inet6 {
    address 2040:2004::1.1.1.1/64;
```

```
}  
}
```

To view the prefix in the ICMPv6 packet, use the **monitor traffic interface pp0.xxx extensive** command. If the prefix is missing, make sure that there is not a mismatch between the family inet6 address configured for the interface and the prefix configured for the interface in the router advertisement configuration.

DHCPv6 Prefix Delegation over a PPPoE Access Network

When you use DHCPv6 prefix delegation over a PPPoE access network, you need to enable unnumbered addressing in the family inet6 configuration.

For dynamic PPPoE interfaces, enable unnumbered addressing in the dynamic profile. For example:

```
[edit dynamic-profiles]  
PPPoE-dyn-ipv4v6-dhcp {  
  interfaces {  
    pp0 {  
      unit "$junos-interface-unit" {  
        ...  
        family inet6 {  
          unnumbered-address lo0.0;  
        }  
      }  
    }  
  }  
}
```

For static PPPoE interfaces, enable unnumbered addressing in the interface configuration. For example:

```
[edit interface pp0]  
unit 2004 {  
  family inet6 {  
    unnumbered-address lo0.0;
```

IPv6 Addressing for Logical Interfaces in PPPoE Dynamic Profiles with ND/RA

When you use ND/RA, always set the IPv6 internet address in dynamic profiles to the **\$junos-ipv6-address** predefined variable. This variable is replaced with the IPv6 address of the interface used for router advertisements.

```
[edit dynamic-profiles]  
dyn-v4v6-ndra {  
  interfaces {  
    pp0 {  
      unit "$junos-interface-unit" {  
        family inet6 {  
          address "$junos-ipv6-address";  
        }  
      }  
    }  
  }  
}
```

```
}
```

IPv6 Addressing for Logical Interfaces in PPPoE Dynamic Profiles with DHCPv6

The IPv6 address configuration for logical interfaces in PPPoE dynamic profiles when you are using DHCPv6 depends on whether or not you are using routing instances.

If you are using routing instances, use the **\$junos-loopback-interface** predefined variable for the IPv6 address. For example:

```
[edit dynamic-profiles]
dyn-v4v6-ri {
  routing-instances {
    "$junos-routing-instance" {
      interface "$junos-interface-name";
    }
  }
  interfaces {
    pp0 {
      unit "$junos-interface-unit" {
        family inet6 {
          unnumbered-address "$junos-loopback-interface";
        }
      }
    }
  }
}
```

If you are not using routing instances, use the unnumbered address for the IPv6 address. The unnumbered address enables the local address to be derived from the specified interface and allows IP processing on the interface without assigning an explicit IP address to the interface. For example:

```
[edit dynamic-profiles]
dyn-v4v6-ndra {
  interfaces {
    pp0 {
      unit "$junos-interface-unit" {
        pppoe-options {
          underlying-interface "$junos-underlying-interface";
          server;
        }
        family inet6 {
          unnumbered-address lo0.0;
        }
      }
    }
  }
}
```

IPv4 Addressing for Logical Interfaces in PPPoE Dynamic Profiles

The IPv4 address configuration for logical interfaces in PPPoE dynamic profiles depends on whether or not you are using routing instances.

If you are using routing instances, use the *\$junos-loopback-interface* variable for the IPv6 address.

```
[edit dynamic-profiles]
dyn-v4v6-ri {
  routing-instances {
    "$junos-routing-instance" {
      interface "$junos-interface-name";
    }
  }
  interfaces {
    pp0 {
      unit "$junos-interface-unit" {
        family inet {
          unnumbered-address "$junos-loopback-interface";
        }
      }
    }
  }
}
```

If you are not using routing instances, use the unnumbered address for the IPv6 address. The unnumbered address enables the local address to be derived from the specified interface and allows IP processing on the interface without assigning an explicit IP address to the interface.

```
[edit dynamic-profiles]
dyn-v4v6-ndra {
  interfaces {
    pp0 {
      unit "$junos-interface-unit" {
        pppoe-options {
          underlying-interface "$junos-underlying-interface";
          server;
        }
        family inet {
          unnumbered-address lo0.0;
        }
      }
    }
  }
}
```

CHAPTER 14

Configuration Tasks for IPv4 and IPv6 Dual Stack

- Overview of Configuration Tasks for IPv4 and IPv6 Dual-Stack in Subscriber Access Networks on page 58
- Configuring a Loopback Interface on page 59
- Configuration Tasks for a PPPoE Access Network in Which DHCP Is Used on page 59
- Configuration Tasks for PPPoE Access Networks in which ND/RA Is Used on page 62
- Configuration Tasks for DHCP Address Assignment Pools on page 66
- Suppressing Accounting Information That Comes from AAA on page 68

Overview of Configuration Tasks for IPv4 and IPv6 Dual-Stack in Subscriber Access Networks

Table 5 on page 58 describes configuration tasks that are specific to IPv4 and IPv6 dual-stack networks. It does not represent a complete router configuration.

Table 5: Overview of Configuration Tasks for IPv4 and IPv6 Dual-Stack in Subscriber Access Networks

Purpose of Task	Procedure
Create a loopback interface for use in the subscriber access network.	"Configuring a Loopback Interface" on page 59
Configure DHCPv6 over the PPPoE IPv6 family.	"Configuring a DHCPv6 Local Server for DHCPv6 over PPPoE" on page 59
For PPPoE access networks that use DHCP addressing, create a dynamic profile that allows IPv4 and IPv6 subscribers to access the network on the same logical interface.	"Configuring a PPPoE Dynamic Profile for Use with DHCP Addressing in a Dual-Stack Network" on page 60
For PPPoE access networks that use ND/RA addressing, configure a dynamic profile that allows IPv4 and IPv6 subscribers to access the network on the same logical interface.	"Configuring a PPPoE Dynamic Profile for Use with ND/RA in a Dual-Stack Network" on page 62
For static ND/RA configurations, create a static PPPoE logical interface.	"Configuring a Static PPPoE Logical Interface for ND/RA" on page 64
Create a pool of IPv6 prefixes that are used in router advertisements.	"Configuring an Address-Assignment Pool Used for Router Advertisements" on page 65
Enable duplicate prefix protection for IPv6 prefixes used in router advertisements.	"Configuring Duplicate Prefix Protection for Router Advertisement" on page 66
Create a pool of IPv6 prefixes for use by DHCPv6 prefix delegation.	"Configuring an Address-Assignment Pool for Use by DHCPv6 Prefix Delegation" on page 66
Create a pool of global IPv6 addresses for use by DHCPv6 IA_NA.	"Configuring an Address-Assignment Pool for Use by DHCPv6 IA_NA" on page 67
Specify a specific address assignment pool to be used by DHCPv6 prefix delegation.	"Specifying the Delegated Address-Assignment Pool to Be Used for DHCPv6 Prefix Delegation" on page 67
Configure AAA to exclude specific attributes from Acct-Start or Acct-Stop messages.	"Suppressing Accounting Information That Comes from AAA" on page 68

Configuring a Loopback Interface

You must configure a loopback interface for use in the subscriber access network. The loopback interface is automatically used for unnumbered interfaces.

If you are using routing instances, you can configure the loopback interface for the default routing instance or for a specific routing instance. The following procedure adds the loopback interface to the default routing instance.

To configure a loopback interface:

1. Create the loopback interface, and assign a unit number to the interface.

```
[edit]
user@host# edit interfaces lo0 unit 0
```

2. Configure the interface for IPv4.

```
[edit interfaces lo0 unit 0]
user@host# set family inet unnumbered-address
```

3. Configure the interface for IPv6.

```
[edit interfaces lo0 unit 0]
user@host# set family inet6 unnumbered-address
```

Configuration Tasks for a PPPoE Access Network in Which DHCP Is Used

- [Configuring a DHCPv6 Local Server for DHCPv6 over PPPoE on page 59](#)
- [Configuring a PPPoE Dynamic Profile for Use with DHCP Addressing in a Dual-Stack Network on page 60](#)

Configuring a DHCPv6 Local Server for DHCPv6 over PPPoE

To layer DHCPv6 above the PPPoE IPv6 family (inet6), create a DHCPv6 local server and associate DHCPv6 with the PPPoE interfaces by adding the PPPoE interfaces to the DHCPv6 local server configuration. Specify static and dynamic PPPoE interfaces as follows:

- Dynamic—Use the pp0.0 (PPPoE) logical interface as a wildcard to indicate that a DHCPv6 binding can be made on top of a PPPoE interface.
- Static—Use unit numbers to explicitly specify static interfaces; for example pp0.2000.

To configure a DHCPv6 local server:

1. Access the DHCPv6 local server configuration.

```
[edit]
user@host# edit system services dhcp-local-server dhcpv6
[edit system services dhcp-local-server dhcpv6]
```

2. Create a group for dynamic PPPoE interfaces and assign a name.

The group feature groups a set of interfaces and then applies a common DHCP configuration to the named interface group.

```
[edit system services dhcp-local-server dhcpv6]
user@host# edit group group-pppoe
```

3. For dynamic PPPoE logical interfaces, add an interface.

```
[edit system services dhcp-local-server dhcpv6 group group-pppoe]
user@host# set interface pp0.0
```

4. For static PPPoE, add a range of interfaces.

```
[edit system services dhcp-local-server dhcpv6 group group-pppoe]
user@host# set interface pp0.2000 upto pp0.2999
```

Configuring a PPPoE Dynamic Profile for Use with DHCP Addressing in a Dual-Stack Network

Configure a dynamic profile for IPv4 and IPv6 subscribers that access the network. The dynamic profile defines the attributes of the dynamic PPPoE logical subscriber interface.

To configure a PPPoE dynamic profile for both IPv4 and IPv6 subscribers:

1. Create and name the dynamic profile.

```
[edit]
user@host# edit dynamic profiles PPPOE-dyn-ipv4v6
```

2. If you are using routing instances, add a routing instance to the profile, and add an interface to the routing instance.

- Specify the **\$junos-routing-instance** variable for the routing instance. The routing instance variable is dynamically replaced with the routing instance the accessing subscriber uses when connecting to the BNG.
- Specify the **\$junos-interface-name** variable for the interface. The interface variable is dynamically replaced with the interface that the accessing subscriber uses when connecting to the BNG.

```
[edit dynamic profiles PPPOE-dyn-ipv4v6]
user@host# set routing-instances $junos-routing-instance interface
$junos-interface-name
```

3. Add a PPPoE logical interface (pp0) to the profile, and specify **\$junos-interface-unit** as the predefined variable to represent the logical unit number for the interface. The variable is dynamically replaced with the actual unit number supplied by the network when the subscriber logs in.

```
[edit dynamic profiles PPPOE-dyn-ipv4v6]
user@host# edit interfaces pp0 unit $junos-interface-unit
```

4. Configure the IPv4 family for the pp0 interface as follows:

- If you are not using routing instances, assign an unnumbered address. The unnumbered address enables the local address to be derived from the specified interface and allows IP processing on the interface without an explicit IP address assigned to the interface.

For example:

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6 interfaces pp0 unit "$junos-interface-unit"]
user@host# set family inet unnumbered-address lo0.0
```

- If you are using routing instances, assign the predefined variable **\$junos-loopback-interface**.

For example:

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6 interfaces pp0 unit "$junos-interface-unit"]
user@host# set family inet unnumbered-address $junos-loopback-interface
```

5. Configure the IPv6 family for the pp0 interface as follows:

- If you are not using routing instances, assign an unnumbered address that specifies the loopback interface. The unnumbered address enables the local address to be derived from the loopback interface and allows IP processing on the interface without an explicit IP address assigned to the interface.

For example:

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6 interfaces pp0 unit "$junos-interface-unit"]
user@host# set family inet6 unnumbered-address lo0.0
```

- If you are using routing instances, assign the predefined variable **\$junos-loopback-interface**.

For example:

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6 interfaces pp0 unit "$junos-interface-unit"]
user@host# set family inet6 unnumbered-address $junos-loopback-interface
```

6. Specify **\$junos-underlying-interface** as the predefined variable to represent the name of the underlying Ethernet interface on which the router creates the dynamic PPPoE logical interface. The variable is dynamically replaced with the actual name of the underlying interface.

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6 interfaces pp0 unit "$junos-interface-unit"]
user@host# set pppoe-options underlying-interface $junos-underlying-interface
```

7. Define the router to act as a PPPoE server when a PPPoE logical interface is dynamically created.

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6 interfaces pp0 unit "$junos-interface-unit"]
user@host# set pppoe-options server
```

8. (Optional) Configure the PPP authentication protocol for the pp0 interface. Specify either **chap** or **pap** (or both).

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6 interfaces pp0 unit "$junos-interface-unit"]
user@host# set ppp-options chap
user@host# set ppp-options pap
```

9. (Optional) Enable keepalives and set an interval for keepalives. We recommend an interval of 30 seconds. For example:

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6 interfaces pp0 unit "$junos-interface-unit"]
user@host# set keepalives interval 30
```

Configuration Tasks for PPPoE Access Networks in which ND/RA Is Used

- [Configuring a PPPoE Dynamic Profile for Use with ND/RA in a Dual-Stack Network on page 62](#)
- [Configuring a Static PPPoE Logical Interface for ND/RA on page 64](#)
- [Configuring an Address-Assignment Pool Used for Router Advertisements on page 65](#)
- [Configuring Duplicate Prefix Protection for Router Advertisement on page 66](#)

Configuring a PPPoE Dynamic Profile for Use with ND/RA in a Dual-Stack Network

Configure a dynamic profile for IPv4 and IPv6 PPPoE subscribers that access the network. The dynamic profile defines the attributes of the dynamic PPPoE logical subscriber interface.

This dynamic profile is for configurations that use ND/RA to assign a global IP address to the CPE WAN link.

To configure a PPPoE dynamic profile for ND/RA:

1. Create and name the dynamic profile.

```
[edit]
user@host# edit dynamic profiles PPPOE-dyn-ipv4v6-ndra
```

2. If you are using routing instances, add a routing instance to the profile and add an interface to the routing instance.
 - Specify the **\$junos-routing-instance** variable for the routing instance. The routing instance variable is dynamically replaced with the routing instance the accessing subscriber uses when connecting to the BNG.
 - Specify the **\$junos-interface-name** variable for the interface. The interface variable is dynamically replaced with the interface that the accessing subscriber uses when connecting to the BNG.

```
[edit dynamic profiles PPPOE-dyn-ipv4v6-ndra]
user@host# set routing-instances $junos-routing-instance interface
$junos-interface-name
```

3. Add a PPPoE logical interface (pp0) to the profile, and specify **\$junos-interface-unit** as the predefined variable to represent the logical unit number for the interface. The variable is dynamically replaced with the actual unit number supplied by the network when the subscriber logs in.

```
[edit dynamic profiles PPPOE-dyn-ipv4v6-ndra]
user@host# edit interfaces pp0 unit $junos-interface-unit
```

4. Configure the IPv4 family for the pp0 interface as follows:
 - If you are not using routing instances, assign an unnumbered address. The unnumbered address enables the local address to be derived from the specified interface and allows IP processing on the interface without assigning an explicit IP address to the interface.

For example:

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6-ndra interfaces pp0 unit
 "$junos-interface-unit"]
user@host# set family inet unnumbered-address lo0.0
```

- If you are using routing instances, assign the predefined variable **\$junos-loopback-interface**.

