

## Network Configuration Example

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



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## Introduction

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This document describes how service providers can implement IPv4 and IPv6 dual stack in a Point-to-Point Protocol over Ethernet (PPPoE) subscriber access network. It also provides a step-by-step configuration example for configuring a dual stack that uses Neighbor Discovery Router Advertisement (NDRA) and Dynamic Host Configuration Protocol for IPv6 (DHCPv6) prefix delegation over PPPoE. You learn how to add two types of IPv6 addressing to your subscriber network, and then how to create a dual stack implementation that uses these types of addressing. This document assumes that you already have IPv4 running in your network.

## Reasons to Use IPv4/IPv6 Dual Stacks

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As a service provider, you can use the Junos<sup>®</sup> 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](#)
- [Using NDRA to Provide IPv6 WAN Link Addressing on page 3](#)
- [Using DHCPv6 Prefix Delegation to Provide IPv6 Addresses on the Subscriber LAN on page 4](#)
- [Example: Configuring a Dual Stack That Uses NDRA and DHCPv6 Prefix Delegation over PPPoE on page 6](#)
- *Basic Architecture of a Subscriber Access Dual-Stack Network*
- *Terms Used in IPv4/IPv6 Dual-Stack Documentation*
- *Steps to Planning an IPv6 Implementation for a Dual-Stack Network*

## IPv6 Addressing Requirements for a Dual-Stack Network

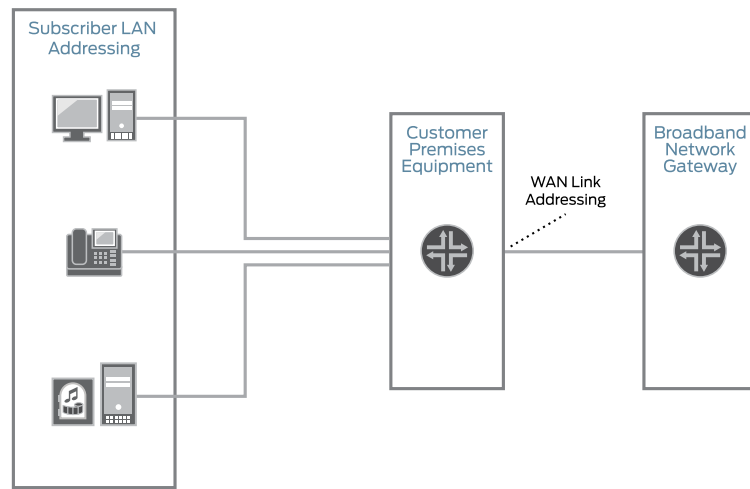
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You need to implement two types of addressing for IPv6 in a subscriber access network:

- 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](#)
- [Using NDRA to Provide IPv6 WAN Link Addressing on page 3](#)

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- [Using DHCPv6 Prefix Delegation to Provide IPv6 Addresses on the Subscriber LAN on page 4](#)
  - [Example: Configuring a Dual Stack That Uses NDRA and DHCPv6 Prefix Delegation over PPPoE on page 6](#)
  - [Overview of Using NDRA to Provide IPv6 WAN Link Addressing](#)
  - [Overview of Using DHCPv6 IA\\_NA to Provide IPv6 WAN Link Addressing](#)
  - [Overview of Using DHCPv6 Prefix Delegation](#)
  - [Overview of Using DHCPv6 IA\\_NA with DHCPv6 Prefix Delegation](#)
  - [Steps to Planning an IPv6 Implementation for a Dual-Stack Network](#)

## Using NDRA to Provide IPv6 WAN Link Addressing

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In a dual-stack network, Neighbor Discovery Router Advertisement (NDRA) provides a lightweight address assignment method for autoconfiguration of the global IPv6 address on the customer premises equipment (CPE) WAN link. The CPE device can construct its own IPv6 global address by combining the interface ID that is negotiated by Internet Protocol version 6 Control Protocol (IPv6CP) and the prefix obtained through NDRA.

