



# MPLS Label Switch Controller and Enhancements

## Document History

The following table lists the changes made to this document:

Release	Modification
11.1CT	This document was introduced as the <i>Tag Switch Controller</i> .
12.0(3)T	Added references to the Cisco IOS switching services documentation.
12.0(5)T	Added support for multi-VCs.
12.0(7)DC	Added support for the Cisco 6400 UAC. Added support for virtual trunking/tunneling. Added support for dedicated LSC with the command <b>mpls atm disable headend-vc</b> .
12.1(3)T	Added support for LSC redundancy.
12.1(5)T	Added access list support for controlling the creation of label switch paths with the command <b>mpls request-labels for</b> . Added support for Cisco IGX 8410, 8420, and 8430 switches. Removed support for the 7500 router as an MPLS LSC.
12.2(4)T	Changed tag-switching commands and terminology to MPLS format. Added support for Cisco MGX 8850 and 8950 switch with the Cisco MGX RPM-PR card as an MPLS LSC. Added DiffServ with MPLS QoS multi-VC feature support. Added the <b>vci-range</b> keyword to the <b>mpls atm vpi</b> and <b>mpls atm vp-tunnel</b> commands. Extended the VPI range from 256 to 4095.

This document describes the Cisco Multiprotocol Label Switching (MPLS) Label Switch Controller (LSC). It describes the MPLS LSC feature, identifies the platforms supported by the MPLS LSC, provides configuration examples for MPLS LSC components, and describes related IOS commands that can be used with the supported platforms.

## Document Organization

This document is organized as follows. The following sections describe MPLS LSC in general:

- [Feature Overview, page 4](#)
- [Platforms Supported by MPLS LSC, page 8](#)
- [Supported Standards, MIBs, and RFCs, page 8](#)
- [Basic MPLS Configuration Tasks, page 9](#)

The following sections describe MPLS LSC features. Each section contains its own configuration steps and examples:

- [Feature 1: Creating Virtual Trunks, page 60](#)
- [Feature 2: Using LSC Redundancy, page 68](#)
- [Feature 3: Reducing the Number of Label Switch Paths Created in an MPLS Network, page 85](#)
- [Feature 4: Differentiated Services and MPLS QoS Multi-VCs, page 91](#)

The following section provides additional information for the Cisco MGX 8850 RPM-PR:

- [Starting Up the Cisco MGX 8850 PXM-45 and Cisco MGX AXSM, page 102](#)

The following sections describe commands used throughout the book:

- [Command Reference, page 112](#)
- [Debug Commands, page 163](#)

## Changing from Tag-Switching to MPLS Terminology

Cisco is moving from tag-switching to MPLS, because MPLS is compliant with the IETF standard. This change necessitates terminology and command changes. [Table 1](#) lists the old tag-switching terms and the equivalent MPLS terms used in this document. [Table 7](#) lists the changes made to commands.

**Table 1** *Equivalency Table for Tag-Switching and MPLS Terms*

<b>Old Tag Switching Terminology</b>	<b>New MPLS Terminology</b>
Tag Switching	MPLS, Multiprotocol Label Switching
Tag (short for Tag Switching)	MPLS
Tag (item or packet)	Label
TDP (Tag Distribution Protocol)	LDP (Label Distribution Protocol)  Cisco TDP and LDP (MPLS Label Distribution Protocol) are nearly identical in function, but use incompatible message formats and some different procedures. Cisco is changing from TDP to a fully compliant LDP.
Tag Switched	Label Switched
TFIB (Tag Forwarding Information Base)	LFIB (Label Forwarding Information Base)
TSR (Tag Switching Router)	LSR (Label Switching Router)
TSC (Tag Switch Controller)	LSC (Label Switch Controller)
ATM-TSR (ATM Tag Switch Router)	ATM-LSR (ATM Label Switch Router, such as the Cisco BPX 8650 switch)
TVC (Tag VC, Tag Virtual Circuit)	LVC (Label VC, Label Virtual Circuit)
TSP (Tag Switch Path)	LSP (Label Switch Path)

## Feature Overview

The MPLS label switch controller (LSC), combined with slave ATM switch, supports scalable integration of IP services over an ATM network. The MPLS LSC enables the slave ATM switch to:

- Participate in an MPLS network
- Directly peer with IP routers
- Support the IP and MPLS features in Cisco Internetwork Operating System (IOS) software

The MPLS LSC supports highly scalable integration of MPLS (IP+ATM) services by using a direct peer relationship between the ATM switch and MPLS routers. This direct peer relationship removes the limitation on the number of IP edge routers (typical of traditional IP-over-ATM networks), allowing service providers to meet growing demands for IP services. The MPLS LSC also supports direct and rapid implementation of advanced IP and MPLS services over ATM networks using ATM switches.

MPLS combines the performance and virtual circuit capabilities of Layer 2 (data link layer) switching with the scalability of Layer 3 (network layer) routing capabilities. This combination enables service providers to deliver solutions for managing growth, providing differentiated services, and leveraging existing networking infrastructures.

The MPLS LSC architecture provides the flexibility to:

- Run MPLS applications over Layer 2 technologies
- Support any Layer 3 protocol while scaling the network to meet future needs

By deploying the MPLS LSC across large enterprise networks or wide area networks, customers can:

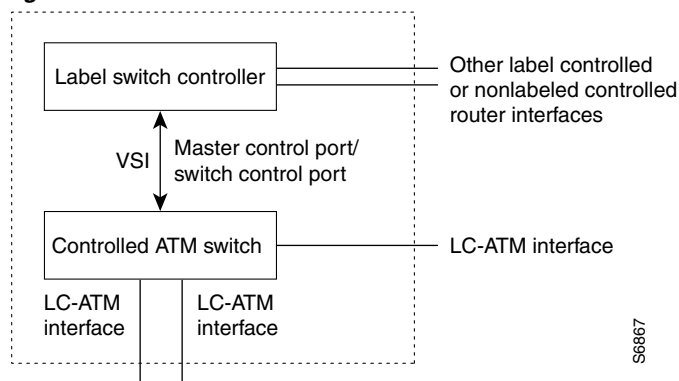
- Save money by using existing ATM infrastructures
- Grow revenue using MPLS-enabled services
- Increase productivity through enhanced network scalability and performance

## MPLS LSC Functional Description

The MPLS LSC is a label switch router (LSR) that is configured to control the operation of a separate ATM switch. Together, the MPLS LSC and the controlled ATM switch function as a single ATM label switched router (ATM-LSR).

Figure 1 shows the functional relationship between the MPLS LSC and the ATM switch that it controls.

**Figure 1 MPLS Label Switch Controller and Controlled ATM Switch**



The following routers can function as an MPLS LSC:

- Cisco 7200 series router
- Cisco 6400 Universal Access Concentrator (UAC)

The following ATM switches can function with the Cisco 7200 series router as the controlled ATM switch:

- Cisco BPX 8600, 8650 (which includes a Cisco 7204 router), and 8680
- Cisco IGX 8410, 8420, and 8430

Also, the Cisco MGX 8850 switch with a Cisco MGX 8850 Route Processor Module (RPM-PR) can function as an MPLS ATM-LSR.

The MPLS LSC controls the ATM switch by means of the Virtual Switch Interface (VSI), which runs over an ATM link connecting the two devices.

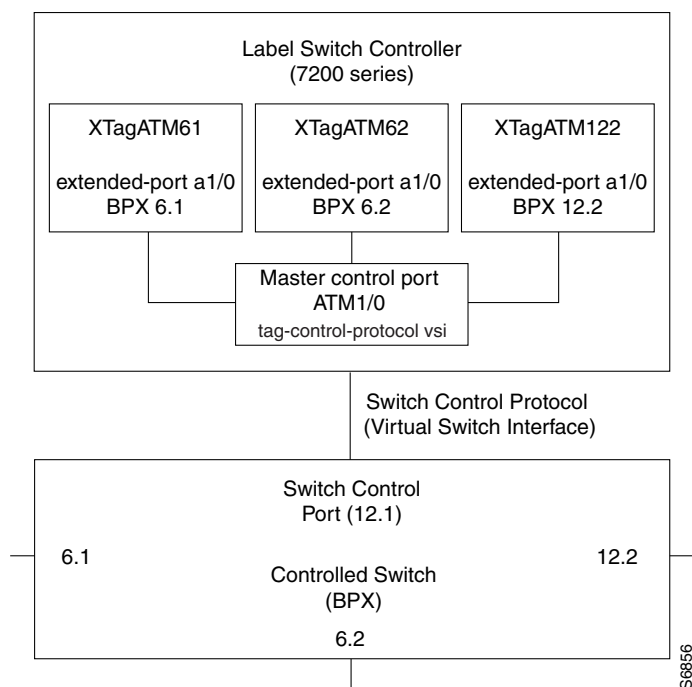
The dotted line in [Figure 1](#) represents the logical boundaries of the external interfaces of the MPLS LSC and the controlled ATM switch, as discovered by the IP routing topology. The controlled ATM switch provides one or more XTagATM interfaces at this external boundary. The MPLS LSC can incorporate other label-controlled or nonlabel-controlled router interfaces.

## Using Controlled ATM Switch Ports as Router Interfaces

The XTagATM ports on the LSC are used as an IOS interface type called extended Label ATM (XTagATM). To associate these XTagATM interfaces with particular physical interfaces on the controlled ATM switch, use the interface configuration command **extended-port**.

[Figure 2](#) shows a typical MPLS LSC configuration that controls three ATM ports on a Cisco BPX switch: ports 6.1, 6.2, and 12.2. These corresponding XTagATM interfaces were created on the MPLS LSC and associated with the corresponding ATM ports on the Cisco BPX switch by means of the **extended-port** command.

**Figure 2** Typical MPLS LSC and BPX Switch Configuration



Observe from [Figure 2](#) that:

- An additional port on the Cisco BPX switch (port 12.1) acts as the switch control port.
- An ATM interface (ATM1/0) on the MPLS LSC acts as the master control port.

## How the LSC, ATM Switch, and VSI Work Together

The LSC and slave ATM switch have the following characteristics:

- The LSC runs all of the control protocols.
- The ATM switch forwards the data.
- Each physical interface on the slave ATM switch maps to an XTagATM interface on the LSC. Each XTagATM interface has a dedicated LDP session with a corresponding interface on the edge. The XTagATM interfaces are mapped in the routing topology, and the ATM switch behaves as a router.

If a component on the LSC fails, the ATM switch's IP switching function is disabled. The standalone LSC is the single point of failure.

The VSI implementation includes the following characteristics:

- The VSI allows multiple, independent control planes to control a switch. The VSI ensures that the control processes (SS7, MPLS, PNNI, and so on) can act independently of each other by using a VSI slave process to control the resources of the switch and apportion them to the correct control planes.
- In MPLS, each physical interface on the slave ATM switch maps to an XTagATM interface on the LSC through the VSI. In other words, physical interfaces are mapped to their respective logical interfaces.
- The routing protocol on the LSC generates route tables entries. The master sends connection requests and connection release requests to the slave.
- The slave sends the configured bandwidth parameters for the ATM switch interface to the master in the VSI messages. The master includes the bandwidth information in the link state topology. You can override these bandwidth values by manually configuring the bandwidth on the XTagATM interfaces.

## MPLS LSC Benefits

By using the MPLS ATM-LSR, you can derive the following benefits:

- IP-ATM Integration—Enables ATM switches to directly support advanced IP and MPLS services and protocols, thereby reducing operational costs and bandwidth requirements, while at the same time decreasing time-to-market for new services.
- Virtual Private Networks (VPNs)—Supports IP-based VPNs on an integrated IP+ATM backbone or a gigabit router backbone.
- The following services over an ATM MPLS network:
  - Any Transport over MPLS (AToM) services
  - Diff-Serve traffic engineering services
  - LLSP-based Diff-Serve multi-vc MPLS services
  - Layer 3 MPLS VPN services

## MPLS LSC Restrictions

- **Supporting ATM Forum Protocols**—You can connect the MPLS LSC to a network that is running ATM Forum protocols while the MPLS LSC simultaneously performs its functions. However, you must connect the ATM Forum network through a separate ATM interface (that is, not through the master control port).
- **Cannot Use the MPLS LSC as an Edge Router**—Using the MPLS LSC as a label edge device is *not* supported. Using the MPLS LSC as a label edge device introduces unnecessary complexity to the network design, configuration, and performance. See “Disabling the LSC from Acting as an Edge LSR” on page 59 to disable edge LSR functionality on the LSC.
- **Using Static Routes in the ATM MPLS network:** When you create static routes in the ATM MPLS network, if the forwarding router is a LSC, it must be a next-hop router to the ingress router. If the forwarding router is an ATM edge router, it can be located anywhere in the network. When creating static routes with the following command, the forwarding router’s address can be a PE router’s address.

```
ip route destination-prefix destination-mask forwarding-router's-address
```

**Note**

Configuring static routes on the LSC is not supported.

## Related Documents

The following documents provide more information about MPLS features:

- *MPLS QoS Multi-VC Mode for PA-A3*  
[http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t4/ft\\_cos4t.htm/](http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t4/ft_cos4t.htm/)
- *MPLS Label Distribution Protocol*  
[http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t4/ft\\_ldp4t.htm](http://www.cisco.com/univercd/cc/td/doc/product/software/ios122/122newft/122t/122t4/ft_ldp4t.htm)

The following documents provide more information about platform-specific features:

### Cisco 6400 UAC

- *Configuring Multiprotocol Label Switching on the Cisco 6400 UAC*  
[http://www.cisco.com/univercd/cc/td/doc/product/dsl\\_prod/6400/softnote/mpls\\_cfg.htm](http://www.cisco.com/univercd/cc/td/doc/product/dsl_prod/6400/softnote/mpls_cfg.htm)

### Cisco BPX 8600 Series Switches

- *Cisco MPLS Controller Software Configuration Guide, Version 9.3.0 and 9.3.10*  
<http://www.cisco.com/univercd/cc/td/doc/product/wanbu/bpx8600/mpls/>

### Cisco IGX 8400 Series Switches

- *Update to the Cisco IGX 8400 Series Installation and Configuration Guide and Cisco IGX 8400 Series Reference Guide, Version 9.3.0*  
[http://www.cisco.com/univercd/cc/td/doc/product/wanbu/igx8400/9\\_3\\_0/update/9\\_3\\_00rn.htm](http://www.cisco.com/univercd/cc/td/doc/product/wanbu/igx8400/9_3_0/update/9_3_00rn.htm)
- *Update to the Cisco IGX 8400 Series Reference Guide, Version 9.3.0*  
[http://www.cisco.com/univercd/cc/td/doc/product/wanbu/igx8400/9\\_3\\_0/update/9\\_3\\_10rn.htm](http://www.cisco.com/univercd/cc/td/doc/product/wanbu/igx8400/9_3_0/update/9_3_10rn.htm)

**Cisco MGX 8850 Route Processor Module**

- *Cisco MGX Route Processor Module Installation and Configuration Guide, Version 2.1*  
<http://www.cisco.com/univercd/cc/td/doc/product/wanbu/8850r21/rpm/index.htm>

## Platforms Supported by MPLS LSC

**Routers**

You can use the following routers to configure an ATM-LSR:

- Cisco 7200 series routers—Support the following interface:
  - ATM Port Adapter (PA-A1 and PA-A3)
- Cisco 6400 Universal Access Concentrator—Supports the following interfaces:
  - DS-3
  - OC-3/STM-1
  - OC-12/STM-4
- Cisco MGX 8850 RPM-PR as an LSC

**Switches**

You can use the following ATM switches to configure an ATM-LSR:

- Cisco BPX 8600, 8650, and 8680 switches
- Cisco IGX 8410, 8420, and 8430 switches with the Cisco 7200 series routers

You can also use the Cisco MGX 8850 switch with the Cisco 8850 Route Processor Module (RPM-PR) as an ATM-LSR.

## Supported Routing Protocols on LC-ATM and MPLS LSC

The following protocols are supported on the LC-ATM and MPLS LSC:

- OSPF
- ISIS

## Supported Standards, MIBs, and RFCs

**Standards**

No new or modified standards are supported by this feature.

**MIBs**

No new or modified MIBs are supported by this feature.

**RFCs:**

- *Multiprotocol Label Switching Architecture, RFC 3031* — [www.ietf.org/rfc/rfc3031.txt](http://www.ietf.org/rfc/rfc3031.txt)
- *LDP Specification, RFC 3036* — [www.ietf.org/rfc/rfc3036.txt](http://www.ietf.org/rfc/rfc3036.txt)

- *MPLS using LDP and ATM VC Switching, RFC 3035* — [www.ietf.org/rfc/rfc3035.txt](http://www.ietf.org/rfc/rfc3035.txt)

## Basic MPLS Configuration Tasks

This section provides examples of basic configuration tasks for enabling MPLS LSC functionality.

- [Configuring Basic MPLS on the 7200 Series LSCs for BPX and IGX Switches, page 9](#)
- [Configuring the Cisco MGX 8850 Switch and RPM-PR as an MPLS LSC, page 16](#)
- [Configuring the Cisco 6400 Universal Access Concentrator as an MPLS LSC, page 49](#)
- [Disabling the LSC from Acting as an Edge LSR, page 59](#)

Refer to the Cisco BPX 8600 or IGX 8400 series switch documentation for BPX/IGX switch configuration examples.

## Configuring Basic MPLS on the 7200 Series LSCs for BPX and IGX Switches

To enable MPLS functionality on the Cisco 7200 series routers connected to BPX and IGX switches, perform the following steps on each LSC in the configuration.



### Note

If you are configuring for LSC redundancy, ensure that the controller ID matches the slave and is unique to the LSC system. Also, make sure that the VPI/VC value for the control VC matches its peer.

	Command	Purpose
Step 1	<pre>Router(config)# interface loopback0 Router(config-if)# ip address 172.103.210.5 255.255.255.255 Router(config-if)# exit</pre>	<p>Create a software-only loopback interface that emulates an interface that is always up. Specify an interface number for the loopback interface. There is no limit on the number of loopback interfaces you can create.</p> <p>Assign an IP address to Loopback0. It is important that all loopback addresses in an MPLS network are host addresses, that is, with a mask of 255.255.255.255. Using a shorter mask can prevent MPLS-based VPN services from working correctly.</p>
Step 2	<pre>Router(config)# mpls atm disable-headend-vc</pre>	<p>Prevent the router from assigning headend VCs for each destination prefix. With downstream on demand, MPLS ATM networks LVCs are a limited resource that are easily depleted with the addition of each new node.</p>

	Command	Purpose
Step 3	<pre>Router(config)# interface atm1/0 Router(config-if)# tag-control-protocol vsi id 1</pre>	<p>Create an ATM interface (atm1/0).</p> <p>Configure a Virtual Switch Interface (VSI) on (atm1/0). The VSI ID is 1. The VSI ID must match the controller ID you assign to the ATM switch.</p> <p>For the IGX switch, use <b>tag-control-protocol vsi slaves 32 id 1</b></p>
Step 4	<pre>Router(config-if)# interface XTagATM61 Router(config-if)# extended-port atm1/0 bpx 6.1</pre>	<p>Create an XTagATM interface (XTagATM61.)</p> <p>Associate the XTagATM interface with an external interface (BPX port 6.1) on the remotely controlled ATM switch</p> <p>atm1/0 identifies the ATM interface used to control the remote ATM switch.</p> <p>For the IGX switch, use the <b>extended-port atm1/0 descriptor 0.6.1.0</b> or <b>extended-port atm1/0 igx</b> command.</p>
Step 5	<pre>Router(config-if)# ip unnumbered loopback0</pre>	<p>Make XTagATM61 an unnumbered interface and use the IP address of loopback 0 as a substitute. The interfaces in an ATM MPLS network should usually be unnumbered. This reduces the number of IP destination-prefixes in the routing table, which reduces the number of labels and LVCs used in the network.</p>
Step 6	<pre>Router(config-if)# mpls ip Router(config-if)# mpls atm vpi 2-5 Router(config-if)# exit</pre>	<p>Enable MPLS on the XTagATM interface.</p> <p>Limit the range of VPIs so that the total does not exceed 4. For example: <b>mpls atm vpi 2-5</b> <b>mpls atm vpi 10-13</b></p>
Step 7	<pre>Router(config-if)# interface XTagATM1222 Router(config-if)# extended-port atm1/0 bpx 12.2.2</pre>	<p>Configure MPLS on another XTagATM virtual interface and bind it to BPX virtual trunk interface 12.2.2.</p> <p>For the Cisco IGX switch, use <b>extended-port atm1/0 descriptor 0.12.2.2</b> or <b>extended-port atm1/0 igx</b>.</p>
Step 8	<pre>Router(config-if)# ip unnumbered loopback0</pre>	<p>Make XTagATM1222 an unnumbered interface and use the IP address of loopback 0 as a substitute. The interfaces in an ATM MPLS network should usually be unnumbered. This reduces the number of IP destination-prefixes in the routing table, which reduces the number of labels and LVCs used in the network.</p>

	Command	Purpose
Step 9	Router(config-if)# <b>mpls atm vp-tunnel 2</b> Router(config-if)# <b>mpls ip</b> Router(config-if)# <b>exit</b>	Enable MPLS on the XTagATM interface using a VP-tunnel interface.  This will limit the VPI to only vpi = 2. The command will also map the label ATM control VC to 2,32.
Step 10	Router(config)# <b>ip cef</b>	Enable Cisco Express Forwarding (CEF).

## Verifying the MPLS LSC Configuration

The following sections explain some of the commands you can use to ensure that you have configured MPLS correctly.

### Check that the Switch Control Port Is Active

Enter the **show controllers vsi status** command to show the switch control port is active. If an interface has been discovered by the LSC, but an XTagATM interface has not been associated with it through the **extended-port interface** configuration command, then the interface name is marked <unknown>, and interface status is marked n/a.

The following is sample output from the **show controllers vsi status** command:

```
Router# show controllers vsi status
Interface Name           IF Status   IFC State   Physical Descriptor
switch control port      n/a        ACTIVE      12.1.0
XTagATM0                 up         ACTIVE      12.2.0
XTagATM1                 up         ACTIVE      12.3.0
<unknown>                n/a        FAILED-EXT  12.4.0
```

### Check that VSI Sessions Are Established

Make sure that every VSI session has been established. A session consists of an exchange of VSI messages between the VSI master (the LSC) and a VSI slave (an entity on the switch). There can be multiple VSI slaves for a switch. On the ATM switch, each port or trunk card assumes the role of a VSI slave.

The following is sample output from the **show controllers vsi session** command. Session State indicates the status of the session between the master and the slave.

- ESTABLISHED is the fully operational steady state.
- UNKNOWN indicates that the slave is not responding.

```
Router# show controllers vsi session
Interface  Session  VCD   VPI/VCI  Switch/Slave Ids  Session State
ATM0/0    0        1     0/40     0/1              ESTABLISHED
ATM0/0    1        2     0/41     0/2              ESTABLISHED
ATM0/0    2        3     0/42     0/3              DISCOVERY
ATM0/0    3        4     0/43     0/4              RESYNC-STARTING
ATM0/0    4        5     0/44     0/5              RESYNC-STOPPING
ATM0/0    5        6     0/45     0/6              RESYNC-UNDERWAY
ATM0/0    6        7     0/46     0/7              UNKNOWN
ATM0/0    7        8     0/47     0/8              UNKNOWN
ATM0/0    8        9     0/48     0/9              CLOSING
ATM0/0    9        10    0/49     0/10             ESTABLISHED
ATM0/0    10       11    0/50     0/11             ESTABLISHED
ATM0/0    11       12    0/51     0/12             ESTABLISHED
```

## Check that the VSI Is Operational

To display information about the switch interface discovered by the MPLS LSC through VSI, use the **show controllers vsi descriptor EXEC** command. The field called IFC state shows the operational state of the interface, according to the switch. It should be ACTIVE.

```
Router# show controllers vsi descriptor 12.2.0
Phys desc: 12.2.0
Log intf: 0x000C0200 (0.12.2.0)
Interface: XTagATM0
IF status: up                IFC state: ACTIVE
Min VPI: 1                   Maximum cell rate: 10000
Max VPI: 259                 Available channels: 2000
Min VCI: 32                  Available cell rate (forward): 10000
Max VCI: 65535               Available cell rate (backward): 10000
```

## Check XTagATM Interfaces

Ensure that the control VC 0/32 has been created to carry non-IP traffic (LDP) on every XTagATM interface. The columns marked VCD, VPI, and VCI display information for the corresponding private VC on the control interface. The private VC connects the XTagATM VC to the external switch. It is termed private because its VPI and VCI are only used for communication between the MPLS LSC and the switch, and it is different from the VPI and VCI seen on the XTagATM interface and the corresponding switch port.

```
Router# show XTagatm vc

AAL / Control Interface

Interface      VCD  VPI  VCI Type  Encapsulation  VCD  VPI  VCI Status
XTagATM0      1    0   32 PVC   AAL5-SNAP      2    0   33 ACTIVE
XTagATM0      2    1   33 TVC   AAL5-MUX       4    0   37 ACTIVE
XTagATM0      3    1   34 TVC   AAL5-MUX       6    0   39 ACTIVE
```

To gather more information about the XTagATM interface, enter the **show interface XTagATM** command:

```
Router# show interface XTagATM0

XTagATM0 is up, line protocol is up
  Hardware is TAG-Controlled Switch Port
  Interface is unnumbered. Using address of Loopback0 (10.0.0.17)
  MTU 4470 bytes, BW 156250 Kbit, DLY 80 usec, rely 255/255, load 1/255
  Encapsulation ATM Labelswitching, loopback not set
  Encapsulation(s): AAL5
  Control interface: ATM1/0, switch port: bpx 10.2
  9 terminating VCs, 16 switch cross-connects
  Switch port traffic:
    129302 cells input, 127559 cells output
  Last input 00:00:04, output never, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/0, 0 drops; input queue 0/75, 0 drops
  Terminating traffic:
  5 minute input rate 1000 bits/sec, 1 packets/sec
  5 minute output rate 0 bits/sec, 1 packets/sec
    61643 packets input, 4571695 bytes, 0 no buffer
    Received 0 broadcasts, 0 runts, 0 giants
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    53799 packets output, 4079127 bytes, 0 underruns
    0 output errors, 0 collisions, 0 interface resets
    0 output buffers copied, 0 interrupts, 0 failures
```

## Check that LDP Is Operational

The **show mpls ldp discovery** privileged EXEC command displays the interfaces over which the LDP discovery process is running. Each interface should display a status of “xmit/recv”, which means the LSC is sending and receiving LDP messages.

```
Router# show mpls ldp discovery

Local LDP Identifier:
  8.1.1.1:0
Discovery Sources:
  Interfaces:
    Ethernet1/1/3 (ldp): xmit/recv
      LDP Id: 172.73.0.77:0
      LDP Id: 172.16.0.44:0
      LDP Id: 172.22.0.55:0
    ATM3/0.1 (ldp): xmit/recv
      LDP Id: 192.168.7.7:2
    ATM0/0.2 (tdp): xmit/recv
      TDP Id: 192.168.0.1:1
  Targeted Hellos:
    10.1.1.1 -> 172.44.0.33 (ldp): active, xmit/recv
      LDP Id: 172.44.0.33:0
    10.1.1.1 -> 192.168.0.16 (tdp): passive, xmit/recv
      TDP Id: 192.168.0.33:0
```

To display the status of LDP sessions, issue the **show mpls ldp neighbor** privileged EXEC command. The output should show that the LDP sessions are operational and sending and receiving messages.

```
Router# show mpls ldp neighbor

Peer LDP Ident: 192.1680.7.7:2; Local LDP Ident 8.1.1.1:1
  TCP connection: 192.168.7.7.11032 - 8.1.1.1.646
  State: Oper; Msgs sent/rcvd: 5855/6371; Downstream on demand
  Up time: 13:15:09
  LDP discovery sources:
    ATM3/0.1
Peer LDP Ident: 10.1.1.1:0; Local LDP Ident 10.1.1.1:0
  TCP connection: 10.1.1.1.646 - 10.1.1.1.11006
  State: Oper; Msgs sent/rcvd: 4/411; Downstream
  Up time: 00:00:52
  LDP discovery sources:
    Ethernet1/0/0
  Addresses bound to peer LDP Ident:
    10.0.0.29      10.1.1.1      109.0.0.199     172.102.1.1
    10.205.0.9
```

## Check that MPLS and LDP Are Operational

Make sure that MPLS is globally enabled and that a label distribution protocol is running on the requested interfaces by issuing the **show mpls interfaces** command.

```
Router# show mpls interfaces

Interface          IP          Tunnel  Operational
(...)
Serial0/1.1        Yes (tdp)   Yes     Yes
Serial0/1.2        Yes         Yes     No
Serial0/1.3        Yes (tdp)   Yes     Yes
(...)
```

The IP field shows that MPLS IP is configured for an interface. The Label Distribution Protocol (LDP) appears in parentheses to the right of the IP status.