For example:

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6-ndra interfaces pp0 unit
 "$junos-interface-unit"]
user@host# set family inet unnumbered-address $junos-loopback-interface
```

5. Configure the IPv6 family for the pp0 interface, and assign **\$junos-ipv6-address** as the predefined variable. Use this variable when you are using router advertisement with or without routing instances. This variable is replaced with the IPv6 address of the interface used for router advertisements.

```
[edit dynamic profiles PPPOE-dyn-ipv4v6-ndra interfaces pp0 unit
 "$junos-interface-unit"]
user@host# set family inet6 address $junos-ipv6-address
```

6. Specify **\$junos-underlying-interface** as the predefined variable to represent the name of the underlying Ethernet interface on which the router creates the dynamic PPPoE logical interface. The variable is dynamically replaced with the actual name of the underlying interface.

```
[edit dynamic profiles PPPOE-dyn-ipv4v6-ndra pp0 interfaces pp0 unit
 "$junos-interface-unit"]
user@host# set pppoe-options underlying-interface $junos-underlying-interface
```

7. Define the router to act as a PPPoE server when a PPPoE logical interface is dynamically created.

```
[edit dynamic profiles PPPOE-dyn-ipv4v6-ndra interfaces pp0 unit
 "$junos-interface-unit"]
user@host# set pppoe-options server
```

8. (Optional) Configure the PPP authentication protocol that is used to identify and authenticate the CPE. Specify either **chap** or **pap** (or both).

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6-ndra interfaces pp0 unit
 "$junos-interface-unit"]
user@host# set ppp-options chap
user@host# set ppp-options pap
```

9. (Optional) Enable keepalives and set an interval for keepalives. We recommend an interval of 30 seconds. For example:

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6-ndra interfaces pp0 unit
"$junos-interface-unit"]
user@host# set keepalives interval 30
```

10. Configure the router advertisement protocol.

- a. Access the router advertisement configuration.

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6-ndra]
user@host# edit protocols router-advertisement
```

- b. Specify the interface on which the ND/RA configuration is applied. Assign **\$junos-interface-name** as the predefined variable. The variable is replaced with the actual name of the interface.

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6-ndra protocols router-advertisement]
user@host# edit interface $junos-interface-name
```

- c. Specify a prefix value contained in router advertisement messages sent to the CPE on interfaces created with this dynamic profile.

If you specify the **\$junos-ipv6-ndra-prefix** predefined variable, the actual value is obtained from a local pool or through AAA.

```
[edit dynamic-profiles PPPOE-dyn-ipv4v6-ndra protocols router-advertisement]
user@host# set prefix $junos-ipv6-ndra-prefix
```

Configuring a Static PPPoE Logical Interface for ND/RA

To configure a static PPPoE logical interface for static ND/RA configurations:

1. Specify the name and logical unit number of the interface.

```
[edit]
user@host# edit interfaces pp0 unit 1000
```

2. Configure a description for the interface.

```
[edit interfaces pp0 unit 1000]
user@host# set description "static IPv4v6 dual stack, NDRA"
```

3. Specify the family inet6 source address.

```
[edit interfaces pp0 unit 1000]
user@host# set family inet6 address 2040:2004::1.1.1/64
```

4. Configure an unnumbered address for family inet.

```
[edit interfaces pp0 unit 1000]
user@host# set family inet unnumbered-address lo0.0
```

5. Specify the underlying Ethernet interface.

```
[edit interfaces pp0 unit 1000]
user@host# set pppoe-options underlying-interface ge-1/0/0.1000
```

6. Define the router to act as a PPPoE server when the PPPoE logical interface is created.

```
[edit interfaces pp0 unit 1000]
user@host# set pppoe-options server
```

7. Access the router advertisement configuration, and specify the prefixes that the BNG sends in router advertisements for the static interface. Make sure that the prefixes match the source address configured for the static PPPoE logical interface configured in Step 3.

```
[edit]
user@host# edit protocols router-advertisement
user@host# set interface pp0.1000 prefix 2040:2004::/64
```

Configuring an Address-Assignment Pool Used for Router Advertisements

If you are using local address-assignment pools to be used for router advertisement, create a pool and add IPv6 prefixes to the pool.

You must configure separate pools for DHCPv6 prefix delegation, DHCPv6 IA_NA, and router advertisement.

To configure an ND/RA address-assignment pool.

1. Create a pool for IPv6 prefixes used by ND/RA.

```
[edit]
user@host# edit access address-assignment pool ndra-2010 family inet6
```

2. Add IPv6 network prefixes to the pool.

```
[edit access address-assignment pool ndra-2010 family inet6]
user@host# set prefix 2001::/64
```

3. Configure the name of the IPv6 address range and define the range. For ND/RA pools, specify the range by setting a prefix length of 64.

```
[edit access address-assignment pool ndra-2010 family inet6]
user@host# set range ndra-range prefix-length 64
```

4. Specify that the address-assignment pool is used for ND/RA.

```
[edit access address-assignment]
user@host# set neighbor-discovery-router-advertisement ndra-2010
```

Configuring Duplicate Prefix Protection for Router Advertisement

If you are using AAA to supply IPv6 prefixes for router advertisement, you can enable duplicate prefix protection to prevent prefixes from being used more than once. If enabled, the following attributes received from external servers are checked:

- *Framed-IPv6-Prefix*
- *Framed-IPv6-Pool*

If a prefix overlaps with a prefix in an address pool, the prefix is taken from the pool if it is available. If the prefix is already in use, it is rejected as unavailable. If the prefix length requested from the external server does not match the pool's prefix length exactly, the authentication request is denied. If configured, the Acct-Stop message will include a termination cause.

To configure duplicate prefix protection:

1. Enter the **access** configuration.

```
[edit]
user@host# edit access
```

2. Enable duplicate prefix protection.

```
[edit access]
user@host# set address-protection
```

Configuration Tasks for DHCP Address Assignment Pools

- [Configuring an Address-Assignment Pool for Use by DHCPv6 Prefix Delegation on page 66](#)
- [Configuring an Address-Assignment Pool for Use by DHCPv6 IA_NA on page 67](#)
- [Specifying the Delegated Address-Assignment Pool to Be Used for DHCPv6 Prefix Delegation on page 67](#)

Configuring an Address-Assignment Pool for Use by DHCPv6 Prefix Delegation

This procedure shows how to configure IPv6 local address pools to allocate IPv6 prefixes for use by DHCPv6 prefix delegation.

You must configure separate pools for DHCPv6 prefix delegation, DHCPv6 IA_NA, and ND/RA.

To configure the pool to be used for prefix delegation:

1. Create a pool and assign a name to it.

```
[edit access]
user@host# edit address-assignment pool v6-prefix-pool-2001
```

2. Under family inet6, add IPv6 prefixes to the pool.

```
[edit access address-assignment pool v6-prefix-pool-2001]
```



```
user@host# edit family inet6
user@host# set prefix 2001:0000:0000:0000::/64
```

3. Configure the name of the IPv6 prefix range, and define the range by setting a prefix length of 64.

```
[edit access address-assignment pool v6-prefix-pool-2001 family inet6]
user@host# edit range prefix-range
user@host# set prefix-length 64
```

Configuring an Address-Assignment Pool for Use by DHCPv6 IA_NA

This procedure shows how to configure IPv6 local address pools to allocate global IPv6 addresses to the CPE WAN link.

You must configure separate pools for DHCPv6 prefix delegation, DHCPv6 IA_NA, and ND/RA.

To configure the pool to be used for DHCPv6 IA_NA:

1. Create a pool and assign a name to it.

```
[edit access]
user@host# edit address-assignment pool v6-ia-na-pool
```

2. Under family inet6, add IPv6 network prefixes to the pool.

```
[edit access address-assignment pool v6-ia-na-pool]
user@host# edit family inet6
user@host# set prefix 2001:0000::/64
```

3. Configure the name of the IPv6 address range, and define the range by setting a low and high range of /128 addresses.

```
[edit access address-assignment pool v6-ia-na-pool family inet6]
user@host# edit range v6-range
user@host# set low 2001::1/128
user@host# set high 2001::ffff:ffff/128
```

Specifying the Delegated Address-Assignment Pool to Be Used for DHCPv6 Prefix Delegation

You can explicitly specify which address pool the BNG uses to assign IPv6 prefixes for use by DHCPv6 prefix delegation. This feature enables you to identify the address pool without using RADIUS or a network match.



NOTE: You can also use by Juniper Networks VSA 26-161 to specify the delegated address pool. The VSA-specified value takes precedence over the delegated-address statement.

To specify the pool to be used for prefix delegation:

1. Specify that you want to configure override options for DHCPv6 local server.

```
[edit system services dhcp-local-server dhcpv6]
user@host# edit overrides
```

2. Specify the name of the delegated address pool.

```
[edit system services dhcp-local-server overrides]
user@host# set delegated-pool paris-cable-12
```

Suppressing Accounting Information That Comes from AAA

The following standard and vendor-specific IPv6 RADIUS attributes are included by default (when available) in Acct-Start and Acct-Stop messages:

- Framed-IPv6-Prefix
- Framed-IPv6-Pool
- Delegated-Ipv6-Prefix
- Framed-IPv4-Route
- Framed-IPv6-Route

You can configure the software to exclude these attributes from Acct-Start or Acct-Stop messages. To do so, configure the access profile:

1. Access the access profile.

```
[edit]
user@host# edit access profile dual-stack radius attributes
```

2. The following examples show how to use the **exclude** statement to exclude attributes from messages.

```
[edit access profile dual-stack radius attributes]
user@host# set exclude delegated-ipv6-prefix accounting-start
```

```
[edit access profile dual-stack radius attributes]
user@host# set exclude framed-ipv6-pool [accounting-start accounting-stop]
```

```
[edit access profile dual-stack radius attributes]
user@host# set exclude framed-ipv6-prefix accounting-start framed-ipv6-route
accounting-start
```

```
[edit access profile dual-stack radius attributes]
user@host# set exclude framed-ipv6-prefix accounting-start framed-ipv6-route
accounting-start
```

CHAPTER 15

Monitoring and Managing IPv6 Subscribers

- [Monitoring Active Subscriber Sessions on page 69](#)
- [Monitoring Both IPv4 and IPv6 Address in Correct Routing Instance on page 70](#)
- [Monitoring Dynamic Subscriber Sessions on page 70](#)
- [Monitoring Address Pools Used for Subscribers on page 71](#)
- [Monitoring Specific Subscriber Sessions on page 72](#)
- [Monitoring the Status of the PPPoE Logical Interface on page 72](#)
- [Monitoring Service Sessions for Subscribers on page 73](#)
- [Monitoring PPP Options Negotiated with the Remote Peer on page 75](#)
- [Monitoring the RADIUS Attribute Used for ND/RA on page 75](#)
- [Monitoring Address Bindings on the DHCPv6 Local Server on page 75](#)

Monitoring Active Subscriber Sessions

Purpose View a summary of active subscriber sessions.

Action From operational mode, enter the **show subscribers summary** command.

```
user@host>show subscribers summary
Subscribers by State
  Active: 2
  Total: 2
```

```
Subscribers by Client Type
  DHCP: 1
  PPPoE: 1
  Total: 2
```

Meaning The output under **Subscribers by State** shows the number of active subscriber sessions.

The output under **Subscribers by Client Type** shows the number of active sessions by type. The two subscriber sessions above represent a DHCPv6 subscriber on a PPPoE access network. When DHCPv6 is layered over PPPoE, two separate subscriber sessions are created for a subscriber.

Monitoring Both IPv4 and IPv6 Address in Correct Routing Instance

Purpose Verify that the subscriber has both an IPv4 and an IPv6 address and is placed in the correct routing-instance.

Action From operational mode, enter the **show subscribers** command.

```
user@host>show subscribers
Interface      IP Address/VLAN ID  User Name      LS:RI
pp0.1073741825 10.16.0.2           ipv4-v6-subscriber default:default
pp0.1073741825 2001:DB8::1         default:default
```

Meaning The **Interface** field shows that there are two subscriber sessions running on the same interface. The **IP Address** field shows that one session is assigned an IPv4 address, and one session is assigned on IPv6 address.

The **LS:RI** field shows that the subscriber is placed in the correct routing instance and that traffic can be sent and received.

Monitoring Dynamic Subscriber Sessions

Purpose Display dynamic PPPoE and DHCPv6 subscriber sessions.

Action From operational mode, enter the **show subscribers detail** command.

```
user@host>show subscribers detail
Type: PPPoE
User Name: SBRSTATICUSER
IP Address: 10.16.0.2
IP Netmask: 255.0.0.0
Logical System: default
Routing Instance: default
Interface: pp0.1073741825
Interface type: Dynamic
Dynamic Profile Name: pppoe-subscriber-profile
MAC Address: 00:01:02:00:00:01
State: Active
Radius Accounting ID: 2
Session ID: 2
Login Time: 2011-12-08 09:11:41 PST

Type: DHCP
IPv6 Address: 2001::1
Logical System: default
Routing Instance: default
Interface: pp0.1073741825
Interface type: Static
MAC Address: 00:01:02:00:00:01
State: Active
Radius Accounting ID: 3
Session ID: 3
Underlying Session ID: 2
Login Time: 2011-12-08 09:12:11 PST
DHCP Options: len 42
00 08 00 02 0b b8 00 01 00 0a 00 03 00 01 00 01 02 00 00 01
```

```
00 06 00 02 00 03 00 03 00 0c 00 00 00 00 00 00 00 00
00 00
```

Meaning If you are using DHCPv6 over a PPPoE access network, the output shows the relationship of the DHCPv6 subscriber session with its underlying PPPoE subscriber session. In the output for the PPPoE session, the **Session ID** is 2. The output of the DHCP session shows that the **Underlying Session ID** is 2.

Monitoring Address Pools Used for Subscribers

Purpose Verify the pool used for ND/RA, the delegated address pool used for DHCPv6 prefix delegation and the length of the IPv6 prefixes that were delegated to the CPE.

Action From operational mode, enter the **show subscribers extensive** command.

```
user@host>show subscribers extensive
Type: PPPoE
User Name: dual-stack-v4v6-pd
IP Address: 2.2.0.5
IP Netmask: 255.255.0.0
IPv6 User Prefix: 2010:0:0:8::/64
Logical System: default
Routing Instance: default
Interface: pp0.1073741864
Interface type: Dynamic
Dynamic Profile Name: DS-dyn-ipv4v6-ra
MAC Address: 00:07:64:11:07:02
State: Active
Radius Accounting ID: 87
Session ID: 87
Login Time: 2012-01-17 14:45:30 PST
IPv6 Delegated Address Pool: dhcpv6-pd-pool
IPv6 Delegated Address Pool: ndra-2010
IPv6 Delegated Network Prefix Length: 48
IPv6 Interface Address: 2010:0:0:8::1/64

Type: DHCP
IPv6 Prefix: 2040:2000:2000:5::/64
Logical System: default
Routing Instance: default
Interface: pp0.1073741864
Interface type: Static
MAC Address: 00:07:64:11:07:02
State: Active
Radius Accounting ID: 88
Session ID: 88
Underlying Session ID: 87
Login Time: 2012-01-17 14:46:00 PST
DHCP Options: len 42
00 08 00 02 0b b8 00 01 00 0a 00 03 00 01 00 07 64 11 07 02
00 06 00 02 00 19 00 19 00 0c 00 00 00 00 00 00 00 00 00 00
00 00
IPv6 Delegated Address Pool: dhcpv6-pd-pool
IPv6 Delegated Network Prefix Length: 64
IPv6 Delegated Network Prefix Length: 48
```

Meaning Under the PPPoE session, the **IPv6 Delegated Address Pool** fields show the names of the pools used for DHCPv6 prefix delegation and for ND/RA prefixes. The **IPv6 Delegated Network Prefix Length** field shows the length of the prefix used to assign the IPv6 address for this subscriber session. The **IPv6 Interface Address** field shows the IPv6 address assigned to the CPE interface from the ND/RA pool.

Under the DHCP session, the **IPv6 Delegated Address Pool** fields show the name of the pool used for DHCPv6 prefix delegation. The **IPv6 Delegated Network Prefix Length** fields shows the length of the prefix used in DHCPv6 prefix delegation.

Monitoring Specific Subscriber Sessions

Purpose Display information about specific subscriber sessions. If you have many subscriber sessions running, you can use this command to display specific sessions.

Action From operational mode, enter the **show subscribers extensive id** command.

