

# Configuring ATM Routing and PNNI

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This chapter describes the ATM routing and Private Network-Network Interface (PNNI) protocol implementation within the LightStream 1010 ATM switch. To place calls between ATM end systems, signaling consults an ATM routing protocol. LightStream 1010 provides the following routing protocols:

- Interim Inter-switch Signaling Protocol (IISP)—A static routing protocol
- PNNI— A dynamic routing protocol that provides quality of service (QoS) routes to signaling based on the QoS requirements specified in the call setup request

The following major sections describe PNNI implementation:

- Overview—Provides a description of general PNNI operation
- Enhanced PNNI Features—Provides a description of additional PNNI features

The following major sections provide procedures for ATM routing and PNNI configuration:

- Global Switch Configuration
- PNNI Routing Configuration
- PNNI Node Configuration
- PNNI Interface Configuration

For a complete description of the commands mentioned in this chapter, refer to the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

## Overview

PNNI provides dynamic ATM routing with QoS support. The PNNI protocol is used as “the routing protocol” for the global ATM internetwork and therefore, has been specified as a hierarchical routing protocol. The number of hierarchical levels can vary from network to network.

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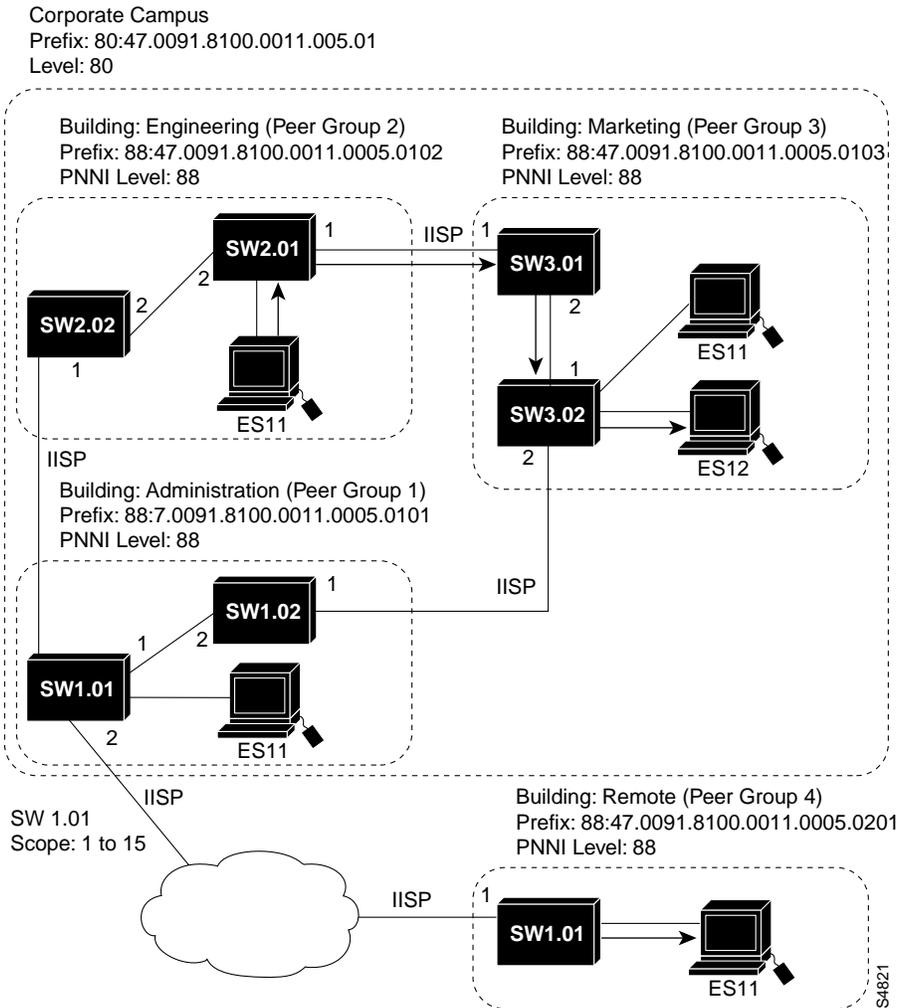
**Note** The initial LightStream 1010 implementation of PNNI supports only a single level of hierarchy.

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Figure 11-1 shows a network using PNNI and IISP protocols, and describe PNNI and IISP routing and PNNI components in the following sections. IISP routing interconnects peer groups at the corporate campus backbone level, but the addresses were assigned to allow future migration to hierarchical PNNI routing. Specifically, the corporate campus eventually forms a PNNI peer group (PG) at level 80.

**Note** IISP can be used to connect PNNI-based private networks.

**Figure 11-1 PNNI Network Example**



A PG is a collection of logical nodes that exchange information with other members of the group, allowing all members of the same PG to maintain an identical view of the group. For example, Hello packets, database synchronization, and flooding are carried out among members of the same PG. The Engineering, Marketing, and Administration buildings are separate PGs in Figure 11-1. For example, SW2.01 and SW2.02 are both members of PG 2.

**Note** PGs are similar to Open Shortest Path First (OSPF) routing protocol areas or to IP routing domains.

SW2.01 is a border node between PG 2 and PG 3. The border nodes must translate between PNNI and IISP and vice versa in order to splice the connections. The border nodes are also configured with reachability information to end systems (ESs) outside the PNNI network. The configured end system addresses are then advertised within the private network so that any internal node can connect to the advertised end system routes to the border node. The signaling messages for IISP and PNNI are both supported at the border nodes.

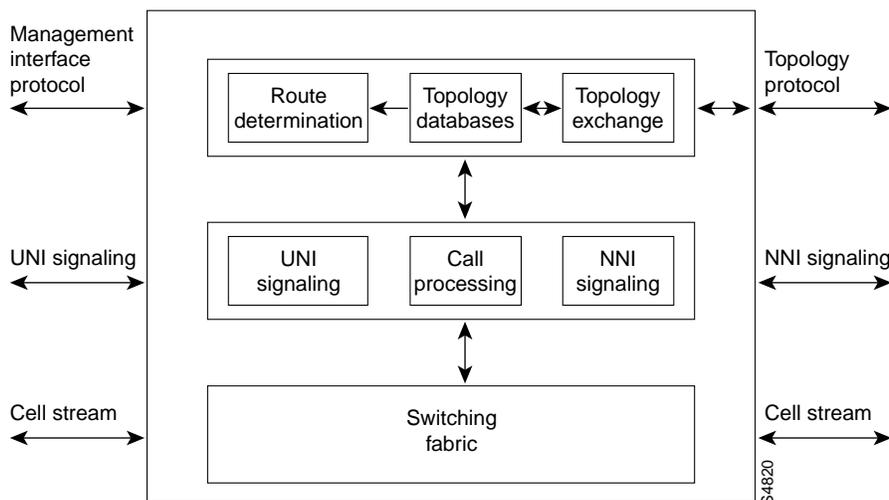
The level of a PG, including all nodes within it, indicates its position in the PNNI hierarchy. A level with a small numerical value implies greater topological aggregation and has a higher level in the PNNI hierarchy. A level with a larger numerical value implies less topological aggregation and has a lower level in the PNNI hierarchy.

The default assignment of nodes to PGs is determined by their addresses. For example, the default lowest level PG ID is determined by the level bit prefix of the node address where the level is configurable.

All lowest level nodes in a PG should share the same level-bit address prefix and should have unique 13-byte address prefixes. See the section “Configure the ATM Address” in this chapter for the command-line interface (CLI) command used to configure the ATM address.

The virtual circuit (VC) routing and call-processing system architecture are shown in Figure 11-2.

**Figure 11-2 PNNI Processing System Architecture**



This architecture is platform-independent, and is valid for both campus and enterprise switches.

### Signaling

When a connection request is received at a User-Network Interface (UNI) or IISP interface, the designated transit list (DTL) or source route must be computed. Signaling requests the source route by sending a message to the PNNI router.

### Dynamic Versus Static ATM Routing

Static routing protocols, which require route configuration, are unsuitable for larger networks because they require a significant amount of configuration. IISP is an example of a static routing protocol.

Dynamic routing protocols adapt to changing network conditions by advertising reachability and topology status information changes. PNNI is a dynamic routing protocol. The LightStream 1010 PNNI implementation can interoperate with IISP to provide routing between multiple PGs.

### QoS Routing

QoS routing is the selection of routes or paths that satisfy a set of constraints for a requested connection. The user can specify QoS parameters for connections such as the following:

- Maximum cell transfer delay
- Peak-to-peak cell delay variation
- Cell loss ratio

Routing must find a path that satisfies the requested QoS for the duration of the connection.

### Source Routing Versus Hop-by-Hop

Two techniques are used to thread a path in a network, as follows:

- Hop-by-hop routing
- Source routing

### Hop-by-Hop Routing

Hop-by-hop routing, well known in datagram switching, is based on the computation of a table that has one entry for each destination node. The next entry in the table specifies what the next node on the path is to that destination. Routing toward the destination is done by forwarding the datagram (call request) to the next node based on the destination node address and the information in the next-hop routing table. Hop-by-hop routing requires the presence of the address of the destination node in the datagram.

When using PNNI, the next-hop routes used by IISP are incorporated into the PNNI routing tables.

## Source Routing

Source routing has the entire path specified by the source node. The path information is included in the call setup message, and signaling follows the path accordingly.

