Configuring ATM Routing and PNNI

This chapter describes the Interim Interswitch Signaling Protocol (IISP) and Private Network-Network Interface (PNNI) ATM routing protocol implementations on the ATM switch router.

Note This chapter provides advanced configuration instructions for the Catalyst 8540 MSR, Catalyst 8510 MSR, and LightStream 1010 ATM switch routers. For further information about IISP and PNNI, refer to the *Guide to ATM Technology.* For complete descriptions of the commands mentioned in this chapter, refer to the *ATM Switch Router Command Reference* publication.

This chapter includes the following sections:

- Overview on page 10-1
- IISP Configuration on page 10-3
- Basic PNNI Configuration on page 10-10
- Advanced PNNI Configuration on page 10-30

Overview

To place calls between ATM end systems, signalling consults either IISP, a static routing protocol, or PNNI, a dynamic routing protocol. PNNI provides quality of service (QoS) routes to signalling based on the QoS requirements specified in the call setup request.

For detailed discussions of the following topics, refer to the *Guide to ATM Technology*:

- IISP routing
- PNNI signaling and routing
- Mechanisms and components of single-level and hierarchical PNNI

ATM Addresses

The autoconfigured ATM address of the ATM switch router suffices when implementing single-level PNNI. Hierarchical PNNI requires an addressing scheme to ensure global uniqueness of the ATM address and to plan for future network expansion.

For detailed discussions of the following related topics, refer to the *Guide to ATM Technology*:

- The autoconfigured ATM address for single-level PNNI
- E.164 ATM end system address (AESA) prefixes
- Designing an ATM address plan for hierarchical PNNI
- Obtaining registered ATM addresses

Configuring PNNI 2.0 E.164 AESA Prefix Encoding Support

The ATM switch router supports automatic PNNI 2.0 encoding of E.164 AESA prefixes. To configure automatic PNNI 2.0 encoding, use the following ATM router configuration command:

Command	Purpose
aesa embedded-number left-justified	Enables automatic conversion of E.164 AESA prefixes into left-justified encoding format.

The **aesa embedded-number left-justified** command causes the conversion of all reachable address prefixes with the E.164 Authority and Format Identifier (AFI), including reachable address prefixes advertised by remote PNNI nodes, routes learned by ILMI, and reachable address prefixes installed by the switch router automatically. This affects the **atm route**, **auto-summary**, **summary-address**, **show atm route**, and **show atm pnni summary** commands. The **atm address**, **atm prefix**, and **show atm addresses** commands are not affected because they do not use PNNI address prefixes.

Note   Configure all switch routers in the PNNI routing domain with the **aesa embedded-number left-justified** command to ensure that each switch router uses the same E.164 AESA prefix encoding.

Example

The following example shows how to configure the switch router to convert the E.164 AESA prefixes to PNNI 2.0 format, beginning in global configuration mode:

```
Switch# configure terminal
Switch(config)# atm router pnni
Switch(config-atm-router)# aesa embedded-number left-justified
```

Displaying the PNNI 2.0 E.164 AESA Prefix Encoding Support Configuration

To display the PNNI 2.0 E.164 AESA prefix encoding support configuration, use the following EXEC command:

Command	Purpose
show atm pnni aesa embedded-number	Displays the configuration of the automatic conversion of E.164 AESA prefixes into left-justified encoding format.

Example

The following example show how to display the configuration of the automatic conversion of E.164 AESA prefixes into left-justified encoding format:

```
Switch# show atm pnni aesa embedded-number
AESA embedded-number is left-justified.
```

IISP Configuration

This section describes the procedures necessary for Interim Interswitch Signaling Protocol (IISP) configuration, and includes the following subsections:

- Configuring the Routing Mode on page 10-3
- Configuring the ATM Address on page 10-5
- Configuring Static Routes on page 10-7

Configuring the Routing Mode

The ATM routing software can be restricted to operate in static mode. In this mode, the call routing is restricted to only the static configuration of ATM routes, disabling operation of any dynamic ATM routing protocols, such as PNNI.

The **atm routing-mode** command is different from deleting all PNNI nodes using the **node** command and affects Integrated Local Management Interface (ILMI) autoconfiguration. If the switch is configured using static routing mode on each interface, the switch ILMI variable atmfAtmLayerNniSigVersion is set to IISP. This causes either of the following to happen:

- ILMI autoconfiguration on the interfaces between two switches determines the interface type as IISP.
- The switch on the other side indicates that the Network-Network Interface (NNI) signalling protocol is not supported.

Note   The **atm routing-mode** command is activated only after the next software reload. The switch continues to operate in the current mode until the software is reloaded.

To configure the routing mode, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm routing-mode static**	Configures the ATM routing mode to static.
Step 2	Switch(config)# **end** Switch#	Exits configuration mode.
Step 3	Switch# **copy system:running-config nvram:startup-config**	Writes the running configuration to the startup configuration.
Step 4	Switch# **reload**	Reloads the switch software.

Example

The following example shows how to use the **atm routing-mode static** command to restrict the switch operation to static routing mode:

```
Switch(config)# atm routing-mode static
This Configuration Will Not Take Effect Until Next Reload.
Switch(config)# end
Switch# copy system:running-config nvram:startup-config
Building configuration...
[OK]
Switch# reload
```

The following example shows how to reset the switch operation back to PNNI if the switch is operating in static mode:

```
Switch(config)# no atm routing-mode static
This Configuration Will Not Take Effect Until Next Reload.
Switch(config)# end
Switch# copy system:running-config nvram:startup-config
Building configuration...
[OK]
Switch# reload
```

Displaying the ATM Routing Mode Configuration

To display the ATM routing mode configuration, use the following privileged EXEC command:

Command	Purpose
more system:running-config	Displays the ATM routing mode configuration.

Example

The following example shows the ATM routing mode configuration using the **more system:running-config** privileged EXEC command:

```
Switch# more system:running-config
Building configuration...

Current configuration:
!
version 11.2
<information deleted>
!
hostname Switch
!
username dtate
ip rcmd remote-username dplatz
!
atm e164 translation-table
 e164 address 1111111 nsap-address 11.111111111111111111111111.112233445566.11
 e164 address 2222222 nsap-address 22.2222222222222222222222222.112233445566.22
 e164 address 3333333 nsap-address 33.3333333333333333333333333.112233445566.33
!
atm routing-mode static
atm address 47.0091.8100.0000.0040.0b0a.2b81.0040.0b0a.2b81.00
!
<information deleted>
```

Configuring the ATM Address

If you are planning to implement only a flat topology network (and have no future plans to migrate to PNNI hierarchy), you can skip this section and use the preconfigured ATM address assigned by Cisco Systems.

✎

Note   For information about ATM address considerations, refer to the "ATM Addresses" section on page 10-2.

To change the active ATM address, create a new address, verify that it exists, and then delete the current active address. Follow these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm address** *new-address-template*	Configures the ATM address for the switch.
Step 2	Switch(config)# **end** Switch#	Returns to privileged EXEC mode.
Step 3	Switch# **show atm addresses**	Verifies the new address.
Step 4	Switch# **configure terminal** Switch(config)#	Enters configuration mode from the terminal.
Step 5	Switch(config)# **no atm address** *old-address-template*	Removes the old ATM address from the switch.

Example

The following example shows how to add the ATM address prefix 47.0091.8100.5670.000.0ca7.ce01.
Using the ellipses (...) adds the default Media Access Control (MAC) address as the last six bytes.

```
Switch(config)# atm address 47.0091.8100.5670.0000.0ca7.ce01...
Switch(config)# no atm address 47.0091.8100.0000.0041.0b0a.1081...
```

Displaying the ATM Address Configuration

To display the ATM address configuration, use the following EXEC command:

Command	Purpose
show atm addresses	Displays the ATM address configuration.

Example

The following example shows the ATM address configuration using the **show atm addresses** EXEC
command:

```
Switch# show atm addresses

Switch Address(es):
    47.00918100000000410B0A1081.00410B0A1081.00 active
    47.00918100567000000CA7CE01.00410B0A1081.00

Soft VC Address(es):
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0000.00 ATM0/0/0
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0000.63 ATM0/0/0.99
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0010.00 ATM0/0/1
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0020.00 ATM0/0/2
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0030.00 ATM0/0/3
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1000.00 ATM0/1/0
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1010.00 ATM0/1/1
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1020.00 ATM0/1/2
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.1030.00 ATM0/1/3
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8000.00 ATM1/0/0
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8010.00 ATM1/0/1
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8020.00 ATM1/0/2
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.8030.00 ATM1/0/3
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9000.00 ATM1/1/0
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9010.00 ATM1/1/1
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9020.00 ATM1/1/2
    47.0091.8100.0000.0041.0b0a.1081.4000.0c80.9030.00 ATM1/1/3

ILMI Switch Prefix(es):
    47.0091.8100.0000.0041.0b0a.1081
    47.0091.8100.0000.0060.3e5a.db01

ILMI Configured Interface Prefix(es):

LECS Address(es):
```

Configuring Static Routes

Use the **atm route** command to configure a static route. A static route attached to an interface allows all ATM addresses matching the configured address prefix to be reached through that interface.

Note   For private User-Network Interface (UNI) interfaces where ILMI address registration is not used, internal-type static routes should be configured to a 19-byte address prefix representing the attached end system.

To configure a static route, use the following global configuration command:

Command	Purpose
atm route *addr-prefix* **atm** *card/subcard/port* [**e164-address** *address-string* [**number-type** *numtype*]] [**internal**] [**scope** *org-scope*] [**aesa-gateway** *aesa-address*]	Specifies a static route to a reachable address prefix.

Examples

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0:

```
Switch(config)# atm route 47.0091.8100.0000.0041.0B0A.1081 atm 0/0/0
```

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0 configured with a scope 1 associated:

```
Switch(config)# atm route 47.0091.8100.0000.0041.0B0A.1081 atm 0/0/0 scope 1
```

Displaying the Static Route Configuration

To display the ATM static route configuration, use the following EXEC command:

Command	Purpose
show atm route	Displays the static route configuration.

Examples

The following example shows the ATM static route configuration using the **show atm route** privileged EXEC command:

```
Switch# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T Node/Port       St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
S  E 1   ATM0/0/0    DN 56  47.0091.8100.0000/56
S  E 1   ATM0/0/0    DN 0   47.0091.8100.0000.00/64
                            (E164 Address 1234567)
R SI 1   0           UP 0   47.0091.8100.0000.0041.0b0a.1081/104
R  I 1   ATM0        UP 0   47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081/152
R  I 1   ATM0        UP 0   47.0091.8100.0000.0041.0b0a.1081.4000.0c/128
R SI 1   0           UP 0   47.0091.8100.5670.0000.0000.0000/104
R  I 1   ATM0        UP 0   47.0091.8100.5670.0000.0000.0000.0040.0b0a.1081/152
R  I 1   ATM0        UP 0   47.0091.8100.5670.0000.0000.0000.4000.0c/128
```

Configuring ATM Address Groups

ATM address groups allow more than one interface to have the same internal address prefix for the same static route. These multiple static routes provide load balancing for traffic from an end station.

Configure the interfaces in a group by performing the following tasks, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port*[**.***vpt#*] Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm interface-group** *number*	Configures the ATM address group.