```
user@host>show subscribers extensive id 2
Type: PPPoE
User Name: SBRSTATICUSER
IP Address: 10.16.0.2
IP Netmask: 255.0.0.0
Logical System: default
Routing Instance: default
Interface: pp0.1073741825
Interface type: Dynamic
Dynamic Profile Name: pppoe-subscriber-profile
MAC Address: 00:01:02:00:00:01
State: Active
Radius Accounting ID: 2
Session ID: 2
Login Time: 2011-12-08 09:11:41 PST

user@host> show subscribers extensive id 3
Type: DHCP
IPv6 Address: 2001::1
Logical System: default
Routing Instance: default
Interface: pp0.1073741825
Interface type: Static
MAC Address: 00:01:02:00:00:01
State: Active
Radius Accounting ID: 3
Session ID: 3
Underlying Session ID: 2
Login Time: 2011-12-08 09:12:11 PST
DHCP Options: len 42
00 08 00 02 0b b8 00 01 00 0a 00 03 00 01 00 01 02 00 00 01
00 06 00 02 00 03 00 03 00 0c 00 00 00 00 00 00 00 00 00 00
00 00
```

Meaning The output shows details about specific subscriber sessions.

Monitoring the Status of the PPPoE Logical Interface

Purpose Display status information about the PPPoE logical interface.

Action user@host> show interfaces pp0.1073741888

```

Logical interface pp0.1073741888 (Index 123) (SNMP ifIndex 707)
Flags: Point-To-Point SNMP-Traps 0x4000 Encapsulation: PPPoE
PPPoE:
  State: SessionUp, Session ID: 16,
  Session AC name: centaurus, Remote MAC address: 00:00:64:01:06:02,
  Underlying interface: ge-1/0/0.1104 (Index 95)
Input packets : 8
Output packets: 51816
LCP state: Opened
NCP state: inet: Opened, inet6: Opened, iso: Not-configured, mpls:
Not-configured
CHAP state: Closed
PAP state: Success
Protocol inet, MTU: 1500
  Flags: Sendbcst-pkt-to-re
  Addresses, Flags: Is-Primary
  Local: 77.1.1.1
Protocol inet6, MTU: 1500
  Addresses, Flags: Is-Preferred Is-Primary
  Destination: 2001:DB8:0:21::/64, Local: 2001:DB8:0:21::1
  Addresses, Flags: Is-Preferred
  Destination: fe80::/64, Local: fe80::2a0:a50f:fc61:6d0

```

Meaning Displays session information about the ppp0 interface.

Monitoring Service Sessions for Subscribers

Purpose Display a details about dual-stack subscriber session.

Action user@host> show subscribers interface pp0.1073741888 extensive

```

Type: PPPoE
User Name: dual-stack-v4v6-2svc-good
IP Address: 10.10.12.140
Logical System: default
Routing Instance: default
Interface: pp0.1073741888
Interface type: Dynamic
Dynamic Profile Name: DS-dyn-ipv4v6-ra
MAC Address: 00:00:64:01:06:02
State: Active
Radius Accounting ID: 155
Session ID: 155
Login Time: 2011-01-30 20:36:53 PST
Service Sessions: 2

Service Session ID: 174
Service Session Name: l3-v4-service
State: Active
IPv4 Input Filter Name: upstrm-filter-ge-1/0/0.1104-in
IPv4 Output Filter Name: dwnstrm-filter-ge-1/0/0.1104-out

Service Session ID: 175
Service Session Name: l3-v6-service
State: Active
IPv6 Input Filter Name: v6-up-filter-ge-1/0/0.1104-in
IPv6 Output Filter Name: v6-dn-filter-ge-1/0/0.1104-out

```

Meaning The highlighted output includes details about a subscriber's service sessions.

Monitoring PPP Options Negotiated with the Remote Peer

Purpose Display the PPP options that were negotiated with the CPE. You can also view the IPv4 address that was negotiated with the remote peer. This address matches the address returned from AAA. You can also see this address by using the **show subscribers** command.

Note that this is the only command that will provide the details about the negotiated interface IDs.

Action `user@host> show ppp interface pp0.1073741888 extensive`

```

Session pp0.1073741888, Type: PPP, Phase: Network
LCP
  State: Opened
  Last started: 2011-01-30 20:36:53 PST
  Last completed: 2011-01-30 20:36:53 PST
  Negotiated options:
    Authentication protocol: pap, Magic number: 1174596353, MRU: 1492
Authentication: PAP
  State: Grant
  Last started: 2011-01-30 20:36:53 PST
  Last completed: 2011-01-30 20:36:53 PST
IPCP
  State: Opened
  Last started: 2011-01-30 20:36:54 PST
  Last completed: 2011-01-30 20:36:54 PST
  Negotiated options:
    Local address: 77.1.1.1, Remote address: 99.11.12.140
IPV6CP
  State: Opened
  Last started: 2011-01-30 20:36:54 PST
  Last completed: 2011-01-30 20:36:54 PST
  Negotiated options:
    Local interface identifier: 2a0:a50f:fc61:6d0,
    Remote interface identifier: 200:64ff:fe01:602

```

Monitoring the RADIUS Attribute Used for ND/RA

Purpose Display the RADIUS attribute used for IPv6 ND/RA.

Action To display the RADIUS attribute used for IPv6 Neighbor Discovery router advertisements:

```

host1#show aaa ipv6-nd-ra-prefix

IPv6 ND RA Prefix      : IPv6-NdRa-Prefix (Juniper VSA)

```

Monitoring Address Bindings on the DHCPv6 Local Server

Purpose Display address bindings in the client table on the DHCPv6 local server.

Action To display address bindings in the client table on the DHCPv6 local server:

```

user@host>show dhcpv6 server binding detail
user@host> show dhcpv6 server binding detail
Session Id: 6
  Client IPv6 Prefix:          2001:bd8:1111:2222::/64
  Client DUID:                LL_TIME0x1-0x2e159c0-00:10:94:00:00:01

```

```

    State:
BOUND(LOCAL_SERVER_STATE_BOUND_ON_INTF_DELETE)
    Lease Expires:                2009-07-21 10:41:15 PDT
    Lease Expires in:             86308 seconds
    Lease Start:                  2009-07-20 10:41:15 PDT
    Incoming Client Interface:    ge-1/0/0.0
    Server Ip Address:            0.0.0.0
    Server Interface:             none
    Client Id Length:             14
    Client Id:
/0x00010001/0x02e159c0/0x00109400/0x0001

Session Id: 7
    Client IPv6 Prefix:           2001:bd8:1111:2222::/64
    Client DUID:                  LL_TIME0x1-0x2e159c0-00:10:94:00:00:02

    State:
BOUND(LOCAL_SERVER_STATE_BOUND_ON_INTF_DELETE)
    Lease Expires:                2009-07-21 10:41:15 PDT
    Lease Expires in:             86308 seconds
    Lease Start:                  2009-07-20 10:41:15 PDT
    Incoming Client Interface:    ge-1/0/0.0
    Server Ip Address:            0.0.0.0
    Server Interface:             none
    Client Id Length:             14
    Client Id:
/0x00010001/0x02e159c0/0x00109400/0x0002

```

PART 5

Examples: IPv4 and IPv6 Dual-Stack Designs

- [Example: Dual-Stack Design That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE on page 79](#)
- [Example: Dual-Stack Design That Uses ND/RA and DHCPv6 Prefix Delegation over PPPoE on page 103](#)
- [Example: Dual-Stack Design That Uses ND/RA over PPPoE on page 123](#)

CHAPTER 16

Example: Dual-Stack Design That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE

- [Example: Configuring a Dual Stack That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE on page 79](#)

Example: Configuring a Dual Stack That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE

- [Requirements on page 79](#)
- [Overview on page 79](#)
- [Configuration on page 81](#)
- [Verification on page 97](#)

Requirements

This example uses the following hardware and software components:

- MX Series 3D Universal Edge Router
- Junos OS Release 11.4 or later

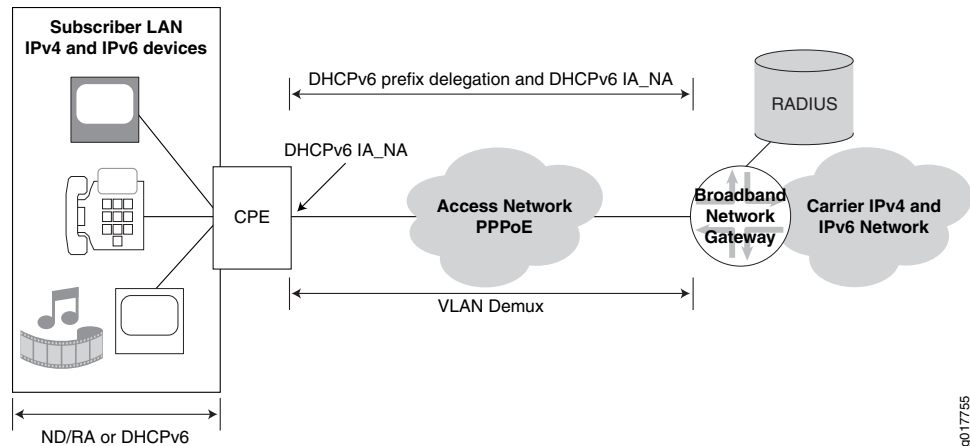
Overview

This design uses DHCPv6 IA_NA and DHCPv6 prefix delegation in your subscriber access network as follows:

- The access network is PPPoE.
- DHCPv6 IA_NA is used to assign a global IPv6 address on the WAN link. The address comes from a local pool that is specified using AAA RADIUS.
- DHCPv6 prefix delegation is used for subscriber LAN addressing. It uses a delegated prefix from a local pool that is specified by AAA RADIUS.
- DHCPv4 is used for subscriber LAN addressing.
- DHCPv6 subscriber sessions are layered over an underlying PPPoE subscriber session.

Topology

Figure 14: PPPoE Subscriber Access Network with DHCPv6 IA_NA and DHCPv6 Prefix Delegation



9017755

Table 6 on page 80 describes the configuration components used in this example.

Table 6: Configuration Components Used in Dual Stack with DHCPv6 IA_NA and DHCPv6 Prefix Delegation

Configuration Component	Component Name	Purpose
Dynamic profile	pppoe-subscriber-profile	Profile that creates a PPPoE logical interface when the subscriber logs in.
Interfaces	ge-0/2/5	Interface used for communication with the RADIUS server.
	ge-0/3/0	Underlying Ethernet interface.
	demux0	VLAN demux interface that runs over the underlying Ethernet interface.
	lo0	Loopback interface for use in the access network. The loopback interface is automatically used for unnumbered interfaces.
Address-assignment pools	pool v4-pool	Pool that provides IPv4 addresses for the subscriber LAN.
	pool v6-ia-na-pool	Pool that provides a global IPv6 address to the CPE WAN link.
	pool v6-pd-pool	Pool that provides a pool of prefixes that are delegated to the CPE and used for assigning IPv6 global addresses on the subscriber LAN.

Configuration

- [Configuring a DHCPv6 Local Server for DHCPv6 over PPPoE on page 84](#)
- [Configuring a Dynamic Profile for the PPPoE Logical Interface on page 85](#)
- [Configuring a Loopback Interface on page 87](#)
- [Configuring a VLAN Demux Interface over an Ethernet Underlying Interface on page 89](#)
- [Configuring an Interface for Communication with RADIUS Server on page 91](#)
- [Specifying the BNG IP Address on page 91](#)
- [Configuring RADIUS Server Access on page 92](#)
- [Configuring RADIUS Server Access Profile on page 93](#)
- [Configuring Local Address-Assignment Pools on page 94](#)

CLI Quick Configuration

The following is the complete configuration for this example:

```
dynamic-profiles {
  pppoe-subscriber-profile {
    routing-instances {
      "$junos-routing-instance" {
        interface "$junos-interface-name";
      }
    }
  }
  interfaces {
    pp0 {
      unit "$junos-interface-unit" {
        ppp-options {
          chap;
          pap;
        }
        pppoe-options {
          underlying-interface "$junos-underlying-interface";
          server;
        }
        keepalives interval 30;
        family inet {
          unnumbered-address "$junos-loopback-interface";
        }
        family inet6 {
          unnumbered-address "$junos-loopback-interface";
        }
      }
    }
  }
}

system {
  services {
    dhcp-local-server {
      dhcpv6 {
        group v6-ppp-subscriber {
          interface pp0.0;
        }
      }
    }
  }
}
```

```
    }
  }
}
interfaces {
  ge-0/2/5 {
    gigether-options {
      no-auto-negotiation;
    }
    unit 0 {
      family inet {
        address 10.9.0.9/32;
      }
    }
  }
  ge-0/3/0 {
    hierarchical-scheduler maximum-hierarchy-levels 2;
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 1;
  }
  demux0 {
    unit 1 {
      proxy-arp;
      vlan-tags outer 1 inner 1;
      demux-options {
        underlying-interface ge-0/3/0;
      }
      family pppoe {
        duplicate-protection;
        dynamic-profile pppoe-subscriber-profile;
      }
    }
  }
  lo0 {
    unit 0 {
      family inet {
        address 10.0.0.1/32 {
          primary;
          preferred;
        }
      }
      family inet6 {
        address 2001:0::1/128 {
          primary;
          preferred;
        }
      }
    }
  }
}
routing-options {
  router-id 10.0.0.0;
}
access {
  radius-server {
```



```
10.9.0.9 {
    secret "$9$lXrv87GUHm5FYgF/CA1l"; ## SECRET-DATA
    timeout 45;
    retry 4;
    source-address 10.0.0.1;
}
}
profile Access-Profile {
    authentication-order radius;
    radius {
        authentication-server 10.9.0.9;
        accounting-server 10.9.0.9;
    }
    accounting {
        order [ radius none ];
        update-interval 120;
        statistics volume-time;
    }
}
address-assignment {
    pool v4-pool {
        family inet {
            network 10.16.0.1/32;
            range v4-range-0 {
                low 10.16.0.1;
                high 10.31.255.255;
            }
            dhcp-attributes {
                maximum-lease-time 99999;
            }
        }
    }
    pool v6-ia-na-pool {
        family inet6 {
            prefix 1000:0000::/64;
            range v6-range-0 {
                low 1000::1/128;
                high 1000::ffff:ffff/128;
            }
        }
    }
    pool v6-pd-pool {
        family inet6 {
            prefix 2012::/48;
            range v6-pd prefix-length 64;
        }
    }
}
address-protection;
}
```

Configuring a DHCPv6 Local Server for DHCPv6 over PPPoE

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit system services dhcp-local-server dhcpv6
edit group v6-ppp-subscriber
set interface pp0.0
```

Step-by-Step Procedure To layer DHCPv6 above the PPPoE IPv6 family (inet6), associate DHCPv6 with the PPPoE interfaces by adding the PPPoE interfaces to the DHCPv6 local server configuration. Because this example uses a dynamic PPPoE interface, we are using the pp0.0 (PPPoE) logical interface as a wildcard to indicate that a DHCPv6 binding can be made on top of a PPPoE interface.