The PNNI protocol is a source routing protocol and has the following advantages over a hop-by-hop routing protocol:

- Avoidance of routing loops
- Faster call setups because of minimal processing at intermediate nodes
- Better adaptive routing

A source route in PNNI consists of DTL stacks, each with a sequence of nodes and links at a level of the PNNI hierarchy.

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**Note** The initial LightStream 1010 ATM switch implementation of PNNI supports only one level of hierarchy, so that each source route consists of only one DTL.

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## Controlling Loops

Hop-by-hop routing controls loops by ensuring that all switches see a consistent topology when computing next-hop routing tables. The next-hop routing tables are computed based on the same metric. Every distributed system has transient conditions, such as a link failure, when the next-hop routing tables are inconsistent. This leads to looping, which is not a problem in datagram routing because the datagrams contain a mechanism that does not allow indefinite packet looping in the network.

Source routing is by definition loop-free. Using source routing allows every switch to compute the source routes independently with its own selected mechanism. Transient conditions are not crucial to PNNI. In the worst case, the call is cranked back to the source and an alternate path is selected, but looping never occurs. See the section “Crankback Mechanism.”

## Computing QoS Paths

Source routing provides the best control over the path selected in the network. The path never diverges from what the source route specifies, regardless of the route selection criteria. PNNI uses the crankback mechanism to correct failures by systematically routing calls to the destination. See the section “Crankback Mechanism.”

## Topology Information in PNNI

PNNI is a topology state algorithm; it advertises information about the status of links and nodes in the network. The advertised information contains multiple metrics and attributes for links and nodes for each ATM service category. Both topological information and address reachability are advertised. PNNI supports a hierarchical organization of the topology database.

## The Hello Protocol

The Hello protocol is used to discover the identity of the adjacent neighbor node. The PNNI Hello protocol is modeled on the Open Shortest Path First (OSPF) protocol with appropriate extensions to support a hierarchical organization of the topological database. Discovering the identity of the neighbor is done via an exchange of hello packets containing appropriate information. If the

switches discover they are members of the same PG, they form an inside link. If they are members of different PGs, additional information about the hierarchy is exchanged and an outside link is created.

### Database Synchronization

When the Hello protocol has declared the link as functional, the adjacent switches exchange a summary of their database contents. This mechanism is similar to the OSPF database synchronization procedures. The synchronization is governed by a master and slave relationship of switches. Nodes exchange database summary packets that contain header information for all PNNI topology state elements (PTSEs) in a node database. After an exchange, differences in the topological databases are updated. When the exchange is completed, both nodes have consistent topological databases.

### PNNI Topology Description and Distribution

PNNI topology state packets (PTSPs) that contain one or more PTSEs are used to disseminate information in the ATM network. PTSPs contain reachability, link, and node status information necessary for PNNI to calculate QoS paths in an ATM network.

### Reachability Information in PNNI

PNNI allows summarization of multiple ATM addresses into a single summary address prefix. Address summarization and the hierarchical organization of the topology enables PNNI to scale to very large networks.

Reachability information is used as the first step in routing a PNNI signaling request for a virtual connection. The call setup packet is directed to a node and advertises a prefix that matches the leading portion of the destination address. The longest matching reachable address prefix is always used.

### Internal Reachable ATM Addresses

This information group describes internal reachable ATM destinations. (Internal means known to PNNI to be local.) For a node representing a single switch, an internally reachable address represents a summary of the end systems attached to the switch, for example, discovered via Interim Local Management Interface (ILMI) address registration. At higher levels of the hierarchy, it summarizes information provided by the members of the PG.

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**Note** Internal static routes can be configured manually to end systems that do not support ILMI. These routes are automatically advertised as internal reachable addresses (subject to address summarization).

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### Exterior Reachable ATM Addresses

Exterior reachable ATM addresses are similar to internal reachable addresses, and describe reachability to a set of ATM destinations. Using an exterior advertisement implies that the reachability information came from somewhere else. This includes cases such as information from other routing domains in which the switch participates or configuration about what is reachable over a specific link. A link connecting to an IISP network is an example of an exterior reachable address.

## Supported Metrics and Attributes

As being a topology state routing protocol, PNNI advertises detailed information about the status of the links and nodes. The status of the topological entities (links and nodes) is described via metrics and attributes. Metrics are combined along a path. The simplest example of a metric is the administrative weight (AW). The AW of a path is the sum of the weights of the links and nodes along the path.

Attributes are treated differently by PNNI in a different way. If an attribute value for a parameter violates the QoS constraint, then PNNI excludes that topological entity from consideration while making a path selection.

Supported metrics and attributes include the following:

- Administrative weight (AW)—Indicates the relative preference of a link or node assigned by the private network operator.
- Available cell rate (AvCR)—Reflects the amount of equivalent bandwidth that is available on the link or node.
- Maximum cell transfer delay (MaxCTD)—The  $(1-\alpha)$  quantile of the elapsed time for transmission of cells across a link or node, including processing and queueing delays plus propagation delay.
- Cell loss ratio (CLR)—The ratio of the number of lost cells to the total number of cells transmitted across the link or node.
- Peak-to-peak cell delay variation (CDV)—The  $(1 - \alpha)$  quantile of the CDV minus the fixed delay experienced by all cells crossing the link or node.
- Maximum cell rate (MaxCR)—The maximum capacity usable by connections belonging to the specific service category.

Metrics and attributes supported by PNNI are listed in Table 11-1.

**Table 11-1 PNNI Metrics and Attributes Supported**

Parameter	Metric/ Attribute	Static/ Dynamic	Unit	Granularity	Range	Encoding
Administrative weight	Metric	Static	Unitless	–	$1 - (2^{32}-1)$	32-bit integer
Available cell rate	Attribute	Dynamic	Cells per second	1 cell per second		32-bit integer
Maximum cell transfer delay	Metric	Static	Microseconds	1 microsecond	1 microsecond - 168 seconds	32-bit integer
Cell delay variation	Metric	Static	Microseconds	1 microsecond	1 microsecond - 168 seconds	32-bit integer
Cell loss ratio	Attribute	Static	Order of magnitude		$10^{-1} - 10^{-15}$	16-bit exponent
Maximum cell rate	Attribute	Static	Cells per second	1 cell per second		32-bit integer

PNNI metrics and attributes are specified separately for each parameter in the following service categories:

- Constant bit rate (CBR)
- Variable bit rate (VBR)
  - Real-time (RT)-VBR
  - Nonreal-time (NRT)-VBR
- Available bit rate (ABR)
- Undefined bit rate (UBR)

### Administrative Weight

Administrative weight is the main metric used by PNNI for computation of paths. The assignment of administrative weights to links and nodes influences how PNNI selects paths in the private ATM network.

Administrative weight indicates the relative preference of a link assigned by the private network owner. For example, it might depend on link capacity or link length. Administrative weight can also be used to exclude certain links from routing, such as a backup link that needs to be used only when the primary link is full. The administrative weight for a path is simply the sum of the individual weights of the links on the path.

The LightStream 1010 selects paths with the least administrative weight when they satisfy the requested QoS of a connection.

### Available Cell Rate

AvCR is the most dynamic metric in PNNI. It reflects the amount of equivalent bandwidth that is available on the link for new connections. Dependent on the calls traversing the link, AvCR is the residual capacity left for use by additional calls. Not every change in AvCR is advertised in the network by PNNI. Only significant changes, as defined by the ATM Forum PNNI specification, are advertised in the network. PNNI needs the knowledge of AvCR to decide whether a given link or node to carry a call. The LightStream 1010 PNNI implementation supports both simple and complex generic connection admission control (GCAC) to make this decision.

AvCR is maintained on a per-service category basis. Three AvCRs are maintained, one each for CBR, RT-VBR, and NRT-VBR service categories.

### Significant Change Definitions

Not every change in parameter value is substantial enough to generate an advertisement. The network would be overwhelmed with PNNI advertisement packets if frequently changing parameters generated advertisements every time any change in their value occurred. Changes in CDV, MaxCTD, or AvCR are measured in terms of a proportional difference from the last advertised value. A proportional multiplier threshold expressed as a percentage provides flexible control over the definition of significant change.

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**Note** For other parameters such as AW, any change in value is considered significant.

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For each parameter, PNNI defines what constitutes a significant change. See the section “Configure Significant Change Thresholds” for configuration information.

## The Generic Connection Admission Control Algorithm

Not all switches have the same mechanism to perform call control for connection admission. PNNI has defined its own mechanisms to determine whether a call with a requested peak cell rate (PCR) and sustainable cell rate (SCR) is admitted on a selected link (node). These mechanisms screen links and nodes for consideration in path computation. Two mechanisms perform this screening function, depending on the number of parameters advertised by each entity:

- Simple GCAC
- Complex GCAC

Simple GCAC requires only AvCR to be advertised.

Complex GCAC provides a more accurate calculation at a price of increased processing complexity. It uses two additional parameters that can be optionally advertised by a PNNI entity:

- Cell rate margin (CRM)
- Variance factor (VF)

By default the LightStream 1010 PNNI uses simple GCAC. It also operates using complex GCAC for those links and nodes that have advertised CRM and VF.