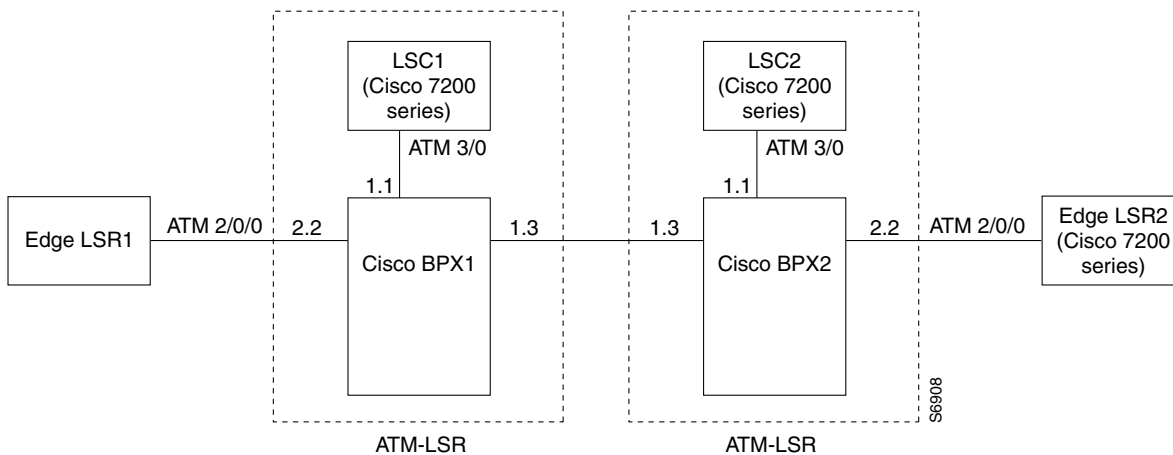
The Tunnel field indicates the capacity of traffic engineering on the interface.

The Operational field shows the status of the LDP. The interfaceSerial0/1.2 is down in the example; therefore, the Operational field shows that LDP is not operational on that interface.

## Configuration Example: Basic MPLS Configuration

The network topology shown in [Figure 3](#) incorporates two ATM-LSRs in an MPLS network. This topology includes two LSCs (Cisco 7200 routers), two BPX switches, and two edge LSRs (Cisco 7200 routers).

**Figure 3** ATM-LSR Network Configuration Example



### Configuration for LSC1

7200 LSC1:

```

ip cef
!
mpls atm disable-headend vc
!
interface loopback0
  ip address 172.103.210.5 255.255.255.255
!
interface ATM3/0
  no ip address
  label-control-protocol vsi
!
interface XTagATM13
  extended-port ATM3/0 bpx 1.3
  ip unnumbered loopback0
  mpls atm vpi 2-15
  mpls ip
!
interface XTagATM22
  extended-port ATM3/0 bpx 2.2
  ip unnumbered loopback0
  mpls atm vpi 2-5
  mpls ip
  
```

## Configuration for BPX1 and BPX2

BPX1 and BPX2:

```
uptrk 1.1
addshelf 1.1 v 1 1
cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 1.3
cnfrsrc 1.3 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 2.2
cnfrsrc 2.2 256 252207 y 1 e 512 4096 2 5 26000 100000
```



### Note

For the shelf controller, you must configure a VSI partition for the slave control port interface (**addshelf 1.1, cnfrsrc 1.1...**). However, do not configure an XTagATM port for the VSI partition (for instance, XTagATM11).

## Configuration for LSC2

7200 LSC2:

```
ip cef
!
mpls atm disable-headend vc
!
interface loopback0
 ip address 172.18.143.22 255.255.255.255
!
interface ATM3/0
 no ip address
 label-control-protocol vsi
!
interface XTagATM13
 extended-port ATM3/0 bpx 1.3
 ip unnumbered loopback0
 mpls atm vpi 2-15
 mpls ip
!
interface XTagATM22
 extended-port ATM3/0 bpx 2.2
 ip unnumbered loopback0
 mpls atm vpi 2-5
 mpls ip
```

## Configuration for Edge LSR1

LSR1:

```
ip cef distributed
!
interface loopback 0
 ip address 172.22.132.2 255.255.255.255
!
interface ATM2/0/0
 no ip address
!
interface ATM2/0/0.5 mpls
 ip unnumbered loopback 0
 mpls atm vpi 2-5
 mpls ip
```

## Configuration for Edge LSR2

```

7200 LSR2:
ip cef
interface loopback 0
    ip address 172.22.172.18 255.255.255.255
!
interface ATM2/0
    no ip address
!
interface ATM2/0.9 mpls
    ip unnumbered loopback 0
    mpls atm vpi 2-5
    mpls ip

```

## Configuring the Cisco MGX 8850 Switch and RPM-PR as an MPLS LSC

You can configure the Cisco MGX 8850 or Cisco MGX 8950 switch with the Cisco 8850 Router Processor Module (RPM-PR) as an MPLS LSC in an MPLS network.

The RPM-PR provides integrated IP in an ATM platform, enabling services such as integrated Point-to-Point Protocol (PPP), Frame Relay termination, and IP virtual private networks (VPNs) using MPLS technology. It provides Cisco IOS-based multiprotocol routing over ATM, Frame Relay and ATM Interface Layer 3 Termination, Local Server Interconnect over High-Speed LANs, access concentration, and switching between Ethernet LANs and the WAN facilities of the MGX 8850 or 8950. The RPM-PR runs Cisco IOS software.

The hardware that supports MPLS LSC functionality on the Cisco MGX 8850 switch and Cisco 8950 switch is described in the following sections.

### Cisco MGX 8850 RPM-PR Overview

The RPM-PR is a router module based on an NPE-400 processor, modified to fit into any full-height module slot on a Cisco MGX 8850 32-slot chassis. It connects to the PXM-45 back card, the 4E/B back card, and other service modules through the midplane. The RPM-PR receives power from the midplane and communicates over the midplane with the PXM-45 using IPC over ATM.

The RPM-PR has an integrated ATM interface—a permanently attached ATM port adapter/back card based on the Cisco ATM Deluxe module—and the RPM-PR can support up to two optional back cards to provide LAN connectivity.

The MGX 8850 shelf can be completely populated with 12 RPM-PRs. This allows you to use multiple RPM-PRs to achieve load sharing. Load sharing is achieved by manually distributing connections across multiple embedded RPM-PR router blades.



#### Note

In the MGX 8850, slots 7 and 8 are reserved for the PXM-45 cards occupying the full height of the chassis. Slots 15, 16, 31, and 32 are also reserved.

You can add RPM-PRs in any of slots 1 through 6 and 11 through 14. RPM-PRs must not be added to slots 7, 8, 15, or 16 in the MGX 8850 switch.

**Note**

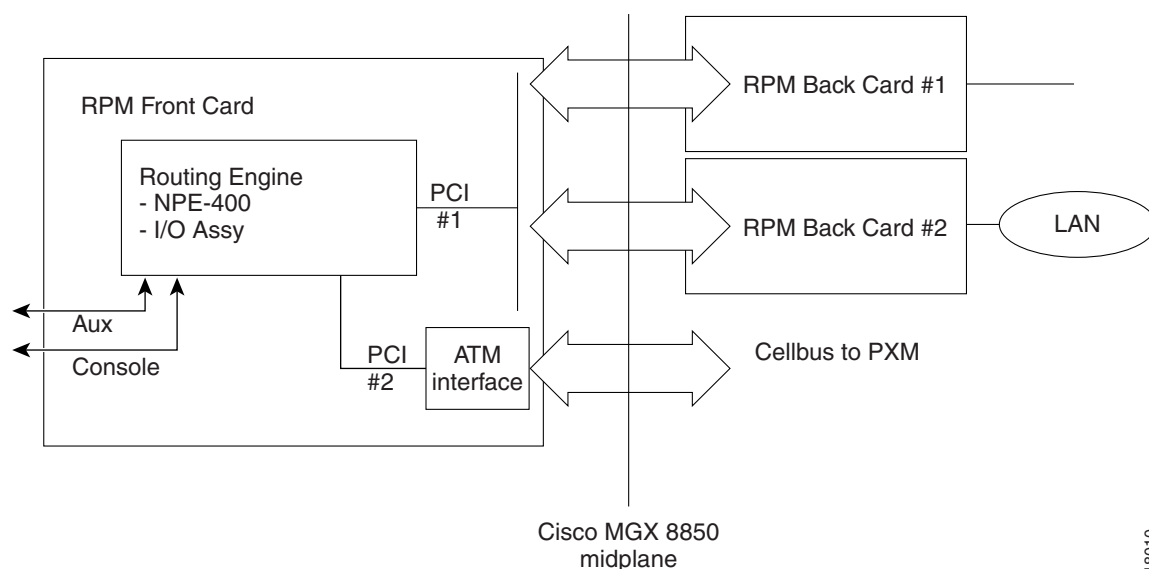
In the MGX 8950, slots 7 and 8 are reserved for the PXM-45 cards occupying the full height of the chassis. Slots 9, 10, 25, and 26 are reserved for the XM-60 cards.

You can add RPM-PRs in any of slots 1 through 6 and 11 through 16. RPM-PRs must not be added to slots 7, 8, 9, or 10 in the MGX 8950 switch.

The RPM-PR fits into the Cisco MGX 8850 and MGX 8850 midplane architecture so that the front card provides Cisco IOS router services, and the back cards provide physical network connectivity. The RPM-PR front card also provides ATM connectivity to the Cisco MGS 8850 or MGX 8950 cellbuses at full-duplex OC-3.

Figure 4 shows a Cisco MGX 8850 RPM-PR connected to the Cisco MGX 8850 midplane and the back cards.

**Figure 4** RPM-PR Connected to the MGX 8850 Midplane and to Back Cards



The RPM-PR back cards are connected to the front card by a dual PCI bus (see Figure 4). Each RPM-PR card can be equipped with up to two single-height back cards.

**Note**

Slots 7 and 8 are reserved for the PXM-45/B cards occupying the full height of the chassis. You can use PXM-45-UI-S3 cards in the top slots and T3 cards in the bottom slots. You can use MGX-RJ45-FE cards in the top slots and MGX-RJ45-4E/B cards in the bottom slots.

**Note**

The RPM-PR card within the MGX 8850 and MGX 8950 chassis supports online insertion and removal of the MGX-RJ45-4E/B and the FE (MGX 8850 only) back cards. However, the ATM port adapter is inside the RPM-PR.

## MGX 8850/8950 Cellbus

The MGX 8850/8950 cellbus in the MGX 8850/8950 midplane communicates between the RPM-PR, service modules (cellbus slaves) and the PXM-45 (cellbus master) (see [Figure 4](#)). Each cellbus is connected to a set of PXM-45 cards. Only one cellbus can be active at a time.

Communication from master to slaves consists of a broadcast to all slaves. The first byte of the cell header contains addressing information. Each slave will monitor data traffic and “pick up” cells that are destined to its slot. Also, a multicast bit allows all slaves to receive a cell simultaneously.

Communication from the slaves to the master is more complicated. Because many slaves might attempt to transmit simultaneously, arbitration among slaves is required. At the start of a given cell period, the master will poll all slaves to see if they have anything to send. By the end of the current cell, the master will grant, or allow, one of the slaves to transmit. Polling and data transmission occur simultaneously.

If two RPM-PRs in adjacent slots share the same cellbus, you need to configure a clock rate of 42 MHz on the PXM-45.

Use the **dspcbclk** command to display the clock rate:

```
PXM> dspcbclk
```

CellBus	Rate (MHz)	Slots	Allowable Rates (MHz)
CB1	21	1, 2	21, 42
CB2	21	3, 4	21, 42
CB3	21	5, 6	21, 42
CB4	21	17 - 22	21
CB5	21	9, 10	21, 42
CB6	21	11, 12	21, 42
CB7	21	13, 14	21, 42
CB8	21	25 - 30	21

Use the **cnfcbclk cbn 42** command to change the clock rate, where *n* is the number of the cellbus:

```
PXM> cnfcbclk cb1 42
```

CellBus	Rate (MHz)	Slots	Allowable Rates (MHz)
CB1	42	1, 2	21, 42
CB2	21	3, 4	21, 42
CB3	21	5, 6	21, 42
CB4	21	17 - 22	21
CB5	21	9, 10	21, 42
CB6	21	11, 12	21, 42
CB7	21	13, 14	21, 42
CB8	21	25 - 30	21

## ATM Deluxe Integrated Port Adapter

The ATM deluxe port adapter provides a single ATM interface to the MGX 8850/8950 cellbus interface (CBI). The ATM port adapter is a permanent, internal ATM interface. As such, it has no cabling to install and does not support interface types. It connects internally and directly to the MGX 8850/8950 midplane.

## Comparing Cisco 7200 LSC Configuration with Cisco RPM-PR LSC Configuration

This section compares the configuration of the Cisco 7200 LSC controlling Cisco BPX or Cisco IGX switches with the configuration of the Cisco MGX 8850 RPM-PR LSC controlling the Cisco MGX 8850 switch.

[Table 2](#) compares the configuration of switch partitions and partition resources for the Cisco 7200 LSC controlling the Cisco BPX or Cisco IGX switch with the configuration of the Cisco MGX 8850 RPM-PR LSC controlling the Cisco MGX 8850 switch.

**Table 2** Configuring Partitions and Partition Resources

Platform	Configuration
Cisco 7200 routers as LSC for Cisco BPX and Cisco IGX switches	<p>Configure VSI MPLS partitioning and resources at the Cisco BPX or Cisco IGX switch, respectively. No switch partition or switch resource is configured at the Cisco 7200 LSC.</p> <p>The following example adds the LSC controller in slot 1 port 1 of the Cisco BPX switch:</p> <pre>uptrk 1.1 addshelf 1.1 v 1 1 cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000</pre> <p>The following example configures slot 2 port 2 of the Cisco BXM for XtagInt in the LSC:</p> <pre>uptrk 2.2 cnfrsrc 2.2 256 252207 y 1 e 512 4096 2 5 26000 100000</pre>
Cisco MGX 8850 RPM-PR as LSC in Cisco MGX 8850 switch	<p>In contrast, configure the following at the RPM-PR (router):</p> <ul style="list-style-type: none"> <li>Partitions—MPLS and Private Network-Network Interface (PNNI)</li> <li>Partition resources—Interface bandwidth and interface resources, virtual path identifier (VPI), and virtual channel identifier (VCI)</li> </ul> <p>The following commands configure the LSC controller ID (8), the switch partition ID (2), and the partition resources in the PRM-PR:</p> <pre>interface Switch1 tag-control-protocol vsi id 8 switch partition vcc 2 8 ingress-percentage-bandwidth 1 100 egress-percentage-bandwidth 1 100 vpi 0 0 vci 32 3808</pre> <p>Add the LSC controller in the PXM-45 card using the <code>addcontroller &lt;cntrlrtid&gt; &lt;i   0&gt; &lt;cntrlrType&gt; &lt;slot&gt; [cntrlrName]</code> command, for example:</p> <pre>SWITCH.7.PXM45.a&gt;addcontroller 8 i 3 5 LSC1</pre>



### Note

In the Cisco MGX 8850 switch, you configure the partition resources of the switch ports in the RPM-PR. In the Cisco BPX or Cisco IGX switch, you configure all the resources in the switch.

Table 3 compares the configuration of interfaces and virtual paths and identifiers of the Cisco 7200 LSC controlling the Cisco BPX or Cisco IGX switch with the configuration of the Cisco MGX 8850 RPM-PR LSC controlling the Cisco MGX 8850 switch.

**Table 3** Configuring Interfaces and Virtual Path Identifiers/Ranges

Platform	Configuration
Cisco 7200 routers as LSC for Cisco BPX and Cisco IGX switches	<p>Configure the Xtag interfaces the same as you would for an Edge LSR. No difference exists in the LSC configuration for the User-Network Interface (UNI), the Network-to-Network Interface (NNI), or the virtual template (VT) interfaces.</p> <p>Use any VPI or VPI range or virtual path (VP) tunnel.</p>
Cisco MGX 8850 RPM-PR as LSC in Cisco MGX 8850 switch	<p>With the Cisco 8850 RPM-PR connected directly to the PXM-45 (in the same Cisco MGX 8850 switch), use VPI = 0 for MPLS with virtual channel connection (VCC) partitioning. For this connection, use VPI = 0, VCI = 32 to 3808 for all Xtag interfaces. In the LSC, you cannot use any other VPI or VP tunnel between directly connected RPM-PRs and PXM-45s.</p> <p>With Cisco MGX 8850 AXSM ports used with the Xtag interfaces, configure all UNI, NNI and Virtual Network-Network Interface (VNNI) connections in the same way that you configure them for Cisco BPX and IGX switches. You can configure any VPI, VPI range, and VP tunnel. In addition, you can configure virtual path connections (VPCs), or virtual channel connections (VCCs), or both.</p> <p>Use a descriptor (instead of the <b>bpx</b> or <b>igx</b> in a Cisco BPX or IGX command) when you configure an extended port command for an Xtag interface for the Cisco MGX 8850 switch. Use the following command if the PXM and RPM-PR are in the same Cisco MGX 8850switch:</p> <pre>Router(config)# extended-port Switch1 descriptor "9.1"</pre> <p>Use this command if the Xtag interface is controlling the AXSM card in a different Cisco MGX 8850switch:</p> <pre>Router(config)# extended-port Switch1 descriptor "1:1.1:1"</pre> <p>In both cases, you may need to enter the <b>show controller vsi des</b> command to get the correct port number.</p>

## Comparing Edge Label Switch Router Configurations

This section compares the configuration of the Cisco 7200 routers, and the Cisco 12000 Internet routers as an Edge Label Switch Router (Edge LSR) with the configuration of the Cisco MGX8850 RPM-PR as an Edge LSR.

Table 4 compares the Edge LSR configuration of the Cisco 7200 routers, and the Cisco 12000 Internet routers with the Cisco MGX 8850 RPM-PR when connected to another RPM-PR and when connected to other routers, such as the Cisco 7200 router.

**Table 4** Edge Label Switch Router Configuration Comparisons

Platform	Configuration
Cisco 7200, and Cisco 12000 routers	<p>Provision the permanent virtual circuits (PVCs) and permanent virtual paths (PVPs) manually. Once you create a PVC or PVP you can run MPLS on the PVC or PVP. With MPLS, you can configure the following:</p> <ul style="list-style-type: none"> <li>On the PVCs—Packet MPLS Downstream Unsolicited Tag Distribution Protocol (TDP) or Label Distribution Protocol (LDP)</li> <li>On the PVPs—Label-controlled ATM (LC-ATM) interface Downstream on Demand TDP or LDP</li> </ul>
Cisco MGX 8850 RPM-PR	<p>Create signaled connections, soft permanent virtual circuit (SPVC) and soft permanent virtual path (SPVP) connections, using PNNI between Cisco MGX 8850 RPM-PRs. For this type of connection with VPC partitions, use any VPI = 1 to 256. You can run MPLS on SPVCs or SPVPs. With MPLS, you can configure the following:</p> <ul style="list-style-type: none"> <li>On the SPVCs—Packet MPLS Downstream Unsolicited TDP or LDP</li> <li>On the SPVPs—LC-ATM Downstream on Demand TDP or LDP</li> </ul>
Connecting Cisco MGX RPM-PR Edge LSR to other routers	<p>Connect the Cisco RPM-PR Edge LSR with other routers (such as the Cisco 7200 router, the Cisco 12000 router, or the Cisco BPX or Cisco IGX switch with the Cisco 7200 router) through AXSM or AXSM-E cards. These routers cannot use PNNI signaling. Therefore, you need to do the following:</p> <ul style="list-style-type: none"> <li>Start the SPVCs and SPVPs from the RPM-PR and terminate them in the AXSM or AXSM-E cards. (PNNI signaling makes the connection between the RPM-PR and the AXSM or AXSM-E cards.)</li> <li>Provision the PVC and PVP connections manually at the Cisco 7200, and Cisco 12000 routers, and the Cisco BPX or Cisco IGX switch with the Cisco 7200 router.</li> </ul>

## Configuring the MGX RPM-PR

This section provides the following configuration information for the Cisco MGX RPM-PR:

- [Accessing the RPM-PR Command Line Interface, page 21](#)
- [Booting the RPM-PR, page 22](#)
- [RPM-PR Bootflash Precautions, page 22](#)
- [Configuring the Cisco MGX 8850 Switch with RPM-PR to Perform Basic LSC Operations, page 23](#)

### Accessing the RPM-PR Command Line Interface

To configure the RPM-PR, you must access the command line interface (CLI) of the RPM-PR.

You can access the RPM-PR CLI using any of the following methods:

- Console port on the front of the RPM-PR.
- `cc` from another MGX 8850 card.
- Telnet from a workstation, PC, or another router.

## Booting the RPM-PR

When the RPM-PR is booted, the boot image must be the first file in the bootflash. (See the section “RPM-PR Bootflash Precautions” to make sure that the first file on the bootflash is a valid boot image.) If the bootflash does not have a valid boot image as a first file, the card may not be able to boot and can result in bootflash corruption. If the bootflash is corrupted, you need to send the card back for an external burn with a valid boot image.

You can reboot the RPM-PR from the PXM by entering the **resetcd** *<card\_number>* command from the switch CLI, where *card\_number* is the slot number of the RPM-PR that is being rebooted.



### Caution

---

Omitting the card number resets the entire system.

---

Also, you can reboot the RPM-PR from the RPM-PR using the RPM-PR console port and entering the **reload** command.



### Note

---

The **boot system bootflash**:*<filename>* command loads the run-time software from the bootflash. The **boot system E**:*<filename>* command loads the run-time software from the PXM-45 hard disk. You can use either command to load the run-time software.

---

In addition, you can use the regular TFTP boot procedures to boot the RPM-PR. Make sure you have the network connection to the tftpboot server first.

## RPM-PR Bootflash Precautions

The RPM-PR bootflash is used to store boot image, and possibly configuration and run-time files. The bootflash stores and accesses data sequentially, and the RPM-PR boot image must be the first file stored to successfully boot the card.

The RPM's boot image, which comes loaded on the bootflash, will work for all RPM IOS images, and therefore, no reason exists to delete or move the factory-installed boot image.



### Caution

---

Erasing or moving the boot image can cause RPM-PRs to fail to boot. When this happens, the RPM must be returned to Cisco and reflashed.

---

To avoid unnecessary failures, requiring card servicing, you should:

- Never erase the boot file from the RPM bootflash.
- Never change the position of the boot file on the RPM bootflash.
- Use care when “squeezing” the bootflash to clean it up.

As long as the boot file remains intact in the first position on the bootflash, the RPM will successfully boot.



### Note

---

The **boot system bootflash**:*<filename>* command loads the run-time software from the bootflash. The **boot system E**:*<filename>* command loads the run-time software from the PXM-45 hard disk. You can use either command to load the run-time software.

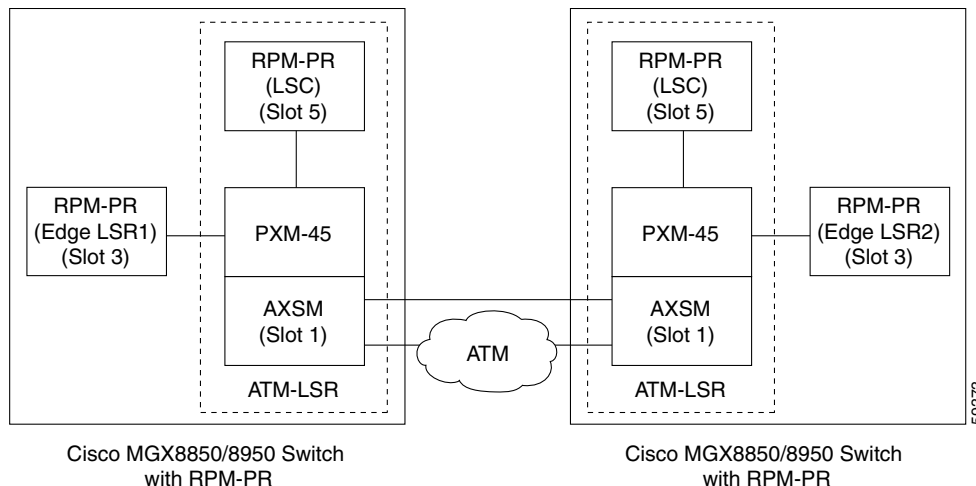
---

## Configuring the Cisco MGX 8850 Switch with RPM-PR to Perform Basic LSC Operations

To support MPLS on the Cisco 8850 switch, you need to configure MPLS support on the RPM-PR, the PXM-45, and the AXSM cards.