To configure a DHCPv6 local server:

1. Access the DHCPv6 local server configuration.

```
[edit]
user@host# edit system services dhcp-local-server dhcpv6
```

2. Create a group for dynamic PPPoE interfaces and assign a name.

The group feature groups a set of interfaces and then applies a common DHCP configuration to the named interface group.

```
[edit system services dhcp-local-server dhcpv6]
user@host# edit group v6-ppp-subscriber
```

3. Add an interface for dynamic PPPoE logical interfaces.

```
[edit system services dhcp-local-server dhcpv6 group v6-ppp-subscriber]
user@host# set interface pp0.0
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit]
user@host# show
system {
  services {
    dhcp-local-server {
      dhcpv6 {
        group v6-ppp-subscriber {
          interface pp0.0;
        }
      }
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring a Dynamic Profile for the PPPoE Logical Interface

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit dynamic-profiles pppoe-subscriber-profile
edit routing-instances $junos-routing-instance
set interface $junos-interface-name
exit
edit interfaces pp0 unit $junos-interface-unit
set family inet unnumbered-address "$junos-loopback-interface"
set family inet6 unnumbered-address "$junos-loopback-interface"
set pppoe-options underlying-interface "$junos-underlying-interface"
set pppoe-options server
set ppp-options pap
set ppp-options chap
set keepalives interval 30
```

Step-by-Step Procedure Create a dynamic profile for the PPPoE logical interface. This dynamic profile supports both IPv4 and IPv6 sessions on the same logical interface.

To configure the dynamic profile:

1. Create and name the dynamic profile.

```
[edit]
user@host# edit dynamic-profiles pppoe-subscriber-profile
```

2. Add a routing instance to the profile.

```
[edit dynamic-profiles pppoe-subscriber-profile]
user@host# edit routing-instances $junos-routing-instance
user@host# set interface $junos-interface-name
```

3. Configure a PPPoE logical interface (pp0) that is used to create logical PPPoE interfaces for the IPv4 and IPv6 subscribers.

```
[edit dynamic-profiles pppoe-subscriber-profile]
user@host# edit interfaces pp0
```

4. Specify **\$junos-interface-unit** as the predefined variable to represent the logical unit number for the **pp0** interface. The variable is dynamically replaced with the actual unit number supplied by the network when the subscriber logs in.

```
[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0]
user@host# edit unit $junos-interface-unit
```

5. Specify **\$junos-underlying-interface** as the predefined variable to represent the name of the underlying Ethernet interface on which the router creates the dynamic PPPoE logical interface. The variable is dynamically replaced with the actual name of the underlying interface, which is supplied by the network when the subscriber logs in.

```
[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
"$junos-interface-unit"]
```

```
user@host# set pppoe-options underlying-interface $junos-underlying-interface
```

6. Configure the router to act as a PPPoE server when a PPPoE logical interface is dynamically created.

```
[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
 "$junos-interface-unit"]
```

```
user@host# set pppoe-options server
```

7. Configure the IPv4 family for the pp0 interface. Specify the unnumbered address to dynamically create loopback interfaces. Because the example uses routing instances, assign the predefined variable **\$junos-loopback-interface**.

```
[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
 "$junos-interface-unit"]
```

```
user@host# set family inet unnumbered-address $junos-loopback-interface
```

8. Configure the IPv6 family for the pp0 interface. Specify the unnumbered address to dynamically create loopback interfaces. Because the example uses routing instances without router advertisement, assign the predefined variable **\$junos-loopback-interface**.

```
[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
 "$junos-interface-unit"]
```

```
user@host# set family inet6 unnumbered-address $junos-loopback-interface
```

9. Configure one or more PPP authentication protocols for the pp0 interface.

```
[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
 "$junos-interface-unit"]
```

```
user@host# set ppp-options chap
```

```
user@host# set ppp-options pap
```

10. Enable keepalives and set an interval for keepalives. We recommend an interval of 30 seconds.

```
[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
 "$junos-interface-unit"]
```

```
user@host# set keepalives interval 30
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit dynamic-profiles pppoe-subscriber-profile]
```

```
user@host# show
```

```
routing-instances {
```

```
  "$junos-routing-instance" {
    interface "$junos-interface-name";
  }
```

```
}
```

```
interfaces {
```

```
  pp0 {
```

```
    unit "$junos-interface-unit" {
```

```
      ppp-options {
```

```
        chap;
```

```
        pap;
```

```
      }
```

```
      pppoe-options {
```

```
        underlying-interface "$junos-underlying-interface";
```

```

        server;
    }
    keepalives interval 30;
    family inet {
        unnumbered-address "$junos-loopback-interface";
    }
    family inet6 {
        unnumbered-address "$junos-loopback-interface";
    }
}
}
}

```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring a Loopback Interface

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```

edit interfaces lo0
set unit 0 family inet address 10.0.0.1/32 primary
set unit 0 family inet address 10.0.0.1/32 preferred
set unit 0 family inet6 address 2001:0::1/128 primary
set unit 0 family inet6 address 2001:0::1/128 preferred

```

Step-by-Step Procedure

To configure a loopback interface:

1. Create the loopback interface and specify a unit number.

```
[edit]
user@host# edit interfaces lo0 unit 0
```
2. Configure the interface for IPv4.

```
[edit interfaces lo0 unit 0]
user@host# set family inet address 10.0.0.1/32 primary preferred
```
3. Configure the interface for IPv6.

```
[edit interfaces lo0 unit 0]
user@host# set family inet6 address 2001:0::1/128 primary preferred
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```

[edit interfaces lo0]
user@host# show
unit 0 {
    family inet {
        address 10.0.0.1/32 {
            primary;
            preferred;
        }
    }
    family inet6 {

```

```
    address 2001:0::1/128 {  
        primary;  
        preferred;  
    }  
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring a VLAN Demux Interface over an Ethernet Underlying Interface

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit interfaces
set ge-0/3/0 hierarchical-scheduler maximum-hierarchy-levels 2
set ge-0/3/0 flexible-vlan-tagging
set ge-0/3/0 encapsulation flexible-ethernet-services
exit
edit interfaces demux0 unit 1
set vlan-tags outer 1
set vlan-tags inner 1
set demux-options underlying-interface ge-0/3/0
set family pppoe dynamic-profile pppoe-subscriber-profile
set family pppoe duplicate-protection
set proxy-arp
```

Step-by-Step Procedure To configure a VLAN demux interface over an Ethernet underlying interface:

1. Configure the underlying Ethernet interface.

```
[edit]
user@host# edit interfaces ge-0/3/0
user@host# set flexible-vlan-tagging
user@host# set encapsulation flexible-ethernet-services
user@host# set hierarchical-scheduler maximum-hierarchy-levels 2
```
2. Create the VLAN demux interface, and specify a unit number.

```
[edit]
user@host# edit interfaces demux0 unit 1
```
3. Configure the VLAN tags.

```
[edit interfaces demux0 unit 1]
user@host# set vlan-tags outer 1 inner 1
```
4. Specify the underlying Ethernet interface.

```
[edit interfaces demux0 unit 1]
user@host# set demux-options underlying-interface ge-0/3/0
```
5. Specify the dynamic profile.

```
[edit interfaces demux0 unit 1]
user@host# set family pppoe dynamic-profile pppoe-subscriber-profile
```
6. Prevent multiple PPPoE sessions from being created for the same PPPoE subscriber on the same VLAN interface.

```
[edit interfaces demux0 unit 1]
user@host# set family pppoe duplicate-protection
```
7. (Optional) Specify that you want the demux interface to use proxy ARP.

```
[edit interfaces demux0 unit 1]
```

```
user@host# set proxy-arp
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit interfaces]
user@host# show
ge-0/3/0 {
  hierarchical-scheduler maximum-hierarchy-levels 2;
  flexible-vlan-tagging;
  encapsulation flexible-ethernet-services;
}
demux0 {
  unit 1 {
    proxy-arp;
    vlan-tags outer 1 inner 1;
    demux-options {
      underlying-interface ge-0/3/0;
    }
    family pppoe {
      duplicate-protection;
      dynamic-profile pppoe-subscriber-profile;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring an Interface for Communication with RADIUS Server

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit interfaces ge-0/2/5
set unit 0 family inet address 10.9.0.9
set gigether-options no-auto-negotiation
```

Step-by-Step Procedure To configure the interface:

1. Create the interface, specify a unit number, and configure the address.

```
[edit]
user@host# edit interfaces ge-0/2/5
```
2. Configure the interface for IPv4 and specify the address.

```
[edit interfaces ge-0/2/5]
user@host# set unit 0 family inet address 10.9.0.9
```
3. Specify that Gigabit Ethernet options are not automatically negotiated.

```
[edit interfaces ge-0/2/5]
user@host# set gigether-options no-auto-negotiation
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit interfaces ge-0/2/5]
user@host# show
gigether-options {
  no-auto-negotiation;
}
unit 0 {
  family inet {
    address 10.9.0.9/32;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Specifying the BNG IP Address

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit routing-options
set router-id 10.0.0.0
```



BEST PRACTICE: We strongly recommend that you configure the BNG IP address, thereby avoiding unpredictable behavior if the interface address on a loopback interface changes.

Step-by-Step Procedure

To configure the IP address of the BNG:

1. Access the routing-options configuration.

```
[edit]
user@host# edit routing-options
```

2. Specify the IP address of the BNG.

```
[edit routing-options]
user@host# set router-id 10.0.0.0
```

Results

From configuration mode, confirm your configuration by entering the **show** command.

```
[edit routing-options]
user@host# show
router-id 10.0.0.0;
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring RADIUS Server Access

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access radius-server 10.9.0.9
set secret "$9$IXRv87GUHm5FYgF/CA1I"
set timeout 45
set retry 4
set source-address 10.0.0.1
```

Step-by-Step Procedure

To configure RADIUS servers:

1. Create a RADIUS server configuration, and specify the address of the server.

```
[edit]
user@host# edit access radius-server 10.9.0.9
```

2. Configure the required secret (password) for the server. Secrets enclosed in quotation marks can contain spaces.

```
[edit access radius-server 10.9.0.9]
user@host# set secret "$9$IXRv87GUHm5FYgF/CA1I"
```

3. Configure the source address that the BNG uses when it sends RADIUS requests to the RADIUS server.

```
[edit access radius-server 10.9.0.9]
```

```
user@host# set source address 10.0.0.1
```

4. (Optional) Configure the number of times that the router attempts to contact a RADIUS accounting server. You can configure the router to retry from 1 through 16 times. The default setting is 3 retry attempts.

```
[edit access radius-server 10.9.0.9]
```

```
user@host# set retry 4
```

5. (Optional) Configure the length of time that the local router or switch waits to receive a response from a RADIUS server. By default, the router or switch waits 3 seconds. You can configure the timeout to be from 1 through 90 seconds.

```
[edit access radius-server 10.9.0.9]
```

```
user@host# set timeout 45
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]
user@host# show
radius-server {
  10.9.0.9 {
    secret "$9$IXRv87GUHm5FYgF/CA1l"; ## SECRET-DATA
    timeout 45;
    retry 4;
    source-address 10.0.0.1;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring RADIUS Server Access Profile

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access profile Access-Profile
set authentication-order radius
set radius authentication-server 10.9.0.9
set radius accounting-server 10.9.0.9
set accounting order radius
set accounting order none
set accounting update-interval 120
set accounting statistics volume-time
```

Step-by-Step Procedure To configure a RADIUS server access profile:

1. Create a RADIUS server access profile.


```
[edit]
user@host# edit access profile Access-Profile
```
2. Specify the order in which authentication methods are used.


```
[edit access profile Access-Profile]
```

```
user@host# set authentication-order radius
```

3. Specify the address of the RADIUS server used for authentication and the server used for accounting.

```
[edit access profile Access-Profile]
user@host# set radius authentication-server 10.9.0.9
user@host# set radius accounting-server 10.9.0.9
```

4. Configure RADIUS accounting values for the access profile.

```
[edit access profile Access-Profile]
user@host# set accounting order [ radius none ]
user@host# set accounting update-interval 120
user@host# set accounting statistics volume-time
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]
user@host# show
profile Access-Profile {
  authentication-order radius;
  radius {
    authentication-server 10.9.0.9;
    accounting-server 10.9.0.9;
  }
  accounting {
    order [ radius none ];
    update-interval 120;
    statistics volume-time;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring Local Address-Assignment Pools

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access address-assignment
set pool v4-pool family inet network 10.16.0.1/32
set pool v4-pool family inet range v4-range-0 low 10.16.0.1
set pool v4-pool family inet range v4-range-0 high 10.31.255.255
set pool v4-pool family inet dhcp-attributes maximum-lease-time 99999
set pool v6-ia-na-pool family inet6 prefix 1000:0000::/64
set pool v6-ia-na-pool family inet6 range v6-range-0 low 1000::1/128
set pool v6-ia-na-pool family inet6 range v6-range-0 high 1000::ffff:ffff/128
set pool v6-pd-pool family inet6 prefix 2012::/48
set pool v6-pd-pool family inet6 range v6-pd prefix-length 64
```

Step-by-Step Procedure Configure three address-assignment pools for DHCPv4, DHCPv6 IA_NA, and DHCPv6 prefix delegation.

To configure the address-assignment pools:

1. Configure the address-assignment pool for DHCPv4.

```
[edit]
user@host# edit access address-assignment pool v4-pool
user@host# edit family inet
user@host# set network 10.16.0.1
user@host# set range v4-range-0 low 10.16.0.1
user@host# set range v4-range-0 high 10.31.255.255
user@host# set dhcp-attributes maximum-lease-time 99999
```

2. Configure the address-assignment pool for DHCPv6 IA_NA.

```
[edit]
user@host# edit access address-assignment pool v6-ia-na-pool
user@host# edit family inet6
user@host# set prefix 1000:0000::/64
user@host# set range v6-range-0 low 1000::1/128
user@host# set range v6-range-0 high 1000::ffff:ffff/128
```

3. Configure the address-assignment pool for DHCPv6 prefix delegation.

```
[edit]
user@host# edit access address-assignment pool v6-pd-pool
user@host# edit family inet6
user@host# set prefix 2012::/48
user@host# set range v6-pd prefix-length 64
```

4. (Optional) Enable duplicate prefix protection.

```
[edit access]
user@host# set address-protection
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]
user@host# show
address-assignment {
  pool v4-pool {
    family inet {
      network 10.16.0.1/32;
      range v4-range-0 {
        low 10.16.0.1;
        high 10.31.255.255;
      }
      dhcp-attributes {
        maximum-lease-time 99999;
      }
    }
  }
  pool v6-ia-na-pool {
    family inet6 {
      prefix 1000:0000::/64;
      range v6-range-0 {
```

```
        low 1000::1/128;
        high 1000::ffff:ffff/128;
    }
}
pool v6-pd-pool {
    family inet6 {
        prefix 2012::/48;
        range v6-pd prefix-length 64;
    }
}
address-protection;
```

If you are done configuring the device, enter **commit** from configuration mode.

Verification

Confirm that the configuration is working properly.

- [Verifying Active Subscriber Sessions on page 97](#)
- [Verifying Both IPv4 and IPv6 Address in Correct Routing Instance on page 97](#)
- [Verifying Dynamic Subscriber Sessions on page 98](#)
- [Verifying DHCPv6 Address Pools Used for DHCPv6 Prefix Delegation on page 99](#)
- [Verifying DHCPv6 Address Bindings on page 100](#)
- [Verifying PPP Options Negotiated with the Remote Peer on page 101](#)

Verifying Active Subscriber Sessions

Purpose Verify active subscriber sessions.

Action From operational mode, enter the **show subscribers summary** command.