The ATM Forum PNNI specification defines GCAC for the following service categories:

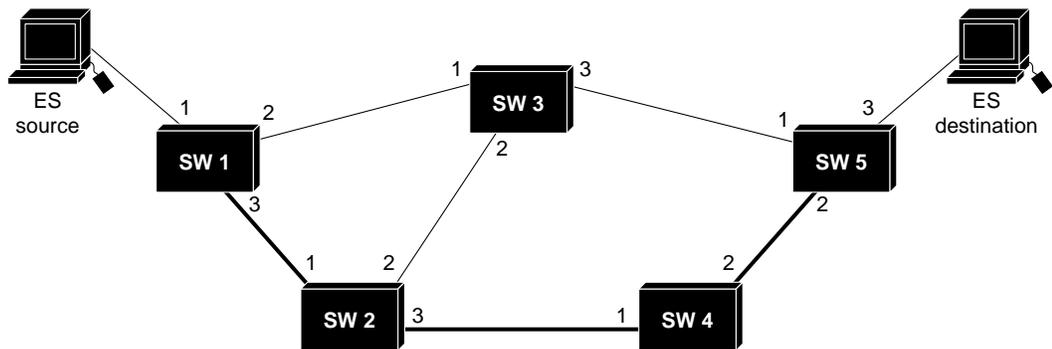
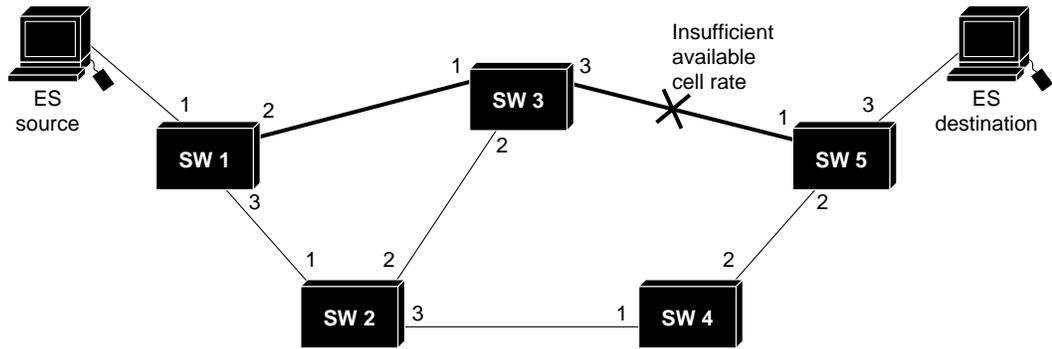
- CBR—This is based on the PCR and AvCR. If AvCR is less than PCR the link is excluded; otherwise it is included.
- VBR—This is based on the PCR, SCR, AvCR, and optionally CRM and VF.
- ABR—For ABR connections that have a minimum cell rate (MCR) of zero, there is no GCAC is performed. For ABR connections with a MCR greater than zero, links are included only if the AvCR is greater than MCR and the advertised MaxCR is greater than zero.
- UBR—For UBR connections, links are included only if the advertised MaxCR is greater than zero. A MaxCR of zero indicates that the link cannot accept additional UBR connections.

## Crankback Mechanism

The crankback concept adapted in PNNI is based on similar mechanisms used in circuit switching. Crankback folds back the call to the source node in the PG that created the DTL, and the source retries on an alternate path. Crankback pinpoints the link or node to be avoided in the next retry. A single call can be cranked back to the source many times. After a limited number of retrials the crankback mechanism indicates that it cannot provide the requested QoS path.

Figure 11-3 is an example of a signaling request encountering insufficient available cell rate at the link SW3p3->SW5p1.

Figure 11-3 Crankback Mechanism Example



Signaling route ———

S4905

Signaling includes a crankback information element (IE) in the call release message indicating the blocked link SW3p3->SW5, and sends it back upstream to the source switch. PNNI computes a new DTL that avoids the blocked link: (SW1p3-> SW2p3-> SW4p2->SW5).

**Note** Crankback is transparent. It is an automatic mechanism that increases the success probability of a call.

## Enhanced PNNI Features

The LightStream 1010 ATM switch PNNI implementation supports the following enhanced PNNI features, as described in the following sections:

- Autoconfiguration and Support for Address Modification
- Tuning PNNI to Specific Network Conditions

- Load Balancing
- VP Tunneling
- Scope of Addresses

## Autoconfiguration and Support for Address Modification

The LightStream 1010 ATM switch PNNI implementation supports autoconfiguration. When the switch initially comes up, an autoconfigured ATM address is assigned. The autoconfigured ATM address provides a unique 13-byte address prefix to each switch used for ILMI address registration and address summarization. All autoconfigured addresses share the same 7-byte address prefix so they belong to the same PG at level 56. This feature allows you to interconnect multiple switches out of the box without any configuration necessary.

You can modify the ATM address using manual configuration commands. In PNNI, by default the node identifier originates from the ATM address assigned to the switch. The node identifier uniquely identifies the node in PNNI. A change of ATM switch address normally result in a change of the node identifier, causing all links to go down and thus disallowing the possibility of smooth address migration in the PG. See the sections “Configure the ATM Address” and “Configure the PNNI Node” for ATM address modification procedures.

## Tuning PNNI to Specific Network Conditions

The LightStream 1010 PNNI implementation allows you to tune to the network conditions using the command-line interface (CLI).

## Load Balancing

Load balancing distributes the traffic throughout the network. Load balancing techniques enable you to transmit more traffic across the network. The LightStream 1010 ATM switch uses two types of load balancing, as follows:

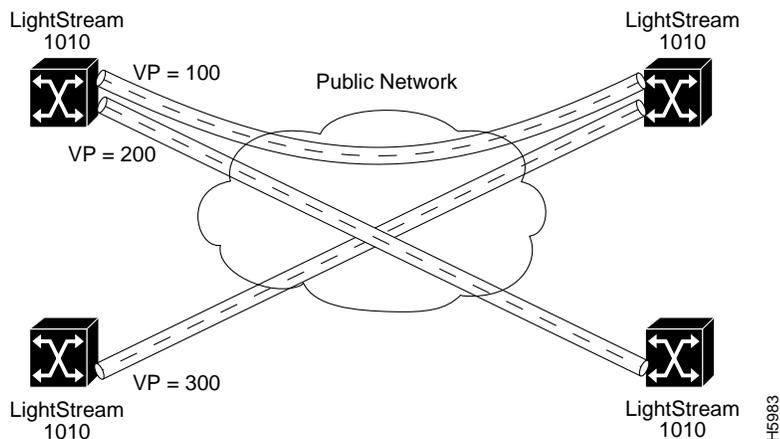
- Balancing between parallel links joining two adjacent switches
- Balancing calls to the same destination on a network-wide basis

For configuration information, see the section “Configure ATM PNNI Link Selection.”

## VP Tunneling

A typical application of virtual path (VP) tunneling using the workgroup and enterprise switch is shown in Figure 11-4. The switches form small private networks over a public cloud. They are interconnected over permanent virtual paths (PVPs), which are essentially logical trunks.

**Figure 11-4 Tunneling Example**



The dashed lines indicate the PVPs that interconnect the ATM switches. Each VP is a logical trunk over which signaling (on channel VP = X, VC = 5) and PNNI (on channel VP = X, VC = 18) can operate normally. Switched virtual circuits (SVCs) can be routed and signaled across the VP tunnel as if both endpoints were connected by a physical link.

## Link Selection

Link selection in the LightStream 1010 ATM switch PNNI allows the network administrator to configure the criteria for selecting a link out of multiple parallel links to allow forwarding of the call setup. The link selection criteria applies to PNNI links between two adjacent LightStream 1010 switches. See the section “Configure ATM PNNI Link Selection” for configuration information.

## Background Routing Tables

The LightStream 1010 ATM switch PNNI supports both background and on-demand route computations. Background routing tables provide improved processing efficiency because most calls can be routed with simple table lookups. In background routing mode, multiple background tables are precomputed for several service categories and QoS metrics. If no route is found in the background tables to satisfy the QoS requirements of a call setup request, route selection reverts to on-demand computation. See the section “Configure On-Demand and Background Path Updates” for configuration information.

## Precedence Control for Different Types of Reachable Addresses

Addresses in a PNNI network can be reached in several ways. For example, internal addresses are reachable within the PNNI network, while exterior addresses are reachable through an exterior network. The *type* of the reachable address specifies how the address can be reached. Multiple nodes in the network might advertise the same reachable address but with different types.

LightStream 1010 ATM switch PNNI allows the user to configure different precedences for different types of reachable addresses. The route selection algorithm first attempts to find routes to destination nodes advertising reachable address types of greatest precedence. See the section “Configure the Precedence” for configuration information.

## Administrative Weight Defaults According to Linespeed

Administrative weight is the primary routing metric for minimizing the use of network resources. It also allows the network administrator to configure the default behavior for assigning weights to PNNI links. In linespeed mode the LightStream 1010 assigns default administrative weights based on the linespeed of individual links with smaller weights assigned to higher speed links. This assignment is based on the reference administrative weight of 5040 for an OC-3 link. See the section “Configure the Administrative Weight Mode” for configuration information.

## Scope of Addresses

The PNNI address scope allows you to limit advertised reachability information within configurable bounds. This feature gives network administrators flexible control of reachability information, in case of network restructuring.

The service scope for a group of addresses is the highest-level PG that contains the group address for anycast purposes. Calling parties are not allowed to establish connections outside of their highest PG.

- Group addresses have authority and format identifiers (AFIs) in the network level address headers with values greater than or equal to 0xA0
- Individual addresses have AFI values less than 0xA0

## Path Selection

A source node routes to the node that advertises the longest address prefix that matches the destination. However, scope checking takes precedence over longest-prefix match routing.

