Network Configuration Example

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

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Introduction

This document describes how service providers can implement IPv4 and IPv6 dual stack in a PPPoE subscriber access network. It also provides a step-by-step configuration example for configuring a dual stack that uses DHCPv6 IA_NA and DHCPv6 prefix delegation over PPPoE.

Reasons to Use IPv4/IPv6 Dual Stacks

As a service provider, you can use the Junos® operating system (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. This 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 to avoid expensive service disruptions while migrating from IPv4 to IPv6.

Related Documentation

- IPv6 Addressing Requirements for a Dual-Stack Network on page 1
- Overview of Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing on page 3
- Overview of Using DHCPv6 Prefix Delegation on page 3
- *Example: Configuring a Dual Stack That Uses NDRA and DHCPv6 Prefix Delegation over PPPoE*
- *Using NDRA to Provide IPv6 WAN Link Addressing*
- *Using DHCPv6 Prefix Delegation to Provide IPv6 Addresses on the Subscriber LAN*
- Overview of Using DHCPv6 IA_NA with DHCPv6 Prefix Delegation on page 5
- Example: Configuring a Dual Stack That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE on page 6

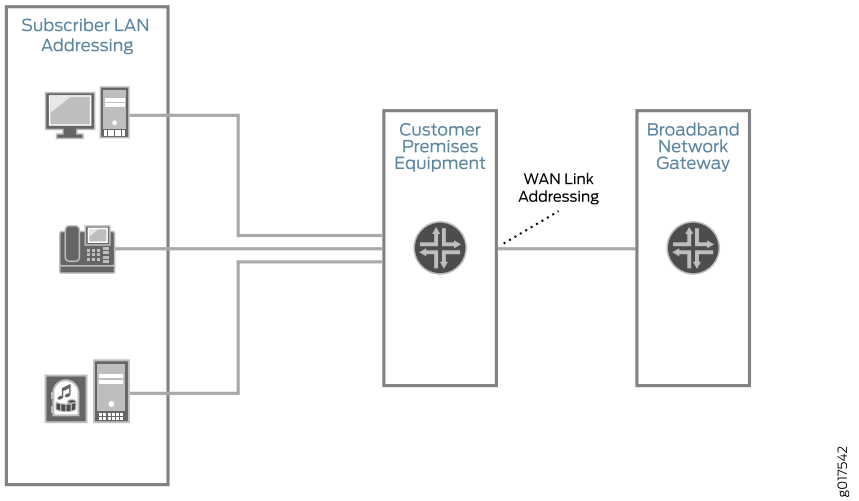
IPv6 Addressing Requirements for a Dual-Stack Network

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

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

Figure 1 on page 2 shows where WAN link addressing and subscriber addressing are assigned in a dual-stack network.

Figure 1: 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 Neighbor Discovery Router Advertisement (NDRA) or Dynamic Host Configuration Protocol for IPv6 (DHCPv6) identity association for nontemporary addresses (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 broadband network gateway (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 Point-to-Point Protocol over Ethernet (PPPoE) access networks. The link-local address is provisioned by appending the interface identifier negotiated by the Internet Protocol version 6 Control Protocol (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.

Related Documentation

- Reasons to Use IPv4/IPv6 Dual Stacks on page 1
- Overview of Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing on page 3
- Overview of Using DHCPv6 Prefix Delegation on page 3

- *Example: Configuring a Dual Stack That Uses NDRA and DHCPv6 Prefix Delegation over PPPoE*
- *Using NDRA to Provide IPv6 WAN Link Addressing*
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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.

Related Documentation

- Reasons to Use IPv4/IPv6 Dual Stacks on page 1
- IPv6 Addressing Requirements for a Dual-Stack Network on page 1
- Overview of Using DHCPv6 Prefix Delegation on page 3
- *Example: Configuring a Dual Stack That Uses NDRA and DHCPv6 Prefix Delegation over PPPoE*
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Overview of Using DHCPv6 Prefix Delegation