```
user@host>show subscribers summary
Subscribers by State
  Active: 2
  Total: 2
```

```
Subscribers by Client Type
  DHCP: 1
  PPPoE: 1
  Total: 2
```

Meaning The fields under **Subscribers by State** show the number of active subscribers.

The fields under **Subscribers by Client Type** show the number of active DHCP and PPPoE subscriber sessions.

Verifying Both IPv4 and IPv6 Address in Correct Routing Instance

Purpose Verify that the subscriber has both an IPv4 and an IPv6 address and is placed in the correct routing instance.

Action From operational mode, enter the **show subscribers** command.

```
user@host>show subscribers
Interface          IP Address/VLAN ID    User Name           LS:RI
pp0.1073741825     10.16.0.2             SBRSTATICUSER       default:default
pp0.1073741825     1000::1               SBRSTATICUSER       default:default
```

Meaning The **Interface** field shows that two subscriber sessions are running on the same interface. The **IP Address** field shows that one session is assigned an IPv4 address, and the second session is assigned an IPv6 address by DHCPv6 IA_NA.

The **LS:RI** field shows that the subscriber is placed in the correct routing instance and that traffic can be sent and received.

Verifying Dynamic Subscriber Sessions

Purpose Verify dynamic PPPoE and DHCPv6 subscriber sessions. In this sample configuration, the DHCPv6 subscriber session should be layered over the underlying PPPoE subscriber session.

Action From operational mode, enter the **show subscribers detail** command.

```
user@host>show subscribers detail
Type: PPPoE
User Name: SBRSTATICUSER
IP Address: 10.16.0.2
IP Netmask: 255.0.0.0
Logical System: default
Routing Instance: default
Interface: pp0.1073741825
Interface type: Dynamic
Dynamic Profile Name: pppoe-subscriber-profile
MAC Address: 00:01:02:00:00:01
State: Active
Radius Accounting ID: 2
Session ID: 2
Login Time: 2011-12-08 09:11:41 PST

Type: DHCP
IPv6 Address: 1000::1
Logical System: default
Routing Instance: default
Interface: pp0.1073741825
Interface type: Static
MAC Address: 00:01:02:00:00:01
State: Active
Radius Accounting ID: 3
Session ID: 3
Underlying Session ID: 2
Login Time: 2011-12-08 09:12:11 PST
DHCP Options: len 42
00 08 00 02 0b b8 00 01 00 0a 00 03 00 01 00 01 02 00 00 01
00 06 00 02 00 03 00 03 00 0c 00 00 00 00 00 00 00 00 00 00
00 00
```

Meaning When a subscriber has logged in and started both an IPv4 and an IPv6 session, the output shows the active underlying PPPoE session and the active DHCPv6 session.

The **Session ID** field for the PPPoE session is 2. The **Underlying Session ID** for the DHCP session is 2, which shows that the PPPoE session is the underlying session.

Verifying DHCPv6 Address Pools Used for DHCPv6 Prefix Delegation

Purpose Verify the delegated address pool used for DHCPv6 prefix delegation and the length of the IPv6 prefix that was delegated to the CPE.

Action From operational mode, enter the **show subscribers extensive** command.

```
user@host>show subscribers extensive
Type: PPPoE
User Name: SBRSTATICUSER
IP Address: 10.16.0.2
IP Netmask: 255.0.0.0
Logical System: default
Routing Instance: default
Interface: pp0.1073741825
Interface type: Dynamic
Dynamic Profile Name: pppoe-subscriber-profile
MAC Address: 00:01:02:00:00:01
State: Active
Radius Accounting ID: 2
Session ID: 2
Login Time: 2011-12-08 09:11:41 PST
IPv6 Delegated Address Pool: v6-na-pool

Type: DHCP
IPv6 Address: 1000::1
Logical System: default
Routing Instance: default
Interface: pp0.1073741825
Interface type: Static
MAC Address: 00:01:02:00:00:01
State: Active
Radius Accounting ID: 3
Session ID: 3
Underlying Session ID: 2
Login Time: 2011-12-08 09:12:11 PST
DHCP Options: len 42
00 08 00 02 0b b8 00 01 00 0a 00 03 00 01 00 01 02 00 00 01
00 06 00 02 00 03 00 03 00 0c 00 00 00 00 00 00 00 00 00 00
00 00
IPv6 Delegated Address Pool: v6-na-pool
IPv6 Delegated Network Prefix Length: 64
```

Meaning The **IPv6 Delegated Address Pool** field shows the name of the pool that DHCPv6 used to assign the IPv6 address for this subscriber session.

Verifying DHCPv6 Address Bindings

Purpose Display the address bindings in the client table on the DHCPv6 local server.

Action From operational mode, enter the **show dhcpv6 server binding detail** command.

```
user@host>show dhcpv6 server binding detail
Session Id:  580547
  Client IPv6 Address:      1000::4/128
    Client DUID:              LL0x1-00:01:02:00:00:01
    State:                    BOUND(DHCPV6_LOCAL_SERVER_STATE_BOUND)

    Lease Expires:           2012-01-05 07:06:04 PST
    Lease Expires in:        82943 seconds
    Lease Start:             2012-01-04 07:06:04 PST
    Last Packet Received:    2012-01-04 07:06:04 PST
    Incoming Client Interface: pp0.1073926645
    Server Ip Address:        0.0.0.0
    Client Pool Name:         v6-na-pool-0
    Client Id Length:         10
    Client Id:                /0x00030001/0x00010200/0x0001
```

Meaning The **Client IPv6 Address** field shows the /128 address that was assigned to the CPE WAN link using DHCPv6 IA_NA.

The **Client Pool Name** field shows the name of the address pool that was used to assign the **Client IPv6 Address**.

Verifying PPP Options Negotiated with the Remote Peer

Purpose Verify PPP options negotiated with the remote peer.

Action From operational mode, enter the **show ppp interface *interface* extensive** command.

```
user@host>show ppp interface pp0.1073741825 extensive
  Session pp0.1073926645, Type: PPP, Phase: Network
    LCP
      State: Opened
      Last started: 2012-01-04 07:05:33 PST
      Last completed: 2012-01-04 07:05:33 PST
      Negotiated options:
        Authentication protocol: pap, Magic number: 191301485, Local MRU: 1492,
        Peer MRU: 65531
    Authentication: PAP
      State: Grant
      Last started: 2012-01-04 07:05:33 PST
      Last completed: 2012-01-04 07:05:33 PST
    IPCP
      State: Opened
      Last started: 2012-01-04 07:05:34 PST
      Last completed: 2012-01-04 07:05:34 PST
      Negotiated options:
        Local address: 10.0.0.1, Remote address: 10.16.0.2
    IPV6CP
      State: Opened
      Last started: 2012-01-04 07:05:34 PST
      Last completed: 2012-01-04 07:05:34 PST
      Negotiated options:
        Local interface identifier: 2a0:a50f:fc71:e049,
        Remote interface identifier: 201:2ff:fe00:1
```

Meaning The output shows the PPP options that were negotiated with the remote peer.

Under IPCP, the **Negotiated options** field shows the IPv4 local and remote addresses that were negotiated by IPCP.

Under IPV6CP, the **Negotiated options** field shows the IPv6 local and remote interface identifiers that were negotiated by IPV6CP.

CHAPTER 17

Example: Dual-Stack Design That Uses ND/RA and DHCPv6 Prefix Delegation over PPPoE

- [Example: Configuring a Dual Stack That Uses ND/RA and DHCPv6 Prefix Delegation over PPPoE on page 103](#)

Example: Configuring a Dual Stack That Uses ND/RA and DHCPv6 Prefix Delegation over PPPoE

- [Requirements on page 103](#)
- [Overview on page 103](#)
- [Configuration on page 105](#)
- [Verification on page 118](#)

Requirements

This example uses the following hardware and software components:

- MX Series 3D Universal Edge Router
- Junos OS Release 11.4 or later

Overview

This design uses ND/RA and DHCPv6 prefix delegation in your subscriber access network as follows:

- The access network is PPPoE.
- ND/RA is used to assign a global IPv6 address on the WAN link. The prefixes used in router advertisements come from a local pool that is specified using AAA RADIUS.
- DHCPv6 prefix delegation is used for subscriber LAN addressing. It uses a delegated prefix from a local pool that is specified using AAA RADIUS.
- DHCPv4 is used for subscriber LAN addressing.
- DHCPv6 subscriber sessions are layered over an underlying PPPoE subscriber session.

Topology

Figure 15: PPPoE Subscriber Access Network with ND/RA and DHCPv6 Prefix Delegation

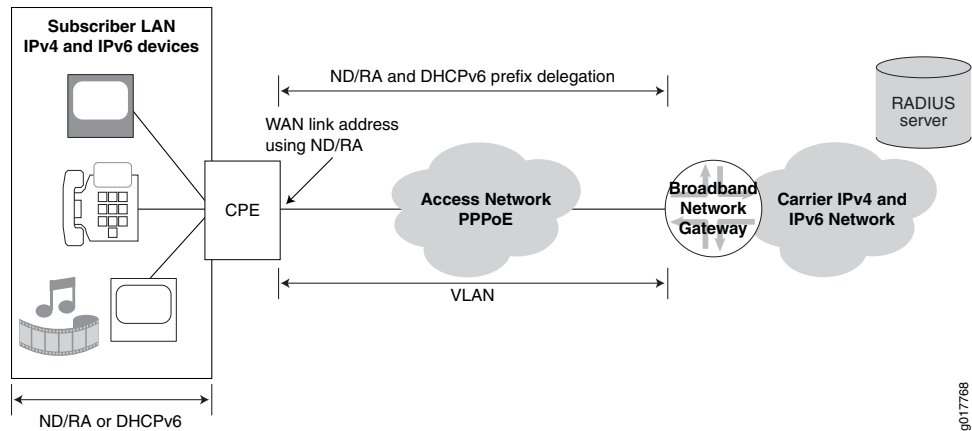


Table 7 on page 104 describes the configuration components used in this example.

Table 7: Configuration Components Used in Dual Stack with ND/RA and DHCPv6 Prefix Delegation

Configuration Component	Component Name	Purpose
Dynamic profiles	DS-dyn-ipv4v6-ndra	Profile that creates a PPPoE logical interface when the subscriber logs in.
Interfaces	ge-3/3/0	Underlying Ethernet interface.
	lo0	Loopback interface for use in the access network. The loopback interface is automatically used for unnumbered interfaces.
Address-assignment pools	default-ipv4-pool-2	Pool that provides IPv4 addresses for the subscriber LAN.
	ndra-2010	Pool that provides IPv6 prefixes used in router advertisements. These prefixes are used to create a global IPv6 address that is assigned to the CPE WAN link.
	dhcpv6-pd-pool	Pool that provides a pool of prefixes that are delegated to the CPE and are used for assigning IPv6 global addresses on the subscriber LAN.

Configuration

- [Configuring a DHCPv6 Local Server for DHCPv6 over PPPoE on page 107](#)
- [Configuring a Dynamic Profile for the PPPoE Logical Interface on page 108](#)
- [Configuring a Loopback Interface on page 111](#)
- [Configuring a Static Underlying Ethernet Interface for Dynamic PPPoE Subscriber Interfaces on page 111](#)
- [Specifying the BNG IP Address on page 113](#)
- [Configuring RADIUS Server Access on page 113](#)
- [Configuring RADIUS Server Access Profile on page 114](#)
- [Configuring Local Address-Assignment Pools on page 115](#)
- [Specifying the Address-Assignment Pool to Be Used for DHCPv6 Prefix Delegation on page 117](#)

CLI Quick Configuration

The following is the complete configuration for this example:

```
dynamic-profiles {
  DS-dyn-ipv4v6-ra {
    interfaces {
      pp0 {
        unit "$junos-interface-unit" {
          ppp-options {
            chap;
            pap;
          }
          pppoe-options {
            underlying-interface "$junos-underlying-interface";
            server;
          }
          keepalives interval 30;
          family inet {
            unnumbered-address lo0.0;
          }
          family inet6 {
            address $junos-ipv6-address;
          }
        }
      }
    }
  }
  protocols {
    router-advertisement {
      interface "$junos-interface-name" {
        prefix $junos-ipv6-ndra-prefix;
      }
    }
  }
}
system {
  services {
    dhcp-local-server {
```

```
    dhcpv6 {
      overrides {
        delegated-pool dhcpv6-pd-pool;
      }
      group DHCPv6-over-pppoe {
        interface pp0.0;
      }
    }
  }
}
interfaces {
  ge-3/3/0 {
    unit 1109 {
      description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd";
      encapsulation ppp-over-ether;
      vlan-id 1109;
      pppoe-underlying-options {
        duplicate-protection;
        dynamic-profile DS-dyn-ipv4v6-ra;
      }
    }
  }
  lo0 {
    description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd";
    unit 0 {
      family inet {
        address 77.1.1.1/32 {
          primary;
        }
      }
      family inet6 {
        address 2030:0:0:0::1/64 {
          primary;
        }
      }
    }
  }
}
routing-options {
  router-id 10.0.0.0;
}
access {
  radius-server {
    10.9.0.9 {
      secret "$9$IxRv87GUHm5FYgF/CA1I"; ## SECRET-DATA
      timeout 45;
      retry 4;
      source-address 10.0.0.1;
    }
  }
}
profile Access-Profile {
  authentication-order radius;
  radius {
    authentication-server 10.9.0.9;
    accounting-server 10.9.0.9;
  }
}
```



```

    }
    accounting {
        order [ radius none ];
        update-interval 120;
        statistics volume-time;
    }
}
address-assignment {
    pool default-ipv4-pool-2 {
        family inet {
            network 10.10.0.0/16;
            range r5 {
                low 10.10.0.1;
                high 10.10.250.250;
            }
        }
    }
}
pool dhcpv6-pd-pool {
    family inet6 {
        prefix 2040:2000:2000::/48;
        range r1 prefix-length 64;
    }
}
pool ndra-2010 {
    family inet6 {
        prefix 2010:0:0:0::/48;
        range L prefix-length 64;
    }
}
}
address-protection;
}

```

Configuring a DHCPv6 Local Server for DHCPv6 over PPPoE

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```

edit system services dhcp-local-server dhcpv6
edit group DHCPv6-over-pppoe
set interface pp0.0

```

Step-by-Step Procedure

To layer DHCPv6 above the PPPoE IPv6 family (inet6), associate DHCPv6 with the PPPoE interfaces by adding the PPPoE interfaces to the DHCPv6 local server configuration. Because this example uses a dynamic PPPoE interface, we are using the pp0.0 (PPPoE) logical interface as a wildcard to indicate that a DHCPv6 binding can be made on top of a PPPoE interface.