Figure 5 shows a Cisco MGX 8850 switch with a Cisco MGX 8850 RPM-PR set up to perform basic MPLS LSC functions. The following sections contain configuration steps and examples that show the setup of MPLS support on the Cisco MGX 8850 switch with a Cisco MGX RPM-PR.

**Figure 5** Typical Cisco MGX 8850 Configuration to Support MPLS LSC Functions



### Note

If two RPM-PRs in adjacent slots share the same cellbus, you need to configure a clock rate of 42 MHz on the PXM-45. Use the **dspcbclk** command to display the clock rate. Use the **cnfcbclk *cbn* 42** command to change the clock rate, where *n* is the number of the cellbus.

## Configuration Steps: Adding an MPLS Controller to the PXM-45

To add an MPLS controller to the PXM-45 card, follow these steps.

	Command	Purpose
<b>Step 1</b>	MGX8850.7.PXM.a> <b>addcontroller 8 i 3 5 LSC1</b>	Identifies a network control protocol to the Virtual Switch Interface (VSI) that runs on the node.  This control protocol is identified by an ID of 8 (possible, 3 to 20), as an internal (i) MPLS controller (3), located in slot 5. The name of the controller is LSC1.
<b>Step 2</b>	MGX8850.7.PXM.a> <b>cc 5</b> Router> <b>enable</b> Password: Router# <b>config terminal</b>	Switches to the router (RPM-PR card).  Accesses the configuration mode of the router.  Enter configuration commands, one per line. End with Ctrl/Z.
<b>Step 3</b>	Router(config)# <b>ip cef</b>	Enables Cisco Express Forwarding (CEF).

	Command	Purpose
<b>Step 4</b>	Router(config)# <b>interface loopback0</b> Router(config-if)# <b>ip address 28.28.28.28 255.255.255.255</b>	Creates a software-only loopback interface that emulates an interface that is always up. Specify an interface number for the loopback interface. There is no limit on the number of loopback interfaces you can create.  Assigns an IP address to Loopback0. It is important that all loopback addresses in an MPLS network are host addresses, that is, with a mask of 255.255.255.255.
<b>Step 5</b>	Router(config-if)# <b>interface switch1</b> Router(config-if)# <b>no ip address</b> Router(config-if)# <b>tag-control-protocol vsi id 8</b>	Creates an ATM interface (switch1) without an IP address.  Configures a VSI on switch1. The VSI ID is 8. The VSI ID must match the controller ID you assign to the ATM switch.
<b>Step 6</b>	Router(config-if)# <b>switch partition vcc 2 8</b> Router(config-if-swpart)#	Configures the resource partition for the controller with a partition ID of 2. The controller ID (8) is the ID set with the <b>addcontroller</b> command.
<b>Step 7</b>	Router(config-if-swpart)# <b>ingress-percentage-bandwidth 1 100</b> Router(config-if-swpart)# <b>egress-percentage-bandwidth 1 100</b>	Sets the ingress bandwidth percentage and the egress bandwidth percentage 1 to 100 percent for the controller.
<b>Step 8</b>	Router(config-if-swpart)# <b>vpi 0 0</b> Router(config-if-swpart)# <b>vci 32 3808</b>	Sets the VPI/VCI ranges for the controller.
<b>Step 9</b>	Router(config-if-swpart)# <b>Ctrl/Z</b>	Exits configuration mode.

When you use the Cisco MGX 8850 RPM-PR as an MPLS LSC, you also need to add and partition an AXSM NNI port for MPLS.

### Configuration Example: Adding and Partitioning an AXSM NNI Port for MPLS

The following example shows adding and then partitioning an NNI port on an AXSM card for MPLS.

```
cc 1
cnfcdsct 4
upln 1.1
addport 1 1.1 353207 353207 4 2
addpart 1 2 8 500000 500000 500000 500000 0 15 32 65535 4000 4000
dsparts
```

Where:

- Options for the **cnfcdsct** are 4 = policing on and 5 = policing off for ATM Forum (ATMF) service types.
- The **addport** command syntax is as follows:

```
addport ifNum bay.line guaranteedRate maxRate sctID ifType [vpiNum]
```

where:

*If Num* = a number between 1 and 60  
*bay.line* = the Line number  
*guaranteedRate* = the virtual rate in cells/sec  
*MaxRate* = OC48 rate—between 50 and 5651320  
 (*maxRate* for OC12 is between 50 and 1412830  
*maxRate* for OC3 is between 50 and 353207  
*maxRate* for T3 is between 50 and 96000 (PLCP), 104268 (ADM)  
*maxRate* for E3 is between 50 and 80000)  
*sctID* = the Port SCT ID between 0 and 255, for default file use 0  
*ifType* = 1 for uni; 2 for nni; 3 for vnni  
 (optional) *vpiNum* = between a number 1 and 4095, used for configuring the interface as a virtual trunk

The *guaranteedRate* argument must equal the *maxRate* argument.

- The **addpart** syntax is as follows:

**addpart** *ifNum partID cntlrID egrminbw egrmaxbw ingrminbw ingrmaxbw minVpi maxVpi minVci maxVci minConns maxConns*

Where:

*ifNum* = a number between 1 and 60  
*partID* = the Partition Identifier between 1 and 20  
*cntlrID* = the Controller Identifier between 1 and 20  
*egrminbw* = the Egress guaranteed percentage of bandwidth in units of 0.0001% of interface bandwidth  
*egrmaxbw* = the Egress maximum percentage of bandwidth in units of 0.0001% of interface bandwidth  
*ingrminbw* = the Ingress guaranteed percentage of bandwidth in units of 0.0001% of interface bandwidth  
*ingrmaxbw* = the Ingress maximum percentage of bandwidth in units of 0.0001% of interface bandwidth  
*minVpi* = the minimum VPI value, which is a number between 0 and 4095 (0 to 255 for UNI interface)  
*maxVpi* = the maximum VPI value, which is number between 0 and 4095 (0 to 255 for UNI interface)  
*minVci* = the minimum VCI value, which is a number between 32 and 65535  
*maxVci* = the maximum VCI value, which is a number between 32 and 65535  
*minConns* = the guaranteed number of connections, which is a number between 0 and the maximum number of connections in portgroup  
*maxConns* = the maximum number of connections, which is a number between 0 and the maximum number of connections in portgroup

- The **dsparts** command shows the newly added partition and verifies its settings.

## Configuration Steps: Mapping an AXSM Port to an XtagATM Interface on the LSC

Enter the following commands into the RPM-PR to map AXSM ports to the LSC:

	Command	Purpose
Step 1	MGX8850.7.PXM.a> <b>cc 5</b>	Switches to the router (RPM-PR card in slot 5).
Step 2	Router> <b>enable</b> Password:	Accesses the router commands.
Step 3	Router# <b>config terminal</b> Router(config)#	Enters the global configuration mode.

	Command	Purpose
Step 4	Router(config)# <b>interface xtagatm1111</b>	Creates an Xtag ATM interface (XtagATM1111).
Step 5	Router(config-if)# <b>ip unnumbered Loopback0</b>	Makes XtagATM1111 an unnumbered interface and uses the IP address of loopback 0 as a substitute. The interfaces in an ATM MPLS network should usually be unnumbered. This reduces the number of IP destination-prefixes in the routing table, which reduces the number of labels and LVCs used in the network.
Step 6	Router(config-if)# <b>extended-port Switch1 descriptor "1:1.1:1"</b>	Associates the XtagATM interface with an external interface (AXSM port 1.1) on the remotely controlled ATM switch.  Switch1 identifies the ATM interface used to control the remote ATM switch.  The <i>descriptor</i> format is x:y.z. <ul style="list-style-type: none"> <li>• x = slot where the AXSM is located (1)</li> <li>• y.y = line number (1.1)</li> <li>• z = port number (1) (this is a logical port)</li> </ul>
Step 7	Router(config-if)# <b>mpls ip</b>	Enables label switching on AXSM port 1.1.
Step 8	Router(config-if)# <b>Ctrl/Z</b>	Exits configuration mode.

When you use the Cisco MGX 8850 RPM-PR as an MPLS LSC, you also need to create the VNNI port on the AXSM card and add an XtagATM interface on the LSC for the VNNI port.

### Configuration Example: Creating the VNNI Port on the AXSM Card

The following example shows the creation of a VNNI port on the AXSM card residing on the PXM-45 shelf.

```
cc 1
cnfcdsct 4
upln 1.2
addport 12 1.2 353207 353207 4 2 11
addpart 12 2 8 250000 250000 250000 250000 11 11 32 65535 10000 10000
dspart 2
```

Where:

- The **addport** command syntax is as follows:  
**addport ifNum bay.line guaranteedRate maxRate sctID ifType [vpiNum]**

Where:

```
If Num = a number between 1 and 60
bay.line = the Line number
guaranteedRate = the virtual rate in cells/sec
MaxRate = OC48 rate-between 50 and 5651320
(maxRate for OC12 is between 50 and 1412830
maxRate for OC3 is between 50 and 353207
maxRate for T3 is between 50 and 96000 (PLCP), 104268 (ADM)
```

```

maxRate for E3 is between 50 and 80000)
sctID = the Port SCT ID between 0 and 255, for default file use 0
ifType = 1 for uni; 2 for nni; 3 for vnni
(optional) vpiNum = VPI between 1 and 4095, used for configuring the interface as
a virtual trunk

```

The *guaranteedRate* argument must equal the *maxRate* argument.

- The **addpart** syntax is as follows:

```

addpart ifNum partID cntlrID egrminbw egrmaxbw ingrminbw ingrmaxbw minVpi maxVpi minVci
maxVci minConns maxConns>

```

Where:

```

ifNum = a number between 1 and 60
partID = the Partition Identifier between 1 and 20
cntlrID = the Controller Identifier between 1 and 20
egrminbw = the Egress guaranteed percentage of bandwidth in units of 0.0001% of
interface bandwidth
egrmaxbw = the Egress maximum percentage of bandwidth in units of 0.0001% of
interface bandwidth
ingrminbw = the Ingress guaranteed percentage of bandwidth in units of 0.0001% of
interface bandwidth
ingrmaxbw = the Ingress maximum percentage of bandwidth in units of 0.0001% of
interface bandwidth
minVpi = the minimum VPI value, which is a number between 0 and 4095 (0 to 255 for
UNI interface)
maxVpi = the maximum VPI value, which is number between 0 and 4095 (0 to 255 for
UNI interface)
minVci = the minimum VCI value, which is a number between 32 and 65535
maxVci = the maximum VCI value, which is a number between 32 and 65535
minConns = the guaranteed number of connections, which is a number between 0 and
the maximum number of connections in portgroup
maxConns = the maximum number of connections, which is a number between 0 and the
maximum number of connections in portgroup

```

- The **dsppart** command shows the newly added partition (2) and verifies its settings.

### Configuration Example: Adding an XtagATM Interface on the LSC for the VNNI Port

The following example shows the addition of an XtagATM interface on the Label Switch Controller (LSC) for the VNNI port.

```

cc 5
enable
Password:
config terminal
Enter configuration commands, one per line. End with CNTL/Z.
!
interface xtagatm11212
 ip unnumbered Loopback0
 extended-port Switch1 descriptor "1:1.2:12"
 mpls ip

```

## Configuration Steps: Configuring an RPM as an Edge Label Switch Router

To configure the RPM-PR as an Edge Label Switch Router (ELSR) on the MGX 8850 Release 2 shelf, follow these steps:

	Command	Purpose
<b>Step 1</b>	MGX8850.7.PXM.a> <b>cc 3</b> Router> <b>enable</b> Password: Router# <b>config terminal</b>	Connects to the router (RPM-PR card).  Accesses router commands.  Enters the global configuration mode of the router.  Enter configuration commands, one per line. End with Ctrl/Z.
<b>Step 2</b>	Router(config)# <b>ip cef</b>	Enables Cisco Express Forwarding (CEF).
<b>Step 3</b>	Router(config)# <b>interface Loopback0</b> Router(config-if)# <b>ip address 192.168.2.11 255.255.255.255</b>	Creates a software-only loopback interface that emulates an interface that is always up. Specifies an interface number for the loopback interface. There is no limit on the number of loopback interfaces you can create.  Assigns an IP address to Loopback0. It is important that all loopback addresses in an MPLS network are host addresses, that is, with a mask of 255.255.255.255.
<b>Step 4</b>	Router(config-if)# <b>switch partition vcc 2 8</b>	Configures the resource partition for the controller with a partition ID of 2. The controller ID (8) is the ID set with the <b>addcontroller</b> command.
<b>Step 5</b>	Router(config-if-swpart)# <b>ingress-percentage-bandwidth 1 100</b> Router(config-if-swpart)# <b>egress-percentage-bandwidth 1 100</b>	Sets the ingress bandwidth percentage and the egress bandwidth percentage 1 to 100 percent for the controller. This command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.
<b>Step 6</b>	Router(config-if-swpart)# <b>vpi 0 0</b> Router(config-if-swpart)# <b>vci 32 3808</b>	Sets the VPI/VCI ranges for the controller.
<b>Step 7</b>	Router(config-if-swpart)# <b>Ctrl/Z</b>	Exits partition configuration mode.
<b>Step 8</b>	Router(config)# <b>interface Switch1.11 mpls</b>	Creates a subinterface on the RPM-PR and identifies the type of link.  The switch interface number is always 1. The subinterface number (11) must be unique for the RPM-PR. You choose the subinterface number when you create the subinterface.
<b>Step 9</b>	Router(config-if)# <b>ip unnumbered Loopback0</b>	Makes the subinterface an unnumbered interface and uses the IP address of loopback 0 as a substitute.

	Command	Purpose
<b>Step 10</b>	Router(config-if)# <b>mpls ip</b>	Enables MPLS forwarding of IPv4 packets.
<b>Step 11</b>	Router(config-if)# <b>Ctrl/Z</b>	Exits configuration mode.

### Configuring an XTag Interface in the LSC Connecting to the RPM-PR Edge LSR

To configure an XTag interface on the LSC connecting to the Cisco MGX 8850 RPM-PR Edge LSR follow these steps:

	Command	Purpose
<b>Step 1</b>	MGX8850.7.PXM.a> <b>cc 3</b> Router> <b>enable</b> Password: Router# <b>config terminal</b>	Connects to the router (RPM-PR card).  Accesses router commands.  Enters the global configuration mode of the router.  Enter configuration commands, one per line. End with Ctrl/Z.
<b>Step 2</b>	Router(config)# <b>ip cef</b>	Enables Cisco Express Forwarding (CEF).
<b>Step 3</b>	Router(config)# <b>interface loopback0</b>  Router(config-if)# <b>ip address 10.9.9.9 255.255.255.255</b>	Create a software-only loopback interface that emulates an interface that is always up. Specifies an interface number for the loopback interface. There is no limit on the number of loopback interfaces you can create.  Assigns an IP address to Loopback0. It is important that all loopback addresses in an MPLS network are host addresses, that is, with a mask of 255.255.255.255.
<b>Step 4</b>	Router(config)# <b>interface switch1</b>	Configures an ATM interface (Switch1).
<b>Step 5</b>	Router(config-if)# <b>switch partition vcc 2 8</b>	Configures the resource partition for the controller with a partition ID of 2. The controller ID (8) is the ID set with the <b>addcontroller</b> command.
<b>Step 6</b>	Router(config-if-swpart)# <b>ingress-percentage-bandwidth 1 100</b> Router(config-if-swpart)# <b>egress-percentage-bandwidth 1 100</b>	Sets the ingress bandwidth percentage and the egress bandwidth percentage 1 to 100 percent for the controller. This command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.
<b>Step 7</b>	Router(config-if-swpart)# <b>vpi 0 0</b> Router(config-if-swpart)# <b>vci 32 3808</b>	Sets the VPI/VCI ranges for the controller.
<b>Step 8</b>	Router(config-if-swpart)# <b>Ctrl/Z</b>	Exits partition configuration mode.
<b>Step 9</b>	Router(config)# <b>interface XTagATM31</b>	Creates an XTag ATM interface (XTagATM31).
<b>Step 10</b>	Router(config-if)# <b>ip unnumbered Loopback0</b>	Makes the subinterface an unnumbered interface and uses the IP address of loopback 0 as a substitute.

	Command	Purpose
Step 11	Router(config-if)# <b>extended-port switch1 descriptor "3.1"</b>	Associates the XtagATM interface with port 3.1.
Step 12	Router(config-if)# <b>mpls ip</b>	Enables MPLS forwarding of IPv4 packets.
Step 13	Router(config-if)# <b>Ctrl/Z</b>	Exits configuration mode.

## MGX ATM MPLS Configuration Examples

This section contains the following sample Cisco MGX 8850 ATM MPLS configurations:

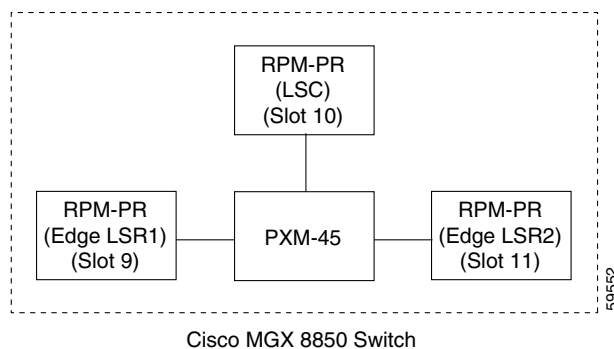
- [Simple Cisco MGX 8850 RPM-PR LSC Network Configuration \(VCC Switch Partition\), page 30](#)
- [Cisco MGX 8850 RPM-PR LSC Network Configuration with Cisco MGX 8850 and Cisco BPX Switches \(VCC Switch Partition\), page 33](#)

### Simple Cisco MGX 8850 RPM-PR LSC Network Configuration (VCC Switch Partition)

Figure 6 represents the sample RPM-PR LSC network configuration for a VCC switch partition for the configuration examples that follow.

- [RPM-PR Edge LSR1 Configuration, page 30](#)
- [PXM LSC Configuration, page 31](#)
- [RPM-PR LSC Configuration, page 31](#)
- [RPM-PR Edge LSR2 Configuration, page 32](#)

**Figure 6** Sample RPM-PR LSC Network Configuration



#### Note

If two RPM-PRs in adjacent slots share the same cellbus, you need to configure a clock rate of 42 MHz on the PXM-45. Use the **dspeblk** command to display the clock rate. Use the **cnfcbclk cbn 42** command to change the clock rate, where **n** is the number of the cellbus.

#### RPM-PR Edge LSR1 Configuration

Following is an example of an RPM-PR Edge LSR(1) configuration. This example uses the **switch partition vcc** command and therefore, only VCI ranges can be used; you cannot use VPI ranges or VP tunnels. In this example, only one label (tag) switching interface is used, so you can use the default VPI = 0 and the VCI range = 32 to 3808.

**Note**

In the Cisco BPX and IGX switches, you normally use VPI range or VP tunnels or both. In the Cisco MGX 8850 switch, a VCI range is commonly used. In the Cisco MGX 8850 switch, the partition resources of the switch ports are configured at the RPM-PR. In the Cisco BPX or IGX switches, all resources are configured in the switch

```

ip cef
!
interface Loopback0
 ip address 10.9.9.9 255.255.255.255
!
 interface Switch1
  switch partition vcc 2 8
  ingress-percentage-bandwidth 1 100
  egress-percentage-bandwidth 1 100
  vpi 0 0
  vci 32 3808
!
interface Switch1.1 mpls
 ip unnumbered Loopback0
 mpls atm vpi 0 vci 33 3000
 mpls ip
!
router ospf 100
 network 10.0.0.0 0.255.255.255 area 0

```

Where:

- The **switch partition vcc 2 8** command configures a partition ID = 2 and a controller ID = 8.
- The **ingress-percentage-bandwidth 1 100** command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.

**PXM LSC Configuration**

The following command adds the LSC controller in the PXM-45. Use the **addcontroller <ctrlrtid> <i | o> <ctrlrType> <slot> [ctrlrName]** command:

```
addcontroller 8 i 3 10 LSC
```

Where:

- The controller ID = 8.
- The controller is internal (i).
- The controller type =MPLS (3).
- The slot number = 10.
- The name of the controller = LSC.

**RPM-PR LSC Configuration**

Following is an example of an RPM-PR LSC configuration. This example uses the **switch partition vcc** command and therefore, you can use only VPI = 0 and VCI ranges; you cannot use VPI ranges or VP tunnels.

```

ip cef
!
mpls atm disable-headend-vc
!
interface Loopback0
 ip address 10.20.20.20 255.255.255.255

```

```

!
interface Switch1
  tag-control-protocol vsi id 8
  switch partition vcc 2 8
  ingress-percentage-bandwidth 1 100
  egress-percentage-bandwidth 1 100
  vpi 0 0
  vci 32 3808
!
interface XTagATM91
  ip unnumbered Loopback0
  extended-port Switch1 descriptor 9.1
  mpls ip
!
interface XTagATM111
  ip unnumbered Loopback0
  extended-port Switch1 descriptor 11.1
  mpls ip
!
router ospf 100
  network 10.0.0.0 0.255.255.255 area 0

```

Where:

- The **tag-control-protocol vsi id 8** command configures an LSC controller with an ID = 8.
- The **switch partition vcc 2 8** command configures the VCC partition with an MPLS partition ID = 2. (The LSC controller ID is 8.)
- The **ingress-percentage-bandwidth 1 100** partition resource command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.
- You need to enter a **show controller vsi des** command to get the port number, for example, 9.1, for the **extended-port Switch1 descriptor 9.1** command. If this Xtag interface is controlling the AXSM card, then the format is different. Again, refer to the output from the **show controller vsi des** command.

### RPM-PR Edge LSR2 Configuration

Following is an example of an RPM-PR Edge LSR(2) configuration. This example uses the **switch partition vcc** command and therefore, only VPI = 0 and any VCI in the allowed range can be used; you cannot use VPI ranges or VP tunnels.

```

ip cef
!
interface Loopback0
  ip address 10.10.10.10 255.255.255.255
!
interface Switch1
  switch partition vcc 2 8
  ingress-percentage-bandwidth 1 100
  egress-percentage-bandwidth 1 100
  vpi 0 0
  vci 32 3808
!
interface Switch1.1 mpls
  ip unnumbered Loopback0
  mpls atm vpi 0 vci 33 3000
  mpls ip
!
router ospf 100
  network 10.0.0.0 0.255.255.255 area 0

```

Where:

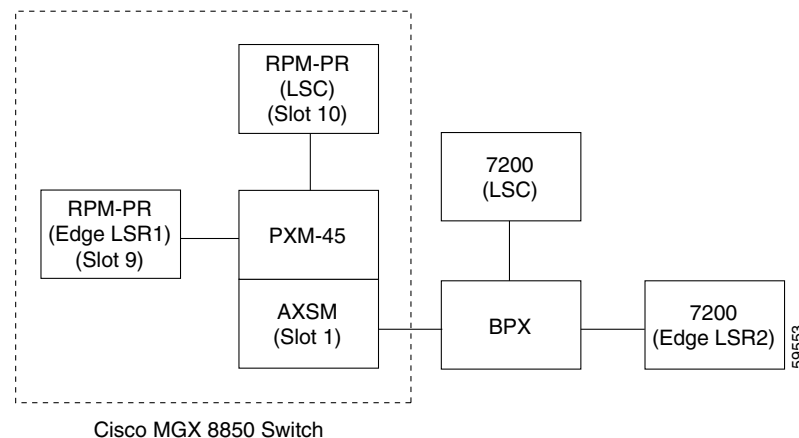
- The **switch partition vcc 2 8** command configures the VCC partition with an MPLS partition ID = 2 and a LSC controller ID = 8.
- The **ingress-percentage-bandwidth 1 100** partition resource command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.

### Cisco MGX 8850 RPM-PR LSC Network Configuration with Cisco MGX 8850 and Cisco BPX Switches (VCC Switch Partition)

Figure 7 represents a sample RPM-PR LSC network configuration with the MGX 8850 and the BPX switches for the configuration examples that follow.

- [RPM-PR Edge LSR1 Configuration, page 33](#)
- [PXM LSC Configuration, page 34](#)
- [RPM-PR LSC Configuration, page 34](#)
- [Mapping a Cisco MGX 8850 AXSM Port to an XtagATM Interface on the Cisco MGX 8850 RPM-PR LSC, page 35](#)
- [AXSM Configuration for the Xtag Interfaces, page 36](#)
- [BPX Configuration, page 37](#)
- [Configuration for 7200 LSC, page 37](#)
- [Cisco 7200 Edge LSR2 configuration, page 38](#)

**Figure 7** Sample RPM-PR LSC Network with Cisco MGX 8850 and Cisco BPX Switches



#### Note

If two RPM-PRs in adjacent slots share the same cellbus, you need to configure a clock rate of 42 MHz on the PXM-45. Use the **dspcbclk** command to display the clock rate. Use the **cnfcbclk cbn 42** command to change the clock rate, where **n** is the number of the cellbus.

#### RPM-PR Edge LSR1 Configuration

Following is an example of a PRM-PR Edge LSR(1) configuration. This example uses the **switch partition vcc** command and therefore, you can use only VCI ranges; you cannot use VPI ranges or VP tunnels. In this example, only one label (tag) switching interface is used, so you use the default VPI = 0 and the VCI range = 33 to 3808.

**Note**

In the Cisco BPX and IGX switches, you normally use a VPI range or VP tunnels or both. In the Cisco MGX 8850 switch, a VCI range is commonly used.

In the Cisco MGX 8850 switch, the partition resources of the switch ports are configured at the RPM-PR. In the Cisco BPX or IGX switches, all resources are configured in the switch.

```
ip cef
!
interface Loopback0
 ip address 10.9.9.9 255.255.255.255
!
interface Switch1
 switch partition vcc 2 8
 ingress-percentage-bandwidth 1 100
 egress-percentage-bandwidth 1 100
 vpi 0 0
 vci 32 3808
!
interface Switch1.1 mpls
 ip unnumbered Loopback0
 mpls atm vpi 0 vci 33 3000
 mpls ip
!
router ospf 100
 network 10.0.0.0 0.255.255.255 area 0
```

Where:

- The **switch partition vcc 2 8** command configures a partition ID = 2 and a controller ID = 8.
- The **ingress-percentage-bandwidth 1 100** partition resource command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.