Before NDRA can provide IPv6 address information to the CPE, you need to first obtain a link-local address for the CPE WAN link. NDRA 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, Point-to-Point Protocol (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 NDRA 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 NDRA address pool configured on the BNG.

If you are using authentication, authorization, and accounting (AAA), a RADIUS server can specify the prefix in the **Framed-Ipv6-Prefix** attribute, or it can specify an NDRA 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.

**Related Documentation**

- [Reasons to Use IPv4/IPv6 Dual Stacks on page 1](#)
- [IPv6 Addressing Requirements for a Dual-Stack Network on page 1](#)
- [Using DHCPv6 Prefix Delegation to Provide IPv6 Addresses on the Subscriber LAN on page 4](#)
- [Example: Configuring a Dual Stack That Uses NDRA and DHCPv6 Prefix Delegation over PPPoE on page 6](#)
- *IPv6 Neighbor Discovery Protocol Overview*
- *How NDRA Works in a Subscriber Access Network*
- *Design 2: IPv6 Addressing with NDRA and DHCPv6 Prefix Delegation*
- *Design 3: IPv6 Addressing with NDRA*
- *Configuration Tasks for PPPoE Access Networks in Which NDRA Is Used*

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## Using DHCPv6 Prefix Delegation to Provide IPv6 Addresses on the Subscriber LAN

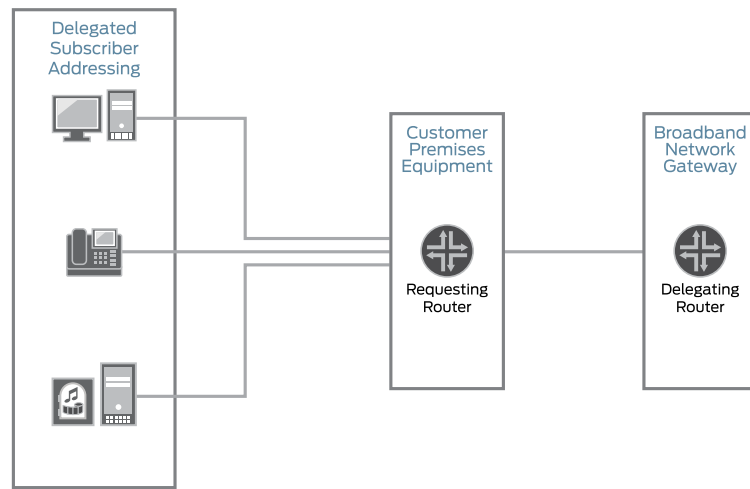
You can use Dynamic Host Configuration Protocol for IPv6 (DHCPv6) prefix delegation to automate the delegation of IPv6 prefixes to the customer premises equipment (CPE). With prefix delegation, a delegating broadband network gateway (BNG) router delegates IPv6 prefixes to a CPE router. The requesting 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 Network Address Translation (NAT) in an IPv6 network.

[Figure 2 on page 5](#) 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 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 Internet Protocol version 6 Control Protocol (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 authentication, authorization, and accounting (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 Identity Association for Prefix Delegation (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.

### Related Documentation

- [Reasons to Use IPv4/IPv6 Dual Stacks on page 1](#)
- [IPv6 Addressing Requirements for a Dual-Stack Network on page 1](#)

- [Using NDRA to Provide IPv6 WAN Link Addressing on page 3](#)
- [Example: Configuring a Dual Stack That Uses NDRA and DHCPv6 Prefix Delegation over PPPoE on page 6](#)
- [Design 1: IPv6 Addressing with DHCPv6 IA\\_NA and DHCPv6 Prefix Delegation](#)
- [Design 2: IPv6 Addressing with NDRA and DHCPv6 Prefix Delegation](#)
- [Design 4: IPv6 Addressing with DHCPv6 Prefix Delegation and No NDRA Prefix](#)
- [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 NDRA and DHCPv6 Prefix Delegation over PPPoE](#)

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

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This example provides a step-by-step procedure and commands for configuring and verifying a dual stack that uses Neighbor Discovery Router Advertisement (NDRA) and Dynamic Host Configuration Protocol for IPv6 (DHCPv6) prefix delegation over Point-to-Point Protocol over Ethernet (PPPoE).