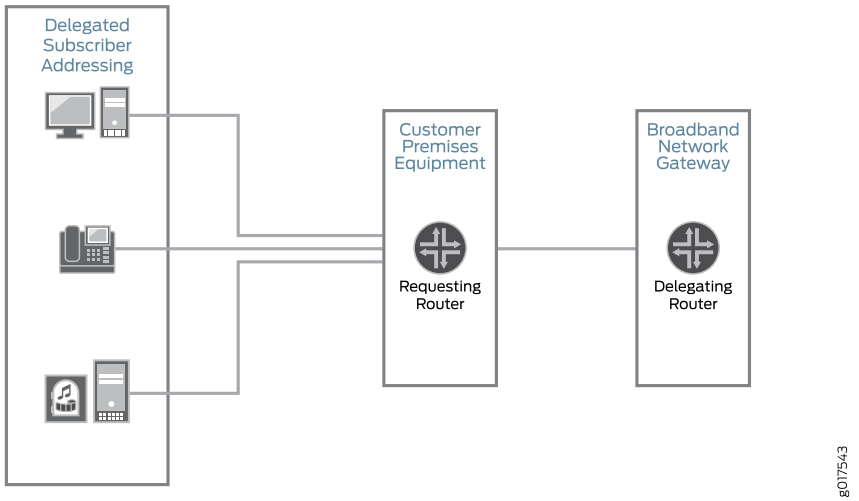
You can use DHCPv6 prefix delegation to automate the delegation of IPv6 prefixes to the CPE. With prefix delegation, a delegating router (the BNG) delegates IPv6 prefixes to a requesting router (the CPE). The requesting router then uses the prefixes to assign global IP addresses to the devices on the 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 2 on page 4 shows how DHCPv6 prefix delegation is used in a dual-stack network.

Figure 2: 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.

Related Documentation

- Reasons to Use IPv4/IPv6 Dual Stacks on page 1
- IPv6 Addressing Requirements for a Dual-Stack Network on page 1
- Overview of Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing on page 3
- Overview of Using DHCPv6 IA_NA with DHCPv6 Prefix Delegation on page 5
- *Methods for Obtaining IPv6 Prefixes for DHCPv6 Prefix Delegation*
- *Selecting the Method of Assigning Global IPv6 Addresses to Subscribers*
- Example: Configuring a Dual Stack That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE on page 6

Overview of Using DHCPv6 IA_NA with DHCPv6 Prefix Delegation

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 timeout from an authentication, authorization, and accounting (AAA) session has the highest precedence and overrides local pool lease times.
- For a 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.

Related Documentation

- Reasons to Use IPv4/IPv6 Dual Stacks on page 1
- IPv6 Addressing Requirements for a Dual-Stack Network on page 1
- Overview of Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing on page 3
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Example: Configuring a Dual Stack That Uses DHCPv6 IA_NA and DHCPv6 Prefix Delegation over PPPoE

This example 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 NDRA or DHCPv6 to allocate IPv6 addresses on the LAN.

Requirements

This example uses the following hardware and software components:

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

NOTE: This configuration example has been tested using the software release listed and is assumed to work on all later releases.

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 3: PPPoE Subscriber Access Network with DHCPv6 IA_NA and DHCPv6 Prefix Delegation

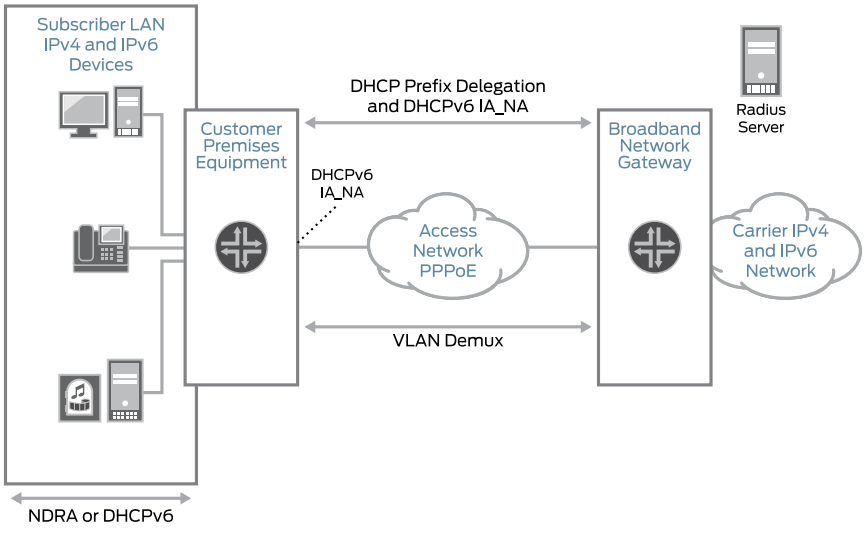

Table 1 on page 7 describes the configuration components used in this example.