**PXM LSC Configuration**

The following command adds the LSC controller in the PXM-45. Use the **addcontroller <cntrlrId> <i | o> <cntrlrType> <slot> [cntrlrName]** command:

```
addcontroller 8 i 3 10 LSC
```

Where:

- The controller has an ID = 8.
- The controller is internal (i).
- The controller type = MPLS (3).
- The slot number = 10.
- The name of the controller = LSC.

**RPM-PR LSC Configuration**

Following is an example of an RPM-PR LSC configuration. This example uses the **switch partition vcc** command and therefore, you can use only VPI = 0 and VCI ranges: you cannot use VPI ranges or VP tunnels.

```
ip cef
!
mpls atm disable-headend vc
!
```

```

interface Loopback0
  ip address 10.20.20.20 255.255.255.255
!
interface Switch1
  tag-control-protocol vsi id 8
  switch partition vcc 2 8
  controller ID is 8.
  ingress-percentage-bandwidth 1 100
  egress-percentage-bandwidth 1 100
  vpi 0 0
  vci 32 3808
!
interface XTagATM91
  ip unnumbered Loopback0
  extended-port Switch1 descriptor 9.1
  mpls ip
!
router ospf 100
  network 10.0.0.0 0.255.255.255 area 0

```

Where:

- The **tag-control-protocol vsi id 8** command configures an LSC controller with an ID = 8.
- The **switch partition vcc 2 8** command configures the VCC partition with an MPLS partition ID = 2. (The LSC controller ID is 8.)
- The **ingress-percentage-bandwidth 1 100** partition resource command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.
- You need to enter a **show controller vsi des** command to get the port number, for example, 9.1, for the **extended-port Switch1 descriptor 9.1** command. If this Xtag interface is controlling the AXSM card, then the format is different. Again, refer to the output from the **show controller vsi des** command.

#### Mapping a Cisco MGX 8850 AXSM Port to an XtagATM Interface on the Cisco MGX 8850 RPM-PR LSC

The following example shows a sample configuration for mapping an AXSM port to an XtagATM interface on the RPM-PR LSC:

```

interface XTagATM1111
  ip unnumbered Loopback0
  extended-port Switch1 descriptor 1:1.1:1
  mpls atm vpi 0-15
  mpls ip
!
router ospf 100
  network 10.0.0.0 0.255.255.255 area 0

```

Where:

- In the **extended-port Switch1 descriptor 1:1.1:1** command, the **descriptor** format is *x:y.z*, where
  - *x* = slot for the AXSM card
  - *y.y* = the line number
  - *z* = the port number (this is a logical port)
- The **mpls atm vpi 0-15** command configures a VPI range of 0 to 15 in the AXSM interface.

**AXSM Configuration for the Xtag Interfaces**

This configuration example shows adding and partitioning an NNI port on an AXSM card for MPLS. Enter the **cc** command to change to an AXSM card, then enter the **cnfcdsct** command to configure the AXSM card service class template (SCT) for PNNI and MPLS:

At the PXM-45 SWITCH.7PXM.a> prompt:

```
cc 1
```

At the AXM SWITCH.1.AXSM.a> prompt:

```
cnfcdsct 4
upln 1.1
addport 1 1.1 353207 353207 4 2
addpart 1 2 5 500000 500000 500000 500000 0 15 32 65535 4000 4000
dsparts

if part Ctlr egr egr ingr ingr min max min max min max
Num ID ID GuarBw MaxBw GuarBw MaxBw vpi vpi vci vci conn conn
      (.0001%) (.0001%) (.0001%) (.0001%)
-----
1 2 5 500000 500000 500000 500000 0 15 32 65535 4000 4000
```

Where:

- For the **cnfcdsct 4** command, 4 = policing on; 5 = policing off (for ATMF service types).
- The **upln 1.1** command brings up the line where you want to add the port.
- The **addport** command adds the port. The syntax for the command is as follows:

**addport** <ifNum> <bay.line> <guaranteedRate> <maxRate> <sctID> <ifType> [vpiNum]

Where:

```
ifNum is a number between 1 and 60
bay.line is the format for the Line Number
guaranteedRate is the virtual rates in cells/sec
maxRate for OC48 = between 50 and 5651320
for OC12 = between 50 and 1412830
for OC3 = between 50 and 353207
for T3 = between 50 and 96000 (PLCP), 104268 (ADM)
for E3 = between 50 and 80000
sctID is the Port SCT ID between 0 and 255, for the default file use 0
ifType is 1 for UNI; 2 for NNI; 3 for VNNI
vpiNum is between 1 and 4095, used for configuring the interface as virtual trunk
```

The *guaranteedRate* argument must equal the *maxRate* argument.

- The **addpart** command partitions the port you just added. The syntax for the command is as follows:

**addpart** <ifNum> <partID> <cntrlrID> <egrminbw> <egrmaxbw> <ingrminbw> <ingrmaxbw> <minVpi> <maxVpi> <minVci> <maxVci> <minConns> <maxConns>

Where:

```
ifNum is a number between 1 and 60
partID is the partition identifier between 1 and 20
cntrlrID is the controller identifier between 1 and 20
egrminbw is the Egress guaranteed percentage of bandwidth in units of 0.0001% of
interface
bandwidth
egrmaxbw is the Egress maximum percentage of bandwidth in units of 0.0001% of
interface bandwidth
ingrminbw is the Ingress guaranteed percentage of bandwidth in units of 0.0001% of
interface bandwidth
```

*ingrmaxbw* is the Ingress maximum percentage of bandwidth in units of 0.0001% of interface bandwidth  
*minVpi* is the minimum VPI value, which is a number between 0 and 4095 (0 to 255 for the UNI interface)  
*maxVpi* is the maximum VPI value, which is number between 0 and 4095 (0 to 255 for the UNI interface)  
*minVci* is the minimum VCI value, which is a number between 32 and 65535  
*maxVci* is the maximum VCI value, which is a number between 32 and 65535  
*minConns* is the guaranteed number of connections, which is a number between 0 and the maximum number of connections in portgroup (see **dspscd** for portgroup info)  
*maxConns* is the maximum number of connections, which is a number between 0 and the maximum number of connections in portgroup (see **dspscd** for portgroup info)

- The **dspparts** command displays the newly added partition and verifies its settings.

### BPX Configuration

BXP:

```
uptrk 1.1
addshelf 1.1 v 1 1
cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 1.3
cnfrsrc 1.3 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 2.2
cnfrsrc 2.2 256 252207 y 1 e 512 4096 2 5 26000 100000
```

### Configuration for 7200 LSC

7200 LSC:

```
ip cef
!
mpls atm disable-headend-vc
!
interface loopback0
 ip address 40.40.40.40 255.255.255.255
!
interface ATM3/0
 no ip address
 tag-control-protocol vsi
!
interface XTagATM13
 extended-port ATM3/0 bpx 1.3
 ip unnumbered loopback0
 mpls atm vpi 2-15
 mpls ip
!
interface XTagATM22
 extended-port ATM3/0 bpx 2.2
 ip unnumbered loopback0
 mpls atm vpi 2-5
 mpls ip
!
router ospf 100
 network 40.0.0.0 0.255.255.255 area 0
```

**Cisco 7200 Edge LSR2 configuration**

7200 LSR2:

```

ip cef
!
interface loopback 0
  ip address 30.30.30.30 255.255.255.255
!
interface ATM2/0/0
  no ip address
!
interface ATM2/0/0.5 mpls
  ip unnumbered loopback 0
  mpls atm vpi 2-5
  mpls ip
!
router ospf 100
  network 30.0.0.0 0.255.255.255 area 0

```

**PVP-Based ATM MPLS Network Configuration**

This section contains sample configurations for the following PVP-based ATM MPLS network configurations:

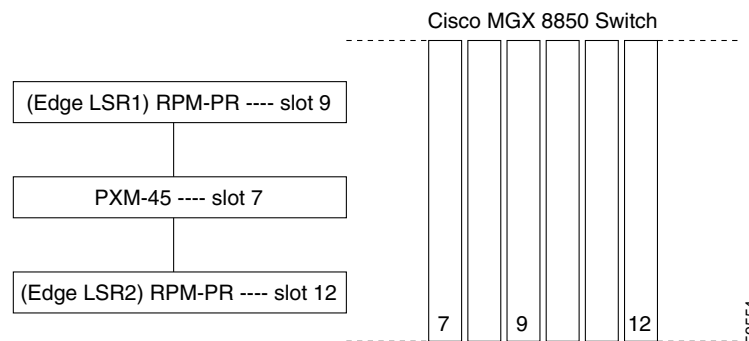
- [Edge LSR to Edge LSR SPVP LC-ATM Interface Configuration, page 38](#)
- [Cisco MGX 8850 RPM-PR Connected to an External Device, page 42](#)

**Edge LSR to Edge LSR SPVP LC-ATM Interface Configuration**

Figure 8 represents a sample permanent virtual path (PVP) configuration with devices in the same Cisco MGX 8850 switch for the ATM MPLS network configuration examples that follow.

- [RPM-PR Edge LSR1 Configuration with VPC Switch Partition, page 39](#)
- [PXM-45 Configuration with VPC Switch Partition, page 39](#)
- [RPM -PR Edge LSR2 Configuration with VPC Switch Partition, page 40](#)

**Figure 8** PVP Configuration with Devices in Same Cisco MGX 8850 Switch

**Note**

If two RPM-PRs in adjacent slots share the same cellbus, you need to configure a clock rate of 42 MHz on the PXM-45. Use the **dspeblk** command to display the clock rate. Use the **cnfcbclk cbn 42** command to change the clock rate, where **n** is the number of the cellbus.

### RPM-PR Edge LSR1 Configuration with VPC Switch Partition

This example uses the **switch partition vpc** command and therefore, you can use VPI ranges or VP tunnels. If you create a VP tunnel between two routers, you need to configure VPC partitioning and PNNI signaling to bring up the PVP. Then you can run the LC-ATM interface on the PVP.



#### Note

In the Cisco MGX 8850 switch, the partition resources of the switch ports are configured at the RPM-PR. In the Cisco BPX switch, you configure all resources in the switch.

Following is a sample configuration for the RPM-PR Edge LSR1:

```
ip cef
!
interface Loopback0
 ip address 10.9.9.9 255.255.255.255
!
interface Switch1
 atm pvp 2 10000
 switch partition vpc 1 2
 ingress-percentage-bandwidth 1 100
 egress-percentage-bandwidth 1 100
 vpi 1 255
 vci 0 65535
!
interface Switch1.2 mpls
 ip unnumbered Loopback0
 pvc 2/0
 mpls atm control-vc 2 32
 mpls atm vpi 2 vci 33-65518
 mpls ip
 switch connection vpc 2 master remote
!
router ospf 100
 network 10.0.0.0 0.255.255.255 area 0
```

Where:

- The **switch partition vpc 1 2** command configures the VPC switch partition. For PNNI, the partition ID = 1 and the controller ID = 2.
- The **ingress-percentage-bandwidth 1 100** partition resource command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.
- In the **interface Switch1.2 mpls** command, the interface is Switch1.2.
- The **pvc 2/0** command configures a PVC = 2/0 on the VP.
- The **switch connection vpc 2 master remote** command enables PNNI to create a PVP (VPI = 2) connection. This command also indicates that the remote peer is the master, therefore, this is slave side.



#### Note

You need to configure the slave side first. Then, you are able to get the ATM NSAP address from the PXM. This is needed at the master side.

### PXM-45 Configuration with VPC Switch Partition

This illustrates the PXM configuration for VPC switch partitioning for a PVP when all devices exist on the same Cisco MGX 8850 switch.

At the PXM-45 SWITCH.7.PXM.a> prompt:

```

addcontroller 2 i 2 7 PNNI
dnnpport 9.2
cnfpnportsig 9.2 -univer none
upnpport 9.2
dspcon 9.2 2

```

```

Port                Vpi Vci      Owner      State
-----
Local 9:-1.2:-1    2.0          SLAVE      FAIL
  Address: 47.009181000000000142265fb2.000001074b02.00
  Node name: SWITCH
Remote Routed      0.0          MASTER     --
  Address: 00.0000000000000000000000000000.000000000000.00
  Node name:
-----
----- Provisioning Parameters -----
Connection Type: VPC                Cast Type: Point-to-Point
Service Category: UBR                Conformance: UBR.1
Bearer Class: BCOB-VP
Last Fail Cause: N/A                Attempts: 0
Continuity Check: Disabled           Frame Discard: Disabled
L-Utills: 0  R-Utills: 0  Max Cost: 0  Routing Cost: 0
OAM Segment Ep: Enabled
----- Traffic Parameters -----
Tx PCR: 353208      Rx PCR: 353208
Tx CDV: N/A        Rx CDV: N/A
Tx CTD: N/A        Rx CTD: N/A

```

Where:

- In the **dsppnport** *port\_id* command, the *port\_id* = *slot#.part*, where *part* options are 1 = VCC; 2 = VPC.
- The **dnnpport** command brings down the port so that it can be configured. In this example, the **dsppnport 9.2** command indicates slot 9 and the VPC partition.
- The **cnfpnportsig 9.2 -univer none** command disables PNNI signaling on the RPM-PR is in slot 9.
- The **upnpport** command brings up the ports after configuration is complete.
- After configuring **switch connection vpc 2 master remote** on slave (Edge LSR1), you use the **dsppcon** command on the PXM to get the slave NSAP address. In the **dsppcon 9.2 2** command, the final **2** is the VPC value.

#### RPM -PR Edge LSR2 Configuration with VPC Switch Partition

This example uses the **switch partition vpc** command and therefore, you can use VPI ranges or VP tunnels. If you create a VP tunnel between two routers, you need to configure VPC partitioning and PNNI signaling to bring up the PVP. Then you can run the LC-ATM interface on the PVP.



#### Note

In the Cisco MGX 8850 switch, the partition resources of the switch ports are configured at the RPM-PR. In the Cisco BPX switch, you configure all resources in the switch.

Following is a sample configuration for the RPM-PR Edge LSR2:

```

ip cef
!
interface Loopback0
  ip address 12.12.12.12 255.255.255.255
!
interface Switch1
  atm pvp 2 10000
  switch partition vpc 1 2

```

```

    ingress-percentage-bandwidth 1 100
    egress-percentage-bandwidth 1 100
    vpi 1 255
    vci 0 65535
!
interface Switch1.2 mpls
 ip unnumbered Loopback0
 pvc 2/0
 mpls atm control-vc 2 32
 mpls atm vpi 2 vci 33-65518
 mpls ip
 switch connection vpc 2 master local raddr
 47.0091.8100.0000.0001.4226.5fb2.0000.0107.4b02.00 2
!
!router ospf 100
 network 12.0.0.0 0.255.255.255 area 0
!
dspcon 9.2 2

```

Port	Vpi Vci	Owner	State
Local 9:-1.2:-1	2.0	SLAVE	OK
Address: <b>47.009181000000000142265fb2.000001074b02.00</b>			
Node name: SWITCH			
Remote Routed	0.0	MASTER	OK
Address: 47.009181000000000142265fb2.000001076302.00			
Node name:			

```

----- Provisioning Parameters -----
Connection Type: VPC                Cast Type: Point-to-Point
Service Category: UBR                Conformance: UBR.1
Bearer Class: BCOB-VP
Last Fail Cause: No Fail              Attempts: 0
Continuity Check: Disabled            Frame Discard: Disabled
L-Utills: 100  R-Utills: 100  Max Cost: -1  Routing Cost: 0
OAM Segment Ep: Enabled
----- Traffic Parameters -----
Tx PCR: 353208      Rx PCR: 353208
Tx CDV: N/A         Rx CDV: N/A
Tx CTD: N/A         Rx CTD: N/A

```

Where:

- The 1,100 in the **ingress-percentage-bandwidth 1 100** command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.
- The NSAP ATM address for the switch connection command is found by entering the **dspcon** command on the PXM-45 card.
- Executing the **dspcon 9.2 2** command, for example, at the end of the configuration should show both local (slave) and remote (master) addresses.

#### PXM-45 Configuration with VPC Switch Partition

This illustrates the PXM configuration for VPC switch partitioning for a PVP when all devices exist on the same Cisco MGX 8850 switch.

At the PXM-45 SWITCH.7.PXM.a> prompt:

```

dnpport 12.2
cnfppportsig 12.2 -univer none
uppport 12.2

```

Where:

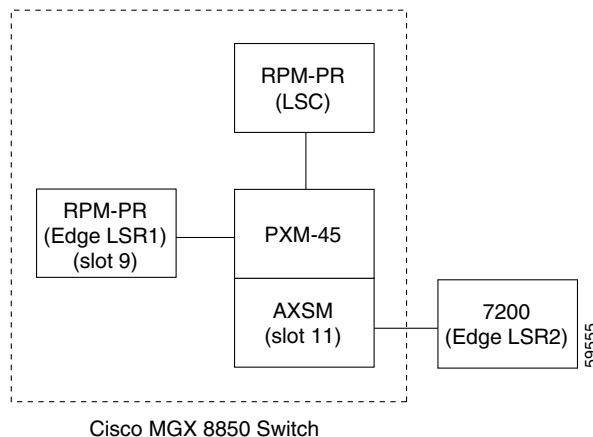
- In the **dsppnport** *port\_id* command, the *port\_id* = *slot#.part*, where *part* options are 1 = VCC; 2 = VPC.
- The **dnpnport** command brings down the port so that it can be configured. In this example, the **dsppnport 12.2** command brings down port 12 and the VPC partition.
- The **cnfnportsig 12.2 -univer none** command disables PNNI signaling for the RPM-PR in slot 12.
- The **upnport** command brings up the ports after configuration is complete.

### Cisco MGX 8850 RPM-PR Connected to an External Device

These sample configurations illustrate a permanent virtual path (PVP) ATM MPLS network with the Cisco MGX 8850 RPM-PR in the Cisco MGX 8850 switch connected to an external device (a Cisco 7200 router, for example). Figure 9 illustrates a PVP configuration with the RPM-PR in the Cisco MGX 8850 switch connected to a Cisco 7200 Edge LSR for the configuration examples that follow.

- [RPM-PR Edge LSR1 Configuration \(VPC Switch Partition\), page 43](#)
- [PXM-45 Configuration \(Switch Partition VPC\), page 43](#)
- [Configuration for Cisco 7200 Edge LSR2, page 45](#)

**Figure 9** RPM-PR in Cisco MGX 8850 Switch Connected to Cisco 7200 Edge LSR



#### Note

If two RPM-PRs in adjacent slots share the same cellbus, you need to configure a clock rate of 42 MHz on the PXM-45. Use the **dspecbclk** command to display the clock rate. Use the **cnfcbclk cbn 42** command to change the clock rate, where *n* is the number of the cellbus.

These examples use the **switch partition vpc** command and therefore, you can use VPI ranges or VP tunnels. If you create a VP tunnel between two routers, you need to configure VPC partitioning and PNNI signaling to bring up the PVP. Then you can run the LC-ATM interface on the PVP.

Between Cisco MGX 8850 RPM-PRs, you can use signaled connections, soft permanent virtual circuit (SPVC) and soft permanent virtual path (SPVP) connections, using PNNI. For this type of connection with VPC partitions, you can use any VPI = 1 to 256. You can run MPLS on SPVCs or SPVPs. With MPLS, you can configure the following:

- On the SPVCs—Packet MPLS Downstream Unsolicited TDP or LDP
- On the SPVPs—LC-ATM Downstream on Demand TDP or LDP

If you are connecting the Cisco RPM-PR Edge LSR with other routers, such as the Cisco 7200 router, the Cisco 12000 router, or the Cisco BPX or Cisco IGX switch with the Cisco 7200 router, then you need to connect these routers through AXSM or AXSM-E cards. The Cisco 7200, and Cisco 12000 routers, and the Cisco BPX or Cisco IGX switch with the Cisco 7200 router cannot use PNNI signaling. You need to do the following:

- Start the SPVCs and SPVPs from the RPM-PR and terminate them in the AXSM or AXSM-E cards. (PNNI signaling makes the connection between the RPM-PR and the AXSM or AXSM-E cards.)
- Provision the PVC and PVP connections manually at the Cisco 7200, and Cisco 12000 routers, and the Cisco BPX or Cisco IGX switch with the Cisco 7200 router.

#### RPM-PR Edge LSR1 Configuration (VPC Switch Partition)

```
ip cef
!
interface Loopback0
  ip address 10.12.12.12 255.255.255.255
!
interface Switch1
  atm pvp 12 100000
  switch partition vpc 1 2
  ingress-percentage-bandwidth 20 100
  egress-percentage-bandwidth 20 100
  vpi 1 100
  vci 0 65535
!
interface Switch1.12 mpls
  ip unnumbered Loopback0
  pvc 12/0
 ubr 100000
  mpls atm vp-tunnel 12 vci-range 33-65518
  mpls ip
  switch connection vpc 12 master remote
!
router ospf 100
  network 12.0.0.0 0.255.255.255 area 0
```

Where:

- The **atm pvp 12 100000** command configures a PVP with PCR = 100000 Kbps. You calculate the AXSM endpoints = about 235900 based on this value of 100000 Kbps ((100000 x 1000) divided by (53 x 8)).
- In the **pvc 12/0** command, the PVC should be the VPI of the SPVP and a VCI = 0.
- The **switch connection vpc 12 master remote** command enables PNNI to set up SPVP 12.

#### PXM-45 Configuration (Switch Partition VPC)

The following examples show PVP based ATM MPLS network configurations for the AXSM and PXM-45 cards.

At the AXSM SWITCH.11.AXSM.a> prompt:

```
upln 1.2
addport 2 1.2 40000 40000 4 2
addpart 2 1 2 235900 235900 235900 235900 1 100 32 65535 10 100
```

At the PXM-45 SWITCH.7.PXM.a> prompt:

```
addcontroller 2 i 27 PNNI
dnport 9.2
```

```

cnfnpnportsig 9.2 -univer none
uppnport 9.2
!
dspports

```

ifNum	Line	Admin State	Oper. State	Guaranteed Rate	Maximum Rate	Port VNNI only)	SCT Id	ifType	VPI
1	1.1	Up	Down	353207	353207	5		UNI	0
2	1.2	Up	Up	40000	40000	4		NNI	0

At the AXSM SWITCH.11.AXSM.a> prompt:

```

dspport 2

```

```

Interface Number      : 2
Line Number           : 1.2
Admin State           : Up      Operational State : Up
Guaranteed bandwidth(cells/sec): 40000   Number of partitions: 1
Maximum bandwidth(cells/sec) : 40000   Number of SPVC : 0
ifType                : NNI      Number of SPVP : 0
Port SCT Id          : 4
VPI number(VNNI only) : 0      Number of SVC : 0

```

```

dspport 1

```

```

Interface Number      : 1
Line Number           : 1.1
Admin State           : Up      Operational State : Down
Guaranteed bandwidth(cells/sec): 353207   Number of partitions: 1
Maximum bandwidth(cells/sec) : 353207   Number of SPVC : 0
ifType                : UNI      Number of SPVP : 0
Port SCT Id          : 5
VPI number(VNNI only) : 0      Number of SVC : 0

```

```

dspport 2 1

```

```

Interface Number      : 2
Partition Id          : 1      Number of SPVC: 0
Controller Id         : 2      Number of SPVP: 0
egr Guaranteed bw(.0001percent): 1000000   Number of SVC : 0
egr Maximum bw(.0001percent) : 1000000
ing Guaranteed bw(.0001percent): 1000000
ing Maximum bw(.0001percent) : 1000000
min vpi               : 1
max vpi               : 100
min vci               : 32
max vci               : 65535
guaranteed connections : 10
maximum connections   : 100

```

At the PXM-45 SWITCH.7.PXM.a> prompt:

```

dspcons

```

Local Port	Vpi.Vci	remote Port	Vpi.Vci	State	Owner
9.1	0 2000	12.1	0 2000	OK	SLAVE
Local Addr: 47.009181000000000142265fb2.000001074b01.00					
Remote Addr: 47.009181000000000142265fb2.000001076301.00					
12.1	0 2000	9.1	0 2000	OK	MASTER
Local Addr: 47.009181000000000142265fb2.000001076301.00					
Remote Addr: 47.009181000000000142265fb2.000001074b01.00					
12.2	12 0	Routed	0 0	FAIL	SLAVE

```
Local Addr: 47.009181000000000142265fb2.000001076302.00
Remote Addr: 00.0000000000000000000000000000.000000000000.00
```

At the AXSM SWITCH.11.AXSM.a> prompt:

```
addcon 2 12 0 8 1 -slave 47009181000000000142265fb200000107630200.12.0 -lpcr
8000 -rpcr 8000
master endpoint added successfully
master endpoint id : 47009181000000000142265FB20000010B180200.12.0
```

At the PXM-45 SWITCH.7.PXM.a> prompt:

```
dspscons
```

Local Port	Vpi.Vci	Remote Port	Vpi.Vci	State	Owner
9.1	0 2000	12.1	0 2000	OK	SLAVE
Local Addr: 47.009181000000000142265fb2.000001074b01.00					
Remote Addr: 47.009181000000000142265fb2.000001076301.00					
12.1	0 2000	9.1	0 2000	OK	MASTER
Local Addr: 47.009181000000000142265fb2.000001076301.00					
Remote Addr: 47.009181000000000142265fb2.000001074b01.00					
12.2	12 0	11:1.2:2	12 0	OK	SLAVE
Local Addr: 47.009181000000000142265fb2.000001076302.00					
Remote Addr: 47.009181000000000142265fb2.0000010b1802.00					
11:1.2:2	12 0	12.2	12 0	OK	MASTER
Local Addr: 47.009181000000000142265fb2.0000010b1802.00					
Remote Addr: 47.009181000000000142265fb2.000001076302.00					
master endpoint id : 47009181000000000142265FB20000010B180200.12.0					

Where:

- The **cnfnpportsig 9.2 -univer none** command configures the signaling for the RPM-PR's switch interface 1.12.