Example

The following example shows how to configure ATM interface 1/1/0 and ATM interface 3/0/1 in ATM address group 5:

```
Switch(config)# interface atm 1/1/0
Switch(config-if)# atm interface-group 5
Switch(config-if)# exit
Switch(config)# interface atm 3/0/1
Switch(config-if)# atm interface-group 5
```

Displaying ATM Address Group Configuration

To determine if an interface is a member of an ATM address group, use the following privileged EXEC command:

Command	Purpose
show running-config interface atm *card*/*subcard*/*port*	Shows the ILMI configuration on a per-port basis.

Example

The following example shows the ATM address group configuration for ATM interface 1/1/0 and ATM interface 3/0/1:

```
Switch# show running-config interface atm 1/1/0
Building configuration...

Current configuration:
!
interface ATM1/1/0
 no ip address
 no ip directed-broadcast
 no atm ilmi-keepalive
 atm prefix 47.0091.8100.5670.0000.0000.1122...
 atm interface-group 5
 clock source free-running
end
Switch# show running-config interface atm 3/0/1
Building configuration...

Current configuration:
!
interface ATM3/0/1
 no ip address
 no ip directed-broadcast
 no atm ilmi-keepalive
 atm prefix 47.0091.8100.5670.0000.0000.1122...
 atm interface-group 5
 clock source free-running
end
```

Basic PNNI Configuration

This section describes all the procedures necessary for a basic PNNI configuration and includes the following subsections:

- Configuring PNNI without Hierarchy on page 10-10
- Configuring the Lowest Level of the PNNI Hierarchy on page 10-10
- Configuring Higher Levels of the PNNI Hierarchy on page 10-17

Configuring PNNI without Hierarchy

The ATM switch router defaults to a working PNNI configuration suitable for operation in isolated flat topology ATM networks. The switch comes with a globally unique preconfigured ATM address. Manual configuration is not required if you:

- Have a flat network topology
- Do not plan to connect the switch to a service provider network
- Do not plan to migrate to a PNNI hierarchy in the future

If you plan to migrate your flat network topology to a PNNI hierarchical topology, proceed to the next section "Configuring the Lowest Level of the PNNI Hierarchy."

Configuring the Lowest Level of the PNNI Hierarchy

This section describes how to configure the lowest level of the PNNI hierarchy. The lowest-level nodes comprise the lowest level of the PNNI hierarchy. When only the lowest-level nodes are configured, there is no hierarchical structure. If your network is relatively small and you want the benefits of PNNI, but do not need the benefits of a hierarchical structure, follow the procedures in this section to configure the lowest level of the PNNI hierarchy.

To implement multiple levels of PNNI hierarchy, first complete the procedures in this section and then proceed to the "Configuring Higher Levels of the PNNI Hierarchy" section on page 10-17.

Configuring an ATM Address and PNNI Node Level

The ATM switch router is preconfigured as a single lowest-level PNNI node (locally identified as node 1) with a level of 56. The node ID and peer group ID are calculated based on the current active ATM address.

Note   If you are planning to implement only a flat topology network (and have no future plans to migrate to PNNI hierarchy), you can skip this section and use the preconfigured ATM address.

To configure a node in a higher level of the PNNI hierarchy, the value of the node level must be a smaller number. For example, a three-level hierarchical network could progress from level 72 to level 64 to level 56. Notice that the level numbers graduate from largest at the lowest level (72) to smallest at the highest level (56).

To change the active ATM address you must create a new address, verify that it exists, and then delete the current active address. After you have entered the new ATM address, disable node 1 and then reenable it. At the same time, you can change the node level if required for your configuration. The identifiers for all higher level nodes are recalculated based on the new ATM address.

⚠

Caution   Node IDs and peer group IDs are not recalculated until the node is disabled and then reenabled.

To change the active ATM address, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm address** *new-address-template*	Configures the new ATM address for the switch.
Step 2	Switch(config)# **end** Switch#	Returns to privileged EXEC mode.
Step 3	Switch# **show atm addresses**	Verifies the new address.
Step 4	Switch# **configure terminal** Switch(config)#	Enters configuration mode from the terminal.
Step 5	Switch(config)# **no atm address** *old-address-template*	Removes the old ATM address from the switch.
Step 6	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode from the terminal.
Step 7	Switch(config-atm-router)# **node 1 disable** Switch(config-pnni-node)#	Disables the PNNI node.
Step 8	Switch(config-pnni-node)# **node 1 level** *number* **enable**	Reenables the node. You can also change the node level if required for your configuration.

Example

The following example changes the ATM address of the switch from the autoconfigured address 47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081.00 to the new address prefix 47.0091.8100.5670.0000.0000.1122.0041.0b0a.1081.00, and causes the node identifier and peer group identifier to be recalculated:

```
Switch(config)# atm address 47.0091.8100.5670.0000.0000.1122...
Switch(config)# no atm address 47.0091.8100.0000.0041.0b0a.1081...
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1 disable
Switch(config-pnni-node)# node 1 enable
```

Displaying the PNNI Node Configuration

To display the ATM PNNI node configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the ATM PNNI node configuration.

Example

The following example shows the PNNI node configuration using the show **atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: eng_1
  System address        47.0091810000000002EB1FFE00.0002EB1FFE00.01
  Node ID         56:160:47.0091810000000002EB1FFE00.0002EB1FFE00.00
  Peer group ID      56:160:47.0000.0000.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 1, No. of neighbors 0
  Parent Node Index: 2
  Node Allows Transit Calls
  Node Representation: simple

  Hello interval 15 sec, inactivity factor 5,
  Hello hold-down 10 tenths of sec
  Ack-delay 10 tenths of sec, retransmit interval 5 sec,
  Resource poll interval 5 sec
  SVCC integrity times: calling 35 sec, called 50 sec,
  Horizontal Link inactivity time 120 sec,
  PTSE refresh interval 1800 sec, lifetime factor 200 percent,
  Min PTSE interval 10 tenths of sec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: uniform
  Max admin weight percentage: -1
  Next resource poll in 3 seconds
  Max PTSEs requested per PTSE request packet: 32
  Redistributing static routes: Yes
```

Configuring Static Routes

Because PNNI is a dynamic routing protocol, static routes are not necessary between nodes that support PNNI. However, you can extend the routing capability of PNNI beyond nodes that support PNNI to:

- Connect to nodes outside of a peer group that do not support PNNI
- Define routes to end systems that do not support Integrated Local Management Interface (ILMI)

Use the **atm route** command to configure a static route. A static route attached to an interface allows all ATM addresses matching the configured address prefix to be reached through that interface.

Note Two PNNI peer groups can be connected using the IISP protocol. Connecting PNNI peer groups requires that a static route be configured on the IISP interfaces, allowing connections to be set up across the IISP link(s).

To configure a static route connection, use the following global configuration command:

Command	Purpose
atm route *addr-prefix* **atm** *card/subcard/port* [**e164-address** *address-string* [**number-type** *numtype*]] [**internal**] [**scope** *org-scope*]	Specifies a static route to a reachable address prefix.

Examples

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0:

```
Switch(config)# atm route 47.0091.8100.0000.0041.0B0A.1081 atm 0/0/0
```

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0 configured with a scope 1 associated:

```
Switch(config)# atm route 47.0091.8100.0000.0041.0B0A.1081 atm 0/0/0 scope 1
```

Displaying the Static Route Configuration

To display the ATM static route configuration, use the following EXEC command:

Command	Purpose
show atm route	Displays the static route configuration.

Example

The following example shows the ATM static route configuration using the **show atm route** EXEC command:

```
Switch# show atm route

Codes: P - installing Protocol (S - Static, P - PNNI, R - Routing control),
       T - Type (I - Internal prefix, E - Exterior prefix, SE -
                 Summary Exterior prefix, SI - Summary Internal prefix,
                 ZE - Suppress Summary Exterior, ZI - Suppress Summary Internal)

P  T  Node/Port        St Lev Prefix
~ ~~ ~~~~~~~~~~~~~~~~ ~~ ~~~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
S  E  1   ATM0/0/0      DN 56  47.0091.8100.0000/56
S  E  1   ATM0/0/0      DN 0   47.0091.8100.0000.00/64
                               (E164 Address 1234567)
R  SI 1   0             UP 0   47.0091.8100.0000.0041.0b0a.1081/104
R  I  1   ATM0          UP 0   47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081/152
R  I  1   ATM0          UP 0   47.0091.8100.0000.0041.0b0a.1081.4000.0c/128
R  SI 1   0             UP 0   47.0091.8100.5670.0000.0000.0000/104
R  I  1   ATM0          UP 0   47.0091.8100.5670.0000.0000.0000.0040.0b0a.1081/152
R  I  1   ATM0          UP 0   47.0091.8100.5670.0000.0000.0000.4000.0c/128
```

Configuring a Summary Address

You can configure summary addresses to reduce the amount of information advertised by a PNNI node and contribute to scalability in large networks. Each summary address consists of a single reachable address prefix that represents a collection of end system or node addresses. We recommend that you use summary addresses when all end system addresses that match the summary address are directly reachable from the node. However, this is not always required because routes are always selected by nodes advertising the longest matching prefix to a destination address.

By default, each lowest-level node has a summary address equal to the 13-byte address prefix of the ATM address of the switch. This address prefix is advertised into its peer group.

You can configure multiple addresses for a single switch which are used during ATM address migration. ILMI registers end systems with multiple prefixes during this period until an old address is removed. PNNI automatically creates 13-byte summary address prefixes from all of its ATM addresses.

You must configure summary addresses (other than the defaults) on each node. Each node can have multiple summary address prefixes. Use the **summary-address** command to manually configure summary address prefixes.

> **Note** The **no auto-summary** command removes the default summary address(es). Use the **no auto-summary** command when systems that match the first 13-bytes of the ATM address(es) of your switch are attached to different switches. You can also use this command for security purposes.

To configure a summary address, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **no auto-summary**	Removes the default summary address(es).
Step 4	Switch(config-pnni-node)# **summary-address** *address-prefix*	Configures the ATM PNNI summary address prefix.

Example

The following example shows how to remove the default summary address(es) and add summary address 47.009181005670:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# no auto-summary
Switch(config-pnni-node)# summary-address 47.009181005670
```

Displaying the Summary Address Configuration

To display the ATM PNNI summary address configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni summary	Displays a summary of the PNNI hierarchy.