- [Requirements on page 6](#)
- [Overview on page 6](#)
- [Configuration on page 8](#)

### Requirements

This example uses the following hardware and software components:

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

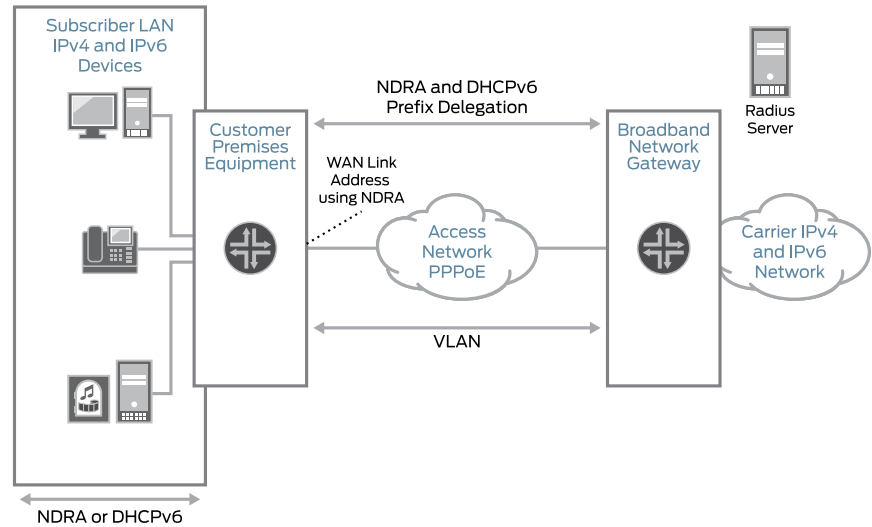
### Overview

This example uses NDRA and DHCPv6 prefix delegation in your subscriber access network as follows:

- The access network is PPPoE.
- NDRA 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 authentication, authorization, and accounting (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 3: PPPoE Subscriber Access Network with NDRA and DHCPv6 Prefix Delegation**



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

**Table 1: Configuration Components Used in Dual Stack with NDRA 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

---

**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 by specifying 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 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 NDRA 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/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 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 NDRA.

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 NDRA.

```
[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 18](#)
- [Verifying Both IPv4 and IPv6 Address in Correct Routing Instance on page 19](#)
- [Verifying Dynamic Subscriber Sessions on page 19](#)
- [Verifying DHCPv6 Address Pools Used for NDRA and DHCPv6 Prefix Delegation on page 20](#)
- [Verifying DHCPv6 Address Bindings on page 21](#)
- [Verifying Router Advertisements on page 21](#)
- [Verifying the Status of the PPPoE Logical Interface on page 22](#)

#### ***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
```

**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 NDRA and DHCPv6 Prefix Delegation*

**Purpose** Verify the pool used for NDRA, 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 NDRA 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 NDRA 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 prefixes 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 solicit messages 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 solicit messages 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 NDRA. 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.

---

## Results

---

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/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 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;
}
```

**Related  
Documentation**

- [Reasons to Use IPv4/IPv6 Dual Stacks on page 1](#)
- [IPv6 Addressing Requirements for a Dual-Stack Network on page 1](#)
- [Using NDRA to Provide IPv6 WAN Link Addressing on page 3](#)
- [Using DHCPv6 Prefix Delegation to Provide IPv6 Addresses on the Subscriber LAN on page 4](#)
- *Design 2: IPv6 Addressing with NDRA and DHCPv6 Prefix Delegation*
- *How NDRA Works in a Subscriber Access Network*
- *DHCPv6 Prefix Delegation over PPPoE*
- *Overview of Configuration Tasks for IPv4 and IPv6 Dual-Stack in Subscriber Access Networks*