#### Configuration for Cisco 7200 Edge LSR2

```
ip cef
!
interface loopback 0
 ip address 10.9.9.9 255.255.255.255
!
interface ATM2/0
 no ip address
!
interface ATM2/0.9 mpls
 ip unnumbered loopback 0
 mpls atm vpi 12
 mpls ip
!
router ospf 100
 network 10.0.0.0 0.255.255.255 area 0
```

#### PXM-45 Configuration with VPC Switch Partition

At the PXM-45 SWITCH.7.PXM.a> prompt:

```
dnport 11:1.2:2
cnfnpportsig 11:1.2:2 -univer none
upnport 11:1.2:2
```

Where:

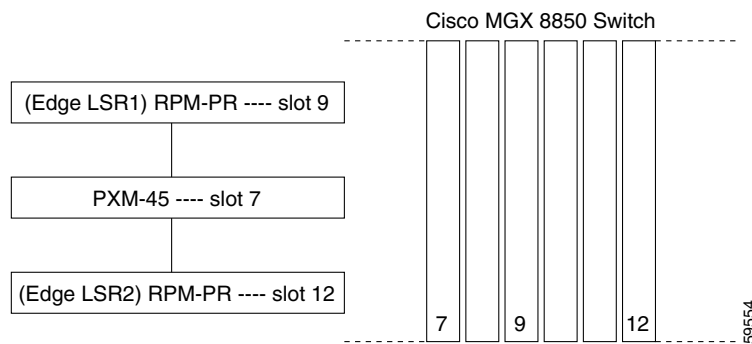
- The `cnfportsig 11:1.2:2 -univer none` command configures the signaling for the AXSM at slot 11 and line 1.2.

## Simple PVC-Based Packet MPLS Network Configuration

This section contains configuration examples for a simple permanent virtual circuit (PVC) packet MPLS network. For this example all devices are in the same Cisco MGX 8850 switch. [Figure 10](#) illustrates a PVC packet MPLS network with all devices in the same Cisco MGX 8850 switch.

- [RPM-PR Edge LSR1 Configuration \(Switch Partition VCC\)](#), page 46
- [PXM-45 Configuration \(Switch Partition VCC\)](#), page 47
- [RPM-PR Edge LSR2 Configuration \(Switch Partition VCC\)](#), page 47

**Figure 10** PVC Packet MPLS Network with All Devices in the Same Cisco MGX 8850 Switch



### Note

If two RPM-PRs in adjacent slots share the same cellbus, you need to configure a clock rate of 42 MHz on the PXM-45. Use the `dspeclk` command to display the clock rate. Use the `cnfcbclk cbn 42` command to change the clock rate, where *n* is the number of the cellbus.

### RPM-PR Edge LSR1 Configuration (Switch Partition VCC)

This example uses the `switch partition vcc` command and therefore, you can use only VCI ranges; you cannot use VPI ranges or VP tunnels. To create and bring up a PVC between two routers, you need to configure VCC partitioning and PNNI signaling. Then you can run packet-based MPLS for the PVC.



### Note

In the Cisco BPX or IGX switches, all resources are configured in the switch.

```
ip cef
!
interface Loopback0
 ip address 9.9.9.9 255.255.255.255
!
interface Switch1
 switch partition vcc 1 2
 ingress-percentage-bandwidth 1 100
 egress-percentage-bandwidth 1 100
 vpi 0 0
 vci 32 3808
```

```

!
interface Switch1.2 point-to-point
  ip unnumbered Loopback0
  pvc 0/2000
  oam-pvc manage
  encapsulation aal5snap
!
mpls ip
  switch connection vcc 0 2000 master remote
!
router ospf 100
  network 9.0.0.0 0.255.255.255 area 0

```

Where:

- The **switch partition vcc 1 2** command configures the VCC switch partition. The PNNI partition ID = 1 and the PNNI controller ID = 2.
- The 1, 100 in the **ingress-percentage-bandwidth 1 100** command guarantees 1 percent of the bandwidth to that partition. The partition can use up to 100 percent of the bandwidth.
- In the **interface Switch1.2 point-to-point** command, the interface is 1.2.
- The **oam-pvc manage** command configures Operation, Administration, and Maintenance (OAM) to check the end-to-end PVC link status.
- The **switch connection vcc 0 2000 master remote** command enables PNNI and makes the PVC (VPI=0, VCI=2000) connection. The command indicates that the remote peer is the master. You are on the slave side. You need to configure the slave side first. Then you can get the ATM NSAP address from the PXM that is required at the master side.

### PXM-45 Configuration (Switch Partition VCC)

This example shows commands to configure the PXM-45 for a simple PVC packet MPLS network.

At the PXM-45 SWITCH.7.PXM.a> prompt:

```

addcontroller 2 i 2 7 PNNI
dnpport 9.1
cnfnpportsig 9.1 -univer none
uppport 9.1

dspcon 9.2 1

```

Where:

- The **dnpport 9.1** command brings the port down for configuration. The 9.1 indicates slot 9 and the VCC (1) partition.
- The **cnfnpportsig 9.1 -univer none** command disables PNNI signaling for the RPM-PR in slot 9.
- The **uppport** command brings the port back up.
- After configuring **switch connection vcc 0 2000 master remote** on the slave (Edge LSR1), use the **dspcon** command on the PXM-45 to get the slave NSAP address.
- In the **dspcon 9.2 1** command, the 1 is the VCC value.

### RPM-PR Edge LSR2 Configuration (Switch Partition VCC)

This example uses the **switch partition vcc** command and therefore, you can use only VCI ranges; you cannot use VPI ranges or VP tunnels. To create and bring up a PVC between two routers, you need to configure VCC partitioning and PNNI signaling. Then you can run packet-based MPLS for the PVC.

```

ip cef
!
interface Loopback0
  ip address 12.12.12.12 255.255.255.255
!
interface Switch1
  switch partition vcc 1 2
  ingress-percentage-bandwidth 1 100
  egress-percentage-bandwidth 1 100
  vpi 0 0
  vci 1501 3808
!
interface Switch1.2 point-to-point
  ip unnumbered Loopback0
  pvc 0/2000
  oam-pvc manage
  encapsulation aal5snap
!
mpls ip
  switch connection vcc 0 2000 master local raddr
  47.0091.8100.0000.0001.4226.5fb2.0000.0107.4b01.00 0 2000
!
router ospf 100
  network 12.0.0.0 0.255.255.255 area 0

```

Where:

- The **switch partition vcc 1 2** command configures the VCC switch partition. The PNNI partition ID = 1 and the PNNI controller ID = 2.
- The **oam-pvc manage** command configures Operation, Administration, and Maintenance (OAM) to check the end-to-end PVC link status.
- The **mpls ip** command enables packet-based MPLS on the PVC.
- In the command **switch connection vcc 0 2000 master local raddr 47.0091.8100.0000.0001.4226.5fb2.0000.0107.4b01.00 0 2000**, the NSAP ATM address is retrieved from the PXM-45 switch, using the **dspon** command.

### PXM-45 Configuration (Switch Partition VCC)

This example shows commands to configure the PXM-45 for a simple PVC packet MPLS network.

At the PXM-45 SWITCH.7.PXM.a> prompt:

```

addcontroller 2 i 2 7 PNNI
dnport 12.1
cnfpnportsig 12.1 -univer none
upport 12.1

```

Where:

- The **dnport 12.1** command brings the port down for configuration. The 12.1 indicates slot 12 and the VCC (1) partition.
- The **cnfpnportsig 12.2 -univer none** command disables PNNI for the RPM-PR is in slot 12.
- The **upport** command brings the port back up.

## Configuring the Cisco 6400 Universal Access Concentrator as an MPLS LSC

You can configure the Cisco 6400 Universal Access Concentrator (UAC) to operate as an MPLS LSC in an MPLS network. The hardware that supports MPLS LSC functionality on the Cisco 6400 UAC is described in the following sections.

**Note**

---

If you configure a Cisco 6400 UAC with a node resource processor (NRP) to function as an LSC, disable MPLS edge LSR functionality. Refer to the command `mpls atm disable-headend-vc` for information on disabling MPLS edge LSR functionality. An NRP LSC should support transit label switch paths only through the controlled ATM switch under VSI control.

---

### Cisco 6400 UAC Architectural Overview

A Cisco 6400 UAC can operate as an MPLS LSC if it incorporates the following components:

- Node switch processor (NSP)— The NSP incorporates an ATM switch fabric, enabling the Cisco 6400 UAC to function as an ATM label switch router (ATM LSR) in a network. The NSP manages all the external ATM interfaces for the Cisco 6400 UAC.
- Node route processor (NRP)—The NRP enables a Cisco 6400 UAC to function as an LSC. When you use the NRP as an LSC, however, you must not configure the NRP to perform other functions. The NRP contains internal ATM interfaces that enable it to be connected to the NSP. However, the NRP cannot access the external ATM interfaces of the Cisco 6400 UAC. Only the NSP can access the external ATM interfaces.

**Note**

---

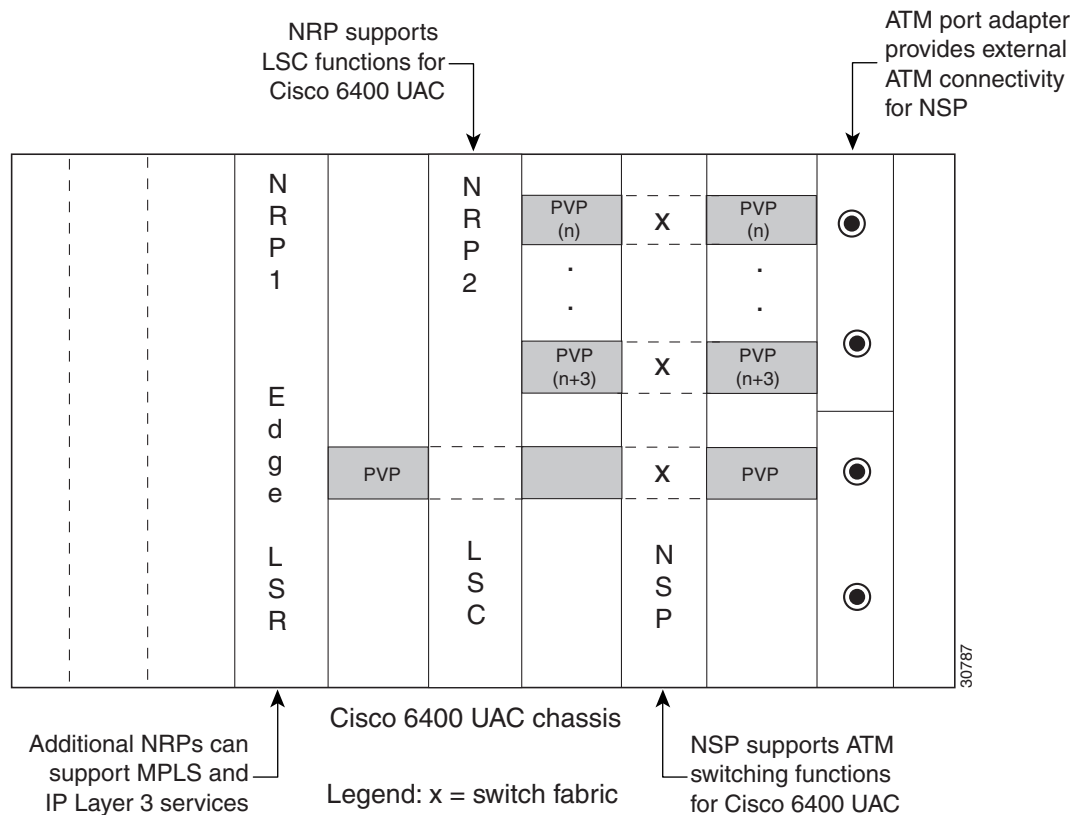
A Cisco 6400 UAC chassis can accommodate multiple NRPs, including one dedicated to MPLS LSC functions. You cannot use an additional NRP as an MPLS LSC. However, you can use additional NRPs to run MPLS and perform other networking services.

---

- ATM port adapter—The Cisco 6400 UAC uses an ATM port adapter to provide external connectivity for the NSP.

Figure 11 shows the components that you can configure to enable the Cisco 6400 UAC to function as an MPLS LSC.

Figure 11 Cisco 6400 UAC Configured as an MPLS LSC



## Configuring Permanent Virtual Circuits and Permanent Virtual Paths

The NRP controls the slave ATM switch through the Virtual Switch Interface (VSI) protocol. The VSI protocol operates over a permanent virtual circuit (PVC) that you configure. The PVC is dedicated to the virtual circuits (VCs) that the VSI control channel uses.

For the NRP to control an ATM switch through the VSI, cross-connect the control VCs from the ATM switch through the NSP to the NRP. The ATM switch uses defined control VCs for each BXM slot of the BPX chassis, enabling the LSC to control external XTagATM interfaces through the VSI.

[Table 5](#) defines the PVCs that must be configured on the NSP interface connected to the BPX VSI shelf. These PVCs are cross-connected via the NSP to the NRP VSI master control port, which is running the VSI protocol.

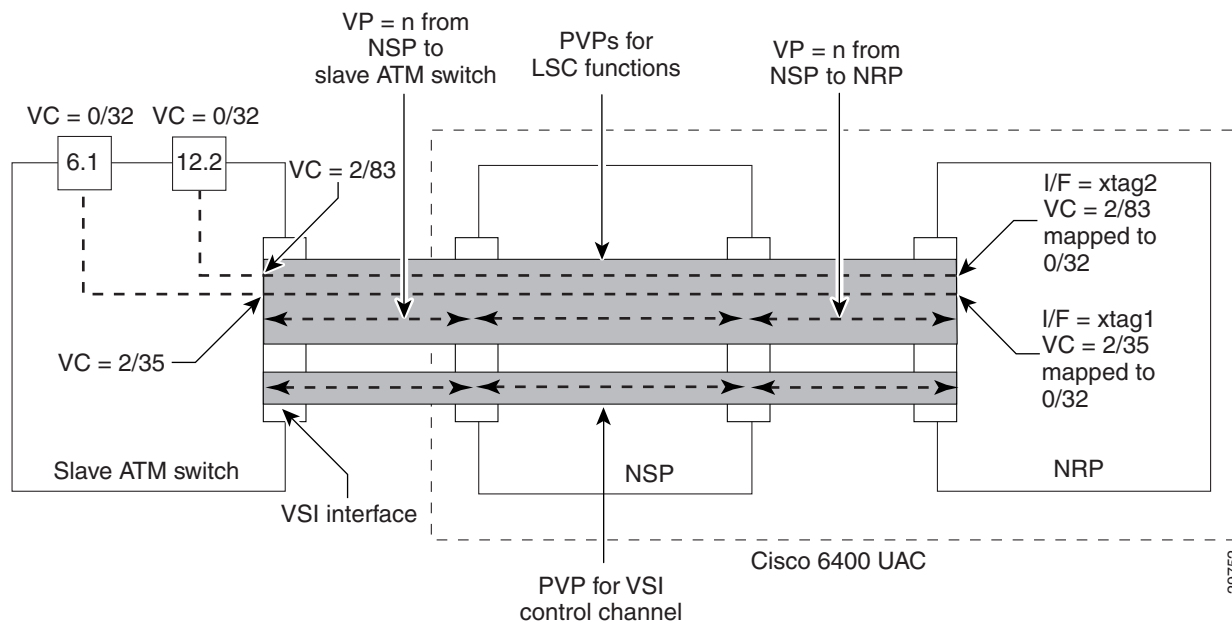
For an NRP that is installed in slot 3 of a Cisco 6400 UAC chassis, the master control port would be ATM3/0/0 on the NSP. As shown in [Figure 2](#), the BPX switch control interface is 12.1. The NSP ATM port connected to interface 12.1 is the ATM interface that is cross-connected to ATM3/0/0. [Figure 2](#) shows that the BXM slaves in BPX slots 6 and 12 are configured as external XTagATM ports. The PVCs that must be cross-connected through the NSP are 0/45 for slot 6 and 0/51 for slot 12, respectively, as outlined in [Table 5](#)

**Table 5 VSI Interface Control PVCs for BPX VSI Slave Slots**

BPX VSI Slave Slot	VSI Interface Control VC
1	0/40
2	0/41
3	0/42
4	0/43
5	0/44
6	0/45
7	0/46
8	0/47
9	0/48
10	0/49
11	0/50
12	0/51
13	0/52
14	0/53

Figure 12 shows the functional relationships among the Cisco 6400 UAC hardware components and the permanent virtual paths (PVPs) that you can configure to support MPLS LSC functionality.

**Figure 12 Cisco 6400 UAC PVP Configuration for MPLS LSC Functions**



All other MPLS LSC functions, such as routing, terminating LVCs, and LDP control VCs (default 0/32), can be accomplished by means of a separate, manually configured PVP (see the upper shaded area in Figure 12). The value of “n” for this manually configured PVP must be the same among all the associated

devices (the NRP, the NSP, and the slave ATM switch). Because the NSP uses VP=0 for ATM Forum signaling and the BPX uses VP=1 for autoroute, the value of “n” for this PVP for MPLS LSC functions must be greater than or equal to 2, while not exceeding an upper bound.

Note that some edge LSRs have ATM interfaces with limited VC space per virtual path (VP). For these interface types, you define several VPs. For example, the Cisco ATM Port Adapter (PA-A1) and the AIP interface are limited to VC range 33 through 1018. To use the full capacity of the ATM interface, configure four consecutive VPs. Make sure the VPs are within the configured range of the BPX.

For internodal BPX connections, it is suggested that you configure VPs 2 through 15; for edge LSRs, it is suggested that you configure VPs 2 through 5. (See the IOS CLI command “mpls atm vpi” on page 121 for examples of how to configure edge LSRs; see the BPX command “cnfrsrc” described in the *Cisco BPX 8600 Series* documentation for examples of how to configure BPX service nodes.)

## Control VC Setup for MPLS LSC Functions

After you connect the NRP, the NSP, and the slave ATM switch by means of manually configured PVPs (as shown in [Figure 12](#)), the NRP can control the slave ATM switch as though it is directly connected to the NRP. The NRP discovers the interfaces of the slave ATM switch and establishes the default control VC to be used in creating MPLS VCs.

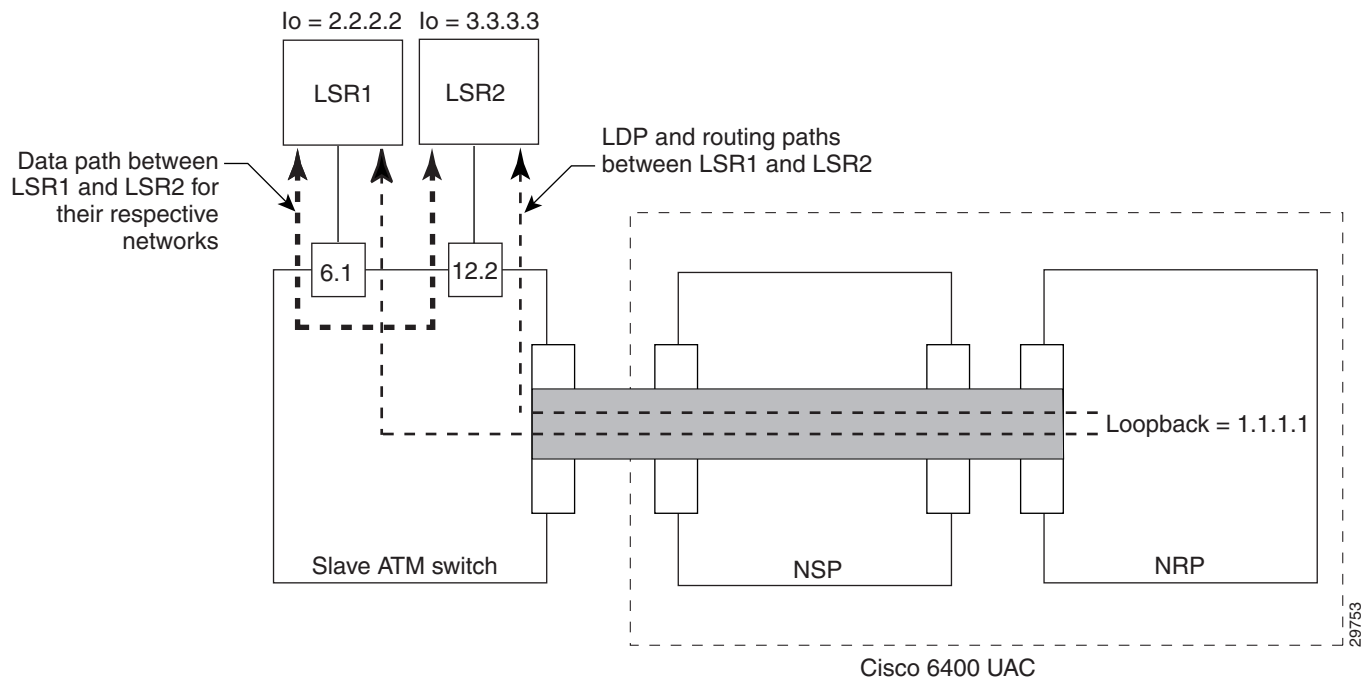
The slave ATM switch shown in [Figure 12](#) incorporates two external ATM interfaces (labeled 1 and 2) that are known to the NRP as XTagATM61 and XTagATM122, respectively. On interface 6.1 of the slave ATM switch, VC 0/32 is connected to VC 2/35 by the VSI protocol. On the NRP, VC 2/35 is terminated on interface XTagATM61 and mapped to VC 0/32, also by means of the VSI protocol. This mapping enables the LDP to discover MPLS LSC neighbors by means of the default control VC 0/32 on the physical interface. On interface 12.2 of the slave ATM switch, VC 0/32 is connected to VC 2/83 by the VSI protocol. On the NRP, VC 2/83 is terminated on interface XTagATM122 and mapped to VC 0/32.

Note that the selection of these VCs depends on the availability of VC space. Hence it is not predictable what physical VC will be mapped to the external default control VC 0/32 on the XTagATM interface. The control VC is shown as a PVC on the LSC, as opposed to a LVC, when you execute the IOS CLI command “show xtagatm vc” on page 162.

## Configuring the Cisco 6400 UAC to Perform Basic MPLS LSC Operations

[Figure 13](#) shows a Cisco 6400 UAC containing a single NRP that has been configured to perform basic MPLS LSC operations.

**Figure 13** Typical Cisco 6400 UAC Configuration to Support MPLS LSC Functions



**Note** If the NRP incurs a fault that causes it to malfunction (in a single NRP configuration), the LVCs and routing paths pertaining to MPLS LSC functions are lost.



**Note** The loopback addresses must be configured with a 32-bit mask and be included in the relevant IGP or BGP routing protocol, as shown in the following example:  
**ip address 172.103.210.5 255.255.255.255**

### Defining the MPLS Control and IP Routing Paths

In the MPLS LSC topology shown in [Figure 13](#), the devices labeled LSR1 and LSR2 are external to the Cisco 6400 UAC. These devices, with loopback addresses as their respective LDP identifiers, are connected to two separate interfaces labeled 6.1 and 12.2 on the slave ATM switch. Both LSR1 and LSR2 learn about each other's routes from the NRP by means of the data path represented as the thick dashed line in [Figure 13](#). Subsequently, LVCs are established by means of LDP operations to create the data paths between LSR1 and LSR2 through the ATM slave switch.

Both LSR1 and LSR2 learn of the loopback address of the NRP and create a data path (LVCs) from each other that terminates in the NRP. These LVCs, called tailend LVCs, are not shown in [Figure 13](#).

### Disabling Edge LVCs

By default, the NRP requests LVCs for the next hop devices (the LSRs shown in [Figure 13](#)). The headend LVCs enable the LSC to operate as an edge LSR. Using the LSC as an edge LSR is not supported. Further, the NRP is dedicated to control the slave ATM switch. Therefore, the headend LVCs are not required.

If a Cisco 6400 UAC with an NRP is configured to function as an LSC, disable the edge LSR functionality. An NRP LSC should support transit label switch paths only through the ATM switch using the VSI protocol. To disable the LSC from acting as an edge LSR, see [“Disabling the LSC from Acting as an Edge LSR”](#) on page 59.

## Configuration Steps: Configuring Cisco 6400 UAC NRP as an MPLS LSC

To configure the Cisco 6400 UAC NRP as an MPLS LSC, perform the following steps.

	Command	Purpose
Step 1	<pre>Router(config)# interface loopback0 Router(config-if)# ip address 172.103.210.5 255.255.255.255 Router(config-if)# exit</pre>	<p>Create a software-only loopback interface that emulates an interface that is always up. Specify an interface number for the loopback interface. There is no limit on the number of loopback interfaces you can create.</p> <p>Assign an IP address to Loopback0. It is important that all loopback addresses in an MPLS network are host addresses, that is, with a mask of 255.255.255.255. Using a shorter mask can prevent MPLS-based VPN services from working correctly.</p>
Step 2	<pre>Router(config)# interface atm1/0/0 Router(config-if)# label-control-protocol vsi</pre>	<p>Create an ATM interface (atm1/0/0).</p> <p>Enable the VSI protocol on the control interface ATM1/0/0.</p>
Step 3	<pre>Router(config-if)# interface XTagATM61 Router(config-if)# extended-port atm1/0/0 bpx 6.1</pre>	<p>Create an XTagATM interface (XTagATM61).</p> <p>Associate the XTagATM interface with an external interface (bpx port 6.1) on the remotely controlled ATM switch</p> <p>atm1/0/0 identifies the ATM interface used to control the remote ATM switch.</p>
Step 4	<pre>Router(config-if)# ip unnumbered loopback0</pre>	<p>Make XTagATM61 an unnumbered interface and use the IP address of loopback 0 as a substitute. The interfaces in an ATM MPLS network should usually be unnumbered. This reduces the number of IP destination-prefixes in the routing table, which reduces the number of labels and LVCs used in the network.</p>
Step 5	<pre>Router(config-if)# mpls ip Router(config-if)# mpls atm vpi 2-5 Router(config-if)# exit</pre>	<p>Enable MPLS on the XTagATM interface.</p> <p>Limit the range so that the total number of VPIs does not exceed 4. For example:</p> <p><b>mpls atm vpi 2-5</b> <b>mpls atm vpi 10-13</b></p>
Step 6	<pre>Router(config-if)# interface XTagATM122 Router(config-if)# extended-port atm1/0/0 bpx 12.2</pre>	<p>Configure MPLS on another XTagATM interface and bind it to BPX port 12.2.</p>

	Command	Purpose
Step 7	Router(config-if)# <b>ip unnumbered loopback0</b>	Make XTagATM61 an unnumbered interface and use the IP address of loopback 0 as a substitute. The interfaces in an ATM MPLS network should usually be unnumbered. This reduces the number of IP destination-prefixes in the routing table, which reduces the number of labels and LVCs used in the network.
Step 8	Router(config-if)# <b>mpls ip</b> Router(config-if)# <b>mpls atm vpi 2-5</b> Router(config-if)# <b>exit</b>	Enable MPLS on the XTagATM interface. Limit the range so that the total number of VPIs does not exceed 4. For example: <b>mpls atm vpi 2-5</b> <b>mpls atm vpi 10-13</b>
Step 9	Router(config)# <b>ip cef</b>	Enable Cisco Express Forwarding (CEF) switching.
Step 10	Router(config)# <b>mpls atm disable-headend-vc</b>	Disable headend VC label advertisement.