Example

The following example shows the ATM PNNI summary address configuration using the **show atm pnni summary** privileged EXEC command:

```
Switch# show atm pnni summary

Codes: Node - Node index advertising this summary
       Type - Summary type (INT - internal, EXT - exterior)
       Sup  - Suppressed flag (Y - Yes, N - No)
       Auto - Auto Summary flag (Y - Yes, N - No)
       Adv  - Advertised flag (Y - Yes, N - No)

 Node Type Sup Auto Adv   Summary Prefix
 ~~~~ ~~~~ ~~~ ~~~~ ~~~   ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   1  Int   N   Y    Y    47.0091.8100.0000.0040.0b0a.2a81/104
   2  Int   N   Y    N    47.01b1.0000.0000.0000.00/80
```

Configuring Scope Mapping

The PNNI address scope allows you to restrict advertised reachability information within configurable boundaries.

Note   On UNI and IISP interfaces, the scope is specified in terms of organizational scope values ranging from 1 (local) to 15 (global). (Refer to the ATM Forum UNI Signalling 4.0 specification for more information.)

In PNNI networks, the scope is specified in terms of PNNI levels. The mapping from organizational scope values used at UNI and IISP interfaces to PNNI levels is configured on the lowest-level node. The mapping can be determined automatically (which is the default setting) or manually, depending on the configuration of the **scope mode** command.

In manual mode, whenever the level of node 1 is modified, the scope map should be reconfigured to avoid unintended suppression of reachability advertisements. Misconfiguration of the scope map might cause addresses to remain unadvertised.

In automatic mode, the UNI to PNNI level mapping is automatically reconfigured whenever the level of the node 1 is modified. The automatic reconfiguration avoids misconfigurations caused by node level modifications. Automatic adjustment of scope mapping uses the values shown in Table 10-1.

Table 10-1   Scope Mapping Table

Organizational Scope	ATM Forum PNNI 1.0 Default Level	Automatic Mode PNNI Level
1 to 3	96	Minimum (1,96)
4 to 5	80	Minimum (1,80)
6 to 7	72	Minimum (1,72)
8 to 10	64	Minimum (1,64)
11 to 12	48	Minimum (1,48)
13 to 14	32	Minimum (1,32)
15 (global)	0	0

Entering the **scope mode automatic** command ensures that all organizational scope values cover an area at least as wide as the current node's peer group. Configuring the scope mode to **manual** disables this feature and no changes can be made without explicit configuration.

To configure the PNNI scope mapping, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **scope mode manual**	Configures scope mode as manual.[1]
Step 4	Switch(config-pnni-node)# **scope map** *low-org-scope* [*high-org-scope*] **level** *number*	Configures node scope mapping.

1.   You must enter the **scope mode manual** command to allow scope mapping configuration.

Example

The following example shows how to configure PNNI scope mapping manually so that organizational scope values 1 through 8 map to PNNI level 72:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# scope mode manual
Switch(config-pnni-node)# scope map 1 8 level 72
```

Displaying the Scope Mapping Configuration

To display the PNNI scope mapping configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni scope	Displays the node PNNI scope mapping configuration.

Example

The following example shows the ATM PNNI scope mapping configuration using the **show atm pnni scope** privileged EXEC command:

```
Switch# show atm pnni scope

UNI scope    PNNI Level
~~~~~~~~~    ~~~~~~~~~~
(1  - 10)      56
(11 - 12)      48
(13 - 14)      32
(15 - 15)       0

Scope mode: manual
```

Configuring Higher Levels of the PNNI Hierarchy

Once you have configured the lowest level of the PNNI hierarchy, you can configure the higher levels. To do so, you must configure peer group leaders (PGLs) and logical group nodes (LGNs).

For an explanation of PGLs and LGNs, as well as guidelines for creating a PNNI hierarchy, refer to the *Guide to ATM Technology.*

Configuring a Logical Group Node and Peer Group Identifier

The LGN is created only when the child node in the same switch (that is, the node whose parent configuration points to this node) is elected PGL of the child peer group.

The peer group identifier defaults to a value created from the first part of the child peer group identifier, and does not need to be specified. If you want a nondefault peer group identifier, you must configure all logical nodes within a peer group with the same peer group identifier.

Higher level nodes are only active if:

• A lower-level node specifies the higher-level node as a parent.

• The election leadership priority of the child node is configured with a non-zero value and is elected as the PGL.

To configure a LGN and peer group identifier, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* **level** *number* [**lowest**] [**peer-group-identifier** *dd:xxx*] [**enable** | **disable**]	Configures the logical node and optionally its peer group identifier. Configures each logical node in the peer group with the same peer group identifier. When you have more than one logical node on the same switch, you must specify a different index number to distinguish it from node 1.

Examples

The following example shows how to create a new node 2 with a level of 56 and a peer group identifier of 56:47009111223344:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 2 level 56 peer-group-identifier 56:47009111223344 enable
Switch(config-pnni-node)# end
```

Notice that the PNNI level and the first two digits of the peer group identifier are the same.

Displaying the Logical Group Node Configuration

To display the LGN configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the PNNI node information.

Example

The following example shows the PNNI node information using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node 2

PNNI node 2 is enabled and not running
  Node name: Switch.2.56
  System address          47.009181000000000000000001.000000000001.02
  Node ID            56:0:00.000000000000000000000000.000000000001.00
  Peer group ID      56:47.0091.1122.3344.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: NONE
  Node Allows Transit Calls
  Node Representation: simple

  Hello interval 15 sec, inactivity factor 5,
  Hello hold-down 10 tenths of sec
  Ack-delay 10 tenths of sec, retransmit interval 5 sec,
  Resource poll interval 5 sec
  SVCC integrity times: calling 35 sec, called 50 sec,
  Horizontal Link inactivity time 120 sec,
  PTSE refresh interval 1800 sec, lifetime factor 200 percent,
  Min PTSE interval 10 tenths of sec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: uniform
  Max admin weight percentage: -1
  Max PTSEs requested per PTSE request packet: 32
  Redistributing static routes: No
```

Configuring the Node Name

PNNI node names default to names based on the host name. However, you can change the default node name to more accurately reflect the peer group. We recommend you chose a node name of 12 characters or less so that your screen displays remain nicely formatted and easy to read.

After a node name has been configured, it is distributed to all other nodes by PNNI flooding. This allows the node to be identified by its node name in PNNI **show** commands.

Note   Refer to section "Configuring System Information" section on page 3-18 for information about configuring host names.

To configure the PNNI node name, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **name** *name*	Configures the node name.

Example

Configure the name of the node as eng_1 using the **name** command, as in the following example:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# name eng_1
```

Displaying the Node Name Configuration

To display the ATM PNNI node name configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the ATM PNNI router configuration.

Example

This example shows how to display the ATM node name configuration using the **show atm pnni local-node** command from user EXEC mode:

```
Switch# show atm pnni local-node
PNNI node 1 is enabled and running
  Node name: eng_1
  System address         47.0091810000000002EB1FFE00.0002EB1FFE00.01
  Node ID           56:160:47.0091810000000002EB1FFE00.0002EB1FFE00.00
  Peer group ID        56:16.0347.0000.0000.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 1, No. of neighbors 0
  Parent Node Index: 2
  Node Allows Transit Calls
  Node Representation: simple

  Hello interval 15 sec, inactivity factor 5,
  Hello hold-down 10 tenths of sec
  Ack-delay 10 tenths of sec, retransmit interval 5 sec,
  Resource poll interval 5 sec
  SVCC integrity times: calling 35 sec, called 50 sec,
  Horizontal Link inactivity time 120 sec,
  PTSE refresh interval 1800 sec, lifetime factor 200 percent,
  Min PTSE interval 10 tenths of sec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: uniform
  Max admin weight percentage: -1
  Next resource poll in 3 seconds
  Max PTSEs requested per PTSE request packet: 32
  Redistributing static routes: Yes
```

Configuring a Parent Node

For a node to be eligible to become a PGL within its own peer group, you must configure a parent node and a nonzero election leadership level (described in the following section, "Configuring the Node Election Leadership Priority"). If the node is elected a PGL, the node specified by the **parent** command becomes the parent node and represents the peer group at the next hierarchical level.

To configure a parent node, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index*	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **parent** *node-index*	Configures the parent node index.

Example

The following example shows how to create a parent node for node 1:

```
Switch(config)# atm router pnni
Switch(config-pnni-node)# node 1
Switch(config-pnni-node)# parent 2
```

Displaying the Parent Node Configuration

To display the parent node configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni hierarchy	Displays the PNNI hierarchy.

Example

The following example shows the ATM parent node information using the **show atm pnni hierarchy** privileged EXEC command:

```
Switch# show atm pnni hierarchy
Locally configured parent nodes:
  Node        Parent
  Index Level Index  Local-node Status      Node Name
  ~~~~~ ~~~~~ ~~~~~~ ~~~~~~~~~~~~~~~~~~~~  ~~~~~~~~~~~~~~~~~~~~~~
  1     80    2      Enabled/ Running      Switch
  2     72    N/A    Enabled/ Running      Switch.2.72
```

Configuring the Node Election Leadership Priority

Normally the node with the highest election leadership priority is elected PGL. If two nodes share the same election priority, the node with the highest node identifier becomes the PGL. To be eligible for election the configured priority must be greater than zero. You can configure multiple nodes in a peer group with nonzero leadership priority so that if one PGL becomes unreachable, the node configured with the next highest election leadership priority becomes the new PGL.

> **Note** The choice of PGL does not directly affect the selection of routes across the peer group.

The control for election is done through the assignment of leadership priorities. We recommend that the leadership priority space be divided into three tiers:

- First tier: 1 to 49
- Second tier: 100 to 149
- Third tier: 200 to 205

This subdivision is used because when a node becomes PGL, it increases the advertised leadership priority by a value of 50. This avoids instabilities after election.

The following guidelines apply when configuring the node election leadership priority:

- Nodes that you do not want to become PGLs should remain with the default leadership priority value of 0.
- Unless you want to force one of the PGL candidates to be the PGL, you should assign all leadership priority values within the first tier. After a node is elected PGL, it remains PGL until it goes down or is configured to step down.
- If certain nodes should take precedence over nodes in the first tier, even if one is already PGL, leadership priority values can be assigned from the second tier. We recommend that you configure more than one node with a leadership priority value from this tier. This prevents one unstable node with a larger leadership priority value from repeatedly destabilizing the peer group.
- If you need a strict master leader, use the third tier.

> **Note** The **election leadership-priority** command does not take effect unless a parent node has already been configured using the **node** and **parent** commands.

To configure the election leadership priority, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode from the terminal.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **election leadership-priority** *number*	Configures the election leadership priority. The configurable range is from 0 to 205.

Example

The following example shows how to change the election leadership priority for node 1 to 100:

```
Switch(config)# atm router pnni
Switch(config-pnni-node)# node 1
Switch(config-pnni-node)# election leadership-priority 100
```

Displaying Node Election Leadership Priority

To display the node election leadership priority, use one of the following privileged EXEC commands:

Command	Purpose
show atm pnni election	Displays the node election leadership priority.
show atm pnni election peers	Displays all nodes in the peer group.

Examples

The following example shows the election leadership priority using the **show atm pnni election** privileged EXEC command:

```
Switch# show atm pnni election

PGL Status.............: PGL
Preferred PGL..........: (1) Switch
Preferred PGL Priority.: 255
Active PGL.............: (1) Switch
Active PGL Priority....: 255
Active PGL For.........: 00:01:07
Current FSM State......: PGLE Operating: PGL
Last FSM State.........: PGLE Awaiting Unanimity
Last FSM Event.........: Unanimous Vote

Configured Priority....: 205
Advertised Priority....: 255
Conf. Parent Node Index: 2
PGL Init Interval......: 15 secs
Search Peer Interval...: 75 secs
Re-election Interval...: 15 secs
Override Delay.........: 30 secs
```

The following example shows all nodes in the peer group using the **show atm pnni election peers** command:

```
Switch# show atm pnni election peers

 Node No.    Priority   Connected    Preferred PGL
 ~~~~~~~~    ~~~~~~~~    ~~~~~~~~~    ~~~~~~~~~~~~~~
 1           255         Yes          Switch
 9           0           Yes          Switch
 10          0           Yes          Switch
 11          0           Yes          Switch
 12          0           Yes          Switch
```

Configuring a Summary Address

Summary addresses can be used to decrease the amount of information advertised by a PNNI node. Summary addresses should only be used when all end system addresses that match the summary address are directly reachable from this node. However, this is not always required because routes are always selected to nodes advertising the longest matching prefix to a destination address.