Table 1: 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

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.

```
set system services dhcp-local-server dhcpv6 group v6-ppp-subscriber 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. Create a group for dynamic PPPoE interfaces, assign a name, and add an interface for dynamic PPPoE logical interfaces.

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

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

2. Commit the configuration.

   ```
   user@host# commit
   ```

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;
        }
      }
    }
  }
}
```

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.

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

   Include the **dynamic-profiles** statement at the **[edit]** hierarchy level and specify **pppoe-subscriber-profile** as the profile name.

   ```
   user@host# set dynamic-profiles pppoe-subscriber-profile
   ```

2. Add a routing instance to the profile and add an interface to the routing instance.

   Include the **routing-instances** statement at the **[edit dynamic-profiles pppoe-subscriber-profile]** hierarchy level and specify **$junos-routing-instance** as the routing instance name variable. Also include the **interface** statement at the **[edit dynamic-profiles pppoe-subscriber-profile routing-instances $junos-routing-instance]** hierarchy level and specify **$junos-interface-name** as the interface variable.

   ```
   user@host# set dynamic-profiles pppoe-subscriber-profile routing-instances
     $junos-routing-instance
   user@host# set dynamic-profiles pppoe-subscriber-profile routing-instances
     $junos-routing-instance 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.

   Include the **interfaces** statement at the **[edit dynamic-profiles pppoe-subscriber-profile]** hierarchy level and specify **pp0** as the interface name.

   ```
   user@host# set dynamic-profiles pppoe-subscriber-profile interfaces pp0
   ```

4. Configure the logical interface.

   Include the **unit** statement at the **[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0]** hierarchy level and 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.

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

5. Configure the underlying interface.

   Include the **underlying-interface** statement at the **[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit "$junos-interface-unit" pppoe-options]** hierarchy level and specify **$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.

   ```
   user@host# set dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
     "$junos-interface-unit" 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.

   Include the **server** statement at the **[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit "$junos-interface-unit" pppoe-options]** hierarchy level.

   ```
   user@host# set dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
     "$junos-interface-unit" pppoe-options server
   ```

7. Configure the IPv4 family for the pp0 interface.

   Include the **unnumbered-address** statement at the **[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit "$junos-interface-unit" family inet]** hierarchy level and specify the unnumbered address to dynamically apply loopback interfaces.

   Because the example uses routing instances, specify the predefined variable **$junos-loopback-interface**.

   ```
   user@host# set dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
     "$junos-interface-unit" family inet unnumbered-address
     $junos-loopback-interface
   ```

8. Configure the IPv6 family for the pp0 interface.

Include the **unnumbered-address** statement at the **[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit "$junos-interface-unit" pppoe-options family inet6]** hierarchy level and specify the unnumbered address to dynamically create loopback interfaces.

Because the example uses routing instances without router advertisement, specify the predefined variable **$junos-loopback-interface**.

```
user@host# set dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
  "$junos-interface-unit" pppoe-options family inet6 unnumbered-address
  $junos-loopback-interface
```

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

   Include the **ppp-options** statement at the **[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit "$junos-interface-unit"]** hierarchy level and specify **chap** and **pap** as the authentication protocols.

   ```
   user@host# set dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
     "$junos-interface-unit" ppp-options chap
   user@host# set dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
     "$junos-interface-unit" ppp-options pap
   ```

10. Enable keepalives and set an interval for keepalives.

    Include the **interval** statement at the **[edit dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit "$junos-interface-unit" keepalives]** hierarchy level and specify **30** seconds.

    We recommend an interval of 30 seconds.

    ```
    user@host# set dynamic-profiles pppoe-subscriber-profile interfaces pp0 unit
      "$junos-interface-unit 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.

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

Step-by-Step Procedure

To configure a loopback interface:

1. Create the loopback interface.

   Include the **unit** statement at the **[edit interfaces lo0]** hierarchy level and specify **0** as the logical interface number.

   Include the **address** statement at the **[edit interfaces lo0 unit 0 family inet]** hierarchy level and specify **10.0.0.1/32** as the IPv4 address.

   ```
   user@host# set interfaces lo0 unit 0 family inet address 10.0.0.1/32
   ```

2. Configure the interface IPv4 address to be the primary and preferred address.

   Include the **primary** and **preferred** statements at the **[edit interfaces lo0 unit 0 family inet address 10.0.0.1/32]** hierarchy level.