## Configuration Steps: Configuring the Cisco 6400 UAC NSP for MPLS Connectivity to the BPX Switch

To configure the Cisco 6400 UAC NSP for MPLS connectivity to the BXP switch, perform the following steps.

	Command	Purpose
Step 1	Switch# <b>show hardware</b> 3/0 NRP 00-0000-00 .....	Show the hardware connected to the Cisco 6400 UAC, including the position (3/0) of the NRP in the Cisco 6400 chassis, as shown in the sample output at the left.
Step 2	Switch(config)# <b>interface atm3/0/0</b>	Specify the ATM interface for which you want to configure PVCs and PVPs.

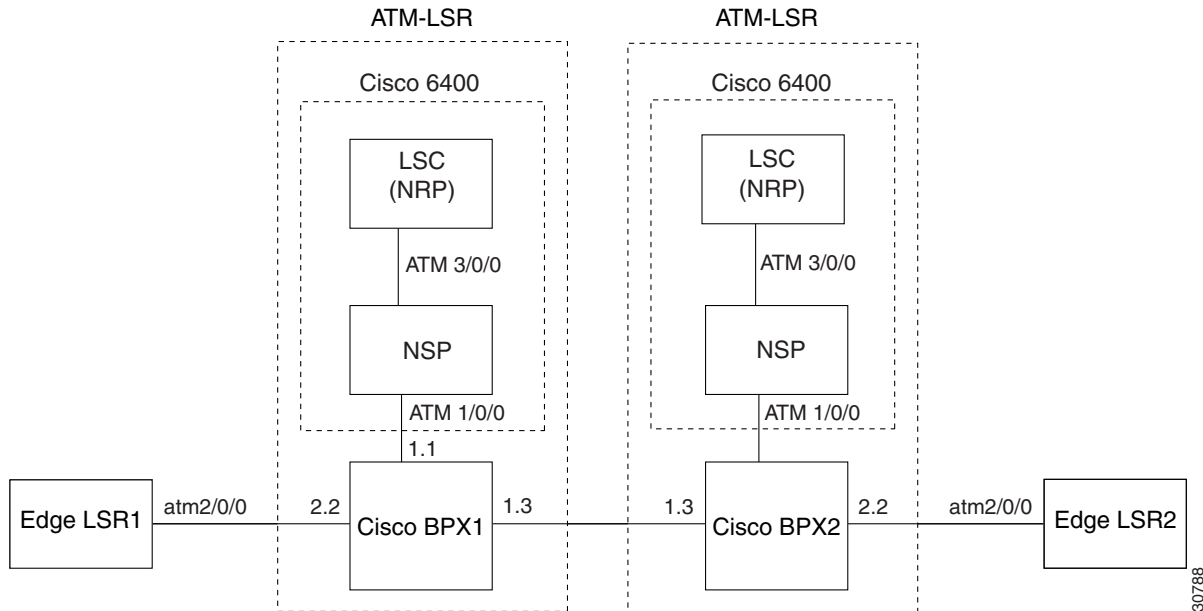
	Command	Purpose
<b>Step 3</b>	<pre>Switch(config-if)# atm pvc 0 40 interface ATM1/0/0 0 40 atm pvc 0 41 interface ATM1/0/0 0 41 atm pvc 0 42 interface ATM1/0/0 0 42 atm pvc 0 43 interface ATM1/0/0 0 43 atm pvc 0 44 interface ATM1/0/0 0 44 atm pvc 0 45 interface ATM1/0/0 0 45 atm pvc 0 46 interface ATM1/0/0 0 46 atm pvc 0 47 interface ATM1/0/0 0 47 atm pvc 0 48 interface ATM1/0/0 0 48 atm pvc 0 49 interface ATM1/0/0 0 49 atm pvc 0 50 interface ATM1/0/0 0 50 atm pvc 0 51 interface ATM1/0/0 0 51 atm pvc 0 52 interface ATM1/0/0 0 52 atm pvc 0 53 interface ATM1/0/0 0 53</pre>	<p>Configure the PVC for the VSI control channel<sup>1</sup>, depending on which of the 14 slots in the Cisco BPX switch is occupied by a Cisco Broadband Switch Module (BXM). If you do not know the BPX slots containing a BXM, configure all 14 PVCs (as shown opposite) to ensure that the NSP functions properly.</p> <p>However, if you know that Cisco BPX switch slots 10 and 12, for example, contain a BXM, you only need to configure PVCs corresponding to those slots, as shown below:</p> <pre>atm pvc 0 49 interface ATM1/0/0 0 49 atm pvc 0 51 interface ATM1/0/0 0 51</pre> <p>Instead of configuring multiple PVCs, as shown opposite in this step, you can configure PVP 0 by deleting all well-known VCs. For example, you can use the command <b>atm manual-well-known-vc delete</b> on both interfaces and then configure PVP 0, as indicated below:</p> <pre>atm pvp 0 interface ATM1/0/0 0</pre>
<b>Step 4</b>	<pre>Switch(config-if)# atm pvp 2 interface ATM1/0/0 2 atm pvp 3 interface ATM1/0/0 3 atm pvp 4 interface ATM1/0/0 4 atm pvp 5 interface ATM1/0/0 5</pre>	<p>Configure the PVPs for the LVCs. For XTagATM interfaces, use the VPI range 2 through 5 (by issuing an <b>mpls atm vpi 2-5</b> command). To use a different VPI range, configure the PVPs accordingly.</p>

1. Do not enable MPLS on this interface.

## Configuration Example: Configuring a Cisco 6400 NRP as an LSC

When you use the NRP as an MPLS LSC in the Cisco 6400 UAC, you must configure the NSP to provide connectivity between the NRP and the Cisco BPX switch. When configured in this way (as shown in [Figure 14](#)), the NRP is connected to the NSP by means of the internal interface ATM3/0/0, while external connectivity from the Cisco 6400 UAC to the Cisco BPX switch is provided by means of the external interface ATM1/0/0 from the NSP.

Figure 14 Cisco 6400 UAC NRP Operating as an LSC



### Configuration for 6400 UAC NSP

6400 NSP:

```

!
interface ATM3/0/0
  atm pvp 0 interface ATM1/0/0 0
  atm pvp 2 interface ATM1/0/0 2
  atm pvp 3 interface ATM1/0/0 3
  atm pvp 4 interface ATM1/0/0 4
  atm pvp 5 interface ATM1/0/0 5
  atm pvp 6 interface ATM1/0/0 6
  atm pvp 7 interface ATM1/0/0 7
  atm pvp 8 interface ATM1/0/0 8
  atm pvp 9 interface ATM1/0/0 9
  atm pvp 10 interface ATM1/0/0 10
  atm pvp 11 interface ATM1/0/0 11
  atm pvp 12 interface ATM1/0/0 12
  atm pvp 13 interface ATM1/0/0 13
  atm pvp 14 interface ATM1/0/0 14
  atm pvp 15 interface ATM1/0/0 15

```



#### Note

Instead of configuring multiple PVCs, you can also configure PVP 0 by deleting all well-known VCs. For example, you can use the command **atm manual-well-known-vc delete** on both interfaces and then configure PVP 0, as indicated below:

```
atm pvp 0 interface ATM1/0/0 0
```

### Configuration for 6400 UAC NRP LSC1

```

ip cef
!
interface Loopback0
  ip address 172.18.143.22 255.255.255.255
!

```

```

interface ATM0/0/0
  no ip address
  label-control-protocol vsi
!
interface XTagATM13
  ip unnumbered Loopback0
  extended-port ATM0/0/0 bpx 1.3
  mpls atm vpi 2-15
  mpls ip
!
interface XTagATM22
  ip unnumbered Loopback0
  extended-port ATM0/0/0 bpx 2.2
  mpls atm vpi 2-5
  mpls ip
!
mpls atm disable-headend-vc

```

## Configuration for BPX1 and BPX2

BPX1 and BPX2:

```

uptrk 1.1
addshelf 1.1 v 1 1
cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 1.3
cnfrsrc 1.3 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 2.2
cnfrsrc 2.2 256 252207 y 1 e 512 4096 2 5 26000 100000

```



### Note

For the shelf controller, you must configure a VSI partition for the slave control port interface (**addshelf 1.1, cnfrsrc 1.1...**). However, do not configure an XTagATM port for the VSI partition (for instance, XTagATM11).

## Configuration for 6400 UAC NRP LSC2

```

ip cef
!
interface Loopback0
  ip address 172.103.210.5 255.255.255.255
!
interface ATM0/0/0
  no ip address
  label-control-protocol vsi
!
interface XTagATM13
  ip unnumbered Loopback0
  extended-port ATM0/0/0 bpx 1.3
  mpls atm vpi 2-15
  mpls ip
!
interface XTagATM22
  ip unnumbered Loopback0
  extended-port ATM0/0/0 bpx 2.2
  mpls atm vpi 2-5
  mpls ip
!
mpls atm disable-headend-vc

```

## Configuration for Edge LSR1

```
LSR1:
ip cef distributed
!
interface loopback 0
  ip address 172.22.132.2 255.255.255.255
!
interface ATM2/0/0
  no ip address
!
interface ATM2/0/0.22 mpls
  ip unnumbered loopback 0
  mpls atm vpi 2-5
  mpls ip
```

## Configuration for Edge LSR2

```
LSR2:
ip cef distributed
!
interface loopback 0
  ip address 172.22.172.18 255.255.255.255
!
interface ATM2/0/0
  no ip address
!
interface ATM2/0/0.22 mpls
  unnumbered loopback 0
  mpls atm vpi 2-5
  mpls ip
```

## Disabling the LSC from Acting as an Edge LSR

Using the MPLS LSC as a label edge device is *not* supported. Using the MPLS LSC as a label edge device introduces unnecessary complexity to the configuration. See the command [mpls atm disable-headend-vc](#), page 120 to disable edge LSR functionality on the LSC.

Disabling the LSC from acting as an edge LSR causes the LSC to stop initiating LSPs to any destination. Therefore, the number of LVCs used in the network is reduced. The LSC can still terminate tailend LVCs, if required.

You can prevent the terminating tailend LVCs from being created between the edge LSRs and LSCs. This helps prevent the unnecessary use of LVC resources in a slave ATM switch. You use the [mpls request-labels for](#) command with an access list to disable the creation of the LSPs. You can create an access list at an edge LSR to restrict the destinations for which a downstream-on-demand request is issued.

With downstream on demand, LVCs are depleted with the addition of each new node. These commands save resources by disabling the LSC from setting up unwanted LSPs. The absence of those LSPs allows traffic to follow the same path as control traffic.

The following example uses the [mpls atm disable-headend-vc](#) command to disable the LSC from functioning as an edge LSR. The following line is added to the LSC configuration:

```
mpls atm disable-headend-vc
```

**Note**

For a Cisco 6400 UAC with an NRP configured to function as an LSC, disable the LSC from acting as an edge LSR. An NRP LSC should only support label switch paths through the controlled ATM switch under VSI control.

## Feature 1: Creating Virtual Trunks

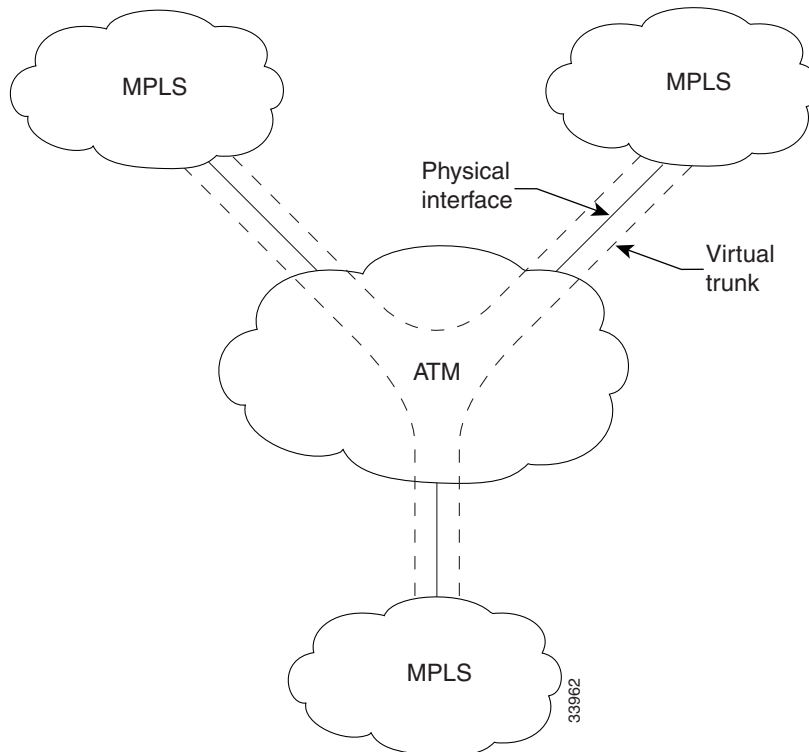
Virtual trunks provide connectivity for Cisco WAN MPLS switches through an ATM cloud, as shown in [Figure 15](#). Because several virtual trunks can be configured across a given private/public physical trunk, virtual trunks provide a cost-effective means of connecting across an entire ATM network.

The ATM equipment in the cloud must support virtual path switching and transmission of ATM cells based solely on the VPI in the ATM cell header. The virtual path identifier (VPI) is provided by the ATM cloud administrator (that is, by the service provider).

### Typical ATM Hybrid Network with Virtual Trunks

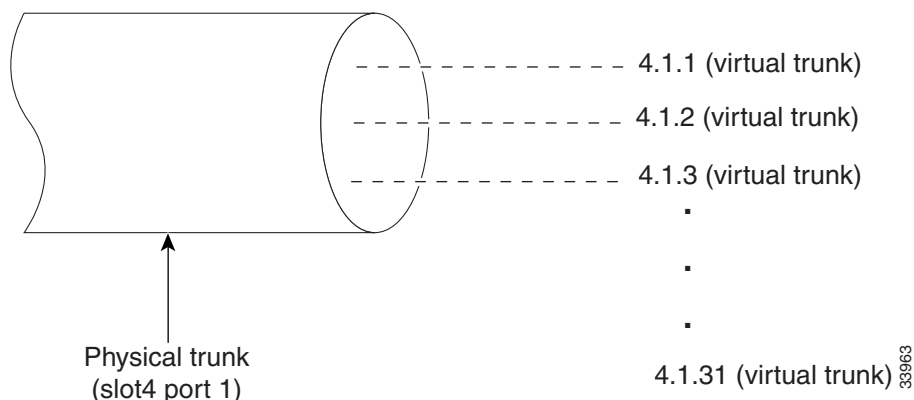
[Figure 15](#) shows three Cisco WAN MPLS switching networks, each connected to an ATM network by a physical line. The ATM network links all three of these subnetworks to every other subnetwork with a fully meshed network of virtual trunks. In this example, each physical interface is configured with two virtual trunks.

**Figure 15** *Typical ATM Hybrid Network Using Virtual Trunks*



A virtual trunk number (slot number.port number.trunk number) differentiates the virtual trunks found within a physical trunk port. In Figure 16, three virtual trunks (4.1.1, 4.1.2, and 4.1.3) are configured on a physical trunk that connects to the port 4.1 interface of a BXM.

**Figure 16 Virtual Trunks Configured on a Physical Trunk**



These virtual trunks are mapped to the XTagATM interfaces on the LSC. On the XTagATM interface, you configure the respective VPI value using the command `mpls atm vp-tunnel vpi`. This VPI should match the VPI in the ATM network. The label virtual circuits (LVCs) are generated inside this VP, and this VP carries the LVCs and their traffic across the network.

## Virtual Trunking Benefits

Virtual trunks provide the following benefits:

- **Reduced costs**—By sharing the resources of a single physical trunk among a number of virtual (logical) trunks, each virtual trunk provided by the public carrier needs to be assigned only as much bandwidth as needed for that interface, rather than the full T3, E3, OC3, or OC12 bandwidth of an entire physical trunk.
- **Migration of MPLS services into existing networks**—VSI virtual trunks allow MPLS services to be carried over part of a network that does not support MPLS services. The part of the network that does not support such services may be a public ATM network, for example, that consists of switches that are not MPLS-enabled.

## Virtual Trunking Restrictions

**Virtual Trunk Bandwidth**—The total bandwidth of all the virtual trunks on one port cannot exceed the maximum bandwidth of the port. Trunk loading (units of load) is maintained per virtual trunk, but the cumulative loading of all virtual trunks on a port is restricted by the transmit and receive rates for the port.

**Maximum Virtual Trunks**—The maximum number of virtual trunks that can be configured per card equals the number of virtual interfaces (VIs) on the BPX/IGX switch.

- The BXM supports 32 virtual interfaces; hence, it supports up to 32 virtual trunks. Accordingly, you can have interfaces ranging from XTagATM411 to XTagATM4131 on the same physical interface.
- The UXM supports 16 virtual interfaces. You can have interfaces ranging from XTagATM411 to XTagATM 4116.

## Configuration Example: Configuring Virtual Trunks with Cisco 7200 LSCs

The network topology shown in [Figure 17](#) incorporates two ATM-LSRs using virtual trunking to create an MPLS network through a private ATM Network. This topology includes:

- Two LSCs (Cisco 7200 routers)
- Two BPX switches
- Two edge LSRs (7200 routers)

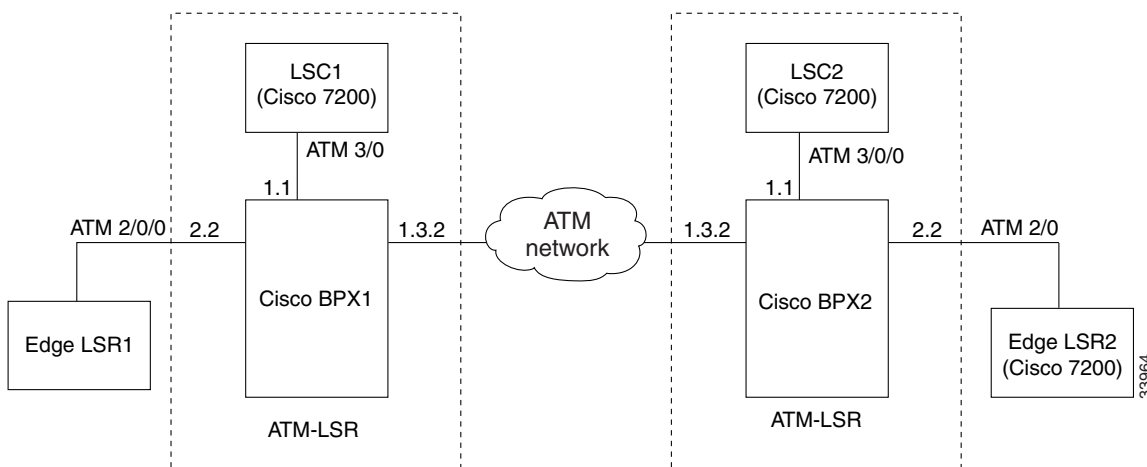


### Note

For the Cisco IGX switch, use the following commands:

```
extended-port atm1/0 descriptor 0.x.x.0
label-control-protocol vsi slaves 32 id x
```

**Figure 17** ATM-LSR Virtual Trunking through ATM Network



Based on [Figure 18](#), the following configuration examples are provided:

- [Configuration for LSC1 Implementing Virtual Trunking, page 62](#)
- [Configuration for BPX1 and BPX2, page 64](#)
- [Configuration for LSC2 Implementing Virtual Trunking, page 64](#)
- [Configuration for Edge LSR1, page 64](#)
- [Configuration for Edge LSR2, page 65](#)

### Configuration for LSC1 Implementing Virtual Trunking

7200 LSC1:

```
ip cef
!
interface loopback0
 ip address 172.103.210.5 255.255.255.255
!
interface ATM3/0
 no ip address
 label-control-protocol vsi
```

```
!  
interface XTagATM132  
    extended-port ATM3/0 bpx 1.3.2  
    ip unnumbered loopback0  
    mpls atm vp-tunnel 2  
    mpls ip  
!  
interface XTagATM22  
    extended-port ATM3/0 bpx 2.2  
    ip unnumbered loopback0  
    mpls atm vpi 2-5  
    mpls ip
```

## Configuration for BPX1 and BPX2

BPX1 and BPX2:

```
uptrk 1.1
addshelf 1.1 v 1 1
cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 1.3.2
cnftrk 1.3.2 100000 N 1000 7F V,TS,NTS,FR,FST,CBR,NRT-VBR,ABR,RT-VBR N TERRESTRIAL 10
0 N N Y Y Y CBR 2
cnfrsrc 1.3.2 256 252207 y 1 e 512 6144 2 2 26000 100000
uptrk 2.2
cnfrsrc 2.2 256 252207 y 1 e 512 4096 2 5 26000 100000
```



### Note

For the shelf controller, you must configure a VSI partition for the slave control port interface (**addshelf 1.1, cnfrsrc 1.1...**). However, do not configure an XTagATM port for the VSI partition (for instance, XTagATM11).

## Configuration for LSC2 Implementing Virtual Trunking

7200 LSC2:

```
ip cef
!
interface loopback0
 ip address 172.18.143.22 255.255.255.255
!
interface ATM3/0
 no ip address
 label-control-protocol vsi
!
interface XTagATM132
 extended-port ATM3/0 bpx 1.3.2
 ip unnumbered loopback0
 mpls atm vp-tunnel 2
 mpls ip
!
interface XTagATM22
 extended-port ATM3/0 bpx 2.2
 ip unnumbered loopback0
 mpls atm vpi 2-5
 mpls ip
```

## Configuration for Edge LSR1

LSR1:

```
ip cef distributed
interface loopback 0
 ip address 172.22.132.2 255.255.255.255
!
interface ATM2/0/0
 no ip address
!
interface ATM2/0/0.22 mpls
 ip unnumbered loopback 0
 mpls atm vpi 2-5
 mpls ip
```

## Configuration for Edge LSR2

7200 LSR2:

```

ip cef
interface loopback 0
  ip address 172.22.172.18 255.255.255.255
!
interface ATM2/0
  no ip address
!
interface ATM2/0.22 mpls
  ip unnumbered loopback 0
  mpls atm vpi 2-5
  mpls ip

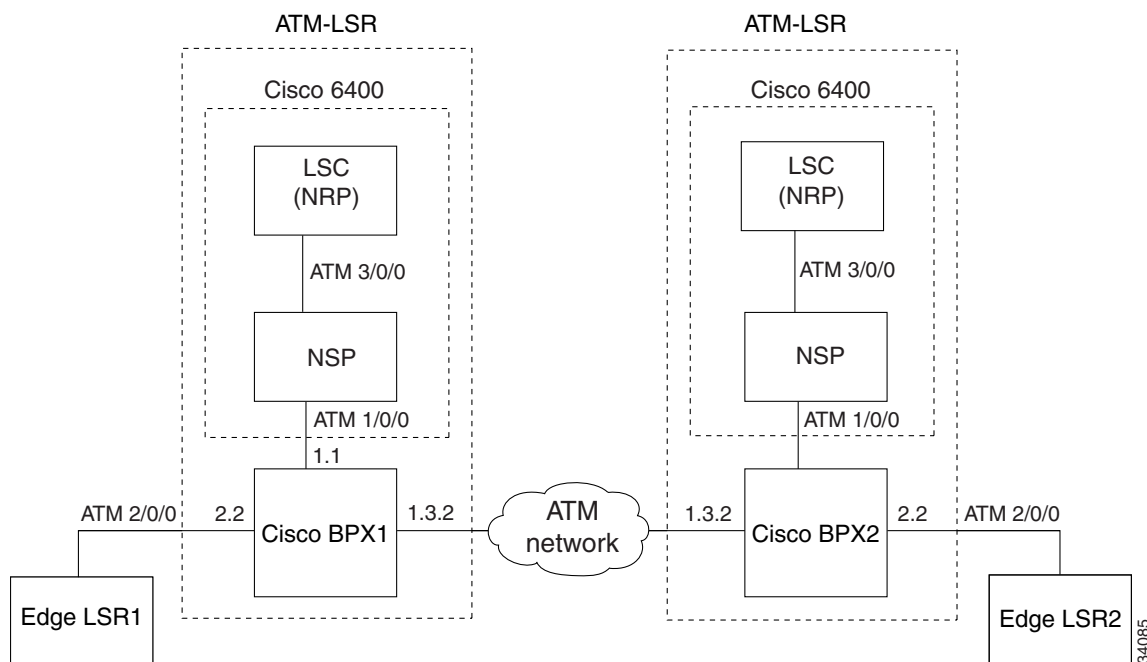
```

## Configuration Example: Configuring Virtual Trunking on Cisco 6400 NRP LSCs

The network topology shown in [Figure 18](#) incorporates two ATM-LSRs using virtual trunking to create an MPLS network through a private ATM Network. This topology includes:

- Two LSCs (Cisco 6400 UAC NRP routers)
- Two BPX switches
- Two edge LSRs (Cisco 7200 routers)

**Figure 18** Cisco 6400 NRP Operating as LSC Implementing Virtual Trunking



## Configuration for 6400 UAC NSP

6400 NSP:

```

!
interface ATM3/0/0
  atm pvp 0 interface ATM1/0/0 0
  atm pvp 2 interface ATM1/0/0 2
  atm pvp 3 interface ATM1/0/0 3
  atm pvp 4 interface ATM1/0/0 4
  atm pvp 5 interface ATM1/0/0 5
  atm pvp 6 interface ATM1/0/0 6
  atm pvp 7 interface ATM1/0/0 7
  atm pvp 8 interface ATM1/0/0 8
  atm pvp 9 interface ATM1/0/0 9
  atm pvp 10 interface ATM1/0/0 10
  atm pvp 11 interface ATM1/0/0 11
  atm pvp 12 interface ATM1/0/0 12
  atm pvp 13 interface ATM1/0/0 13
  atm pvp 14 interface ATM1/0/0 14
  atm pvp 15 interface ATM1/0/0 15

```



### Note

Instead of configuring multiple PVCs, you can also configure PVP 0 by deleting all well-known VCs. For example, you can use the **atm manual-well-known-vc delete** command on both interfaces and then configure PVP 0, as indicated below:

**atm pvp 0 interface ATM1/0/0 0**

## Configuration for 6400 UAC NRP LSC1 Implementing Virtual Trunking

```

ip cef
!
interface Loopback0
  ip address 172.18.143.22 255.255.255.255
!
interface ATM0/0/0
  no ip address
  label-control-protocol vsi
!
interface XTagATM132
  ip unnumbered Loopback0
  extended-port ATM0/0/0 bpx 1.3.2
  mpls atm vp-tunnel 2
  mpls ip
!
interface XTagATM22
  ip unnumbered Loopback0
  extended-port ATM0/0/0 bpx 2.2
  mpls atm vpi 2-5
  mpls ip
!
mpls atm disable-headend-vc

```

## Configuration for BPX1 and BPX2

BPX1 and BPX2:

```

uptrk 1.1
addshelf 1.1 v 1 1

```

```

cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 1.3.2
cnftrk 1.3.2 100000 N 1000 7F V,TS,NTS,FR,FST,CBR,NRT-VBR,ABR,RT-VBR N TERRESTRIAL 10
0 N N Y Y CBR 2
cnfrsrc 1.3.2 256 252207 y 1 e 512 6144 2 2 26000 100000
uptrk 2.2
cnfrsrc 2.2 256 252207 y 1 e 512 4096 2 5 26000 100000

```

**Note**

For the shelf controller, you must configure a VSI partition for the slave control port interface (**addshelf 1.1, cnfrsrc 1.1...**). However, do not configure an XTagATM port for the VSI partition (for instance, XTagATM11).