A single default summary address is configured for each logical group node (LGN) in the PNNI hierarchy. The length of that summary for any LGN equals the level of the child peer group, and its value is equal to the first level bits of the child peer group identifier. This address prefix is advertised into the LGN's peer group.

Summary addresses other than defaults must be explicitly configured on each node. A node can have multiple summary address prefixes. Note also that every node in a peer group that has a potential to become a peer group leader (PGL) should have the same summary address lists in its parent node configuration.

Note   The **no auto-summary** command removes the default summary address(es). Use the **no auto-summary** command when systems that match the first 13-bytes of the ATM address(es) of your switch are attached to different switches.

To configure the ATM PNNI summary address prefix, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **no auto-summary**	Removes the default summary address(es).
Step 4	Switch(config-pnni-node)# **summary-address** *address-prefix*	Configures the ATM PNNI summary address prefix.

Example

The following example shows how to remove the default summary address(es) and add summary address 47.009181005670:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# no auto-summary
Switch(config-pnni-node)# summary-address 47.009181005670
```

Displaying the Summary Address Configuration

To display the ATM PNNI summary address configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni summary	Displays the ATM PNNI summary address configuration.

Example

The following example shows the ATM PNNI summary address configuration using the **show atm pnni summary** privileged EXEC command:

```
Switch# show atm pnni summary

Codes: Node - Node index advertising this summary
       Type - Summary type (INT - internal, EXT - exterior)
       Sup  - Suppressed flag (Y - Yes, N - No)
       Auto - Auto Summary flag (Y - Yes, N - No)
       Adv  - Advertised flag (Y - Yes, N - No)

 Node Type Sup Auto Adv  Summary Prefix
 ~~~~ ~~~~ ~~~ ~~~~ ~~~  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
   1  Int  N   Y    Y    47.0091.8100.0000.0040.0b0a.2a81/104
   2  Int  N   Y    N    47.01b1.0000.0000.0000.00/80
```
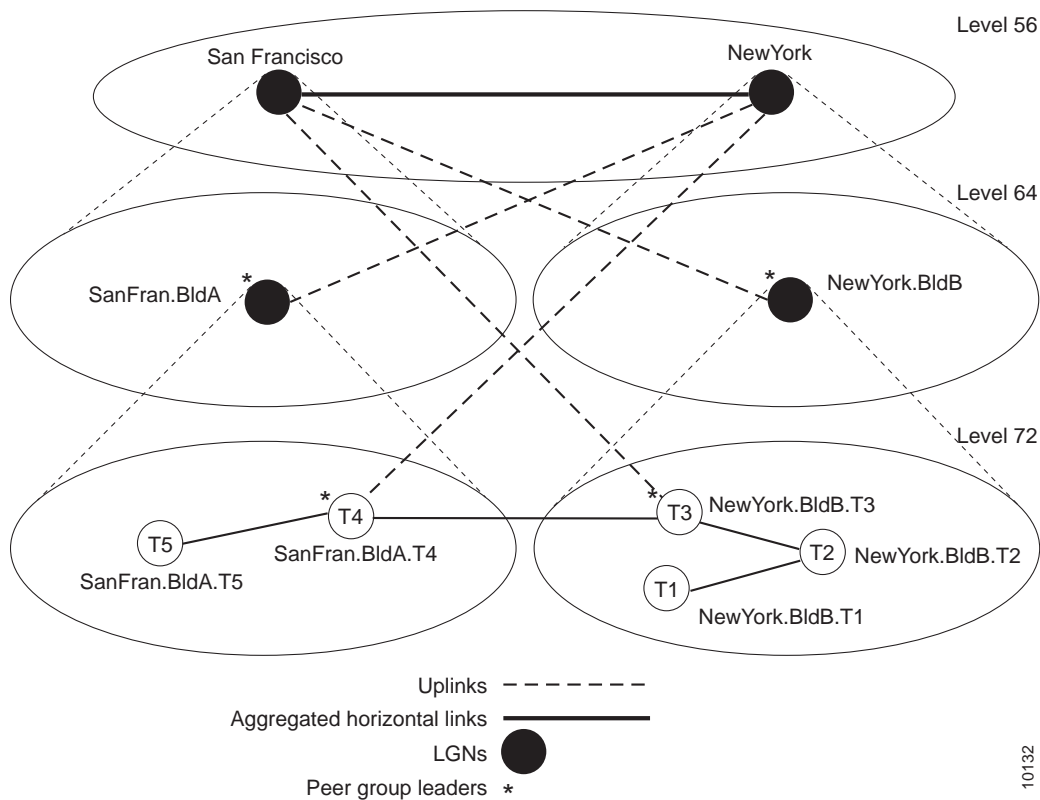
PNNI Hierarchy Configuration Example

An example configuration for a three-level hierarchical topology is shown in Figure 10-1. The example shows the configuration of only five switches, although there can be many other switches in each peer group.

Figure 10-1   Example Three-Level Hierarchical Topology

At the lowest level (level 72), the hierarchy represents two separate peer groups. Each of the four switches named T2 to T5 are eligible to become a peer group leader (PGL) at two levels, and each has two configured ancestor nodes (a parent node or a parent node's parent). Switch T1 has no configured

ancestor nodes and is not eligible to become a PGL. As a result of the peer group leader election at the lowest level, switches T4 and T3 become leaders of their peer groups. Therefore, each switch creates an LGN at the second level (level 64) of the hierarchy. As a result of the election at the second level of the hierarchy, logical group nodes (LGNs) SanFran.BldA and NewYork.BldB are elected as PGLs, creating LGNs at the highest level of the hierarchy (level 56). At that level, the uplinks that have been induced through level 64 form an aggregated horizontal link within the common peer group at level 56.

Examples

The sections that follow show the configurations for each switch and the outputs of the **show atm pnni local-node** command. Some of the output text has been suppressed because it is not relevant to the example.

Switch NewYork.BldB.T1 Configuration

```
hostname NewYork.BldB.T1
atm address 47.0091.4455.6677.1144.1011.1233.0060.3e7b.3a01.00
atm router pnni
  node 1 level 72 lowest
  redistribute atm-static

NewYork.BldB.T1# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: NewYork.BldB.T1
  System address         47.009144556677114410111233.00603E7B3A01.01
  Node ID         72:160:47.009144556677114410111233.00603E7B3A01.00
  Peer group ID       72:47.0091.4455.6677.1144.0000.0000
  Level 72, Priority 0 0, No. of interfaces 3, No. of neighbors 2
  Parent Node Index: NONE

<information deleted>
```

Switch NewYork.BldB.T2 Configuration

```
hostname NewYork.BldB.T2
atm address 47.0091.4455.6677.1144.1011.1244.0060.3e5b.bc01.00
atm router pnni
node 1 level 72 lowest
  parent 2
  redistribute atm-static
  election leadership-priority 40
 node 2 level 64
  parent 3
  election leadership-priority 40
  name NewYork.BldB
 node 3 level 56
  name NewYork

NewYork.BldB.T2# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: NewYork.BldB.T2
  System address        47.009144556677114410111244.00603E5BBC01.01
  Node ID        72:160:47.009144556677114410111244.00603E5BBC01.00
  Peer group ID      72:47.0091.4455.6677.1144.0000.0000
  Level 72, Priority 40 40, No. of interfaces 3, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and not running
  Node name: NewYork.BldB
  System address        47.009144556677114410111244.00603E5BBC01.02
  Node ID        64:72:47.009144556677114400000000.00603E5BBC01.00
  Peer group ID      64:47.0091.4455.6677.1100.0000.0000
  Level 64, Priority 40 40, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: 3

<information deleted>

PNNI node 3 is enabled and not running
  Node name: NewYork
  System address        47.009144556677114410111244.00603E5BBC01.03
  Node ID        56:64:47.009144556677110000000000.00603E5BBC01.00
  Peer group ID      56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: NONE

<information deleted>
```

Switch NewYork.BldB.T3 Configuration

```
hostname NewYork.BldB.T3
atm address 47.0091.4455.6677.1144.1011.1255.0060.3e5b.c401.00
atm router pnni
 node 1 level 72 lowest
  parent 2
  redistribute atm-static
  election leadership-priority 45
 node 2 level 64
  parent 3
  election leadership-priority 45
  name NewYork.BldB
 node 3 level 56
  name NewYork
```

```
NewYork.BldB.T3# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: NewYork.BldB.T3
  System address          47.009144556677114410111255.00603E5BC401.01
  Node ID          72:160:47.009144556677114410111255.00603E5BC401.00
  Peer group ID       72:47.0091.4455.6677.1144.0000.0000
  Level 72, Priority 45 95, No. of interfaces 4, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and running
  Node name: NewYork.BldB
  System address          47.009144556677114410111255.00603E5BC401.02
  Node ID          64:72:47.009144556677114400000000.00603E5BC401.00
  Peer group ID       64:47.0091.4455.6677.1100.0000.0000
  Level 64, Priority 45 95, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: 3

<information deleted>

PNNI node 3 is enabled and running
  Node name: NewYork
  System address          47.009144556677114410111255.00603E5BC401.03
  Node ID          56:64:47.009144556677110000000000.00603E5BC401.00
  Peer group ID       56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 1
  Parent Node Index: NONE

<information deleted>
```

Switch SanFran.BldA.T4 Configuration

```
hostname SanFran.BldA.T4
atm address 47.0091.4455.6677.2233.1011.1266.0060.3e7b.2001.00
atm router pnni
 node 1 level 72 lowest
  parent 2
  redistribute atm-static
  election leadership-priority 45
 node 2 level 64
  parent 3
  election leadership-priority 45
  name SanFran.BldA
 node 3 level 56
  name SanFran
```

```
SanFran.BldA.T4# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: SanFran.BldA.T4
  System address         47.009144556677223310111266.00603E7B2001.01
  Node ID        72:160:47.009144556677223310111266.00603E7B2001.00
  Peer group ID      72:47.0091.4455.6677.2233.0000.0000
  Level 72, Priority 45 95, No. of interfaces 4, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and running
  Node name: SanFran.BldA
  System address         47.009144556677223310111266.00603E7B2001.02
  Node ID         64:72:47.009144556677223300000000.00603E7B2001.00
  Peer group ID      64:47.0091.4455.6677.2200.0000.0000
  Level 64, Priority 45 95, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: 3
<information deleted>

PNNI node 3 is enabled and running
  Node name: SanFran
  System address         47.009144556677223310111266.00603E7B2001.03
  Node ID         56:64:47.009144556677220000000000.00603E7B2001.00
  Peer group ID      56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 1
  Parent Node Index: NONE

<information deleted>
```