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**Note** If two destination nodes have the same address prefix, the node closest to the source will be selected.

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Configure the scope for path selection using the following rules:

- The destination address should have a scope at least as wide as the scope of the path across the PNNI domain.
- The scope may be configured. If not specified, the scope defaults to the following:
  - Group addresses map to the local (1) network.
  - Individual addresses map to the global (15) network.

Anycast connections use the scope to make point-to-point connections to a group address. The anycast route to one or any of the groups is determined by the longest prefix address.

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**Note** Only members of the group that are reachable within the indicated connection scope are considered.

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## UNI Scope to PNNI Level Mapping

The UNI design of the membership scope control considers how it is used in the real network applications. Most applications would like to control reachability according to human organization hierarchies (for example, intranetwork or intrasite).

Table 11-2 lists each UNI scope number and the corresponding hierarchy.

**Table 11-2 UNI Scope Hierarchy**

Scope Number	Hierarchy
1	Local
2	Local plus one
3	Local plus two
4	Site minus one
5	Intrasite
6	Intrasite plus one
7	Organization minus one
8	Intraorganization
9	Organization plus one
10	Community minus one
11	Intracommunity
12	Community plus one
13	Regional
14	inter regional
15	Global

The LightStream 1010 switch uses the UNI scope numbers to display the UNI scope value.

## Automatic Scope Mapping Assignment

The scope of an ATM address affects how widely the ATM address is advertised. When modifying the level of the peer group, configure the scope map table accordingly to avoid unintentionally suppressing reachability information advertisements.



**Caution** Scope map modifications should be done carefully as misconfiguration of the scope map might cause addresses to remain unadvertised.

The LightStream 1010 automatically reconfigures UNI-to-PNNI level mapping to avoid any misconfigurations caused by node level modifications. Automatic adjustment of scope mapping uses the values shown Table 11-3.

**Table 11-3 Scope Mapping Table**

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

For each organizational scope value, the corresponding PNNI level is the minimum of the ATM Forum PNNI 1.0 default value and level 1 of this node.

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**Note** For additional information, see Section 5.3.6 of the “PNNI Version 1.0 Specification.”

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Configuring scope mode as automatic ensures that all organizational scope values cover an area at least as wide as the current node’s peer group. Configuring the scope mode as manual disables the feature and no changes to the scope map table can be made without explicit configuration. Scope mode is configured as automatic mode by default on the LightStream 1010.

The PNNI scope associated with the ATM address and prefix can be configured in automatic or manual mode. See the section “Configure ATM PNNI Scope Mode” for configuration steps. To manually configure the scope mode, see the sections “Configure Static Routes” and “Scope of Addresses” in this chapter.

## Global Switch Configuration

This section describes the following LightStream 1010 ATM switch PNNI global configurations:

- Configure the ATM Address
- Configure the Routing Mode
- Configure Static Routes
- Configure a Static Route with an E.164 Address
- Configure an ATM E.164 Address on an Interface

### Configure the ATM Address

During the initial startup, the LightStream 1010 generates an ATM address using the defaults described in the section “Configure the ATM Address” in the chapter “Initially Configuring the LightStream 1010 ATM Switch.” The switch’s ATM address uses a hierarchical addressing model similar to the Open System Interconnection (OSI) network service access point (NSAP) addresses. PNNI uses this hierarchy to construct ATM PGs. ILMI uses the first 13 bytes of this address as the switch prefix that it registers with end systems.

To configure a new ATM address that replaces the previous ATM address and is used to generate a new PNNI node ID and PG ID, see the section “Configure the PNNI Node.”

Multiple addresses can be configured for a single switch, and this configuration can be used during ATM address migration. ILMI registers end systems with multiple prefixes during this period until the old address is removed. PNNI automatically summarizes all prefixes for the switch in its reachable address advertisement.

To manually configure an additional ATM address, use the following commands. Use the **no** form of the **atm address** command to disable the address.

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
Configure the ATM address for the switch.	<b>atm address</b> <i>atm-address</i>

1. This command is documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### 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)#
```

### Display the ATM Address Configuration

To display the ATM address configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM address configuration.	<b>show atm addresses</b>

## Example

This example shows how to display the ATM address configuration using the **show atm addresses** command from user EXEC mode:

```
Switch# show atm addresses

Switch Address(es):
47.0091810000000410B0A1081.00410B0A1081.00 active
47.0091810000000603E5ADB01.00603E5ADB01.00

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):
Switch#
```

## Configure the Routing Mode

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

---

**Note** The static routing mode is the same as the default IISP software image in Release 11.1.

---

Since you can now configure the routing mode, you no longer need separate software images for PNNI and IISP, as you did in Release 11.1. The default mode is dynamic, and PNNI functionality is available on all interfaces.

The **atm routing-mode** command is different from deleting all PNNI nodes using the **node** command and affects 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 Network-to-Network Interface (NNI) signaling protocol is not supported.

---

**Note** The **atm routing-mode** command differs from other CLI commands. It 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 ATM routing mode to static, use the **atm routing-mode** command. Use the **no** form of this command to return the switch to dynamic routing mode (PNNI) operation.

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
Configure the ATM routing mode to static.	<b>atm routing-mode static</b>
Exit configuration mode.	<b>end</b>
Write the running configuration to the startup configuration.	<b>copy running-config startup-config</b>
Reload the switch software.	<b>reload</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### 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 running-config 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 running-config startup-config
Building configuration...
[OK]
Switch# reload
```

## Display the ATM Routing Mode Configuration

To display the ATM routing mode configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM routing mode configuration.	<b>show running-config</b>

### Example

This example shows how to display the ATM routing mode configuration using the **show running-config** command from user EXEC mode:

```
Switch# show running-config
Building configuration...

Current configuration:
!
version 11.2
no service pad
service udp-small-servers
service tcp-small-servers
!
hostname Switch
!
!
username dtate
ip rcmd remote-username dplatz
!
atm e164 translation-table
e164 address 1111111 nsap-address 11.1111111111111111111111111111.112233445566.11
e164 address 2222222 nsap-address 22.2222222222222222222222222222.112233445566.22
e164 address 3333333 nsap-address 33.3333333333333333333333333333.112233445566.33
!
atm routing-mode static
atm address 47.0091.8100.0000.0040.0b0a.2b81.0040.0b0a.2b81.00
!
interface CBR0/0/0
no ip address

<Information Deleted>

Switch#
```

## Configure 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** 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 **atm route** command. Use the **no** form of this command to return to the default.

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm route</b> <i>atm-address-prefix</i> <b>atm</b> <i>card/subcard/port</i> <b>[e164-address</b> <i>e164-address</i> <b>[number-type</b> <b>{international   local   national  </b> <b>subscriber}]</b> <b>[internal]</b> <b>[ scope1-15]</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Examples

The following example uses the **atm route** command to configure a static route to the 13-byte switch prefix 47.0091810000000410B0A1081 to ATM interface 0/0/0:

```
Switch(config)# atm route 47.0091810000000410B0A1081 atm 0/0/0  
Switch(config)#
```

The following example uses the **atm route** command configure a static route to the 13-byte switch prefix 47.0091810000000410B0A1081 to ATM interface 0/0/0 configured with a scope 1 associated:

```
Switch(config)# atm route 47.0091.8100.0000 atm 0/0/0 scope 1  
Switch(config)# ^Z
```

### Display the Static Route Configuration

To display the ATM static route configuration, perform the following task in user EXEC mode:

Task	Command
Display the static route configuration.	<b>show atm route</b>

## Examples

The following example displays the ATM static route configuration using the **show atm route** command from user EXEC mode:

```
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 I  ATM0/0/0   DN 56 47.0091.8100.0000/56
S E I  ATM0/0/0   DN 0  47.0091.8100.0000.00/64
              (E164 Address 1234567)
R SI I  0         UP 0  47.0091.8100.0000.0041.0b0a.1081/104
R I I  ATM2/0/0   UP 0  47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081/152
R I I  ATM2/0/0   UP 0  47.0091.8100.0000.0041.0b0a.1081.4000.0c/128
R SI I  0         UP 0  47.0091.8100.5670.0000.0000.0000/104
R I I  ATM2/0/0   UP 0  47.0091.8100.5670.0000.0000.0000.0040.0b0a.1081/152
R I I  ATM2/0/0   UP 0  47.0091.8100.5670.0000.0000.0000.4000.0c/128

Switch#
```

## Configure a Static Route with an E.164 Address

Use the **atm route** command to configure a static route to an E.164 address. A static route attached to an interface allows all ATM addresses that match the configured address prefix to be reached through that interface and routed to an E.164 address.