## Configuration for 6400 UAC NRP LSC2 Implementing Virtual Trunking

```

ip cef
!
interface Loopback0
    ip address 172.103.210.5 255.255.255.255
!
interface ATM0/0/0
    no ip address
    label-control-protocol vsi
!
interface XTagATM132
    ip unnumbered Loopback0
    extended-port ATM0/0/0 bpx 1.3.2
    mpls atm vp-tunnel 2
    mpls ip
!
interface XTagATM22
    ip unnumbered Loopback0
    extended-port ATM0/0/0 bpx 2.2
    mpls atm vpi 2-5
    mpls ip
!
mpls atm disable-headend-vc

```

## Configuration for Edge LSR1

LSR1:

```

ip cef distributed
!
interface loopback 0
    ip address 172.22.132.2 255.255.255.255
!
interface ATM2/0/0
    no ip address
!
interface ATM2/0/0.22 mpls
    ip unnumbered loopback 0
    mpls atm vpi 2-5
    mpls ip

```

## Configuration for Edge LSR2

LSR2:

```
ip cef distributed
!
interface loopback 0
  ip address 172.22.172.18 255.255.255.255
!
interface ATM2/0/0
  no ip address
!
interface ATM2/0/0.22 mpls
  unnumbered loopback 0
  mpls atm vpi 2-5
  mpls ip
```

## Feature 2: Using LSC Redundancy

LSC redundancy allows you to create a highly reliable IP network, one whose reliability is nearly equivalent to that provided by hot standby routing. Instead of using hot standby routing processes to create redundancy, this method uses a combination of LSCs, the Virtual Switch Interface (VSI), and IP routing paths with the same cost path for hot redundancy, or different costs for warm redundancy. The VSI allows multiple control planes (MPLS, PNNI, and voice) to control the same switch. Each control plane controls a different partition of the switch.

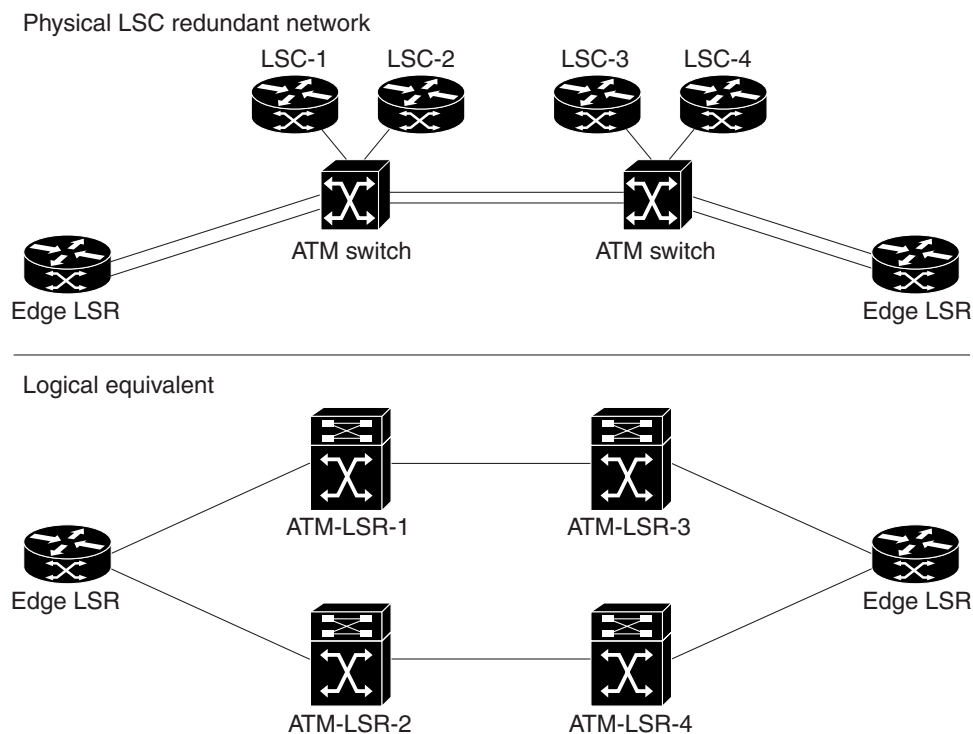
In the LSC redundancy model, two independent LSCs control the different partitions of the switch. Thus, two separate MPLS control planes set up connections on different partitions of the same switch. This is where LSC redundancy differs from hot standby redundancy. The LSCs do not need copies of each other's internal state to create redundancy. The LSCs control the partitions of the switch independently.

A single IP network consists of switches with one LSC (or a hot standby pair of LSCs) and MPLS edge label switch routers (LSRs).

If you change that network configuration by assigning two LSCs per switch, you form two separate MPLS control planes for the network. You logically create two independent parallel IP subnetworks linked at the edge.

If the two LSCs on each switch are assigned identical shares of the switch's resources and links, the two subnetworks are identical. You have two identical parallel IP subnetworks on virtually the same equipment, which would otherwise support only one network.

For example, [Figure 19](#) shows a network of switches that each have two LSCs. MPLS edge LSRs are located at the edge of the network, to form a single IP network. The LSCs on each switch have identical shares of the switch's resources and links, which makes the networks identical. In other words, there are two identical parallel IP subnetworks.

**Figure 19 LSC Redundancy Model**

Part of the redundancy model includes edge LSRs, which link the two networks at the edge.

If the network uses Open Shortest Path First (OSPF) or a similar IP routing protocol with an equal cost on each path, then there are at least two equally viable paths from every edge LSR to every other edge LSR. The OSPF equal cost multipath distributes traffic evenly on both paths. Therefore, MPLS sets up two identical sets of connections for the two MPLS control planes. IP traffic travels equally across the two sets of connections.

**Note**

The LSC redundancy model works with any routing protocol. For example, you can use Open Shortest Path First (OSPF) or Intermediate System to Intermediate System (IS-IS). Also, you can use both the Tag Distribution Protocol (TDP) and the Label Distribution Protocol (LDP).

With the LSC redundancy model, if one LSC on a switch fails, IP traffic uses the other path, without having to establish new links. LSC redundancy does not require the network to set up new connections when a controller fails. Because the connections to the other paths have already been established, the interruption to the traffic flow is negligible. The LSC redundancy model is as reliable as networks that use hot standby controllers. LSC redundancy requires hardware like that used by hot standby controllers. However, the controllers act independently, rather than in hot standby mode. For LSC redundancy to work, the hardware must have connection capacity for doubled-up connections.

If an LSC fails and LSC redundancy is not present, IP traffic halts until other switches break their present connections and reroute traffic around the failed controller. The stopped IP traffic results in undesirable unreliability.

## Hot LSC Redundancy

Hot redundancy provides near-instant failover to the other path when an LSC fails. When you set up hot redundancy, both LSCs are active and have the same routing costs on both paths. To ensure that the routing costs are the same, run the same routing protocols on the redundant LSCs.

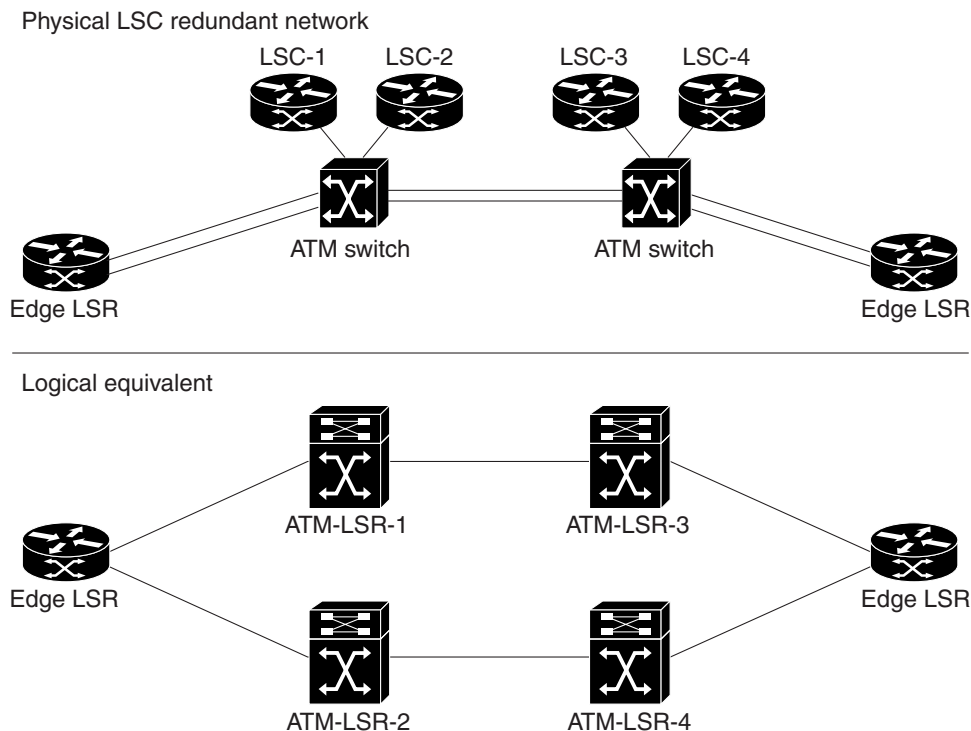
In hot redundancy, the LSCs run parallel and independent Label Distribution Protocols (LDPs). At the edge LSRs, when the LDP has multiple routes for the same destination, it requests multiple labels. It also requests multiple labels when it needs to support class of service (CoS). When one LSC fails, the labels distributed by that LSC are removed.

To achieve hot redundancy, you can implement the following redundant components:

- Redundant physical interfaces between the edge LSR and the ATM-LSR to ensure reliability in case one physical interface fails.
- Redundant interfaces or redundant VP tunnels between the ATM switches.
- Slave ATM switches, such as the BPX 8650, can have redundant control cards and switch fabrics. If redundant switch fabrics are used and the primary switch fails, the other switch fabric takes over.
- Redundant LSCs.
- The same routing protocol running on both LSCs. (You can have different tag/label distribution protocols.)

Figure 20 shows one example of how hot LSC redundancy can be implemented.

**Figure 20** Hot LSC Redundancy



# Warm LSC Redundancy

To achieve warm redundancy, you need only redundant LSCs. You do not necessarily need to run the same routing protocols or distribution protocols on the LSCs.

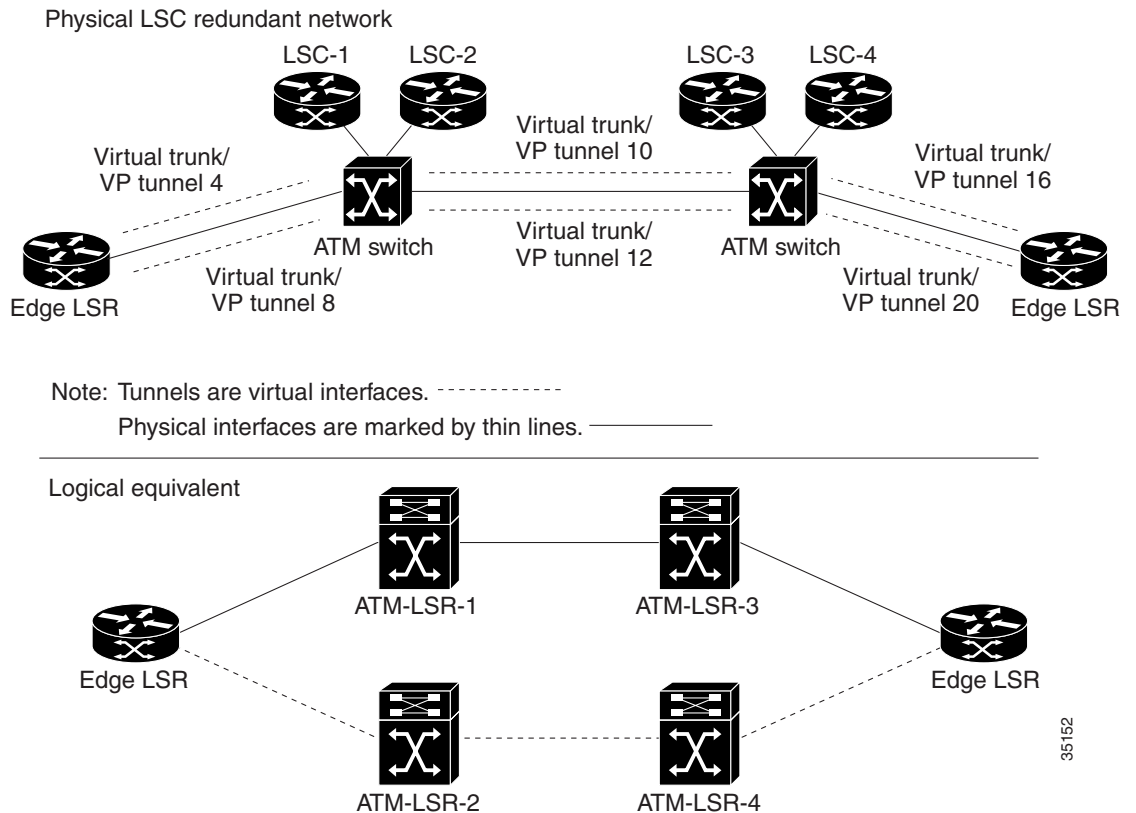
**Note**

You can use different routing protocols on parallel LSCs. However, you do not get near-instant failover. The failover time includes the time it takes to reroute the traffic, plus the LDP bind request time. If the primary routing protocol fails, the secondary routing protocol finds new routes and creates new label virtual circuits (LVCs). An advantage to using different routing protocols is that the ATM switch uses fewer resources and offers more robust redundancy.

If you run the same routing protocols, you specify a higher cost for the interfaces on the backup LSC. This causes the data to use only the lower-cost path. This also saves resources on the ATM switch, because the edge LSR requests LVCs only through the lower-cost LSC. When the primary LSC fails, the edge LSR uses the backup LSC and creates new paths to the destination. Creating new paths requires reroute time and LDP negotiation time.

Figure 21 shows one example of how warm LSC redundancy can be implemented.

**Figure 21 Warm LSC Redundancy**



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## Differences Between Hot and Warm LSC Redundancy

Virtually any configuration of switches and LSCs that provides hot redundancy can also provide warm redundancy. You can also switch from warm to hot redundancy with little or no change to the links, switch configurations, or partitions.

Hot and warm redundancy differ in the following ways:

- Hot redundancy uses both paths to route traffic. You set up both paths using equal cost multipath routing, so that traffic is load balanced between the two paths. As a result, hot redundancy uses twice the number of MPLS label VCs as warm redundancy.
- Warm redundancy uses only one path at a time. You set up the paths so that one path has a higher cost than the other. Traffic only uses one path and the other path is a backup path.

## General Redundancy Operational Modes

The LSC redundancy model allows you to use the following four operational models. Most other redundancy models cannot accommodate all of these redundancy models.

- **Transparent Mode**—The primary and secondary redundant systems have the same copies of the image and startup configurations. When one system fails, the other takes over, and the operations are identical. However, this mode risks software failures, because both systems use the same algorithms. A software problem on the primary system is likely to affect the secondary system as well.
- **Upgrade mode**—You can upgrade the image or configuration of the redundant system, without rebooting the entire system. You can use this mode to change the resources between different partitions of the slave ATM switch.
- **Nontransparent mode**—The primary and secondary systems have different images or configurations. This mode is more reliable than transparent mode, which loads the same software on both controllers. In nontransparent mode, the use of different images and configurations reduces the risk of both systems encountering the same problem.
- **Experimental mode**—You load an experimental version of the image or configuration on the secondary system. You can use experimental mode when you want to test the new images in a real environment.

## How LSC Redundancy Differs from Router and Switch Redundancy

In traditional IP router networks, network managers ensure reliability by creating multiple paths through the network from every source to every destination. If a device or link on one path fails, IP traffic uses an alternate path to reach its destination.

### LSC Redundancy

Connecting two independent LSCs to each switch by the Virtual Switch Interface (VSI) creates two identical subnetworks. Multipath IP routing uses both subnetworks equally. Thus, both subnetworks have identical connections. If a controller in one subnetwork fails, the multipath IP routing diverts traffic to the other path. Because the connections already exist in the alternate path, the reroute time is very fast. The LSC redundancy model matches the reliability of networks with hot standby controllers, without the difficulty of implementing hot standby redundancy.

## Router Redundancy

Because routers do not need to establish a virtual circuit to transfer data, they are inherently connectionless. When a router discovers a failed device or link, it requires approximately less than a second to reroute traffic from one path to another.

Routers can incorporate a warm or hot standby routing process to increase reliability. The routing processes share information about the routes to direct different streams of IP traffic. They do not need to keep or share connection information. Routers can also include redundant switch fabrics, backplanes, power supplies, and other components to decrease the chances of node failures.

## ATM, Frame Relay, and Circuit Switch Redundancy

Circuit switch, ATM, and Frame Relay networks transfer data by establishing circuits or virtual circuits. To ensure the transfer of data in switches, network managers incorporate redundant switch components. If any component fails, a spare component takes over. Switches can have redundant line cards, power supplies, fans, backplanes, switch fabrics, line cards, and control cards.

- The redundant backplanes include all the hardware to operate two backplanes and to switch to the backup backplane if one fails.
- Redundant line cards protect against failed links. If a link to a line card fails, the redundant line card takes over. To create redundant line cards, you must program the same connection information into both line cards. This ensures that the circuits or virtual circuits are not disrupted when the new line card takes over.
- The redundant switch fabric must also have the same connection information as the active switch fabric.

A software application usually monitors the state of the switches and their components. If a problem arises, the software sets an alarm to bring attention to the faulty component.

The redundant switch hardware and software are required, because switches take some time to reroute traffic when a failure occurs. Switches can have connection routing software, such as Cisco automatic connection routing, PNNI, or MPLS. However, rerouting the connections in a switch takes much more time than rerouting traffic in a router network. Rerouting connections in a switch requires calculating routes and reprogramming some hardware for each connection. In router networks, large aggregates of traffic can be rerouted simultaneously, with little or no hardware programming. Therefore, router networks can reroute traffic more quickly and easily than connection oriented networks. Router networks rely on rerouting techniques to ensure reliability. Connection-oriented networks use rerouting only as a last resort.

## General Hot/Warm Standby Redundancy in Switches

Network managers can install redundant copies of the connection routing software for ATM and Frame Relay switches on a redundant pair of control processors.

With hot standby redundancy, the active process sends its state to the spare process to keep the spare process up to date in case it needs to take over. The active process sends the state information to the spare process or writes the state to a disk, where both processes can access the information. In either case, the state information is shared between controllers. Because the state of the network routing tables changes frequently, the software must perform much work to maintain consistent routing states between redundant pairs of controllers.

With warm standby redundancy, the state information is not shared between the active and spare processes. If a failure occurs, the spare process resets all of the connections and re-establishes them. Reliability decreases when the spare resets the connections. The chance of losing data increases.

## LSC Redundancy Benefits

By implementing the LSC redundancy model, you eliminate the single point of failure between the LSC and the ATM switch it controls. If one LSC fails, the other LSC takes over and routes the data on the other path. The following sections explain the other benefits of LSC redundancy.

### LSC Redundancy Does Not Use Shared States or Databases

In the LSC redundancy model, the LSCs do not share states or databases, which increases reliability. Sometimes, when states and databases are shared, an error in the state or database information can cause both controllers to fail simultaneously.

Also, new software features and enhancements do not affect LSC redundancy. Because the LSCs do not share states or database information, you do not have to worry about ensuring redundancy during every step of the update.

### LSC Redundancy Allows Different Software Versions

The LSCs work independently and there is no interaction between the controllers. They do not share the controller's state or database, as other redundancy models require. Therefore, you can run different versions of the IOS software on the LSCs, which provides the following advantages:

- You can test the features of the latest version of software without risking reliability. You can run the latest version of the IOS software on one LSC and an older version of the IOS software on a different LSC. If the LSC running the new IOS software fails, the LSC running the older software takes over.
- Running different versions of the IOS software reduces the chance of having both controllers fail. If you run the same version of the IOS software on both controllers and that version contains a problem, it could cause both controllers to fail. Running different versions on the controllers eliminates the possibility of each controller failing because of the same problem.



#### Note

Using different IOS software version on different LSCs is recommended only as a temporary measure. Different versions of IOS software in a network could be incompatible, although it is unlikely. For best results, run the same version of IOS software on all devices.

### LSC Redundancy Allows You to Use Different Router Models

You can use different models of routers in this LSC redundancy model. Using different hardware in the redundancy model reduces the chance that a hardware fault would interrupt network traffic.

### LSC Redundancy Allows You to Switch from Hot to Warm Redundancy on the Fly

You can implement hot or warm redundancy and switch from one model to the other. Hot redundancy can use redundant physical interfaces, slave ATM switches with Y redundancy, and redundant LSCs. This enables parallel paths and near-instant failover. If your resources are limited, you can implement warm redundancy, which uses only redundant LSCs. When one controller fails, the backup controller requires some reroute time. As your network grows, you can switch from hot to warm redundancy and back, without bringing down the entire network.

Other redundancy models require complex hardware and software configurations, which are difficult to alter when you change the network configuration. You must manually change the connection routing software from hot standby mode to warm standby mode.

### **LSC Redundancy Provides an Easy Migration from Standalone LSCs to Redundant LSCs**

You can migrate from a standalone LSC to a redundant LSC and back again without affecting network operations. Because the LSCs work independently, you can add a redundant LSC without interrupting the other LSC.

### **LSC Redundancy Allows Configuration Changes in a Live Network**

The hot LSC redundancy model provides two parallel, independent networks. Therefore, you can disable one LSC without affecting the other LSC. This feature has the following benefits:

- LSC redundancy model facilitates configuration changes and updates. After you finish with configuration changes or image upgrades to the LSC, you can add the LSC back to the network and resume the LSC redundancy model.
- The redundancy model protects the network during partitioning of the ATM switch. You can disable one path and perform partitioning on that path. While you are performing the partitioning, data uses the other path. The network is safe from the effects of the partitioning, which include breaking/establishing LVC connections.

### **LSC Redundancy Provides Fast Reroute in IP+ATM Networks**

The hot LSC redundancy model offers redundant paths for every destination. Therefore, reroute recovery is very fast. Other rerouting processes in IP+ATM networks require many steps and take more time.

In normal IP+ATM networks, the reroute process consists of the following steps:

- Detecting the failure
- Converging the Layer 2 routing protocols
- Completing label distribution for all destinations
- Establishing new connections for all destinations

After this reroute process, the new path is ready to transfer data. Rerouting data using this process takes time.

The hot LSC redundancy method allows you to quickly reroute data in IP+ATM networks without using the normal reroute process. When you incorporate hot LSC redundancy, you create parallel paths. Every destination has at least one alternative path. If a device or link along the path fails, the data uses the other path to reach its destination. The hot LSC redundancy model provides the fastest reroute recovery time for IP+ATM networks.

## **LSC Redundancy Restrictions**

### **Hot LSC Redundancy Restrictions**

The following list explains the items you need to consider when implementing hot LSC redundancy:

- LSC hot redundancy needs parallel paths. Specifically, there must be the capacity for at least two end-to-end parallel paths traveling from each source to each destination. Each path is controlled by one of a pair of redundant LSCs.
- Label switch paths (LSPs) for the destinations are initiated from the edge LSR. The edge LSR initiates multiple paths for a destination only if it has parallel paths to its next hop. Therefore, it is important to have parallel paths from the edge LSR. You can achieve parallel paths by having two physical links from the edge LSR or by having two separate VP tunnels on one link.
- Hot redundancy protection extends from the edge LSR only as far as parallel paths are present. So, it is best if parallel paths are present throughout the entire network.

- Hot redundancy increases the number of VCs used in the network. Each physical link with two VSI partitions has twice the number of VCs used than would otherwise be the case. Various techniques can be used to alleviate VC usage. The use of unnumbered links (“ip unnumbered” in the IOS link configuration) reduces the number of routes in the routing table and hence the number of VCs required. On the LSCs, you can use the command `mpls atm disable-headend-vc` to disable edge LSR functionality on the LSC and also reduce the number of VCs used. The `mpls request-labels for` command with an access list also restricts the creation of LVCs.

### Warm LSC Redundancy Restrictions

The following list explains the items you need to consider when implementing warm LSC redundancy:

- LSC warm redundancy needs a single active path between the source and destination. However, there is also a requirement for end-to-end parallel paths, as in the hot redundancy case. Only one path has an active LSP for the destination. In the event of the failure, the other path is established, with some delay due to rerouting.
- The number of VCs in the network does not change with the warm redundancy.
- Hot LSC redundancy achieves failure recovery with little loss of traffic. However, hot redundancy doubles the VC requirements in the network. Warm LSC redundancy requires the same number of VCs as a similar network without LSC redundancy. However, traffic loss due to a failure is greater; traffic may be lost for a period of seconds during rerouting.