Switch SanFran.BldA.T5 Configuration

```
hostname SanFran.BldA.T5
atm address 47.0091.4455.6677.2233.1011.1244.0060.3e7b.2401.00
atm router pnni
 node 1 level 72 lowest
  parent 2
  redistribute atm-static
  election leadership-priority 10
 node 2 level 64
  parent 3
  election leadership-priority 40
  name SanFran.BldA
 node 3 level 56
  name SanFran
```

```
SanFran.BldA.T5# show atm pnni local-node

PNNI node 1 is enabled and running
  Node name: SanFran.BldA.T5
  System address          47.009144556677223310111244.00603E7B2401.01
  Node ID          72:160:47.009144556677223310111244.00603E7B2401.00
  Peer group ID        72:47.0091.4455.6677.2233.0000.0000
  Level 72, Priority 10 10, No. of interfaces 2, No. of neighbors 1
  Parent Node Index: 2

<information deleted>

PNNI node 2 is enabled and not running
  Node name: SanFran.BldA
  System address          47.009144556677223310111244.00603E7B2401.02
  Node ID          64:72:47.009144556677223300000000.00603E7B2401.00
  Peer group ID        64:47.0091.4455.6677.2200.0000.0000
  Level 64, Priority 40 40, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: 3

<information deleted>

PNNI node 3 is enabled and not running
  Node name: SanFran
  System address          47.009144556677223310111244.00603E7B2401.03
  Node ID          56:64:47.009144556677220000000000.00603E7B2401.00
  Peer group ID        56:47.0091.4455.6677.0000.0000.0000
  Level 56, Priority 0 0, No. of interfaces 0, No. of neighbors 0
  Parent Node Index: NONE

<information deleted>
```

Advanced PNNI Configuration

This section describes how to configure advanced PNNI features. The advanced features described in this section are not required to enable PNNI, but are provided to tune your network performance.

For additional information about the features described in this section, refer to the *Guide to ATM Technology.*

This section includes the following subsections:

- Tuning Route Selection on page 10-31
- Tuning Topology Attributes on page 10-41
- Tuning Protocol Parameters on page 10-52
- Configuring ATM PNNI Statistics Collection on page 10-56

Tuning Route Selection

The tasks described in the following subsections are used to tune the mechanisms by which routes are selected in your PNNI network.

Configuring Background Route Computation

The ATM switch router supports the following two route selection modes:

- On-demand—A separate route computation is performed each time a SETUP or ADD PARTY message is received over a User-Network Interface (UNI) or Interim Interswitch Signaling Protocol (IISP) interface. In this mode, the most recent topology information received by this node is always used for each setup request.

- Background routes—Call setups are routed using precomputed routing trees. In this mode, multiple background trees are precomputed for several service categories and quality of service (QoS) metrics. If no route can be found in the multiple background trees that satisfies the QoS requirements of a particular call, route selection reverts to on-demand route computation.

The background routes mode should be enabled in large networks where it usually exhibits less stringent processing requirements and better scalability. Route computation is performed at almost every poll interval when a significant change in the topology of the network is reported or when significant threshold changes have occurred since the last route computation.

To configure the background route computation, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **background-routes-enable** [**insignificant-threshold number**] [**poll-interval** *seconds*]	Enables background routes and configures background route parameters.

Example

The following example shows how to enable background routes and configures the background routes poll interval to 30 seconds:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# background-routes-enable poll-interval 30
```

Displaying the Background Route Computation Configuration

To display the background route configuration, use the following privileged EXEC commands:

Command	Purpose
show atm pnni background status	Displays the background route configuration.
show atm pnni background routes	Displays background routing tables.

Examples

The following example shows the ATM PNNI background route configuration using the **show atm pnni background status** privileged EXEC command:

```
Switch# show atm pnni background status

Background Route Computation is Enabled
Background Interval is set at 10 seconds
Background Insignificant Threshold is set at 32
```

The following example shows the ATM PNNI background route tables for constant bit rate (CBR) using the **show atm pnni background routes** privileged EXEC command:

```
Switch# show atm pnni background routes cbr

  Background Routes From CBR/AW Table
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  2 Routes To Node 2
      1. Hops 1. 1:ATM0/1/2 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
      2. Hops 1. 1:ATM0/1/1 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  1 Routes To Node 5
      1. Hops 1. 1:ATM0/1/0 -> 5
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  Background Routes From CBR/CDV Table
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
  2 Routes To Node 2
      1. Hops 1. 1:ATM0/1/2 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
      2. Hops 1. 1:ATM0/1/1 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  1 Routes To Node 5
      1. Hops 1. 1:ATM0/1/0 -> 5
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  Background Routes From CBR/CTD Table
  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
2 Routes To Node 2
      1. Hops 1. 1:ATM0/1/2 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
      2. Hops 1. 1:ATM0/1/1 -> 2
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

  1 Routes To Node 5
      1. Hops 1. 1:ATM0/1/0 -> 5
          ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
          <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
```

```
Background Routes From CBR/CTD Table
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
2 Routes To Node 2
   1. Hops 1. 1:ATM0/1/2 -> 2
       ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
       <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
   2. Hops 1. 1:ATM0/1/1 -> 2
       ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
       <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10

1 Routes To Node 5
   1. Hops 1. 1:ATM0/1/0 -> 5
       ->: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
       <-: aw 5040  cdv 138  ctd 154 acr 147743 clr0 10 clr01 10
```

Configuring Link Selection

Link selection applies to parallel PNNI links between two switches. Link selection allows you to choose the method the switch uses during call setup for selecting one link among multiple parallel links to forward the call.

Note   Calls always use the load balance method over parallel IISP links between two switches.

Table 10-2 lists the PNNI link selection methods from which you can choose.

Table 10-2   PNNI Link Selection Methods

Precedence Order	Method	Description	Service Category Availability
1	admin-weight-minimize	Places the call on the link with the lowest administrative weight.	CBR[1], VBR-RT[2], VBR-NRT[3]
2	blocking-minimize	Places the call on the link so that higher bandwidth is available for subsequent calls, thus minimizing call blocking.	CBR, VBR-RT, VBR-NRT
3	transmit-speed-maximize	Places the call on the highest speed link.	CBR, VBR-RT, VBR-NRT
4	load-balance	Places the call on the link so that the load is balanced among parallel links for a group.	CBR, VBR-RT, VBR-NRT, ABR[4], UBR[5]

1. CBR = constant bit rate
2. VBR-RT = variable bit rate real time
3. VBR-NRT = variable bit rate non-real time
4. ABR = available bit rate
5. UBR = unspecified bit rate

The switch applies a single link selection method for a group of parallel links connected to a neighbor switch. If multiple links within this group are configured with a different link selection method, then the switch selects a method according to the order of precedence as shown in Table 10-2.

The link selection feature allows you to specify one or more links among the parallel links as an alternate (or backup) link. An alternate link is a link that is used only when all other non-alternate links are either down or full. Alternate links are not considered part of the parallel link group targeted for link selection. Calls are always load balanced over multiple parallel alternate links by default.

To configure the PNNI link selection feature, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies an ATM interface and enter interface configuration mode.
Step 2	Switch(config-if)# **atm pnni link-selection** {**cbr** | **vbr-rt** | **vbr-nrt** | **abr** | **ubr** | **all**} {**admin-weight-minimize** | **alternate** | **blocking-minimize** | **load-balance** | **transmit-speed-maximize**}	Configures ATM PNNI link selection for a specific link.

Examples

The following example shows how to configure link selection on ATM interface 0/0/0 with a VBR-NRT service category and transmit-speed-maximize mode:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pnni link-selection vbr-nrt transmit-speed-maximize
```

The following example shows how to configure link selection on ATM interface 0/0/0 with a CBR service category and then designate the link as an alternate:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pnni link-selection cbr alternate
```

Displaying the Link Selection Configuration

To display the ATM PNNI link selection configuration, use the following EXEC command:

Command	Purpose
show atm pnni neighbor	Displays the ATM PNNI link selection configuration.

Example

The following example shows the detailed PNNI link selection configuration using the **show atm pnni neighbor** EXEC command:

```
Switch# show atm pnni neighbor

Neighbors For Node (Index 1, Level 56)

  Neighbor Name: XXXXXX, Node number: 9
  Neighbor Node Id: 56:160:47.00918100000000E04FACB401.00E04FACB401.00
  Neighboring Peer State: Full
  Link Selection For CBR    : minimize blocking of future calls
  Link Selection For VBR-RT : minimize blocking of future calls
  Link Selection For VBR-NRT: minimize blocking of future calls
  Link Selection For ABR    : balance load
  Link Selection For UBR    : balance load
   Port                      Remote Port Id          Hello state
   ATM4/0/0                  ATM3/1/1                2way_in  (Flood Port)
Switch#
```

Configuring the Maximum Administrative Weight Percentage

The maximum administrative weight percentage feature, a generalized form of a hop count limit, allows you to prevent the use of alternate routes that consume too many network resources. The maximum acceptable administrative weight is equal to the specified percentage of the least administrative weight of any route to the destination (from the background routing tables).

To configure the maximum AW percentage, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **max-admin-weight-percentage** *percent*	Configures the maximum AW percentage. The value can range from 100 to 2000.

Note   The **max-admin-weight-percentage** command only takes effect if background route computation is enabled. See the "Configuring Background Route Computation" section on page 10-31.

Example

The following example shows how to configure the node maximum AW percentage value as 300:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# max-admin-weight-percentage 300
```

Displaying the Maximum Administrative Weight Percentage Configuration

To display the node ATM PNNI maximum AW percentage configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the node ATM PNNI maximum AW configuration.

Example

The following example shows the maximum AW percentage configuration using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
PNNI node 1 is enabled and running
  Node name: eng_1
  System address 47.009181000000000000001212.121212121212.00
  Node ID 56:160:47.009181000000000000001212.121212121212.00
  Peer group ID 56:47.0091.8100.0000.0000.0000.0000
  Level 56, Priority 0, No. of interface 4, No. of neighbor 1

  Hello interval 15 sec, inactivity factor 5, Hello hold-down 10 tenths of sec
  Ack-delay 2 sec, retransmit interval 10 sec, rm-poll interval 10 sec
  PTSE refresh interval 90 sec, lifetime factor 7, minPTSEinterval 1000 msec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: linespeed
→ Max admin weight percentage: 300
  Next RM poll in 3 seconds
```

Configuring the Precedence

The route selection algorithm chooses routes to particular destinations using the longest match reachable address prefixes known to the switch. When there are multiple longest match reachable address prefixes known to the switch, the route selection algorithm first attempts to find routes to reachable addresses with types of greatest precedence. Among multiple longest match reachable address prefixes of the same type, routes with the least total administrative weight are chosen first.

Local internal reachable addresses, whether learned via Integrated Local Management Interface (ILMI) or as static routes, are given highest precedence or a precedence value of one. The precedence of other reachable address types is configurable.

To configure the precedence of reachable addresses, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **precedence** [**pnni-remote-exterior** *value* | **pnni-remote-exterior-metrics** *value* | **pnni-remote-internal** *value* | **pnni-remote-internal-metrics** *value* | **static-local-exterior** *value* | **static-local-exterior-metrics** *value* | **static-local-internal-metrics** *value*]	Enters PNNI precedence and configure the PNNI node.

Example

The following example shows how to configure all PNNI remote exterior routes with a precedence value of 4:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# precedence pnni-remote-exterior 4
```

Displaying Precedence Configuration

To display the ATM PNNI route determination precedence configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni precedence	Displays the node ATM PNNI route determination precedence configuration.