Configuring a static route with an E.164 address is a two-step process and is described in this section:

**Step 1** Configure a static ATM route with an E.164 address.

**Step 2** Configure the E.164 address to an interface.

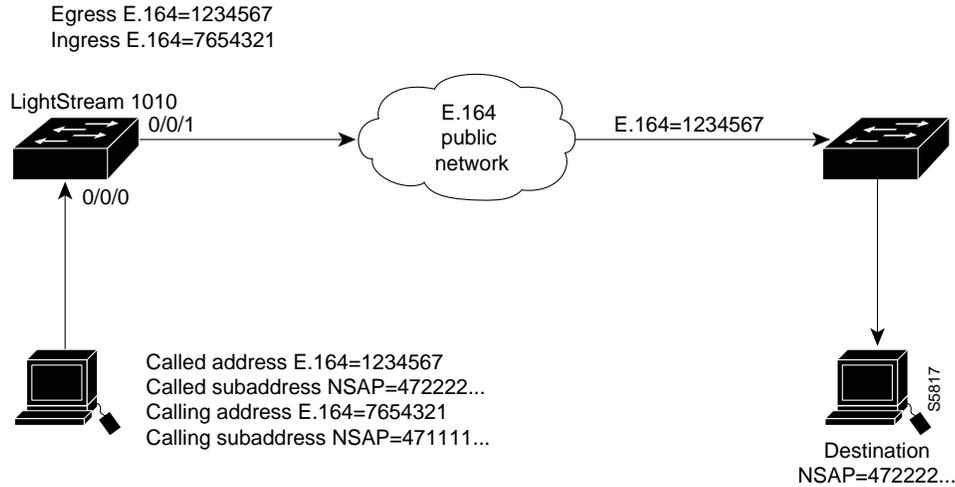
One E.164 address can be configured per ATM port. Signaling uses E.164 addresses in called and calling party information elements (IEs). Signaling uses NSAP addresses in the called and calling party subaddress IEs when a network supports E.164 addressing.

The E.164 addresses have the following properties:

- Configure one E.164 address can be configured per port
- Conform to International Telecommunications Union (ITU) E.164 specification
- Addresses contain 7 to 15 digits
- Decimal digits 0 to 9
- IA5 number, ASCII, 8-bits, MSB = 0
- Result equals one digit per byte
- UNI or IISP support only; PNNI does not support E.164 addresses

Figure 11-5 illustrates an E.164 address switch static route configuration.

Figure 11-5 E.164 Address Connection Setup Example



The NSAP address is used to initiate the call at the ingress to the public network. The public network routes the call based on the E.164 address. NSAP subaddresses are carried through the public network in the subaddress field. The NSAP address is used to complete the call at egress from the public network.

The following commands are used to configure E.164 address static routes:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, configure the static route with the E.164 address.	<b>atm route atm-address-prefix atm card/subcard/port [e164-address e164-address [number-type {international   local   national   subscriber}]] [internal] [scope1-15]</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

Example

The following example uses the **atm route** command configuring a static route to the 13-byte switch prefix 47.00918100000000410B0A1081 to ATM interface 0/0/0 configured with E.164 address 1234567:

```
Switch(config)#atm route 47.00918100000000410B0A1081 atm 0/0/0 e164-address 1234567
Switch(config)#^Z
```

To complete the E.164 address static route configuration, proceed to the section “Configure an ATM E.164 Address on an Interface.”

Display the E.164 Static Route Configuration

To display the E.164 address configuration, perform the following tasks in user EXEC mode:

Task	Command
Display the static route E.164 address configuration.	<b>show atm route</b>

## Examples

The following example displays the E.164 address configuration using the **show atm route** command from user EXEC mode:

```
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 I  ATM0/1/0   DN 0  47.0091.8100.0000.0001/72
P SI 1  0         UP 0  47.0091.8100.0000.0002.eb1f.fe00/104
R I 1  ATM2/0/0   UP 0  47.0091.8100.0000.0002.eb1f.fe00.0002.eb1f.fe00/152
R I 1  ATM2/0/0   UP 0  47.0091.8100.0000.0002.eb1f.fe00.4000.0c/128
P SI 1  0         UP 0  47.0091.8100.0000.0040.0b0a.2b81/104
S E I  ATM0/0/0   DN 0  47.0091.8100.0000.0040.0b0a.2b81/104
           (E164 Address 1234567)
R I 1  ATM2/0/0   UP 0  47.0091.8100.0000.0040.0b0a.2b81.0040.0b0a.2b81/152
R I 1  ATM2/0/0   UP 0  47.0091.8100.0000.0040.0b0a.2b81.4000.0c/128
Switch#
```

## Configure an ATM E.164 Address on an Interface

One E.164 address can be configured per ATM port. Signaling uses E.164 addresses in called and calling party IEs. Signaling uses NSAP addresses in the called and calling party subaddress IEs if a network supports E.164 addressing.

To configure an E.164 address on a per-interface basis, perform the following task. Use the **no** form of the following commands to disable:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> [terminal]
Select interface port.	<b>interface atm</b> <i>card/subcard/port</i>
Associate the E.164 address to the interface.	<b>atm e164 address</b> <i>E164-address</i>

1. This command is documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

## Example

The following example shows how to configure the E.164 address 7654321 on ATM interface 0/0/1:

```
Switch# config t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)# interface atm 0/0/1
Switch(config-if)# atm e164 address 7654321
Switch(config-if)# ^Z
```

## Display the E.164 Address Association to Interface Configuration

To display the E.164 configuration, use the following EXEC mode command:

Task	Command
Show the E.164 address configuration on a per-port basis.	<b>show atm interface atm</b> <i>card/subcard/port</i>

### Example

The following example shows how to display the E.164 address configuration for ATM interface 0/0/1:

```
Switch# show atm interface atm 0/0/1

Interface:  ATM0/0/1      Port-type:  oc3suni
IF Status:  UP           Admin Status: up
Auto-config: enabled     AutoCfgState: completed
IF-Side:    Network     IF-type:    NNI
Uni-type:   not applicable Uni-version: not applicable
Max-VPI-bits: 8         Max-VCI-bits: 14
Max-VP:     255         Max-VC:     16383
Svc Upc Intent: pass    Signalling: Enabled
ATM Address for Soft VC: 47.0091.8100.0000.0041.0b0a.1081.4000.0c80.0010.00
ATM E164 Address: 7654321
Configured virtual links:
  PVCLs SoftVCLs  SVCLs  PVPLs SoftVPLs  SVPLs Total-Cfgd Installed-Conns
    3    0    0    0    0    0    3    3
Logical ports(VP-tunnels): 0
Input cells: 226064      Output cells: 226139
5 minute input rate:    0 bits/sec,    0 cells/sec
5 minute output rate:  0 bits/sec,    0 cells/sec
Input AAL5 pkts: 147608, Output AAL5 pkts: 147636, AAL5 crc errors: 0

Switch#
```

### Display ATM PNNI Configuration

To display the ATM PNNI router configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM PNNI router configuration.	<b>show atm pnni</b>

### Examples

The following example shows how to display the available ATM PNNI global configuration variables using the **show atm pnni** command from user EXEC mode:

```
Switch# show atm pnni ?
background  PNNI Background Route Table Info
database    PTSE database information
election    PNNI PGL election information
identifiers PNNI internal node number to node-id mapping
interface   interface information
neighbor    neighbor information
node        PNNI node information
precedence  Prefix Priorities For Routing
prefix      PNNI prefix information
resource-info resource management information
scope      UNI scope to PNNI level map table
statistics  PNNI Statistics
topology    PNNI topology database
traffic     PNNI control traffic

Switch#
```

The next example shows how to display the ATM PNNI node configuration using the **show atm pnni node** command for node index number 1 from user EXEC mode:

```
Switch# show atm pnni 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
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
Switch#
```

## PNNI Routing Configuration

This section describes the following LightStream 1010 ATM switch PNNI routing configuration tasks:

- Enter ATM Router PNNI Configuration Mode
- Configure On-Demand and Background Path Updates
- Configure the Precedence
- Configure the Administrative Weight Mode
- Configure the Maximum Administrative Weight Percentage
- Configure the Resource Management Poll Interval
- Configure the ATM PNNI Statistics Gathering
- Configure the PNNI Node

### Enter ATM Router PNNI Configuration Mode

To enter the ATM router PNNI configuration mode, perform the following task in global configuration mode:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure<sup>1</sup></b> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Example

The following example changes the configuration mode to the ATM router PNNI mode and displays the variables using the ? help command:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# ?
ATM router configuration commands:
administrative-weight    Select mode of administrative weight assignment
background-routes-enable Enable or Disable Background Routes
bg                       Background SPF Related Parameters
exit                    Exit from ATM routing protocol configuration
mode
max-admin-weight-percentage Maximum Administrative Weight Percentage
no                       Negate or set default values of a command
node                    Configure PNNI node
precedence              Define Prefix Priorities For Routing
rm-poll-interval        How Often To Poll Resource Manager
statistics              Turn on PNNI statistics

Switch(config-atm-router)#
```

## Configure On-Demand and Background Path Updates

Most calls are routed using precomputed routing trees. To satisfy QoS requirements, multiple background trees are precomputed. The LightStream 1010 ATM switch supports the following two route selection modes:

- On-demand—A separate route computation is performed each time a SETUP or ADD PARITY message is received over a UNI or IISP interface. In this mode, the most recent topology information received by this node is always used for each setup request.
- Background routes—Most calls can be routed using precomputed routing trees. In this mode, multiple background trees are precomputed for several service categories and QoS metrics. If no route can be found in the background trees, the QoS requirements of a particular setup request are satisfied and route selection returns to on-demand route computation.

The background routes mode should be enabled in large networks where it will usually exhibit 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 route selection mode to use background routes, perform the following task in global configuration mode. Use the **no** form of the **background-routes-enable** command to return to on-demand mode:.

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
Enable background routes and configure background route parameters.	<b>background-routes-enable</b> <b>{insignificant-threshold value   poll-interval seconds}</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Syntax Description

- **insignificant-threshold**—Insignificant threshold value from 1 to 100
- **poll-interval**—Background routes poll interval value from 1 to 60 seconds

See the section “PNNI Topology Description and Distribution” for more information about ATM PNNI database updates.

### 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
```

### Display the On-Demand and Background Path Updates Configuration

To display the background route configuration, perform the following tasks in user EXEC mode:

Task	Command
Display the background route configuration.	<b>show atm pnni background status</b>
Display background routing tables.	<b>show atm pnni background-route</b>

### Examples

The following example shows how to display the ATM PNNI background route configuration:

```
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
Switch#
```

The following example shows how to display the ATM PNNI background route tables for CBR:

```
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

Switch#
```

## Configure the Precedence

The LightStream 1010 ATM switch 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 AW are chosen first.