To configure a DHCPv6 local server:

1. Access the DHCPv6 local server configuration.

[edit]

```
user@host# edit system services dhcp-local-server dhcpv6
```

2. Create a group for dynamic PPPoE interfaces and assign a name.

The group feature groups a set of interfaces and then applies a common DHCP configuration to the named interface group.

```
[edit system services dhcp-local-server dhcpv6]
user@host# edit group DHCPv6-over-pppoe
```

3. Add an interface for dynamic PPPoE logical interfaces.

```
[edit system services dhcp-local-server dhcpv6 group DHCPv6-over-pppoe]
user@host# set interface pp0.0
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit]
user@host# show
system {
  services {
    dhcp-local-server {
      dhcpv6 {
        group DHCPv6-over-pppoe {
          interface pp0.0;
        }
      }
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring a Dynamic Profile for the PPPoE Logical Interface

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit dynamic-profiles DS-dyn-ipv4v6-ra
edit interfaces pp0 unit $junos-interface-unit
set family inet unnumbered-address lo0.0
set family inet6 address $junos-ipv6-address
set pppoe-options underlying-interface "$junos-underlying-interface"
set pppoe-options server
set ppp-options pap
set ppp-options chap
set keepalives interval 30
up 3
edit protocols router-advertisement
edit interface $junos-interface-name
set prefix $junos-ipv6-ndra-prefix
```

Step-by-Step Procedure Create a dynamic profile for the PPPoE logical interface. This dynamic profile supports both IPv4 and IPv6 sessions on the same logical interface.

To configure the dynamic profile:

1. Create and name the dynamic profile.

```
[edit]
user@host# edit dynamic-profiles DS-dyn-ipv4v6-ra
```

2. Configure a PPPoE logical interface (pp0) that is used to create logical PPPoE interfaces for the IPv4 and IPv6 subscribers.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra]
user@host# edit interfaces pp0
```

3. Specify `$junos-interface-unit` as the predefined variable to represent the logical unit number for the `pp0` interface. The variable is dynamically replaced with the actual unit number supplied by the network when the subscriber logs in.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0]
user@host# edit unit $junos-interface-unit
```

4. Specify `$junos-underlying-interface` as the predefined variable to represent the name of the underlying Ethernet interface on which the router creates the dynamic PPPoE logical interface. The variable is dynamically replaced with the actual name of the underlying interface supplied by the network when the subscriber logs in.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set pppoe-options underlying-interface $junos-underlying-interface
```

5. Configure the router to act as a PPPoE server when a PPPoE logical interface is dynamically created.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set pppoe-options server
```

6. Configure the IPv4 family for the pp0 interface. Specify the unnumbered address to dynamically create loopback interfaces.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set family inet unnumbered-address lo0.0
```

7. Configure the IPv6 family for the pp0 interface. Because the example uses router advertisement, assign the predefined variable `$junos-ipv6-address`.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set family inet6 unnumbered-address $junos-ipv6-address
```

8. Configure one or more PPP authentication protocols for the pp0 interface.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set ppp-options chap
user@host# set ppp-options pap
```

9. Enable keepalives and set an interval for keepalives. We recommend an interval of 30 seconds.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set keepalives interval 30
```

10. Access the router advertisement configuration.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra]  
user@host# edit protocols router-advertisement
```
11. Specify the interface on which the ND/RA configuration is applied.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra protocols router-advertisement]  
user@host# edit interface $junos-interface-name
```
12. Specify a prefix value contained in router advertisement messages sent to the CPE on interfaces created with this dynamic profile. If you specify the \$junos-ipv6-ndra-prefix predefined variable, the actual value is obtained from a local pool or through AAA.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra protocols router-advertisement interface  
"$junos-interface-name"]  
user@host# set prefix $junos-ipv6-ndra-prefix
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra]  
user@host# show  
interfaces {  
  pp0 {  
    unit "$junos-interface-unit" {  
      ppp-options {  
        chap;  
        pap;  
      }  
      pppoe-options {  
        underlying-interface "$junos-underlying-interface";  
        server;  
      }  
      keepalives interval 30;  
      family inet {  
        unnumbered-address lo0.0;  
      }  
      family inet6 {  
        address $junos-ipv6-address;  
      }  
    }  
  }  
}  
protocols {  
  router-advertisement {  
    interface "$junos-interface-name" {  
      prefix $junos-ipv6-ndra-prefix;  
    }  
  }  
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring a Loopback Interface

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit interfaces lo0 unit 0
set family inet address 77.1.1.1/32 primary
set family inet6 address 2030:0:0:0::1/64 primary
```

Step-by-Step Procedure To configure a loopback interface:

1. Create the loopback interface and specify a unit number.

```
[edit]
user@host# edit interfaces lo0 unit 0
```
2. Configure the interface for IPv4.

```
[edit interfaces lo0 unit 0]
user@host# set family inet address 77.1.1.1/32 primary
```
3. Configure the interface for IPv6.

```
[edit interfaces lo0 unit 0]
user@host# set family inet6 address 2030:0:0:0::1/64 primary
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit interfaces lo0]
user@host# show
unit 0 {
  family inet {
    address 77.1.1.1/32 {
      primary;
    }
  }
  family inet6 {
    address 2030:0:0:0::1/64 {
      primary;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring a Static Underlying Ethernet Interface for Dynamic PPPoE Subscriber Interfaces

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit interfaces ge-3/3/0 unit 1109
set description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd"
set encapsulation ppp-over-ether
set vlan-id 1109
set pppoe-underlying-options duplicate-protection
set pppoe-underlying-options dynamic-profile DS-dyn-ipv4v6-ra
```

**Step-by-Step
Procedure**

To configure the underlying Ethernet interface:

1. Specify the name and logical unit number of the static underlying Ethernet interface to which you want to attach the IPv4 and IPv6 dynamic profile.

```
[edit]
user@host# edit interfaces ge-3/3/0 unit 1109
```

2. Configure a description for the interface.

```
[edit interfaces ge-3/3/0 unit 1109]
user@host# set description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd"
```

3. Configure PPPoE encapsulation on the underlying interface.

```
[edit interfaces ge-3/3/0 unit 1109]
user@host# set encapsulation ppp-over-ether
```

4. Configure the VLAN ID.

```
[edit interfaces ge-3/3/0 unit 1109]
user@host# set vlan-id 1109
```

5. Attach the dynamic profile to the underlying interface.

```
[edit interfaces ge-3/3/0 unit 1109]
user@host# set pppoe-underlying-options dynamic-profile DS-dyn-ipv4v6-ra
```

6. (Optional) Prevent multiple PPPoE sessions from being created for the same PPPoE subscriber on the same VLAN interface.

```
[edit interfaces ge-3/3/0 unit 1109]
user@host# set pppoe-underlying-options duplicate-protection
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit interfaces]
user@host# show
ge-3/3/0 {
  unit 1109 {
    description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd";
    encapsulation ppp-over-ether;
    vlan-id 1109;
    pppoe-underlying-options {
      duplicate-protection;
      dynamic-profile DS-dyn-ipv4v6-ra;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Specifying the BNG IP Address

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit routing-options
set router-id 10.0.0.0
```



BEST PRACTICE: We strongly recommend that you configure the BNG IP address to avoid unpredictable behavior if the interface address on a loopback interface changes.

Step-by-Step Procedure To configure the IP address of the BNG:

1. Access the routing-options configuration.

```
[edit]
user@host# edit routing-options
```

2. Specify the IP address of the BNG.

```
[edit routing-options]
user@host# set router-id 10.0.0.0
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit routing-options]
user@host# show
router-id 10.0.0.0;
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring RADIUS Server Access

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access radius-server 10.9.0.9
set secret "$9$IXRv87GUHm5FYgF/CA1I"
set timeout 45
set retry 4
set source-address 10.0.0.1
```

Step-by-Step Procedure To configure RADIUS servers:

1. Create a RADIUS server configuration, and specify the address of the server.

```
[edit]
```

```
user@host# edit access radius-server 10.9.0.9
```

2. Configure the required secret (password) for the server. Secrets enclosed in quotation marks can contain spaces.

```
[edit access radius-server 10.9.0.9]  
user@host# set secret "$9$IXRv87GUHm5FYgF/CA1I"
```

3. Configure the source address that the BNG uses when it sends RADIUS requests to the RADIUS server.

```
[edit access radius-server 10.9.0.9]  
user@host# set source address 10.0.0.1
```

4. (Optional) Configure the number of times that the router attempts to contact a RADIUS accounting server. You can configure the router to retry from 1 through 16 times. The default setting is 3 retry attempts.

```
[edit access radius-server 10.9.0.9]  
user@host# set retry 4
```

5. (Optional) Configure the length of time that the local router or switch waits to receive a response from a RADIUS server. By default, the router or switch waits 3 seconds. You can configure the timeout to be from 1 through 90 seconds.

```
[edit access radius-server 10.9.0.9]  
user@host# set timeout 45
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]  
user@host# show  
radius-server {  
  10.9.0.9 {  
    secret "$9$IXRv87GUHm5FYgF/CA1I"; ## SECRET-DATA  
    timeout 45;  
    retry 4;  
    source-address 10.0.0.1;  
  }  
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring RADIUS Server Access Profile

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access profile Access-Profile  
set authentication-order radius  
set radius authentication-server 10.9.0.9  
set radius accounting-server 10.9.0.9  
set accounting order radius  
set accounting order none  
set accounting update-interval 120
```


set accounting statistics volume-time**Step-by-Step Procedure**

To configure a RADIUS server access profile:

1. Create a RADIUS server access profile.

```
[edit]
user@host# edit access profile Access-Profile
```
2. Specify the order in which authentication methods are used.

```
[edit access profile Access-Profile]
user@host# set authentication-order radius
```
3. Specify the address of the RADIUS server used for authentication and the server used for accounting.

```
[edit access profile Access-Profile]
user@host# set radius authentication-server 10.9.0.9
user@host# set radius accounting-server 10.9.0.9
```
4. Configure RADIUS accounting values for the access profile.

```
[edit access profile Access-Profile]
user@host# set accounting order [ radius none ]
user@host# set accounting update-interval 120
user@host# set accounting statistics volume-time
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]
user@host# show
profile Access-Profile {
  authentication-order radius;
  radius {
    authentication-server 10.9.0.9;
    accounting-server 10.9.0.9;
  }
  accounting {
    order [ radius none ];
    update-interval 120;
    statistics volume-time;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring Local Address-Assignment Pools

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access
set address-assignment pool default-ipv4-pool-2 family inet network 10.10.0.0/16
set address-assignment pool default-ipv4-pool-2 family inet range r5 low 10.10.0.1
```

```
set address-assignment pool default-ipv4-pool-2 family inet range r5 high 10.10.250.250
set address-assignment pool dhcpv6-pd-pool family inet6 prefix 2040:2000:2000::/48
set address-assignment pool dhcpv6-pd-pool family inet6 range r1 prefix-length 64
set address-assignment pool ndra-2010 family inet6 prefix 2010:0:0:0::/48
set address-assignment pool ndra-2010 family inet6 range L prefix-length 64
set address-protection
```

Step-by-Step Procedure Configure three address-assignment pools for DHCPv4, DHCPv6 prefix delegation, and ND/RA.

To configure the address-assignment pools:

1. Configure the address-assignment pool for DHCPv4.

```
[edit]
user@host# edit access address-assignment pool default-ipv4-pool-2
user@host# edit family inet
user@host# set network 10.10.0.0/16
user@host# set range r5 low 10.10.0.1
user@host# set range r5 high 10.10.250.250
```

2. Configure the address-assignment pool for DHCPv6 prefix delegation.

```
[edit]
user@host# edit access address-assignment pool dhcpv6-pd-pool
user@host# edit family inet6
user@host# set prefix 2040:2000:2000::/48
user@host# set range r1 prefix-length 64
```

3. Configure the address-assignment pool for ND/RA.

```
[edit]
user@host# edit access address-assignment pool ndra-2010
user@host# edit family inet6
user@host# set prefix 2010:0:0:0::/48
user@host# set range L prefix-length 64
```

4. (Optional) Enable duplicate prefix protection.

```
[edit access]
user@host# set address-protection
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]
user@host# show
address-assignment {
  pool default-ipv4-pool-2 {
    family inet {
      network 10.10.0.0/16;
      range r5 {
        low 10.10.0.1;
        high 10.10.250.250;
      }
    }
  }
  pool dhcpv6-pd-pool {
    family inet6 {
```

```

        prefix 2040:2000:2000::/48;
        range r1 prefix-length 64;
    }
}
pool ndra-2010 {
    family inet6 {
        prefix 2010:0:0:0::/48;
        range L prefix-length 64;
    }
}
}
address-protection;

```

If you are done configuring the device, enter **commit** from configuration mode.

Specifying the Address-Assignment Pool to Be Used for DHCPv6 Prefix Delegation

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```

edit system services dhcp-local-server dhcpv6
set overrides delegated-pool dhcpv6-pd-pool

```

Step-by-Step Procedure

To specify that the dhcp-pd-pool is used for DHCPv6 prefix delegation:

1. Access the DHCPv6 local server configuration.

```

[edit]
user@host# edit system services dhcp-local-server dhcpv6

```
2. Specify the address pool that assigns the delegated prefix.

```

[edit system services dhcp-local-server dhcpv6]
user@host# set overrides delegated-pool dhcpv6-pd-pool

```

Results From configuration mode, confirm your configuration by entering the **show** command.

```

[edit system]
user@host# show
services {
    dhcp-local-server {
        dhcpv6 {
            overrides {
                delegated-pool dhcpv6-pd-pool;
            }
        }
    }
}

```

If you are done configuring the device, enter **commit** from configuration mode.

Verification

Confirm that the configuration is working properly.

- [Verifying Active Subscriber Sessions on page 118](#)
- [Verifying Both IPv4 and IPv6 Address in Correct Routing Instance on page 118](#)
- [Verifying Dynamic Subscriber Sessions on page 119](#)
- [Verifying DHCPv6 Address Pools Used for ND/RA and DHCPv6 Prefix Delegation on page 120](#)
- [Verifying DHCPv6 Address Bindings on page 121](#)
- [Verifying Router Advertisements on page 121](#)
- [Verifying the Status of the PPPoE Logical Interface on page 121](#)

Verifying Active Subscriber Sessions

Purpose Verify active subscriber sessions.

Action From operational mode, enter the **show subscribers summary** command.

```
user@host>show subscribers summary
Subscribers by State
  Active: 2
  Total: 2

Subscribers by Client Type
  DHCP: 1
  PPPoE: 1
  Total: 2
```

Meaning The fields under **Subscribers by State** show the number of active subscribers.

The fields under **Subscribers by Client Type** show the number of active DHCP and DHCPoE subscriber sessions.

Verifying Both IPv4 and IPv6 Address in Correct Routing Instance

Purpose Verify that the subscriber has both an IPv4 and IPv6 address and is placed in the correct routing instance.

Action From operational mode, enter the **show subscribers** command.

```
user@host>show subscribers
Interface      IP Address/VLAN ID  User Name      LS:RI
pp0.1073741864 2.2.0.5             dual-stack-v4v6-pd default:default
*              2010:0:0:8::/64
pp0.1073741864 2040:2000:2000:5::/64 default:default
```

Meaning The **Interface** field shows that there are two subscriber sessions running on the same interface. The **IP Address** field shows that one session is assigned an IPv4 address, and one session is assigned on IPv6 address.

The **LS:RI** field shows that the subscriber is placed in the correct routing instance and that traffic can be sent and received.

Verifying Dynamic Subscriber Sessions

Purpose Verify dynamic PPPoE and DHCPv6 subscriber sessions. In this sample configuration, the DHCPv6 subscriber session should be layered over the underlying PPPoE subscriber session.