Example

The following example shows the ATM PNNI route determination precedence configuration using the **show atm pnni precedence** privileged EXEC command:

```
Switch# show atm pnni precedence
                                Working   Default
   Prefix Poa Type              Priority  Priority
   ---------------------------  --------  --------
   local-internal                  1         1
   static-local-internal-metrics   2         2
   static-local-exterior           3         3
   static-local-exterior-metrics   2         2
   pnni-remote-internal            2         2
   pnni-remote-internal-metrics    2         2
→  pnni-remote-exterior            4         4
   pnni-remote-exterior-metrics    2         2
```

Configuring Explicit Paths

The explicit path feature enables you to manually configure either a fully specified or partially specified path for routing soft permanent virtual channels (soft PVC) and soft permanent virtual path (soft PVP) connections. Once these routes are configured, up to three explicit paths might be applied to these connections.

A fully specified path includes all adjacent nodes (and optionally the corresponding exit port) for all segments of the path. A partially specified path consists of one or more segment target nodes that should appear in their proper order in the explicit path. The standard routing algorithm is used to determine all unspecified parts of the partially specified path.

You can specify a path name for an explicit path and the switch assigns the next available unused *path-id* value, or you can choose the *path-id* value and assign or modify its name.

To enter the PNNI explicit path configuration mode, use the following global configuration command:

Command	Purpose
atm pnni explicit-path {**identifier** *path-id-number* [**name** *path-name*]	**name** *path-name*} [**enable**	**disable**]	Enters the PNNI explicit path configuration mode.

The **disable** option can be used to prevent an explicit path from being used for routing while it is being configured, if any soft connections already reference it. If the explicit path has not been created, the initial default is to enable the explicit path upon configuration.

Example

The following example shows how to enter the PNNI explicit path configuration mode for a path named boston_2.path1:

```
Switch(config)# atm pnni explicit-path name boston_2.path1
Switch(cfg-pnni-expl-path)#
```

Adding Entries to the Explicit Path

Once in PNNI explicit path configuration mode, you can use the following subcommands repeatedly to build up the ordered list that specifies the explicit path:

Command	Purpose
next-node {*name-string*	*node-id*	*node-id-prefix*} [**port** *hex-port-id*	**agg-token** *hex-agg-token-id*]	The **next-node** keyword specifies the next adjacent node for fully specified paths. Add next PNNI explicit path entry with this command.
segment-target {*name-string*	*node-id*	*node-id-prefix*} [**port** *hex-port-id*	**agg-token** *hex-agg-token-id*]	The **segment-target** keyword specifies the target node for cases where the path through intermediate nodes should be automatically routed.
exclude-node {*name-string*	*node-id*	*node-id-prefix*} [**port** *hex-port-id*	**agg-token** *hex-agg-token-id*]	The **exclude-node** keyword specifies nodes or ports that are excluded from all partial path segments.

Node IDs can be entered either with the full 22-byte length address or as a Node ID prefix with a length of 15 or more bytes. To specify routes that include higher level nodes (parent LGNs) for other peer groups, we recommend that you enter exactly 15 bytes so that the address remains valid in the event of a PGL update.

Node IDs appear in the following format:

dec : *dec* : *13-20 hex digits*

Node names can be entered instead of Node IDs. If names are used to identify higher level LGNs, the resulting explicit paths are not guaranteed to remain valid if the PGL changes in the neighboring peer group. To prevent invalid paths, configure all parent LGNs (for all potential PGL nodes) with the same node name.

Optionally, an exit port can be specified for any entry. The port should be specified as a *hex-port-id* rather than a *port-name*. For excluded entries, only this port is excluded from the path.

Since the port ID could change if the following neighbor peer group changes PGL leaders, the aggregation token is used in place of the port ID for nodes with higher level LGNs. The LGN aggregation token can only identify the port uniquely if the following entry is a next-node entry. Aggregation tokens are not allowed for excluded nodes.

Example

The following example shows how to configure an explicit path list consisting of four entries. The first two are adjacent nodes and, in one case, an exit port is specified. Next, a partially-specified segment to the node chicago_2 is configured, several hops away. Finally, a higher level LGN node adjacent to chicago_2 is configured, which is specified by its 15-byte Node ID prefix.

```
Switch(cfg-pnni-expl-path)# next-node dallas_2
Switch(cfg-pnni-expl-path)# next-node dallas_4 port 80003004
Switch(cfg-pnni-expl-path)# segment-target chicago_2
Switch(cfg-pnni-expl-path)# next-node 40:72:47.009181000000106000000000
```

Displaying Node IDs

To display the node IDs that correspond to named nodes in a network, use either of the following EXEC commands:

Command	Purpose
show atm pnni identifier	Displays the node IDs.
show atm pnni topology node *name-or-number*	Displays the node IDs.

Displaying Hex-Port-IDs

Since the explicit path subcommands require a *hex-port-id* rather than a *port name*, use either of the following EXEC commands to display the corresponding *hex-port-ids* for a node:

Command	Purpose
show atm pnni identifiers *node-number* **port**	Displays hex-port-ids for a node.
show atm pnni topology node *node-number* **hex-port-id**	Displays hex-port-ids for a node.

Editing Entries within the Explicit Path

Each entry has an index that gives its relative position within the list. Indices are used as an aid to edit an explicit path. The entire current list showing the entry index displays after each entry is added, or it is redisplayed when you use the **list** keyword.

The optional **index** keyword allows the exact index to be specified for an entry. If no index is specified for a new entry, it always defaults to one higher than the last path entry. If the index matches the index of an existing entry, the index is overwritten with new information. The **no** form deletes an existing entry for a given index.

Example

The following example shows the original path:

```
Explicit_path name new_york.path1 (id 5) from node dallas_1:
1 next-node dallas_2
2 next-node dallas_4 port 80003004
3 segment    chicago_2
4 next-node 40:72:47.009181000000106000000000.
```

You can modify the first entry to add an exit port for the original path. As shown in the following example, use the **index** keyword to specify the index of the entry to modify:

```
dallas_1 (cfg-pnni-expl-path)# index 1 next-node dallas_2 port 80000000
Explicit_path name new_york.path1 (id 5) from node dallas_1:
1 next-node dallas_2 port 80000000
2 next-node dallas_4 port 80003004
3 segment    chicago_2
4 next-node 40:72:47.009181000000106000000000.
```

The **append-after** keyword adds a path entry after the specified index. Renumbering the following path entries, if necessary, to make room for the new entry.

Example

If there are four **next-node** entries labelled as index 1 through 4, you can squeeze a new entry in after index 2 (using the **append-after** keyword), resulting in index 3. The following two entries are automatically renumbered to indexes 4 and 5 in order to make room for index 3.

```
dallas_1(cfg-pnni-expl-path)# append 2 next-node st_louis
Explicit_path name new_york.path1 (id 5) from node dallas_1:
1 next-node dallas_2 port 80000000
2 next-node dallas_4 port 80003004
3 next-node st_louis
4 segment    chicago_2
5 next-node 40:72:47.009181000000106000000000.
```

Displaying Explicit Path Configuration

To display the PNNI explicit path configuration, use the following EXEC command:

Command	Purpose
show atm pnni explicit-path [{**name** *path-name* | **identifier** *path-id*} [**upto** *index*]] [**detail**]	Displays the PNNI explicit path configuration.

Example

The following example shows a summary of explicit paths:

```
Switch# show atm pnni explicit-paths
Summary of configured Explicit Paths:
 PathId Status      UpTo  Routable AdminWt Explicit Path Name
 ~~~~~~ ~~~~~~~~~~~ ~~~~~ ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~~~~~~~~~~~
 1      enabled     3     yes      10040   dallas_4.path1
 2      enabled     6     yes      15120   chicago_2.path1
 3      enabled     2     yes      10080   chicago_2.path2
 4      enabled     2     yes      20595   new_york.path1
```

The following example shows the detailed configuration including any known warnings and error
messages for a non-routable explicit path named new_york.path2:

```
Switch# show atm pnni explicit-paths name new_york.path2 detail
 PathId Status      UpTo  Routable AdminWt Explicit Path Name
 ~~~~~~ ~~~~~~~~~~~ ~~~~~ ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~~~~~~~~~~~
 1      enabled     4     no       0       new_york.path2
  PNNI routing err_code for UBR call = 6 (PNNI_DEST_UNREACHABLE)

 Entry Type       Node [Port] specifier
 ~~~~~ ~~~~~~~~~~ ~~~~~~~~~~~~~~~~~~~~~~~
 1     next-node dallas_2
 2     next-node dallas_4 port 80000004
                 Warning:Entry index 2 specifies a non-routable port
 3     next-node wash_dc_1
                 Warning:Entry index 3 has no connectivity from prior node
 4     segment   new_york.2.40
```

Note   The **upto** keyword can be used for troubleshooting explicit paths that are shown as
non-routable. Routable status is only calculated up to the specified path entry index which
allows the first failing path entry to be isolated.

Tuning Topology Attributes

The tasks in the following subsections describe how to configure attributes that affect the network
topology.

Configuring the Global Administrative Weight Mode

Administrative weight is the primary routing metric for minimizing use of network resources. You can
configure the administrative weight to indicate the relative desirability of using a link. For example,
assigning equal administrative weight to all links in the network minimizes the number of hops used by
each connection.

To configure the administrative weight mode, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **administrative-weight** {**linespeed** | **uniform**}	Configures the administrative weight for all node connections.

Example

The following example shows how to configure the administrative weight for the node as line speed:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# administrative-weight linespeed
```

Displaying the Administrative Weight Mode Configuration

To display the administrative weight configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the AW configuration for the node.