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

To configure the ATM router PNNI precedence, perform the following task in global configuration mode. Use the **no** form of these commands to change to the default value.

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, enter PNNI precedence and configure the PNNI node.	<b>precedence [pnni-remote-exterior value_2-4   pnni-remote-exterior-metrics value_2-4   pnni-remote-internal value_2-4   pnni-remote-internal-metrics value_2-4   static-local-exterior value_2-4   static-local-exterior-metrics value_2-4   static-local-internal-metrics value_2-4]</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Example

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

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

### Display ATM PNNI Precedence Configuration

To display the ATM PNNI route determination precedence configuration, perform the following task in user EXEC mode:

Task	Command
Display the node ATM PNNI route determination precedence configuration.	<b>show atm pnni precedence</b>

### Example

The following example shows how to display ATM PNNI route determination precedence configuration:

```
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

Switch#
```

## Configure the Administrative Weight Mode

You can configure the administrative weight (AW) to indicate the relative desirability of using a link. In addition to the per-interface **atm pnni administrative-weight** command, the ATM router PNNI **administrative-weight** command can be used to change the default AW assignment. For example, assigning equal AWs to all links in the network will minimize the number of hops used by each connection. For more information, see the section “Administrative Weight.”

To configure the ATM router PNNI AW mode, perform the following task in global configuration mode using the **no** form of this command to assign the default value:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure<sup>1</sup></b> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure router prompt, configure the administrative weight for all node connections.	<b>administrative-weight {linespeed   uniform}</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Syntax Description

- **linespeed**—Sets default AW to values determined by the interface line speed (maximum cell rate)

---

**Note** Higher line speeds (maximum cell rates) have lower administrative weight and are selected first during routing.

---

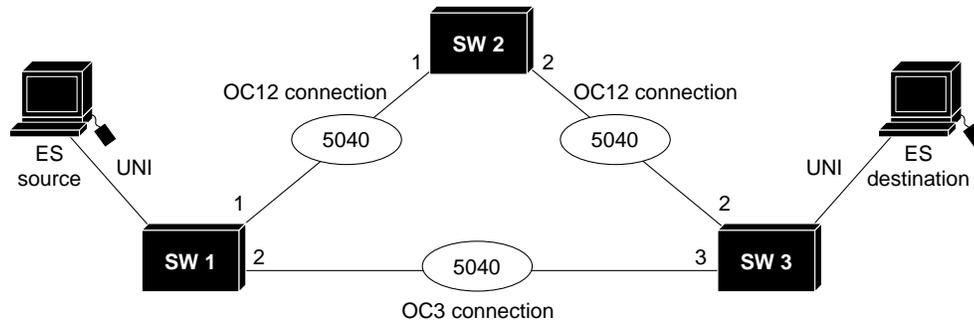
- **uniform**—Sets all interface AWs that are not explicitly configured to the uniform value of 5040

Figure 11-6 is an example of how AW affects call routing. In Figure 11-6, the top network is configured as uniform, causing equal AW to be assigned to each link. In the bottom network configuration the same network is configured, as linespeed. The links between

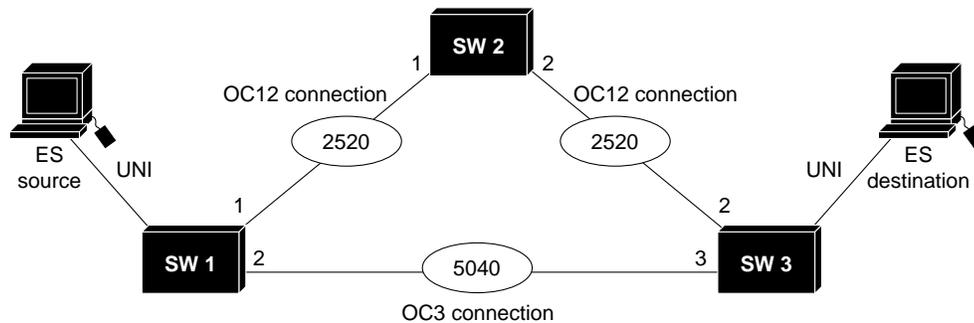
SW1 and SW2 (SW1p1->SW2p1) and between SW2 and SW3 (SW2p2->SW3p2) are both faster OC-12 connections and have lower AWs. PNNI interprets the route over the two OC-12 links as being administratively equivalent to a more direct route between SW1 and SW3 using the OC-3 connection.

Figure 11-6 Network Administrative Weight Example

**Administrative Weight Configured Uniform**



**Administrative Weight Configured Linespeed**



 = Administrative weight

S4904

**Example**

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

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

### Display the Administrative Weight Mode Configuration

To display the AW configuration, perform the following task in user EXEC mode:

Task	Command
Display the AW configuration for the node.	<b>show atm pnni node</b>

### Example

The following example shows how to display the AW configuration for the node:

```
Switch# show atm pnni 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
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
Switch#
```

### Configure the Maximum Administrative Weight Percentage

AW is the main metric that PNNI uses to compute the paths. The assignment of AWs to links and nodes impacts how PNNI selects paths in the private ATM network. For more detailed information, see the section “Administrative Weight.”

To configure the maximum AW percentage, perform the following task in global configuration mode using the **no** form of this command to assign the default value:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure<sup>1</sup></b> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
Configure the maximum AW percentage.	<b>max-admin-weight-percentage</b> {value 100 to 2000}

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

---

**Note** Configure the maximum AW command only if background route computation is enabled. See the section “Configure On-Demand and Background Path Updates.”

---

## Example

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

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

## Display the Maximum Administrative Weight Percentage Configuration

To display the node ATM PNNI maximum AW percentage configuration, perform the following task in user EXEC mode:

Task	Command
Display the node ATM PNNI maximum AW configuration.	<b>show atm pnni node</b>

## Example

The following example shows how to display maximum AW percentage configuration:

```
Switch# show atm pnni 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
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
Switch#
```

## Configure the Resource Management Poll Interval

The resource management (RM) poll interval specifies how often PNNI polls RM to update the values of link metrics and attributes. Configuration of the resource poll interval allows you to control the trade-off between the processing load and the accuracy of PNNI information. A larger value will probably generate a smaller number of PTSE updates. A smaller value results in greater accuracy in tracking resource information.

To configure the RM poll interval, perform the following task in global configuration. Use the **no** form of this command to assign the default value:

At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure<sup>1</sup></b> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
Configure the resource management poll interval.	<b>resource-poll-interval seconds</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Example

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

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

### Display the Resource Management Poll Interval

To display the RM poll interval configuration, perform the following task in user EXEC mode:

Task	Command
Display the RM poll interval configuration.	<b>show atm pnni resource-info</b>

### Example

The following example shows how to display the RM poll interval configuration:

```
Switch# show atm pnni resource-info
acr pm 50, acr mt 3, cdv pm 25, ctd pm 50, rm poll interval 5 sec
Interface insignificant change bounds:
ATM0/0/0, port ID 80000000
  CBR : MCR 155519, ACR 147743 [73871,155519], CTD 154 [77,231],CDV 138 [104, 172], CLR 10,
  VBR-RT : MCR 155519, ACR 147743 [73871,155519], CTD 707 [354,1060],CDV 691 [519,863], CLR 8,
  VBR-NRT: MCR 155519, ACR 147743 [73871,155519], CLR 8,
  UBR : MCR 155519
ATM0/0/1, port ID 80001000
  CBR : MCR 155519, ACR 147743 [73871,155519], CTD 154 [77,231],CDV 138 [104, 172], CLR 10,
  VBR-RT : MCR 155519, ACR 147743 [73871,155519], CTD 707 [354,1060],CDV 691 [519,863], CLR 8,
  VBR-NRT: MCR 155519, ACR 147743 [73871,155519], CLR 8,
  UBR : MCR 155519
<Information Deleted>

ATM1/1/3, port ID 80903000
  CBR : MCR 155519, ACR 147743 [73871,155519], CTD 154 [77,231],CDV 138 [104, 172], CLR 10,
  VBR-RT : MCR 155519, ACR 147743 [73871,155519], CTD 707 [354,1060],CDV 691 [519,863], CLR 8,
  VBR-NRT: MCR 155519, ACR 147743 [73871,155519], CLR 8,
  UBR : MCR 155519
Switch#
```

## Configure the ATM PNNI Statistics Gathering

The following statistics on routing of ATM connections can be gathered:

- 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 ATM PNNI statistics, perform the following tasks in global configuration mode, using the **no** form of these commands to assign the default value:

At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure<sup>1</sup></b> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
Enable ATM PNNI statistics gathering.	<b>statistics [call]</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Example

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

```
Switch# config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)# atm router pnni
Switch(config-atm-router)# statistics call
Switch(config-atm-router)#
```

## Display the ATM PNNI Statistics

To display the ATM PNNI statistics, perform the following task in user EXEC mode:

<b>Task</b>	<b>Command</b>
Display the ATM PNNI statistics.	<b>show atm pnni statistics [call]</b>

### Example

The following example shows how to display the ATM PNNI statistics:

```
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
Switch#
```

### Configure the PNNI Node

Each LightStream 1010 ATM switch is modeled as a single lowest-level PNNI node (locally identified as node 1). The node command is used to change the level of a node and to disable and enable a node, causing the node ID and PG ID of the node to be recalculated based on the level and the first ATM address.