Action From operational mode, enter the **show subscribers detail** command.

```
user@host>show subscribers detail
Type: PPPoE
User Name: dual-stack-v4v6-pd
IP Address: 2.2.0.5
IP Netmask: 255.255.0.0
IPv6 User Prefix: 2010:0:0:8::/64
Logical System: default
Routing Instance: default
Interface: pp0.1073741864
Interface type: Dynamic
Dynamic Profile Name: DS-dyn-ipv4v6-ra
MAC Address: 00:07:64:11:07:02
State: Active
Radius Accounting ID: 87
Session ID: 87
Login Time: 2012-01-17 14:45:30 PST

Type: DHCP
IPv6 Prefix: 2040:2000:2000:5::/64
Logical System: default
Routing Instance: default
Interface: pp0.1073741864
Interface type: Static
MAC Address: 00:07:64:11:07:02
State: Active
Radius Accounting ID: 88
Session ID: 88
Underlying Session ID: 87
Login Time: 2012-01-17 14:46:00 PST
DHCP Options: len 42
00 08 00 02 0b b8 00 01 00 0a 00 03 00 01 00 07 64 11 07 02
00 06 00 02 00 19 00 19 00 0c 00 00 00 00 00 00 00 00 00 00
00 00
```

Meaning When a subscriber has logged in and started both an IPv4 and an IPv6 session, the output shows the active underlying PPPoE session and the active DHCPv6 session.

The **Session ID** field for the PPPoE session is 87. The **Underlying Session ID** for the DHCP session is 87, which shows that the PPPoE session is the underlying session.

Verifying DHCPv6 Address Pools Used for ND/RA and DHCPv6 Prefix Delegation

Purpose Verify the pool used for ND/RA, the delegated address pool used for DHCPv6 prefix delegation, and the length of the IPv6 prefixes that were delegated to the CPE.

Action From operational mode, enter the **show subscribers extensive** command.

```

user@host>show subscribers extensive
Type: PPPoE
User Name: dual-stack-v4v6-pd
IP Address: 2.2.0.5
IP Netmask: 255.255.0.0
IPv6 User Prefix: 2010:0:0:8::/64
Logical System: default
Routing Instance: default
Interface: pp0.1073741864
Interface type: Dynamic
Dynamic Profile Name: DS-dyn-ipv4v6-ra
MAC Address: 00:07:64:11:07:02
State: Active
Radius Accounting ID: 87
Session ID: 87
Login Time: 2012-01-17 14:45:30 PST
IPv6 Delegated Address Pool: dhcpv6-pd-pool
IPv6 Delegated Address Pool: ndra-2010
IPv6 Delegated Network Prefix Length: 48
IPv6 Interface Address: 2010:0:0:8::1/64

Type: DHCP
IPv6 Prefix: 2040:2000:2000:5::/64
Logical System: default
Routing Instance: default
Interface: pp0.1073741864
Interface type: Static
MAC Address: 00:07:64:11:07:02
State: Active
Radius Accounting ID: 88
Session ID: 88
Underlying Session ID: 87
Login Time: 2012-01-17 14:46:00 PST
DHCP Options: len 42
00 08 00 02 0b b8 00 01 00 0a 00 03 00 01 00 07 64 11 07 02
00 06 00 02 00 19 00 19 00 0c 00 00 00 00 00 00 00 00 00
00 00
IPv6 Delegated Address Pool: dhcpv6-pd-pool
IPv6 Delegated Network Prefix Length: 64
IPv6 Delegated Network Prefix Length: 48

```

Meaning Under the PPPoE session, the **IPv6 Delegated Address Pool** fields show the names of the pools used for DHCPv6 prefix delegation and for ND/RA prefixes. The **IPv6 Delegated Network Prefix Length** field shows the length of the prefix used to assign the IPv6 address for this subscriber session. The **IPv6 Interface Address** field shows the IPv6 address assigned to the CPE interface from the ND/RA pool.

Under the DHCP session, the **IPv6 Delegated Address Pool** field shows the name of the pool used for DHCPv6 prefix delegation. The **IPv6 Delegated Network Prefix Length** fields show the length of the prefix used in DHCPv6 prefix delegation.

Verifying DHCPv6 Address Bindings

Purpose Display the address bindings in the client table on the DHCPv6 local server.

Action From operational mode, enter the **show dhcpv6 server binding** command.

```
user@host>show dhcpv6 server binding
Prefix                Session Id  Expires  State  Interface  Client DUID
2040:2000:2000:5::/64  88         86189    BOUND  pp0.1073741864
LL0x1-00:07:64:11:07:02
```

If you have many active subscriber sessions, you can display the server binding for a specific interface.

```
user@host>show dhcpv6 server binding interface pp0.1073741864
Prefix                Session Id  Expires  State  Interface  Client DUID
2040:2000:2000:5::/64  88         86182    BOUND  pp0.1073741864
LL0x1-00:07:64:11:07:02
```

Meaning The **Prefix** field shows the DHCPv6 prefix assigned to the subscriber session from the pool used for DHCPv6 prefix delegation.

Verifying Router Advertisements

Purpose Verify that router advertisements are being sent, and that router solicits are being received.

Action From operational mode, enter the **show ipv6 router-advertisement** command.

```
user@host>show ipv6 router-advertisement
Interface: pp0.1073741864
  Advertisements sent: 3, last sent 00:03:29 ago
  Solicits received: 0
  Advertisements received: 0
```

If you have a large number of subscriber interfaces, you can display router advertisements for a specific interface.

```
user@host>show ipv6 router-advertisement interface pp0.1073741864
Interface: pp0.1073741864
  Advertisements sent: 3, last sent 00:03:34 ago
  Solicits received: 0
  Advertisements received: 0
```

Meaning The display shows the number of advertisements that the router sent, the number of solicits that the router received, and the number of advertisements that the router received.

Verifying the Status of the PPPoE Logical Interface

Purpose Display status information about the PPPoE logical interface (pp0).

Action From operational mode, enter the **show interfaces pp0.logical** command.

```
user@host>show interfaces pp0.1073741864
```

```
Logical interface pp0.1073741864 (Index 388) (SNMP ifIndex 681)
  Flags: Point-To-Point SNMP-Traps 0x4000 Encapsulation: PPPoE
  PPPoE:
    State: SessionUp, Session ID: 10,
    Session AC name: almach, Remote MAC address: 00:07:64:11:07:02,
    Underlying interface: ge-3/3/0.1109 (Index 367)
  Bandwidth: 1000mbps
  Input packets : 22
  Output packets: 50
  Keepalive settings: Interval 30 seconds, Up-count 1, Down-count 3
  LCP state: Opened
  NCP state: inet: Opened, inet6: Opened, iso: Not-configured, mpls: Not-configured

  CHAP state: Closed
  PAP state: Success
  Protocol inet, MTU: 65531
    Flags: Sendbroadcast-pkt-to-re
    Addresses, Flags: Is-Primary
    Local: 77.1.1.1
  Protocol inet6, MTU: 65531
    Addresses, Flags: Is-Preferred Is-Primary
    Destination: 2010:0:0:8::/64, Local: 2010:0:0:8::1
    Local: fe80::2a0:a50f:fc63:a842
```

Meaning The **Underlying interface** field shows the underlying Ethernet interface configured in the example.

The **Destination** field under **Protocol inet6** shows the IPv6 address obtained through ND/RA. This is the value of the *\$junos-ipv6-ndra-prefix* variable configured in the dynamic profile.

The **Local** field under **Protocol inet6** shows the value of the *\$junos-ipv6-address* variable configured for family inet6 in the pp0 configuration of the dynamic profile.

CHAPTER 18

Example: Dual-Stack Design That Uses ND/RA over PPPoE

- [Example: Configuring a Dual Stack That Uses ND/RA over PPPoE on page 123](#)

Example: Configuring a Dual Stack That Uses ND/RA over PPPoE

This example shows a dual-stack configuration for a residential subscriber with a single PC. It uses ND/RA to provide a prefix used to obtain a global IPv6 address for the PC.

- [Requirements on page 123](#)
- [Overview on page 123](#)
- [Configuration on page 125](#)
- [Verification on page 136](#)

Requirements

This example uses the following hardware and software components:

- MX Series 3D Universal Edge Router
- Junos OS Release 11.4 or later

Overview

This design uses ND/RA in your subscriber access network as follows:

- The access network is PPPoE.
- ND/RA is used to assign a global IPv6 address on the WAN link. The prefixes used in router advertisements come from a local pool that is specified by AAA RADIUS.

Topology

Figure 16: PPPoE Subscriber Access Network with ND/RA

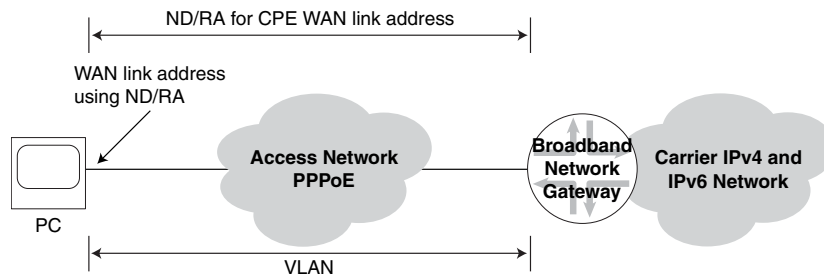


Table 8 on page 124 describes the configuration components used in this example.

Table 8: Configuration Components Used in Dual Stack with ND/RA and DHCPv6 Prefix Delegation

Configuration Component	Component Name	Purpose
Dynamic profiles	DS-dyn-ipv4v6-ndra	Profile that creates a PPPoE logical interface when the subscriber logs in.
Interfaces	ge-3/3/0	Underlying Ethernet interface.
	lo0	Loopback interface for use in the access network. The loopback interface is automatically used for unnumbered interfaces.
Address-assignment pools	default-ipv4-pool-2	Pool that provides IPv4 addresses for the subscriber LAN.
	ndra-2010	Pool that provides IPv6 prefixes used in router advertisements. These prefixes are used to create a global IPv6 address that is assigned to the CPE WAN link.

Configuration

To configure this example, perform these tasks:

- [Configuring a Dynamic Profile for the PPPoE Logical Interface on page 127](#)
- [Configuring a Loopback Interface on page 129](#)
- [Configuring a Static Underlying Ethernet Interface for Dynamic PPPoE Subscriber Interfaces on page 130](#)
- [Specifying the BNG IP Address on page 131](#)
- [Configuring RADIUS Server Access on page 132](#)
- [Configuring RADIUS Server Access Profile on page 133](#)
- [Configuring Local Address-Assignment Pools on page 134](#)

CLI Quick Configuration

The following is the complete configuration for this example:

```
dynamic-profiles {
  DS-dyn-ipv4v6-ra {
    interfaces {
      pp0 {
        unit "$junos-interface-unit" {
          ppp-options {
            chap;
            pap;
          }
          pppoe-options {
            underlying-interface "$junos-underlying-interface";
            server;
          }
          keepalives interval 30;
          family inet {
            unnumbered-address lo0.0;
          }
          family inet6 {
            address $junos-ipv6-address;
          }
        }
      }
    }
  }
  protocols {
    router-advertisement {
      interface "$junos-interface-name" {
        prefix $junos-ipv6-ndra-prefix;
      }
    }
  }
}
system {
  services {
    dhcp-local-server {
      dhcpv6 {
        group DHCPv6-over-pppoe {
```

```
        interface pp0.0;
      }
    }
  }
}
interfaces {
  ge-3/3/0 {
    unit 1004 {
      description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd";
      encapsulation ppp-over-ether;
      vlan-id 1004;
      pppoe-underlying-options {
        duplicate-protection;
        dynamic-profile DS-dyn-ipv4v6-ra;
      }
    }
  }
  lo0 {
    description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd";
    unit 0 {
      family inet {
        address 77.1.1.1/32 {
          primary;
        }
      }
      family inet6 {
        address 2030:0:0:0::1/64 {
          primary;
        }
      }
    }
  }
}
routing-options {
  router-id 10.0.0.0;
}
access {
  radius-server {
    10.9.0.9 {
      secret "$9$IXRv87GUHm5FYgF/CA1I"; ## SECRET-DATA
      timeout 45;
      retry 4;
      source-address 10.0.0.1;
    }
  }
  profile Access-Profile {
    authentication-order radius;
    radius {
      authentication-server 10.9.0.9;
      accounting-server 10.9.0.9;
    }
    accounting {
      order [ radius none ];
      update-interval 120;
      statistics volume-time;
    }
  }
}
```

```

    }
  }
  address-assignment {
    pool default-ipv4-pool-2 {
      family inet {
        network 10.10.0.0/16;
        range r5 {
          low 10.10.0.1;
          high 10.10.250.250;
        }
      }
    }
    pool ndra-2010 {
      family inet6 {
        prefix 2010:0:0:0::/48;
        range L prefix-length 64;
      }
    }
  }
  address-protection;
}

```

Configuring a Dynamic Profile for the PPPoE Logical Interface

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```

edit dynamic-profiles DS-dyn-ipv4v6-ra
edit interfaces pp0 unit $junos-interface-unit
set family inet unnumbered-address lo0.0
set family inet6 address $junos-ipv6-address
set pppoe-options underlying-interface "$junos-underlying-interface"
set pppoe-options server
set ppp-options pap
set ppp-options chap
set keepalives interval 30
up 3
edit protocols router-advertisement
edit interface $junos-interface-name
set prefix $junos-ipv6-ndra-prefix

```

Step-by-Step Procedure Create a dynamic profile for the PPPoE logical interface. This dynamic profile supports both IPv4 and IPv6 sessions on the same logical interface.

To configure the dynamic profile:

1. Create and name the dynamic profile.