Example

The following example shows the AW configuration for the node using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
PNNI node 1 is enabled and running
  Node name: switch
  System address 47.009181000000000000001212.121212121212.00
  Node ID 56:160:47.009181000000000000001212.121212121212.00
  Peer group ID 56:47.0091.8100.0000.0000.0000.0000
  Level 56, Priority 0, No. of interface 4, No. of neighbor 1

  Hello interval 15 sec, inactivity factor 5, Hello hold-down 10 tenths of sec
  Ack-delay 2 sec, retransmit interval 10 sec, rm-poll interval 10 sec
  PTSE refresh interval 90 sec, lifetime factor 7, minPTSEinterval 1000 msec
  Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
  Default administrative weight mode: linespeed
  Max admin weight percentage: 300
  Next RM poll in 3 seconds
```

Configuring Administrative Weight Per Interface

In addition to the global administrative weight (AW), you can also configure the administrative weight for an interface. To configure the administrative weight on an interface, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies an ATM interface and enters interface configuration mode.
Step 2	Switch(config-if)# **atm pnni admin-weight** *number service-category*	Configures the ATM AW for this link.

Example

The following example shows how to configure ATM interface 0/0/0 with ATM PNNI AW of 7560 for traffic class ABR:

```
Switch(config)# interface atm 0/0/0
Switch(config-if)# atm pnni admin-weight 7560 abr
```

Displaying the Administrative Weight Per Interface Configuration

To display the ATM PNNI interface AW configuration, use the following EXEC command:

Command	Purpose
show atm pnni [**interface atm** *card*/*subcard*/*port*] [**detail**]	Displays the interface ATM PNNI AW configuration.

Example

The following example shows the AW configuration for interface 0/0/0 using the **show atm pnni interface** EXEC command:

```
Switch# show atm pnni interface atm 0/0/0 detail

Port ATM0/0/0 is up  , Hello state 2way_in with node eng_18
    Next hello occurs in 11 seconds, Dead timer fires in 73 seconds
    CBR    : AW 5040 MCR 155519 ACR 147743 CTD 154 CDV 138 CLR0 10 CLR01 10
    VBR-RT : AW 5040 MCR 155519 ACR 155519 CTD 707 CDV 691 CLR0 8 CLR01 8
    VBR-NRT: AW 5040 MCR 155519 ACR 155519 CLR0 8 CLR01 8
    ABR    : AW 5040 MCR 155519 ACR 0
    UBR    : AW 5040 MCR 155519
    Remote node ID 56:160:47.00918100000000613E7B2F01.00613E7B2F99.00
    Remote node address 47.00918100000000613E7B2F01.00613E7B2F99.00
    Remote port ID  ATM0/1/2 (80102000) (0)
```

Configuring Transit Restriction

Transit calls originate from another ATM switch and pass through the switch. Some edge switches might want to eliminate this transit traffic and only allow traffic originating or terminating at the switch.

To configure a transit restriction, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **transit-restricted**	Enables transit restricted on this node.

Example

The following example shows how to enable the transit-restricted feature:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# transit-restricted
```

Displaying the Transit Restriction Configuration

To display the ATM PNNI transit-restriction configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the ATM configuration.

Example

The following example shows the ATM PNNI transit-restriction configuration using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
  PNNI node 1 is enabled and running
    Node name: Switch
    System address 47.00918100000000400B0A3081.00400B0A3081.00
    Node ID 56:160:47.00918100000000400B0A3081.00400B0A3081.00
    Peer group ID 56:47.0091.8100.0000.0000.0000.0000
    Level 56, Priority 0, No. of interfaces 4, No. of neighbors 2
→   Node Does Not Allow Transit Calls

    Hello interval 15 sec, inactivity factor 5,
    Hello hold-down 10 tenths of sec
    Ack-delay 10 tenths of sec, retransmit interval 5 sec,
    Resource poll interval 5 sec
    PTSE refresh interval 1800 sec, lifetime factor 200 percent,
    Min PTSE interval 10 tenths of sec
    Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
    Default administrative weight mode: uniform
    Max admin weight percentage: -1
    Next resource poll in 3 seconds
    Max PTSEs requested per PTSE request packet: 32
    Redistributing static routes: Yes
```

Configuring Redistribution

Redistribution instructs PNNI to distribute reachability information from non-PNNI sources throughout the PNNI routing domain. The ATM switch router supports redistribution of static routes, such as those configured on Interim Interswitch Signaling Protocol (IISP) interfaces.

Note   By default, redistribution of static routes is enabled.

To enable redistribution of static routes, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **redistribute atm-static**	Enables redistribution of static routes.

Example

The following example shows how to enable redistribution of static routes:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# redistribute atm-static
```

Displaying the Redistribution Configuration

To display the node redistribution configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the node redistribution configuration.

Example

The following example shows the node redistribution configuration using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
  PNNI node 1 is enabled and running
    Node name: Switch
    System address 47.00918100000000400B0A3081.00400B0A3081.00
    Node ID 56:160:47.00918100000000400B0A3081.00400B0A3081.00
    Peer group ID 56:47.0091.8100.0000.0000.0000.0000
    Level 56, Priority 0, No. of interfaces 4, No. of neighbors 2
    Node Allows Transit Calls

    Hello interval 15 sec, inactivity factor 5,
    Hello hold-down 10 tenths of sec
    Ack-delay 10 tenths of sec, retransmit interval 5 sec,
    Resource poll interval 5 sec
    PTSE refresh interval 1800 sec, lifetime factor 200 percent,
    Min PTSE interval 10 tenths of sec
    Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
    Default administrative weight mode: uniform
    Max admin weight percentage: -1
    Next resource poll in 3 seconds
    Max PTSEs requested per PTSE request packet: 32
→   Redistributing static routes: Yes
```

Configuring Aggregation Token

The aggregation token controls the grouping of multiple physical links into logical links. Uplinks to the same higher level node, or upnode, with the same aggregation token value, are represented at a higher level as horizontal aggregated links. Resource Availability Information Groups (RAIGs) are computed according to the aggregation algorithm.

To specify an aggregation token value, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **interface atm** *card*/*subcard*/*port* Switch(config-if)#	Specifies the ATM interface.
Step 2	Switch(config-if)# **atm pnni aggregation-token** *value*	Enters a value for the aggregation-token on the ATM interface.

Example

The following example shows how to configure an aggregation token on ATM interface 1/0/1:

```
Switch(config)# interface atm 1/0/1
Switch(config-if)# atm pnni aggregation-token 100
```

Displaying the Aggregation Token Configuration

To display the aggregation token configuration, use the following EXEC command:

Command	Purpose
show atm pnni interface atm *card*/*subcard*/*port* [**detail**]	Displays the interface PNNI configuration.

Examples

The following example shows the aggregation token value for all interfaces using the **show atm pnni interface** EXEC command:

```
NewYork.BldB.T3# show atm pnni interface

PNNI Interface(s) for local-node 1 (level=56):
  Local Port     Type  RCC Hello St Deriv Agg  Remote Port   Rem Node(No./Name)
  ~~~~~~~~~~~~~  ~~~~~ ~~~ ~~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~~~~~ ~~~~~~~~~~~~~~~~~~
  ATM0/0/2       Phy   UP  comm_out 2          ATM0/0/3      - SanFran.BldA.T4
  ATM0/1/2       Phy   DN  down     35
  ATM0/1/3       Phy   UP  2way_in  0          ATM1/1/3      10 NewYork.BldB.T1
NewYork.BldB.T3#
```

The following example shows the aggregation token value details for a specific interface using the **show atm pnni interface** EXEC command with the **detail** keyword:

```
NewYork.BldB.T3# show atm pnni interface atm 0/0/2 detail

PNNI Interface(s) for local-node 1 (level=56):

Port ATM0/0/2 RCC is up  , Hello state common_out with node SanFran.BldA.T4
  Next hello occurs in 4 seconds, Dead timer fires in 72 seconds
  CBR    : AW 5040 MCR 155519 ACR 147743 CTD 154 CDV 138 CLR0 10 CLR01 10
  VBR-RT : AW 5040 MCR 155519 ACR 155519 CTD 707 CDV 691 CLR0 8 CLR01 8
  VBR-NRT: AW 5040 MCR 155519 ACR 155519 CLR0 8 CLR01 8
  ABR    : AW 5040 MCR 155519 ACR 0
  UBR    : AW 5040 MCR 155519
  Aggregation Token: configured 0 , derived 2, remote 2
  Tx ULIA seq# 1, Rx ULIA seq# 1, Tx NHL seq# 1, Rx NHL seq# 2
  Remote node ID        72:160:47.00914455667723310111266.00603E7B2001.00
  Remote node address        47.00914455667723310111266.00603E7B2001.01
  Remote port ID        ATM0/0/3 (80003000) (0)
  Common peer group ID    56:47.0091.4455.6677.0000.0000.0000
  Upnode ID             56:72:47.00914455667723300000000.00603E7B2001.00
  Upnode Address             47.00914455667723310111266.00603E7B2001.02
  Upnode number: 11    Upnode Name: SanFran
NewYork.BldB.T3#
```

Configuring Aggregation Mode

You configure the aggregation mode for calculating metrics and attributes for aggregated PNNI links and nodes advertised to higher PNNI levels. The ATM switch router has two algorithms to perform link and node aggregation: best link and aggressive.

To configure link or node aggregation, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode and specify the local node you want to configure.
Step 3	Switch(config-pnni-node)# **aggregation-mode** {**link** | **node**} {**abr** | **cbr** | **ubr** | **vbr-rt** | **vbr-nrt** | **all**} {**best-link** | **aggressive**}	Configures the service category and aggregation mode for a link or a complex node.

Examples

The following example shows how to configure aggressive link aggregation mode for constant bit rate (CBR) traffic:

```
Switch(config)# atm router pnni
Switch(config-pnni-node)# node 2
Switch(config-pnni-node)# aggregation-mode link cbr aggressive
```

The following example shows how to configure best link aggregation mode for variable bit rate real time (VBR-RT) traffic on node 2:

```
Switch(config)# atm router pnni
Switch(config-pnni-node)# node 2
Switch(config-pnni-node)# aggregation-mode node vbr-rt best-link
```

Displaying the Aggregation Mode Configuration

To display the aggregation mode configuration, enter the following commands in EXEC mode:

Command	Purpose
show atm pnni aggregation link	Displays the link aggregation mode.
show atm pnni aggregation node	Displays the node aggregation mode.

Examples

The following example shows the link aggregation mode:

```
Switch# show atm pnni aggregation link

PNNI PGL link aggregation for local-node 2 (level=72, name=Switch.2.72)

  Configured aggregation modes (per service class):
      CBR          VBR-RT       VBR-NRT        ABR          UBR
   ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~
    aggressive  best-link    best-link    best-link    best-link

 No Aggregated links for this node.
Switch#
```

The following example shows how to display the node aggregation mode:

```
Switch# show atm pnni aggregation node
PNNI nodal aggregation for local-node 2 (level=56, child PG level=60)
  Complex node representation, exception threshold: 60%

  Configured nodal aggregation modes (per service class):
     CBR          VBR-RT       VBR-NRT        ABR          UBR
   ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~  ~~~~~~~~~~~
   best-link    best-link    best-link    best-link    aggressive

Summary Complex Node Port List:
  Port ID  Rem Inn Agg-Token  Border Cnt In-Spoke  Out-Spoke Agg-Accur
  ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~  ~~~~~~~~~~ ~~~~~~~~~ ~~~~~~~~~ ~~~~~~~~~~~
  21FB000  12      0           1          default   default   ok
  2371000  13      0           1          default   default   ok

Summary Complex Node Bypass Pairs  List (exception bypass pairs only)
  /~~~~~~~~ LOWER PORT ID ~~~~~~~~\ /~~~~~~~~ HIGHER PORT ID ~~~~~~~~\
  Port ID  Rem Inn Agg-Token  Inacc Port ID  Rem Inn Agg-Token  Inacc Exceptns
  ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~~ ~~~~~ ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~~ ~~~~~ ~~~~~~~~
  21FB000  12      0           no    2371000  13      0           no    fwd rev
```

Configuring Significant Change Thresholds

PNNI topology state elements (PTSEs) would overwhelm the network if they were transmitted every time any parameter in the network changed. To avoid this problem, PNNI uses significant change thresholds that control the origination of PTSEs.

Note   Any change in administrative weight (AW) and cell loss ratio (CLR) is considered significant and triggers a new PTSE.