---

**Note** The level of a node can be modified only when the node is disabled.

---

When the **node** command is entered, the switch changes to node configuration mode.

To change the ATM address of the switch and the level of the node and to recalculate the node ID and PG ID based on the new ATM address and level, perform the following task in global configuration mode:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure<sup>1</sup></b> <b>[terminal]</b>
At the configuration mode prompt, configure the new ATM address for the switch.	<b>atm address atm_address</b>
At the configuration mode prompt, remove the old ATM address from the switch.	<b>no atm address atm_address</b>
At the configuration mode prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, disable the PNNI node.	<b>node 1 disable</b>
Change the level of the PNNI node.	<b>node 1 level level_indicator</b>
Enable the PNNI node, causing the node ID and PG ID to be recalculated.	<b>node 1 enable</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### 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 changes the level of the node to 96 and causes the node ID and PG ID 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 level 96
Switch(config-pnni-node)# node 1 enable
```

### Display PNNI Node Configuration

To display the ATM PNNI node configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM PNNI node configuration.	<b>show atm pnni node</b>

```
Switch# show atm pnni node
PNNI node 1 is enabled and running
Node name: eng_1
System address 47.0091810000000400B0A3081.00400B0A3081.00
Node ID 56:160:47.0091810000000400B0A3081.00400B0A3081.00
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
Switch#
```

## PNNI Node Configuration

This section describes configuration of the following LightStream 1010 ATM switch PNNI node attributes:

- Enter PNNI Node-Level Configuration
- Configure Node Name
- Configure PNNI Summary Address
- Configure ATM PNNI Scope Mode
- Configure ATM PNNI Scope Mapping
- Configure Redistribution
- Configure Restricted Transit Nodes
- Configure Significant Change Thresholds
- Configure PNNI Hello, Database Synchronization, and Flooding Parameters

## Enter PNNI Node-Level Configuration

To configure the ATM router PNNI node, perform the following task in global configuration mode:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni {exit   no   node   precedence}</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node node_index</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Example

Following is an example of entering node-level configuration mode and displaying the variables using the ? help command:

```
Switch#confi t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#atm router pnni
Switch(config-atm-router)#node 1
Switch(config-pnni-node)#?
PNNI router node configuration commands:
 auto-summary      Automatically summarize switch address prefix
 exit              Exit from PNNI router node configuration mode
 name              Configure Node's Name
 no                Negate or set default values of a command
 ptse              PTSE generation parameters
 redistribute      Route redistribution from another routing protocol
 scope             PNNI Scope
 summary-address   Summarize reachable addresses into PNNI
 timer            PNNI timer variables
 transit-restricted Transit calls are not allowed
Switch(config-pnni-node)#
```

## Configure Node Name

To configure the ATM router PNNI node, perform the following task in global configuration mode, using the **no** form of the ATM router node configuration commands to assign the default value:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni {exit   no   node   precedence}</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node node_index</b>
Configure the node name.	<b>name name_string</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### 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
Switch(config-pnni-node)#
```

### Display the Node-Name Configuration

Use the **show atm pnni node** command to display the ATM PNNI node name configuration.

To display the ATM PNNI node name configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM PNNI router configuration.	<b>show atm pnni node</b>

### Examples

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

```
Switch# show atm pnni node
PNNI node 1 is enabled and running
Node name: eng_1
System address 47.009181000000000000001212.1212121212.00
Node ID 56:160:47.009181000000000000001212.1212121212.00
Peer group ID 56:47.0091.8100.0000.0000.0000
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
Switch#
```

### Configure PNNI Summary Address

Address summarization allows scalability across multiple networks. By default, the 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 PG.

Multiple addresses can be configured for a single switch and this configuration can be 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.

Summary address prefixes can also be manually configured using the **summary-address** command. A node can have multiple summary address prefixes.

---

**Note** The command **no auto-summary** removes the default summary address(es). The **no auto-summary** command should be used whenever systems matching the first 13-bytes of the ATM address(es) of this switch are attached to different switches. It can also be used for security reasons.

---

To configure address summarization, perform the following task in global configuration mode:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node</b> <i>node_index</i>
Remove the default summary address(es).	<b>no auto-summary</b>
Configure the ATM PNNI summary address prefix.	<b>summary-address</b> <i>address_prefix</i>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### 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
Switch(config-pnni-node)#
```

### Display the ATM PNNI Summary-Address Configuration

To display the ATM PNNI summary address configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM PNNI summary address configuration.	<b>show atm route</b>

### Example

The following example shows how to display the ATM PNNI summary address configuration:

```
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 I  ATM0/0/0  DN 56 47.0091.8100.0000/56
S E I  ATM0/0/0  DN 0 47.0091.8100.0000.00/64
              (E164 Address 1234567)
R SI I  0        UP 0 47.0091.8100.0000.0041.0b0a.1081/104
R I I  ATM2/0/0  UP 0 47.0091.8100.0000.0041.0b0a.1081.0041.0b0a.1081/152
R I I  ATM2/0/0  UP 0 47.0091.8100.0000.0041.0b0a.1081.4000.0c/128
R SI I  0        UP 0 47.0091.8100.5670.0000.0000.0000/104
R I I  ATM2/0/0  UP 0 47.0091.8100.5670.0000.0000.0000.0040.0b0a.1081/152
R I I  ATM2/0/0  UP 0 47.0091.8100.5670.0000.0000.0000.4000.0c/128

Switch#
```

## Configure ATM PNNI Scope Mode

Addresses and address prefixes used in PNNI can have scopes associated with either their individual addresses or their group address. See the section “Scope of Addresses” for detailed ATM PNNI scope description.

ATM addresses and prefixes may be configured automatically (which is the default setting) or manually. Configuring the ATM address scope as automatic sets all connections on the node as scope 1 to 15.

- Scope 1—allows local address reachability
- Scope 15—allows global address reachability

The individual and group ATM addresses and prefixes may have scopes configured manually using the following commands:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node node_index</b>
Configure scope mode as either automatic or manual.	<b>scope mode {automatic   manual}</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

## Example

The following example changes ATM PNNI router scope mode to automatic for node 1:

```
Switch(config)# atm router pnni
Switch(config-atm-router)# node 1
Switch(config-pnni-node)# scope mode ?
    automatic mode does not allow scope map table configuration
    manual    mode allows scope map table configuration

Switch(config-pnni-node)# scope mode manual
Switch(config-pnni-node)#
```

## Display the ATM PNNI Scope Mode Configuration

To display the ATM PNNI address and address prefix scope configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM PNNI scope map configuration.	<b>show atm pnni scope</b>

## Example

The following example shows how to display the ATM PNNI scope mode configuration:

```
Switch# show atm pnni scope
UNI scope  PNNI Level
~~~~~
(1 - 10)   56
(11 - 12)  48
(13 - 14)  32
(15 - 15)  0

Scope mode: automatic
Switch#
```

## Configure ATM PNNI Scope Mapping

Addresses and address prefixes used in PNNI can have scopes associated with either their individual addresses or their group address. See the section “Scope of Addresses” for detailed ATM PNNI scope description.

The individual and group ATM addresses and prefixes may have their scopes configured manually using the following commands:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node</b> <i>node_index</i>
Configure scope mode as either automatic or manual.	<b>scope mode</b> { <b>automatic</b>   <b>manual</b> }
Configure node scope mapping.	<b>scope map</b> <i>low-org-scope</i> [ <i>high-org-scope</i> ] <b>level</b> <i>level-number</i>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

Use the **no** form of the **scope map** command to return the node to the default scope mapping configuration.

---

**Note** The **scope mode** command must be configured as **manual** to allow scope-mapping configuration.

---

### Example

The following example shows how to configure scope mapping as low organization scope **1** and high organization scope **15** to PNNI level **56** for node 1:

```
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 15 level 56
Switch(config-pnni-node)# ^Z
Switch#
```

### Display ATM PNNI Scope Mapping Configuration

Use the **show atm scope map** command to display the ATM PNNI scope configuration.

To display the node redistribution configuration, perform the following task in user EXEC mode:

Task	Command
Display the node PNNI scope mapping configuration.	<b>show atm pnni scope</b>

## Example

The following example shows how to display the ATM PNNI scope mapping manual configuration:

```
Switch# show atm pnni scope
UNI scope PNNI Level
~~~~~
(1 - 15) 56

Scope mode: manual
Switch#
```

## Configure Redistribution

Redistribution instructs PNNI to distribute reachability information from non-PNNI sources throughout the PNNI routing domain. The LightStream 1010 ATM switch supports redistribution of static routes, such as those configured on IISp interfaces.

---

**Note** By default, redistribution of static routes is enabled.

---

To enable redistribution of static routes throughout the PNNI routing domain, perform the following tasks in global configuration mode, using the **no** form of these commands to stop redistribution:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node node_index</b>
Enable redistribution of static routes.	<b>redistribute atm-static</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

## 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
Switch(config-pnni-node)#
```

## Display the Redistribution Configuration

Use the **show atm pnni node** command to display the redistribution configuration.