   ```
   user@host# set interfaces lo0 unit 0 family inet address 10.0.0.1/32 primary preferred
   ```

3. Configure the interface IPv6 address to be the primary and preferred address.

   Include the **address** statement at the **[edit interfaces lo0 unit 0 family inet6]** hierarchy level and specify **2001:0::1/128** as the IPv6 address.

   Include the **primary** and **preferred** statements at the **[edit interfaces lo0 unit 0 family inet6 address 2001:0::1/128]** hierarchy level.

   ```
   user@host# set interfaces lo0 unit 0 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.

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

Step-by-Step Procedure

To configure a VLAN demux interface over an Ethernet underlying interface:

1. Configure the underlying Ethernet interface.

   ```
   user@host# set interfaces ge-0/3/0 flexible-vlan-tagging
   user@host# set interfaces ge-0/3/0 encapsulation flexible-ethernet-services
   user@host# set interfaces ge-0/3/0 hierarchical-scheduler
     maximum-hierarchy-levels 2
   ```

2. Create the VLAN demux interface and specify a unit number.

   ```
   user@host# set interfaces demux0 unit 1
   ```

3. Configure the VLAN tags.

   ```
   user@host# set interfaces demux0 unit 1 vlan-tags outer 1 inner 1
   ```

4. Specify the underlying Ethernet interface.

   ```
   user@host# set interfaces demux0 unit 1 demux-options underlying-interface
     ge-0/3/0
   ```

5. Specify the dynamic profile.

```
user@host# set interfaces demux0 unit 1 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.

```
user@host# set interfaces demux0 unit 1 family pppoe duplicate-protection
```

7. (Optional) Specify that you want the demux interface to use proxy ARP.

```
user@host# set interfaces demux0 unit 1 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 a 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.

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

Step-by-Step Procedure To configure the interface:

1. Create the interface, specify a logical interface unit number, and configure the IPv4 address.

```
user@host# set interfaces ge-0/2/5 unit 0 family inet address 10.9.0.9
```

2. Specify that Gigabit Ethernet options are not automatically negotiated.

```
user@host# set interfaces ge-0/2/5 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 Router Identifier

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.

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

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

Step-by-Step Procedure Configure the router ID of the BNG.

```
user@host# set routing-options 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.

```
set access radius-server 10.9.0.9 secret "$9$lXRv87GUHm5FYgF/CA1l"
set access radius-server 10.9.0.9 timeout 45
set access radius-server 10.9.0.9 retry 4
set access radius-server 10.9.0.9 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.

   user@host# set access radius-server 10.9.0.9

2. Configure the required secret (password) for the server.

   Secrets enclosed in quotation marks can contain spaces.

   user@host# set access radius-server 10.9.0.9 secret "9lXRv87GUHm5FYgF/CA1I"

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

   user@host# set access radius-server 10.9.0.9 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.

   user@host# set access radius-server 10.9.0.9 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.

   user@host# set access radius-server 10.9.0.9 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 "$9$lXRv87GUHm5FYgF/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 the 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.

```
set access profile Access-Profile
set access profile Access-Profile authentication-order radius
set access profile Access-Profile radius authentication-server 10.9.0.9
```

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

Step-by-Step Procedure

To configure a RADIUS server access profile:

1. Create a RADIUS server access profile.

   ```
   user@host# set access profile Access-Profile
   ```

2. Specify the order in which authentication methods are used.

   ```
   user@host# set access profile Access-Profile authentication-order radius
   ```

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

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

4. Configure RADIUS accounting values for the access profile.

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

```
set access address-assignment pool v4-pool family inet network 10.16.0.1/32
set access address-assignment pool v4-pool family inet range v4-range-0 low 10.16.0.1
```

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

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

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

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

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

4. (Optional) Enable duplicate prefix protection.

```
user@host# set access 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

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 Addresses 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                                    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.

Results

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/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 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;
    }
```

Related Documentation

- Reasons to Use IPv4/IPv6 Dual Stacks on page 1
- IPv6 Addressing Requirements for a Dual-Stack Network on page 1
- Overview of Using DHCPv6 IA_NA to Provide IPv6 WAN Link Addressing on page 3
- Overview of Using DHCPv6 Prefix Delegation on page 3
- Overview of Using DHCPv6 IA_NA with DHCPv6 Prefix Delegation on page 5
- *Overview of Configuration Tasks for IPv4 and IPv6 Dual-Stack in Subscriber Access Networks*