```
[edit]
user@host# edit dynamic-profiles DS-dyn-ipv4v6-ra
```
2. Configure a PPPoE logical interface (pp0) that is used to create logical PPPoE interfaces for the IPv4 and IPv6 subscribers.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra]
user@host# edit interfaces pp0
```

3. Specify **\$junos-interface-unit** as the predefined variable to represent the logical unit number for the pp0 interface. The variable is dynamically replaced with the actual unit number supplied by the network when the subscriber logs in.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0]
user@host# edit unit $junos-interface-unit
```

4. Specify **\$junos-underlying-interface** as the predefined variable to represent the name of the underlying Ethernet interface on which the router creates the dynamic PPPoE logical interface. The variable is dynamically replaced with the actual name of the underlying interface supplied by the network when the subscriber logs in.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set pppoe-options underlying-interface $junos-underlying-interface
```

5. Configure the router to act as a PPPoE server when a PPPoE logical interface is dynamically created.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set pppoe-options server
```

6. Configure the IPv4 family for the pp0 interface. Specify the unnumbered address to dynamically create loopback interfaces.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set family inet unnumbered-address lo0.0
```

7. Configure the IPv6 family for the pp0 interface. Because the example uses router advertisement, assign the predefined variable **\$junos-ipv6-address**.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set family inet6 unnumbered-address $junos-ipv6-address
```

8. Configure one or more PPP authentication protocols for the pp0 interface.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set ppp-options chap
user@host# set ppp-options pap
```

9. Enable keepalives and set an interval for keepalives. We recommend an interval of 30 seconds.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra interfaces pp0 unit "$junos-interface-unit"]
user@host# set keepalives interval 30
```

10. Access the router advertisement configuration.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra]
user@host# edit protocols router-advertisement
```

11. Specify the interface on which the ND/RA configuration is applied.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra protocols router-advertisement]
user@host# edit interface $junos-interface-name
```

12. Specify a prefix value contained in router advertisement messages sent to the CPE on interfaces created with this dynamic profile. If you specify the

`$junos-ipv6-ndra-prefix` predefined variable, the actual value is obtained from a local pool or through AAA.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra protocols router-advertisement interface
 "$junos-interface-name"]
user@host# set prefix $junos-ipv6-ndra-prefix
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit dynamic-profiles DS-dyn-ipv4v6-ra]
user@host# show
interfaces {
  pp0 {
    unit "$junos-interface-unit" {
      ppp-options {
        chap;
        pap;
      }
      pppoe-options {
        underlying-interface "$junos-underlying-interface";
        server;
      }
      keepalives interval 30;
      family inet {
        unnumbered-address lo0.0;
      }
      family inet6 {
        address $junos-ipv6-address;
      }
    }
  }
}
protocols {
  router-advertisement {
    interface "$junos-interface-name" {
      prefix $junos-ipv6-ndra-prefix;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring a Loopback Interface

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit interfaces lo0 unit 0
set family inet address 77.1.1.1/32 primary
set family inet6 address 2030:0:0:0::1/64 primary
```

Step-by-Step Procedure

To configure a loopback interface:

1. Create the loopback interface and specify a unit number.

```
[edit]  
user@host# edit interfaces lo0 unit 0
```
2. Configure the interface for IPv4.

```
[edit interfaces lo0 unit 0]  
user@host# set family inet address 77.1.1.1/32 primary
```
3. Configure the interface for IPv6.

```
[edit interfaces lo0 unit 0]  
user@host# set family inet6 address 2030:0:0:0::1/64 primary
```

Results

From configuration mode, confirm your configuration by entering the **show** command.

```
[edit interfaces lo0]  
user@host# show  
unit 0 {  
  family inet {  
    address 77.1.1.1/32 {  
      primary;  
    }  
  }  
  family inet6 {  
    address 2030:0:0:0::1/64 {  
      primary;  
    }  
  }  
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring a Static Underlying Ethernet Interface for Dynamic PPPoE Subscriber Interfaces

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit interfaces ge-3/3/0 unit 1004  
set description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd"  
set encapsulation ppp-over-ether  
set vlan-id 1004  
set pppoe-underlying-options duplicate-protection  
set pppoe-underlying-options dynamic-profile DS-dyn-ipv4v6-ra
```

Step-by-Step Procedure

To configure the underlying Ethernet interface:

1. Specify the name and logical unit number of the static underlying Ethernet interface to which you want to attach the IPv4 and IPv6 dynamic profile.

```
[edit]
```



```
user@host# edit interfaces ge-3/3/0 unit 1004
```

2. Configure a description for the interface.

```
[edit interfaces ge-3/3/0 unit 1004]
user@host# set description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd"
```

3. Configure PPPoE encapsulation on the underlying interface.

```
[edit interfaces ge-3/3/0 unit 1004]
user@host# set encapsulation ppp-over-ether
```

4. Configure the VLAN ID.

```
[edit interfaces ge-3/3/0 unit 1004]
user@host# set vlan-id 1004
```

5. Attach the dynamic profile to the underlying interface.

```
[edit interfaces ge-3/3/0 unit 1004]
user@host# set pppoe-underlying-options dynamic-profile DS-dyn-ipv4v6-ra
```

6. (Optional) Prevent multiple PPPoE sessions from being created for the same PPPoE subscriber on the same VLAN interface.

```
[edit interfaces ge-3/3/0 unit 1004]
user@host# set pppoe-underlying-options duplicate-protection
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit interfaces]
user@host# show
ge-3/3/0 {
  unit 1004 {
    description "dynamic ipv4v6 dual stack, ndra, dhcpv6 pd";
    encapsulation ppp-over-ether;
    vlan-id 1004;
    pppoe-underlying-options {
      duplicate-protection;
      dynamic-profile DS-dyn-ipv4v6-ra;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Specifying the BNG IP Address

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit routing-options
set router-id 10.0.0.0
```



BEST PRACTICE: We strongly recommend that you configure the BNG IP address to avoid unpredictable behavior if the interface address on a loopback interface changes.

**Step-by-Step
Procedure**

To configure the IP address of the BNG:

1. Access the routing-options configuration.

```
[edit]
user@host# edit routing-options
```

2. Specify the IP address or the BNG.

```
[edit routing-options]
user@host# set router-id 10.0.0.0
```

Results

From configuration mode, confirm your configuration by entering the **show** command.

```
[edit routing-options]
user@host# show
router-id 10.0.0.0;
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring RADIUS Server Access

**CLI Quick
Configuration**

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access radius-server 10.9.0.9
set secret "$9$IXRv87GUHm5FYgF/CA1I"
set timeout 45
set retry 4
set source-address 10.0.0.1
```

**Step-by-Step
Procedure**

To configure RADIUS servers:

1. Create a RADIUS server configuration, and specify the address of the server.

```
[edit]
user@host# edit access radius-server 10.9.0.9
```

2. Configure the required secret (password) for the server. Secrets enclosed in quotation marks can contain spaces.

```
[edit access radius-server 10.9.0.9]
user@host# set secret "$9$IXRv87GUHm5FYgF/CA1I"
```

3. Configure the source address that the BNG uses when it sends RADIUS requests to the RADIUS server.

```
[edit access radius-server 10.9.0.9]
```

```
user@host# set source address 10.0.0.1
```

4. (Optional) Configure the number of times that the router attempts to contact a RADIUS accounting server. You can configure the router to retry from 1 through 16 times. The default setting is 3 retry attempts.

```
[edit access radius-server 10.9.0.9]
user@host# set retry 4
```

5. (Optional) Configure the length of time that the local router or switch waits to receive a response from a RADIUS server. By default, the router or switch waits 3 seconds. You can configure the timeout to be from 1 through 90 seconds.

```
[edit access radius-server 10.9.0.9]
user@host# set timeout 45
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]
user@host# show
radius-server {
  10.9.0.9 {
    secret "$9$IXRv87GUHm5FYgF/CA1l"; ## SECRET-DATA
    timeout 45;
    retry 4;
    source-address 10.0.0.1;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring RADIUS Server Access Profile

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access profile Access-Profile
set authentication-order radius
set radius authentication-server 10.9.0.9
set radius accounting-server 10.9.0.9
set accounting order radius
set accounting order none
set accounting update-interval 120
set accounting statistics volume-time
```

Step-by-Step Procedure To configure a RADIUS server access profile:

1. Create a RADIUS server access profile.


```
[edit]
user@host# edit access profile Access-Profile
```
2. Specify the order in which authentication methods are used.


```
[edit access profile Access-Profile]
```

```
user@host# set authentication-order radius
```

3. Specify the address of the RADIUS server used for authentication and the server used for accounting.

```
[edit access profile Access-Profile]
user@host# set radius authentication-server 10.9.0.9
user@host# set radius accounting-server 10.9.0.9
```

4. Configure RADIUS accounting values for the access profile.

```
[edit access profile Access-Profile]
user@host# set accounting order [ radius none ]
user@host# set accounting update-interval 120
user@host# set accounting statistics volume-time
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]
user@host# show
profile Access-Profile {
  authentication-order radius;
  radius {
    authentication-server 10.9.0.9;
    accounting-server 10.9.0.9;
  }
  accounting {
    order [ radius none ];
    update-interval 120;
    statistics volume-time;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Configuring Local Address-Assignment Pools

CLI Quick Configuration To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit access
set address-assignment pool default-ipv4-pool-2 family inet network 10.10.0.0/16
set address-assignment pool default-ipv4-pool-2 family inet range r5 low 10.10.0.1
set address-assignment pool default-ipv4-pool-2 family inet range r5 high 10.10.250.250
set address-assignment pool ndra-2010 family inet6 prefix 2010:0:0:0::/48
set address-assignment pool ndra-2010 family inet6 range L prefix-length 64
set address-protection
```

Step-by-Step Procedure Configure three address-assignment pools for DHCPv4, DHCPv6 prefix delegation, and ND/RA.

To configure the address-assignment pools:

1. Configure the address-assignment pool for DHCPv4.

```
[edit]
user@host# edit access address-assignment pool default-ipv4-pool-2
user@host# edit family inet
user@host# set network 10.10.0.0/16
user@host# set range r5 low 10.10.0.1
user@host# set range r5 high 10.10.250.250
```

2. Configure the address-assignment pool for ND/RA.

```
[edit]
user@host# edit access address-assignment pool ndra-2010
user@host# edit family inet6
user@host# set prefix 2010:0:0:0::/48
user@host# set range L prefix-length 64
```

3. (Optional) Enable duplicate prefix protection.

```
[edit access]
user@host# set address-protection
```

Results From configuration mode, confirm your configuration by entering the **show** command.

```
[edit access]
user@host# show
address-assignment {
  pool default-ipv4-pool-2 {
    family inet {
      network 10.10.0.0/16;
      range r5 {
        low 10.10.0.1;
        high 10.10.250.250;
      }
    }
  }
  pool ndra-2010 {
    family inet6 {
      prefix 2010:0:0:0::/48;
      range L prefix-length 64;
    }
  }
}
address-protection;
```

If you are done configuring the device, enter **commit** from configuration mode.

Verification

Confirm that the configuration is working properly.

- [Verifying Active Subscriber Sessions on page 136](#)
- [Verifying Both IPv4 and IPv6 Address in Correct Routing Instance on page 136](#)
- [Verifying Dynamic Subscriber Sessions on page 137](#)
- [Verifying the ND/RA Prefix Pool and Prefix Length on page 137](#)
- [Verifying the Status of the PPPoE Logical Interface on page 138](#)
- [Verifying Router Advertisements on page 138](#)

Verifying Active Subscriber Sessions

Purpose Verify active subscriber sessions.

Action From operational mode, enter the **show subscribers summary** command.

```
user@host>show subscribers summary
Subscribers by State
  Active: 2
  Total: 2
```

```
Subscribers by Client Type
  DHCP: 1
  PPPoE: 1
  Total: 2
```

Meaning The fields under **Subscribers by State** show the number of active subscribers.

The fields under **Subscribers by Client Type** show the number of active DHCP and underlying PPPoE subscriber sessions.

Verifying Both IPv4 and IPv6 Address in Correct Routing Instance

Purpose Verify that the subscriber has both an IPv4 and IPv6 address and is placed in the correct routing instance.

Action From operational mode, enter the **show subscribers** command.

```
user@host>show subscribers
Interface      IP Address/VLAN ID  User Name          LS:RI
pp0.1073741864 2.2.0.5             dual-stack-v4v6-pd default:default
*              2010:0:0:8::/64
pp0.1073741864 2040:2000:2000:5::/64 default:default
```

Meaning The **Interface** field shows that there are two subscriber sessions running on the same interface. The **IP Address** field shows that one session is assigned an IPv4 address, and one session is assigned on IPv6 address.

The **LS:RI** field shows that the subscriber is placed in the correct routing instance and that traffic can be sent and received.

Verifying Dynamic Subscriber Sessions

- Purpose** Verify that the dynamic subscriber session is active and that the IPv6 prefix is obtained from the ND/RA pool.
- Action** From operational mode, enter the **show subscribers detail** command.
- ```
user@host>show subscribers detail
Type: PPPoE
User Name: dual-stack-v4v6-nas
IP Address: 2.2.0.4
IP Netmask: 255.255.0.0
IPv6 User Prefix: 2010:0:0:6::/64
Logical System: default
Routing Instance: default
Interface: pp0.1073741859
Interface type: Dynamic
Dynamic Profile Name: DS-dyn-ipv4v6-ra
MAC Address: 00:00:64:10:04:02
State: Active
Radius Accounting ID: 81
Session ID: 81
Login Time: 2012-01-17 14:19:41 PST
```
- Meaning** The **IPv6 User Prefix** field shows the prefix that was obtained from the ND/RA pool. The **State** field shows that the session is active.

### Verifying the ND/RA Prefix Pool and Prefix Length

- Purpose** Verify the pool used for ND/RA and the prefix length used with the pool
- Action** From operational mode, enter the **show subscribers extensive** command.
- ```
user@host>show subscribers extensive
Type: PPPoE
User Name: dual-stack-v4v6-nas
IP Address: 2.2.0.4
IP Netmask: 255.255.0.0
IPv6 User Prefix: 2010:0:0:6::/64
Logical System: default
Routing Instance: default
Interface: pp0.1073741859
Interface type: Dynamic
Dynamic Profile Name: DS-dyn-ipv4v6-ra
MAC Address: 00:00:64:10:04:02
State: Active
Radius Accounting ID: 81
Session ID: 81
Login Time: 2012-01-17 14:19:41 PST
IPv6 Delegated Address Pool: ndra-2010
IPv6 Delegated Network Prefix Length: 48
IPv6 Interface Address: 2010:0:0:6::1/64
```
- Meaning** Under the PPPoE session, the **IPv6 Delegated Address Pool** field shows the name of the pool used for ND/RA prefixes. The **IPv6 Delegated Network Prefix Length** field shows the length of the prefix used to assign the IPv6 address for this subscriber session. The **IPv6**

Interface Address field shows the IPv6 address assigned to the CPE interface from the ND/RA pool.

Verifying the Status of the PPPoE Logical Interface

Purpose Display status information about the PPPoE logical interface (pp0).

Action From operational mode, enter the **show interfaces pp0.logical** command.

```
user@host>show interfaces pp0.1073741859
Logical interface pp0.1073741859 (Index 388) (SNMP ifIndex 674)
  Flags: Point-To-Point SNMP-Traps 0x4000 Encapsulation: PPPoE
  PPPoE:
    State: SessionUp, Session ID: 10,
    Session AC name: almach, Remote MAC address: 00:00:64:10:04:02,
    Underlying interface: ge-3/3/0.1004 (Index 354)
  Bandwidth: 1000mbps
  Input packets : 15
  Output packets: 44
  Keepalive settings: Interval 30 seconds, Up-count 1, Down-count 3
  LCP state: Opened
  NCP state: inet: Opened, inet6: Opened, iso: Not-configured, mp1s: Not-configured

  CHAP state: Closed
  PAP state: Success
  Protocol inet, MTU: 65531
    Flags: Sendbcst-pkt-to-re
    Addresses, Flags: Is-Primary
      Local: 77.1.1.1
  Protocol inet6, MTU: 65531
    Addresses, Flags: Is-Preferred Is-Primary
      Destination: 2010:0:0:6::/64, Local: 2010:0:0:6::1
      Local: fe80::2a0:a50f:fc63:a842
```

Meaning The **Local** field under **Protocol inet** shows the IPv4 address of the pp0 interface. This is the IPv4 address configured for the loopback interface.

The **Destination** field under **Protocol inet6** shows the IPv6 address obtained through ND/RA. This is the value of the *\$junos-ipv6-ndra-prefix* variable configured in the dynamic profile.

The **Local** field under **Protocol inet6** shows the value of the *\$junos-ipv6-address* variable configured for family inet6 in the pp0 configuration of the dynamic profile.

Verifying Router Advertisements

Purpose Verify that router advertisements are being sent and that router solicits are being received.

Action From operational mode, enter the **show ipv6 router-advertisement** command.

```
user@host>show ipv6 router-advertisement
Interface: pp0.1073741859
  Advertisements sent: 3, last sent 00:09:53 ago
```



```
Solicits received: 0  
Advertisements received: 0
```

If you have a large number of subscriber interfaces, you can display router advertisements for a specific interface.

```
user@host>show ipv6 router-advertisement interface pp0.1073741859  
Interface: pp0.1073741859  
  Advertisements sent: 3, last sent 00:10:31 ago  
  Solicits received: 0  
  Advertisements received: 0
```

Meaning The display shows the number of advertisements that the router sent, the number of solicits that the router received, and the number of advertisements that the router received.