To configure the PTSE significant change threshold, take these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.
Step 3	Switch(config-pnni-node)# **ptse significant-change** {**acr-mt** *percent* | **acr-pm** *percent* | **cdv-pm** *percent* | **ctd-pm** *percent*}	Configures a PTSE significant change percentage.

For an example of other **ptse** command keywords, see the "Configuring PNNI Hello, Database Synchronization, and Flooding Parameters" section on page 10-52.

Example

The following example shows how to configure a PTSE being sent only if the available cell rate changes 30 percent from the current metric:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# ptse significant-change acr-pm 30
```

Displaying the Significant Change Thresholds Configuration

To display the PTSE configuration, use the following EXEC command:

Command	Purpose
show atm pnni resource-info	Displays the PTSE identifier.

Example

The following example shows the significant change threshold configuration using the **show atm pnni resource-info** EXEC command:

```
Switch# show atm pnni resource-info
PNNI:80.1 Insignificant change parameters
acr pm 50,  acr mt 3, cdv pm 25, ctd pm 50, resource poll interval 5 sec
Interface insignificant change bounds:
Interface ATM1/0/0
  CBR    : MCR 155519, ACR 147743 [73871,366792], CTD 50 [25,75],CDV 34 [26,42],
 CLR0 10, CLR01 10,
  VBR-RT : MCR 155519, ACR 155519 [77759,366792], CTD 359 [180,538],CDV 342 [257
,427], CLR0 8, CLR01 8,
  VBR-NRT: MCR 155519, ACR 155519 [77759,155519], CLR0 8, CLR01, 8
  ABR    : MCR 155519 ACR 147743 [73871,155519]
  UBR    : MCR 155519
<information deleted>
```

Configuring the Complex Node Representation for LGNs

By default, higher-level logical group nodes (LGNs) represent their child peer groups (PGs) in the simple node representation. With simple node representation, the entire peer group is represented as a single node. When there are many nodes in the child peer group, you can use complex node representation to present a more accurate model of the PG. With complex node representation, the PG is represented by a nucleus, or center, and border ports.

For a detailed description of complex node representation and implementation guidelines, refer to the *Guide to ATM Technology*.

To configure complex node representation, perform the following steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *local-node-index* Switch(config-pnni-node)#	Enters node configuration mode and specifies the local node you want to configure.
Step 3	Switch(config-pnni-node)# **nodal-representation** {**simple** | **complex** [**threshold** *threshold-value* | **radius-only**]}	Configures complex nodal representation and specifies how to handle exceptions.

Example

The following example shows how to configure a PNNI complex node:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 2
Switch(config-pnni-node)# nodal-representation complex
```

Displaying the PNNI Complex Node Configuration

To display the PNNI complex node configuration, perform the following task in privileged EXEC mode:

Command	Purpose
show atm pnni aggregation node	Displays the PNNI complex node configuration.

Example

The following example shows the PNNI complex node configuration:

```
Switch# show atm pnni aggregation node
PNNI nodal aggregation for local-node 2 (level=56, child PG level=60)
  Complex node representation, exception threshold: 60%

  Configured nodal aggregation modes (per service class):
    CBR         VBR-RT      VBR-NRT      ABR          UBR
  ~~~~~~~~~~~ ~~~~~~~~~~~ ~~~~~~~~~~~ ~~~~~~~~~~~ ~~~~~~~~~~~
  best-link   best-link   best-link   best-link   aggressive

Summary Complex Node Port List:
  Port ID  Rem Inn Agg-Token  Border Cnt In-Spoke  Out-Spoke Agg-Accur
  ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~ ~~~~~~~~~~ ~~~~~~~~~~
  21FB000  12      0          1          default   default   ok
  2371000  13      0          1          default   default   ok

Summary Complex Node Bypass Pairs  List (exception bypass pairs only)
  /~~~~~~~~ LOWER PORT ID ~~~~~~~~\ /~~~~~~~~ HIGHER PORT ID ~~~~~~~~\
  Port ID  Rem Inn Agg-Token  Inacc Port ID  Rem Inn Agg-Token  Inacc Exceptns
  ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~ ~~~~~~~~ ~~~~~~~ ~~~~~~~~~~ ~~~~~ ~~~~~~~~
  21FB000  12      0          no    2371000  13      0          no    fwd rev
```

Tuning Protocol Parameters

The tasks in the following subsections describe how to tune the PNNI protocol parameters that can affect the performance of your network.

Configuring PNNI Hello, Database Synchronization, and Flooding Parameters

PNNI uses the Hello protocol to determine the status of neighbor nodes and PNNI topology state elements (PTSEs) to disseminate topology database information in the ATM network.

To configure the Hello protocol parameters and PTSE significant change, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **node** *node-index* Switch(config-pnni-node)#	Enters node configuration mode.

	Command	Purpose
Step 3	Switch(config-pnni-node)# **timer** [**ack-delay** *tenths-of-second*] [**hello-holddown** *tenths-of-second*] [**hello-interval** *seconds*] [**inactivity-factor** *number*] [**retransmit-interval** *seconds*]	Configures Hello database synchronization and flooding parameters.
Step 4	Switch(config-pnni-node)# **ptse** [**lifetime-factor** *percentage-factor*] [**min-ptse-interval** *tenths-of-second*] [**refresh-interval** *seconds*] [**request** *number*] [**significant-change acr-mt** *percent*] [**significant-change acr-pm** *percent*] [**significant-change cdv-pm** *percent*] [**significant-change ctd-pm** *percent*]	Configure PTSE significant change percent number.

Example

The following example shows how to configure the PTSE refresh interval to 600 seconds:

```
Switch(config-pnni-node)# ptse refresh-interval 600
```

The following example shows how to configure the retransmission of the Hello timer to 60 seconds:

```
Switch(config-pnni-node)# timer hello-interval 60
```

Displaying the PNNI Hello, Database Synchronization, and Flooding Configuration

To display the ATM PNNI Hello, database synchronization, and flooding configuration, use the following privileged EXEC command:

Command	Purpose
show atm pnni local-node	Displays the ATM PNNI Hello, database synchronization, and flooding configuration.

Example

The following example shows the ATM PNNI Hello, database synchronization, and flooding configuration using the **show atm pnni local-node** privileged EXEC command:

```
Switch# show atm pnni local-node
PNNI node 1 is enabled and running
    Node name: Switch
    System address 47.00918100000000400B0A3081.00400B0A3081.00
    Node ID 56:160:47.00918100000000400B0A3081.00400B0A3081.00
    Peer group ID 56:47.0091.8100.0000.0000.0000.0000
    Level 56, Priority 0, No. of interfaces 4, No. of neighbors 2
    Node Allows Transit Calls

    Hello interval 15 sec, inactivity factor 5,
    Hello hold-down 10 tenths of sec
    Ack-delay 10 tenths of sec, retransmit interval 5 sec,
    Resource poll interval 5 sec
    PTSE refresh interval 1800 sec, lifetime factor 200 percent,
    Min PTSE interval 10 tenths of sec
    Auto summarization: on, Supported PNNI versions: newest 1, oldest 1
    Default administrative weight mode: uniform
    Max admin weight percentage: -1
    Next resource poll in 3 seconds
    Max PTSEs requested per PTSE request packet: 32
    Redistributing static routes: Yes
```

Configuring the Resource Management Poll Interval

The resource management poll interval specifies how often PNNI polls resource management to update the values of link metrics and attributes. You can configure the resource poll interval to control the tradeoff between the processing load and the accuracy of PNNI information. A larger value usually generates a smaller number of PTSE updates. A smaller value results in greater accuracy in tracking resource information.

To configure the resource management poll interval, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **resource-poll-interval** *seconds*	Configures the resource management poll interval.

Example

The following example shows how to configure the resource management poll interval to 10 seconds:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# resource-poll-interval 10
```

Displaying the Resource Management Poll Interval Configuration

To display the resource management poll interval configuration, use the following EXEC command:

Command	Purpose
show atm pnni resource-info	Displays the resource management poll interval configuration.

Example

The following example shows the resource management poll interval configuration using the **show atm pnni resource-info** EXEC command:

```
Switch# show atm pnni resource-info
PNNI:80.1 Insignificant change parameters
acr pm 50,  acr mt 3, cdv pm 25, ctd pm 50, resource poll interval 5 sec
Interface insignificant change bounds:
Interface ATM1/0/0
  CBR    : MCR 155519, ACR 147743 [73871,366792], CTD 50 [25,75],CDV 34 [26,42],
 CLR0 10, CLR01 10,
  VBR-RT : MCR 155519, ACR 155519 [77759,366792], CTD 359 [180,538],CDV 342 [257
,427], CLR0 8, CLR01 8,
  VBR-NRT: MCR 155519, ACR 155519 [77759,155519], CLR0 8, CLR01, 8
  ABR    : MCR 155519 ACR 147743 [73871,155519]
  UBR    : MCR 155519
Interface ATM1/0/3
  CBR    : MCR 155519, ACR 147743 [73871,366792], CTD 50 [25,75],CDV 34 [26,42],
 CLR0 10, CLR01 10,
  VBR-RT : MCR 155519, ACR 155519 [77759,366792], CTD 359 [180,538],CDV 342 [257
,427], CLR0 8, CLR01 8,
  VBR-NRT: MCR 155519, ACR 155519 [77759,155519], CLR0 8, CLR01, 8
  ABR    : MCR 155519 ACR 147743 [73871,155519]
  UBR    : MCR 155519
<information deleted>
```

Configuring ATM PNNI Statistics Collection

You can collect the following statistics about the routing of ATM connections:

- Number of source route requests
- Number of micro-seconds spent in dijkstra algorithm
- Number of crankback source route requests
- Number of next port requests
- Number of background route lookups
- Number of on-demand route computations

To enable statistics collection, perform these steps, beginning in global configuration mode:

	Command	Purpose
Step 1	Switch(config)# **atm router pnni** Switch(config-atm-router)#	Enters ATM router PNNI mode.
Step 2	Switch(config-atm-router)# **statistics call**	Enables ATM PNNI statistics gathering.

Example

The following example shows how to enable PNNI ATM statistics gathering:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# statistics call
```

Displaying ATM PNNI Statistics

To display the ATM PNNI statistics, use the following privileged EXEC command:

Command	Purpose
show atm pnni statistics call	Displays the ATM PNNI statistics.

Example

The following example shows the ATM PNNI statistics using the **show atm pnni statistics** privileged EXEC command:

```
Switch# show atm pnni statistics call

pnni call statistics since 22:19:29
```

	total	cbr	rtvbr	nrtvbr	abr	ubr
source route reqs	1346	0	0	0	0	0
successful	1342	1342	0	0	0	0
unsuccessful	4	4	0	0	0	0
crankback reqs	0	0	0	0	0	0
successful	0	0	0	0	0	0
unsuccessful	0	0	0	0	0	0
on-demand attempts	0	0	0	0	0	0
successful	0	0	0	0	0	0
unsuccessful	0	0	0	0	0	0
background lookups	0	0	0	0	0	0
successful	0	0	0	0	0	0
unsuccessful	0	0	0	0	0	0
next port requests	0	0	0	0	0	0
successful	0	0	0	0	0	0
unsuccessful	0	0	0	0	0	0

	total	average
usecs in queue	2513166	1867
usecs in dijkstra	0	0
usecs in routing	132703	98