To display the node redistribution configuration, perform the following task in user EXEC mode:

Task	Command
Display the node redistribution configuration.	<b>show atm pnni node</b>

### Example

The following example shows how to display the node redistribution configuration:

```
Switch# show atm pnni 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
Switch#
```

## Configure Restricted Transit Nodes

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

To configure whether a node allows transit calls, perform the following tasks in ATM PNNI node level configuration mode, using the **no** form of these commands to assign the default value:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure<sup>1</sup></b> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node node_index</b>
Enable transit restricted on this node.	<b>transit-restricted</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### 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
Switch(config-pnni-node)#
```

## Display the Transit-Restriction Configuration

To display the ATM PNNI transit-restriction configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM configuration.	<b>show atm pnni node</b>

### Example

The following example shows how to display the ATM PNNI transit-restriction configuration of a node named "Switch":

```
Switch# show atm pnni 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
Switch#
```

## Configure Significant Change Thresholds

PTSPs 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 origination of PTSEs.

---

**Note** Any change in AW and CLR is considered significant and triggers origination of a new PTSE instance.

---

To configure the PTSE significant change thresholds, perform the following tasks in global configuration mode using the **no** form of these commands to assign the default value:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node node_index</b>
Configure PTSE significant change percent number.	<b>ptse significant-change {acr-mt percentage / acr-pm multiplier   cdv-pm multiplier   ctd-pm multiplier}</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Syntax Description

The significant change variables are:

- **acr-mt**—Available cell rate maximum threshold percentage
- **acr-pm**—Available cell rate proportional multiplier
- **cdv-pm**—Cell delay variation proportional multiplier
- **ctd-pm**—Max CTD proportional multiplier

For an example of other **ptse** command keywords, see the section “Configure PNNI Hello, Database Synchronization, and Flooding Parameters.”

### 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
Switch(config-pnni-node)#
```

### Display the Significant Change Thresholds Configuration

Use the **show atm pnni resource-info** command to display the significant change threshold configuration.

To display the PTSE configuration, perform the following task in user EXEC mode:

Task	Command
Display the PTSE ID.	<b>show atm pnni resource-info</b>

## Example

The following example shows how to display the significant change threshold configuration:

```
Switch# show atm pnni resource-info
acr pm 50, acr mt 3, cdv pm 25, ctd pm 50, resource poll interval 5 sec
Interface insignificant change bounds:
ATM0/1/3 , port ID 80103000
  CBR   : MCR 155519 ACR 21520 [10760,32280] CTD 154 [77,231]
         CDV 138 [104,172] CLR0 10 CLR01 10
  VBR-RT : MCR 155519 ACR 43041 [21520,64561] CTD 707 [354,1060]
         CDV 691 [519,863] CLR0 8 CLR01 8
  VBR-NRT: MCR 155519 ACR 43041 [21520,64561] CLR0 8 CLR01 8
  ABR   : MCR 155519 ACR 0 [0,4665]
  UBR   : MCR 155519
<Information Deleted>
```

Switch#

## Configure PNNI Hello, Database Synchronization, and Flooding Parameters

PNNI uses the Hello protocol to determine the status of neighbor nodes and PTSEs to disseminate topology database information in the ATM network. See the sections “The Hello Protocol,” “Database Synchronization,” and “Topology Information in PNNI” for more information.

To configure the hello, database synchronization, and flooding parameters, perform the following task in global configuration mode using the **no** form of these commands to assign the default value:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> [terminal]
At the configure prompt, enter ATM router PNNI mode from the terminal. The prompt will change to Switch(config-atm-router)#.	<b>atm router pnni</b>
At the configure ATM router prompt, enter node configuration mode. The prompt will change to Switch(config-pnni-node)#.	<b>node</b> <i>node_index</i>
Configure Hello database synchronization and flooding parameters.	<b>timer</b> [ <b>ack-delay</b> <i>tenths_of_seconds</i> ] [ <b>hello-holddown</b> <i>tenths_of_seconds</i> ] [ <b>hello-interval</b> <i>seconds</i> ] [ <b>inactivity-factor</b> <i>number</i> ] [ <b>retransmit-interval</b> <i>seconds</i> ]
Configure PTSE significant change percent number.	<b>ptse</b> [ <b>lifetime-factor</b> <i>percentage_factor</i> ] [ <b>min-ptse-interval</b> <i>tenths_of_seconds</i> ] [ <b>refresh-interval</b> <i>seconds</i> ] [ <b>request</b> <i>number</i> ] [ <b>significant-change</b> <i>acr-mt percent</i> ] [ <b>significant-change</b> <i>acr-pm percent</i> ] [ <b>significant-change</b> <i>cdv-pm percent</i> ] [ <b>significant-change</b> <i>ctd-pm percent</i> ]

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Syntax Description

- **ack-delay**—Delay before acknowledging packets
- **hello-holddown**—Hello generation hold-down time
- **hello-interval**—Hello interval
- **inactivity-factor**—Multiplier of hello interval
- **retransmit-interval**—PTSE retransmit interval

### Example

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

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

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

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

## Display the PNNI Hello, Database Synchronization and Flooding Configuration

To display the ATM PNNI Hello, database synchronization, and flooding configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM PNNI Hello, database synchronization and flooding configuration.	<b>show atm pnni node</b>

### Example

The following example shows how to display the ATM PNNI Hello, database synchronization, and flooding configuration:

```
Switch# show atm pnni 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
Switch#
```

## PNNI Interface Configuration

The following sections describe configuration of the LightStream 1010 ATM switch PNNI interfaces:

- Configure Administrative Weight per Interface
- Configure ATM PNNI Link Selection

### Configure Administrative Weight per Interface

AW is the main metric for computation of the paths by PNNI. The assignment of AWs to links and nodes impacts the way PNNI selects paths in the private ATM network. For more detailed information see the section “Administrative Weight.”

To configure the AW for an individual interface, perform the following task in global configuration mode, using the **no** form of the **atm pnni admin-weight** command to assign the default value:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
Specify an ATM interface and enter interface configuration mode.	<b>interface atm</b> <i>card/subcard/port</i>
Configure the ATM AW for this link.	<b>atm pnni admin-weight</b> <i>number traffic_class</i>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

#### Syntax Description

- *number*—A value from 1 to 1000000
- *traffic class*—CBR, VBR-RT, VBR-NRT, ABR, UBR, or all

#### 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
Switch(config-if)#
```

### Display the Interface Administrative Weight Configuration

To display the ATM PNNI interface AW configuration, perform the following task in user EXEC mode:

Task	Command
Display the interface ATM PNNI AW configuration.	<b>show atm pnni</b> [ <b>interface atm</b> <i>card/subcard/port</i> ] [ <b>detail</b> ]

### Example

The following example shows how to display the AW for interface 0/0/0 configuration:

```
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)
Switch#
```

## Configure ATM PNNI Link Selection

The Lightstream 1010 ATM Switch Link Selection feature allows you to choose the mode for selecting one specific link among several parallel links.

When multiple parallel links are configured inconsistently, the order of precedence of configured values is as follows:

- 1 Admin-weight-minimize
- 2 Blocking-minimize
- 3 Transmit-speed-maximize
- 4 Load-balance

For example, if any link is configured as admin-weight minimize, that link is used for the entire link group.

To configure ATM PNNI link selection, perform the following task in global configuration mode, using the **no** form of the **atm pnni link-selection** command to assign the default value:

Task	Command
At the privileged EXEC prompt, enter configuration mode from the terminal.	<b>configure</b> <sup>1</sup> <b>[terminal]</b>
Specify an ATM interface and enter interface configuration mode.	<b>interface atm</b> <i>card/subcard/port</i>
Configure ATM PNNI link selection for a specific link.	<b>atm pnni link-selection</b> <b>{admin-weight-minimize  </b> <b>blocking-minimize   load-balance  </b> <b>transmit-speed-maximize}</b>

1. These commands are documented in the *LightStream 1010 ATM Switch Command Reference (11.2)* publication.

### Syntax Description

- admin-weight-minimize**—Transmits call on the interface with lowest AW
- blocking-minimize**—Minimizes subsequent call blocking
- load-balance**—Balances calls across all parallel links
- transmit-speed-maximize**—Transmits call on highest-speed parallel link

## Example

The following example shows how to configure ATM interface 0/0/0 to use the transmit-speed-maximize link selection mode:

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

## Display the PNNI Link Selection Configuration

To display the ATM PNNI link selection configuration, perform the following task in user EXEC mode:

Task	Command
Display the ATM PNNI link selection configuration.	<b>show atm pnni neighbor</b>

## Example

The following example shows how to display detailed PNNI link selection configuration:

```
Switch# show atm pnni neighbor

Neighbor Name: eng_22, Node number: 2
Neighbor Node Id: 56:160:47.0091810000000003DDE74601.0003DDE74601.00
Neighboring Peer State: Full
Link Selection Set To: minimize blocking of future calls
Port      Remote port ID      Hello state
ATM0/1/2  ATM3/1/2  (81902000) 2way_in
ATM0/1/1  ATM3/1/1  (81901000) 2way_in (Flooding Port)
Switch#
```