#### Note

The precise traffic loss depends on the type of failure. If the failure is in an LSC, the LSPs controlled by that LSC typically remain connected for some time. Traffic can still flow successfully on the “failed” path until the edge LSRs switch all traffic to the alternate path (which might occur tens of seconds later, depending on routing protocol configuration). The only traffic loss might occur in the edge LSR when traffic changes to the new path, which typically takes a few milliseconds or less.

## Configuring LSC Redundancy

To make an LSC redundant, you can partition the resources of the slave ATM switch, implement a parallel VSI model, assign redundant LSCs to each switch, and create redundant LSRs. The following sections explain each of these steps.

### Partitioning the Resources of the ATM Switch

In the LSC redundancy model, two LSCs control different partitions of the ATM switch. When you partition the ATM switch for LSC redundancy, use the following guidelines:

- Make the MPLS partitions identical. If you create two partitions, make sure both partitions have the same amount of resources. (You can have two MPLS VSI partitions per switch.) Use the `cnfrsrc` command to configure the partitions.

- If the partitions are on the same switch card, perform the following:
  - Create different control VCs for each partition. For example, there can be only one (0, 32) control VC on the XTagATM interface. To map two XTagATM interfaces on the same ATM switch interface, use a different control VC for the second LSC. Use the `mpls atm control-vc` command.
  - Create the LVC on the XTagATM interfaces using nonintersecting VPI ranges. Use the `mpls atm vpi` command.
- Specify the bandwidth information on the XTagATM interfaces. Normally, this information is read from the slave ATM switch. When you specify the bandwidth on the XTagATM interface, the value you enter takes precedence over the switch-configured interface bandwidth.
- Configure the logical channel number (LCN) ranges for each partition according to the expected number of connections.

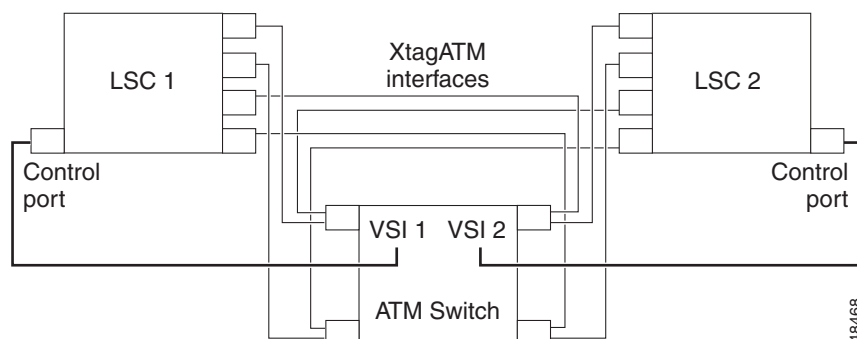
See the documentation on the Cisco BPX 8600 series or Cisco IGX 8400 series switches for more information about configuring the slave ATM switch.

## Implementing the Parallel VSI Model

The parallel VSI model means that the physical interfaces on the ATM switch are shared by more than one LSC. For instance, LSC1 maps VSI slave interfaces 1 to N to the ATM switch's physical interfaces 1 to N. LSC2 maps VSI slave interfaces to the ATM switch's physical interfaces 1 to N. LSC1 and LSC2 share the same physical interfaces on the ATM switch. With this mapping, you achieve fully meshed independent masters.

Figure 22 shows four ATM physical interfaces mapped as four XTagATM interfaces at LSC1 and LSC2. Each LSC is not aware that the other LSC is mapped to the same interfaces. Both LSCs are active all the time. The ATM switch runs the same VSI protocol on both partitions.

**Figure 22** XTagATM Interfaces

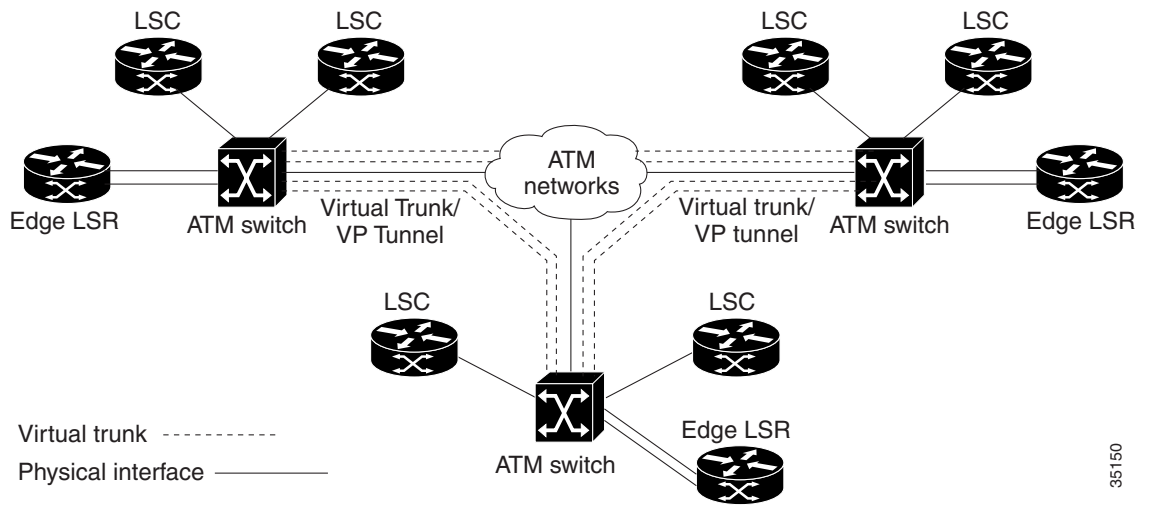


## Adding Interface Redundancy

To ensure reliability throughout the LSC redundant network, you can also implement:

- Redundant interfaces between the edge LSR and the ATM-LSR. Most edge LSRs are colocated with the LSCs. Creating redundant interfaces between the edge LSRs and the ATM LSRs reduces the chance of a disruption in network traffic by providing parallel paths.
- Redundant virtual trunks and VP tunnels between slave ATM switches. To ensure hot redundancy between the ATM switches, you can create redundant virtual trunks and VP tunnels. See Figure 23.

Figure 23 Interface Redundancy

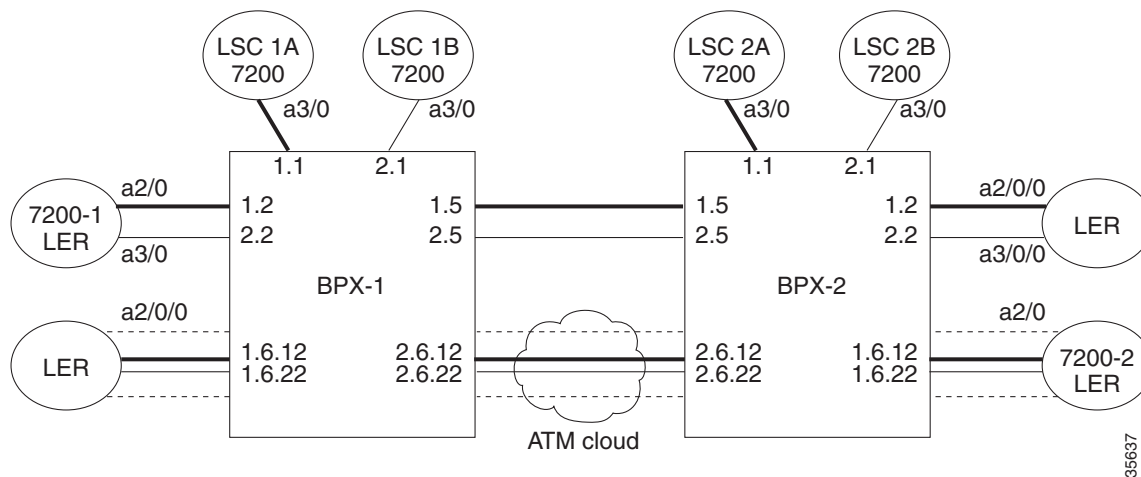


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## Configuration Example: Configuring LSC Hot Redundancy

The network topology shown in Figure 24 incorporates two ATM-LSRs in an MPLS network. This topology includes two LSCs on each BPX node and four edge LSRs.

Figure 24 ATM-LSR Network Configuration Example



The following configuration examples show the label-switching configuration for both standard downstream-on-demand interfaces and downstream-on-demand over a VP-tunnel. The difference between these two types of configurations is:

- Standard interface configuration configures a VPI range of one or more VPIs while LDP control information flows in PVC 0,32.
- VP-tunnel, on the other hand, configures a single VPI (for example, vpi 12) and uses an mpls atm control-vc of vpi,32 (i.e. 12,32). You can use a VP-tunnel to establish label-switching neighbor relationships through a private ATM cloud.

The following configuration examples are provided in this section.



### Note

For the Cisco IGX switch, use the following commands:

```
extended-port atm1/0 descriptor 0.x.x.0  
label-control-protocol vsi slaves 32 id x
```



### Note

In the following configuration examples for the LSCs, you can use the **mpls request-labels for** command instead of the **mpls atm disable-headend-vc** command.

## Configuration for LSC 1A

7200 LSC 1A:

```
ip cef
!  
mpls atm disable-headend-vc
!  
interface loopback0  
ip address 172.103.210.5 255.255.255.255
```

```

!
interface ATM3/0
  no ip address
  label-control-protocol vsi id 1
!
interface XTagATM12
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 1.2
  mpls atm vpi 2-5
  mpls ip
!
interface XTagATM15
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 1.5
  mpls atm vpi 2-15
  mpls ip
!
interface XTagATM1612
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 1.6.12
  mpls atm vp-tunnel 12
  mpls ip
!
interface XTagATM2612
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 2.6.12
  mpls atm vp-tunnel 12
  mpls ip

```

## Configuration for LSC 1B

7200 LSC 1B:

```

ip cef
!
mpls atm disable-headend-vc
!
!
interface loopback0
  ip address 172.103.210.6 255.255.255.255
!
interface ATM3/0
  no ip address
  label-control-protocol vsi id 2
!
interface XTagATM22
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 2.2
  mpls atm vpi 2-5
  mpls ip
!
interface XTagATM25
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 2.5
  mpls atm vpi 2-15
  mpls ip
!
interface XTagATM1622
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 1.6.22
  mpls atm vp-tunnel 22
  mpls ip

```

```

!
interface XTagATM2622
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 2.6.22
  mpls atm vp-tunnel 22
  mpls ip

```

## Configuration for LSC 2A

7200 LSC 2A:

```

ip cef
!
mpls atm disable-headend-vc
!
interface loopback0
  ip address 172.103.210.7 255.255.255.255
!
interface ATM3/0
  no ip address
  label-control-protocol vsi id 1
!
interface XTagATM12
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 1.2
  mpls atm vpi 2-5
  mpls ip
!
interface XTagATM15
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 1.5
  mpls atm vpi 2-15
  mpls ip
!
interface XTagATM1612
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 1.6.12
  mpls atm vp-tunnel 12
  mpls ip
!
interface XTagATM2612
  ip unnumbered loopback0
  extended-port ATM3/0 bpx 2.6.12
  mpls atm vp-tunnel 12
  mpls ip

```

## Configuration for LSC 2B

7200 LSC 2B:

```

ip cef
!
mpls atm disable-headend-vc
!
interface loopback0
  ip address 172.103.210.8 255.255.255.255
!
interface ATM3/0
  no ip address
  label-control-protocol vsi id 2
!
interface XTagATM22

```

```

        ip unnumbered loopback0
        extended-port ATM3/0 bpx 2.2
        mpls atm vpi 2-5
        mpls ip
    !
interface XTagATM25
    ip unnumbered loopback0
    extended-port ATM3/0 bpx 2.5
    mpls atm vpi 2-15
    mpls ip
!
interface XTagATM1622
    ip unnumbered loopback0
    extended-port ATM3/0 bpx 1.6.22
    mpls atm vp-tunnel 22
    mpls ip
!
interface XTagATM2622
    ip unnumbered loopback0
    extended-port ATM3/0 bpx 2.6.22
    mpls atm vp-tunnel 22
    mpls ip

```

## Configuration for BPX1 and BPX2

### BPX1 and BPX2:

```

uptrk 1.1
addshelf 1.1 vsi 1 1
cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000
upln 1.2
upport 1.2
cnfrsrc 1.2 256 252207 y 1 e 512 6144 2 5 26000 100000
uptrk 1.5
cnfrsrc 1.5 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 1.6.12
cnftrk 1.6.12 110000 N 1000 7F V,TS,NTS,FR,FST,CBR,NRT-VBR,ABR,
    RT-VBR N TERRESTRIAL 10 0 N N Y Y Y CBR 12
cnfrsrc 1.6.12 256 252207 y 1 e 512 6144 12 12 26000 100000
uptrk 1.6.22
cnftrk 1.6.22 110000 N 1000 7F V,TS,NTS,FR,FST,CBR,NRT-VBR,ABR,
    RT-VBR N TERRESTRIAL 10 0 N N Y Y Y CBR 22
cnfrsrc 1.6.22 256 252207 y 2 e 512 6144 22 22 26000 100000
uptrk 2.1
addshelf 2.1 vsi 2 2
cnfrsrc 2.1 256 252207 y 2 e 512 6144 2 15 26000 100000
upln 2.2
upport 2.2
cnfrsrc 2.2 256 252207 y 2 e 512 4096 2 5 26000 100000
uptrk 2.5
cnfrsrc 2.5 256 252207 y 2 e 512 6144 2 15 26000 100000
uptrk 2.6.12
cnftrk 2.6.12 110000 N 1000 7F V,TS,NTS,FR,FST,CBR,NRT-VBR,ABR,
    RT-VBR N TERRESTRIAL 10 0 N N Y Y Y CBR 12
cnfrsrc 2.6.12 256 252207 y 1 e 512 6144 12 12 26000 100000
uptrk 2.6.22
cnftrk 2.6.22 110000 N 1000 7F V,TS,NTS,FR,FST,CBR,NRT-VBR,ABR,
    RT-VBR N TERRESTRIAL 10 0 N N Y Y Y CBR 22
cnfrsrc 2.6.22 256 252207 y 2 e 512 6144 22 22 26000 100000

```

**Note**

For the shelf controller, you must configure a VSI partition for the slave control port interface (**addshelf 1.1, cnfrsrc 1.1...**). However, do not configure an XTagATM port for the VSI partition (for instance, XTagATM11).

## Configuration for Edge LSR 7200-1

7200-1 edge LSR:

```
ip cef
!
interface loopback0
  ip address 172.103.210.1 255.255.255.255
!
interface ATM2/0
  no ip address
!
interface ATM2/0.12 mpls
  ip unnumbered loopback 0
  mpls atm vpi 2-5
  mpls ip
!
interface ATM3/0
  no ip address

interface ATM3/0.22 mpls
  ip unnumbered loopback 0
  mpls atm vpi 2-5
  mpls ip
```

## Configuration for Edge LSR-1

Edge LSR-1:

```
ip cef distributed
!
interface loopback0
  ip address 172.103.210.2 255.255.255.255
!
interface ATM2/0/0
  no ip address
!
interface ATM2/0/0.1612 mpls
  ip unnumbered loopback0
  mpls atm vp-tunnel 12
  mpls ip
!
interface ATM2/0/0.1622 mpls
  ip unnumbered loopback0
  mpls atm vp-tunnel 22
  mpls ip
```

## Configuration for Edge LSR-2

Edge LSR-2:

```
ip cef distributed
!
interface loopback0
```

```

        ip address 172.103.210.3 255.255.255.255
    !
interface ATM2/0/0
    no ip address
    !
interface ATM2/0/0.12 mpls
    ip unnumbered loopback0
    mpls atm vpi 2-5
    mpls ip
    !!
interface ATM3/0/0
    no ip address
    !
interface ATM3/0/0.22 mpls
    ip unnumbered loopback0
    mpls atm vpi 2-5
    mpls ip

```

## Configuration for Edge LSR 7200-2

7200-2 edge LSR:

```

ip cef
!
interface loopback0
    ip address 172.103.210.4 255.255.255.255
!
interface ATM2/0
    no ip address
    !
interface ATM2/0.1612 mpls
    ip unnumbered loopback0
    mpls atm vp-tunnel 12
    mpls ip
    !
interface ATM2/0.1622 mpls
    ip unnumbered loopback0
    mpls atm vp-tunnel 22
    mpls ip

```

## Configuration Example: Configuring LSC Warm Standby Redundancy

You can implement the configuration of LSC warm standby redundancy by configuring the redundant link for either a higher routing cost than the primary link or configuring a bandwidth allocation that is less desirable. You need to perform this only at the edge LSR nodes, because the LSCs are configured to disable the creation of headend VCs, which reduces the LVC overhead.

## Configuration Example: Configuring an Interface Using Two VSI Partitions

A special case may arise where a network topology can only support a neighbor relationship between peers using a single trunk or line interface. To configure the network, use the following procedure:

- 
- Step 1** Configure the interface to use both VSI partitions. The VSI partition configuration for the interface must be made with no overlapping vp space. For instance, for interface 2.8 on the ATM LSR, the following configuration is required:

```
uptrk 2.8
cnfrsrc 2.8 256 252207 y 1 e 512 6144 2 15 26000 100000
cnfrsrc 2.8 256 252207 y 2 e 512 6144 16 29 26000 100000
```

Thus partition 1 will create LVCs using VPIs 2-15 and partition 2 will create LVCs using VPIs 16-29.

- Step 2** Configure the control-vc. Each LSC requires a control VC (default 0,32); however, only one LSC can use this default control-vc for any one trunk interface. The following command forces the control VC assignment:

```
mpls atm control-vc <vpi>,<vci>
```

Therefore, LSC 1 XTagATM28 can use the default control-vc 0,32 (but it is suggested that you use 2,32 to reduce configuration confusion) and the LSC 2 XTagATM28 should use control-vc 16,32.



**Note**

For the Cisco IGX switch, use the following commands:  
**extended-port atm1/0 descriptor 0.x.x.0**  
**label-control-protocol vsi slaves 32 id x**

The following example shows the configuration steps:

LSC1:

```
interface XTagATM2801
 ip unnumbered loopback0
 extended-port ATM3/0 bpx 2.8
 mpls atm vpi 2-15
 mpls atm control-vc 2 32
 mpls ip
```

LSC2:

```
interface XTagATM2802
 ip unnumbered loopback0
 extended-port ATM3/0 bpx 2.8
 mpls atm vpi 16-29
 mpls atm control-vc 16 32
 mpls ip
```

## Feature 3: Reducing the Number of Label Switch Paths Created in an MPLS Network

You can reduce the number of LSPs created in an MPLS network by disabling LSPs from being created from an edge LSR or LSC to a destination IP address. Use the **mpls request-labels for** command. Specify the destination IP addresses that you want to disable from creating LSPs. This command allows you to permit creation of some LSPs, while preventing the creation of others.

### Using an Access List to Disable Creation of LSPs to Destination IP Addresses

You can prevent LSPs from being created between edge LSRs and LSCs. This helps prevent the unnecessary use of LVC resources in a slave ATM switch. You use the **mpls request-labels for** command with an access list to disable the creation of the LSPs.

Some LSPs are often unnecessary between some edge LSRs in an MPLS network. Every time a new destination is created, LSPs are created from all edge LSRs in the MPLS network to the new destination. You can create an access list at an edge LSR or LSC to restrict the destinations for which a downstream-on-demand request is issued.

For example, [Figure 25](#) is an MPLS ATM network that consists of the following elements:

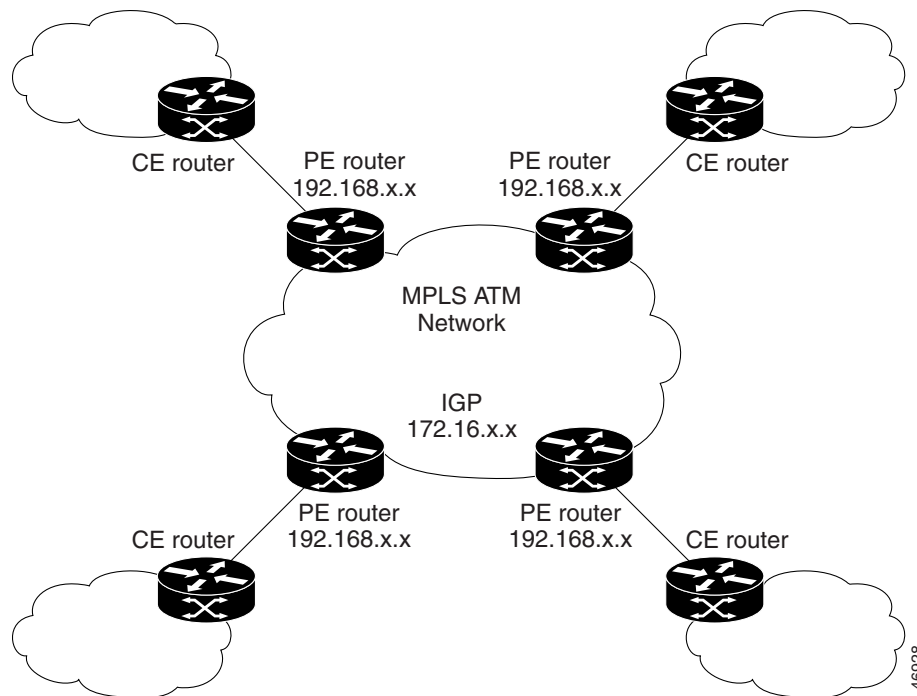
- The PE routers in the virtual private network require LSPs to communicate with each other.
- All the PE routers are in network 1 (192.168.x.x).
- All the IGP IP addresses are in network 2 (172.16.x.x).
- If numbered interfaces are required (for network management or other purposes), they are placed in network 2 (172.16.x.x).

Use `mpls request-labels for` commands to accomplish the following tasks:

- Allow the PE routers in network 1 to create LSPs and communicate with each other.
- Prevent LSPs from being created in network 2.

Performing these tasks reduces the number of LSPs in the MPLS ATM cloud, which reduces the VC usage in the cloud.

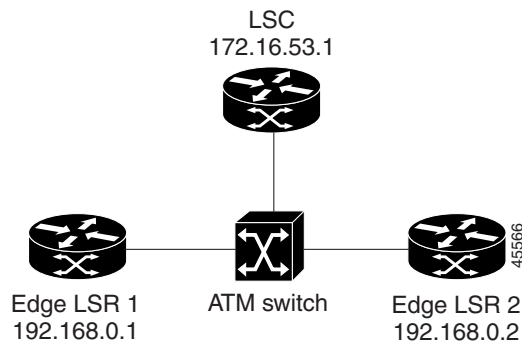
**Figure 25** Sample MPLS ATM Network



**Note**

When using access lists to prevent the creation of headend LVCs or LSPs, do not disable the LSC from acting as an edge LSR with the `mpls atm disable-headend-vc` command, which prevents all LSPs from being established.

The following examples of the `mpls request-labels for` command use [Figure 26](#) as a basis. The examples show different ways to disable the creation of LSPs from the LSC to the edge LSR, and from the edge LSRs to the LSC.

**Figure 26** Sample Configuration for `mpls request-labels` for Command

## Using a Numbered Access List

The following examples use a numbered access list to restrict creation of LSPs.

### Preventing LSPs from the LSC to the Edge LSRs

The following example prevents LSPs from being established from the LSC to all 192.x.x.x destinations. However, transit LSPs are allowed between 192.x.x.x destinations. Add the following commands to the LSC configuration:

```
mpls request-labels for 1
access-list 1 deny 192.168.0.0 0.255.255.255
access-list 1 permit any
```

### Preventing LSPs from the Edge LSRs to the LSC

The following example prevents headend LVCs from being established from edge LSR 1 and edge LSR 2 to the LSC (172.16.x.x). However, transit LSPs are allowed between 192.168.x.x destinations. Add the following commands to the edge LSR 1 and 2 configurations:

```
mpls request-labels for 1
access-list 1 deny 172.16.0.0 0.255.255.255
access-list 1 permit any
```

## Using a Named Access List

The following examples use a named access list to perform the same tasks as the previous examples.

```
mpls request-labels for nolervcs
ip access-list standard nolervcs
deny 192.168.0.0 0.255.255.255
permit any
```

```
mpls request-labels for nolervcs
ip access-list standard nolervcs
deny 172.16.0.0 0.255.255.255
permit any
```

## Specifying Exact Match IP Addresses with an Access List

The following examples use exact IP addresses to perform the same tasks as the previous examples.

```
mpls request-labels for 1
```

```

access-list 1 deny 192.168.0.1 0.0.0.0
access-list 1 deny 192.168.0.2 0.0.0.0
access-list 1 permit any

mpls request-labels for 1
access-list 1 deny 172.16.53.1 0.0.0.0
access-list 1 permit any

```

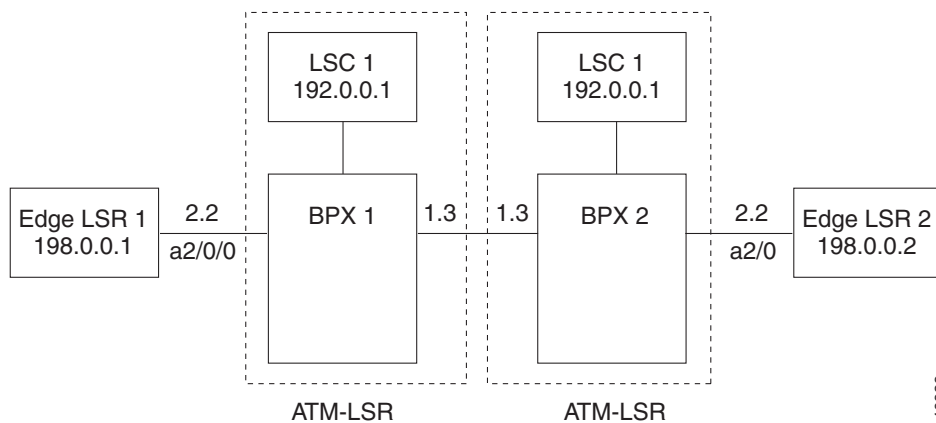
Instead of configuring an access list on the LSC, you can issue the `mpls atm disable-headend-vc` command to disable the creation of LSPs. This command works only with LSCs.

## Configuration Example: Using an Access List to Limit Headend VCs

The following example shows how to use an access list to control the creation of headend VCs in an MPLS network, which allows the network to support more destinations.

Figure 27 shows two edge LSRs and two ATM-LSRs. In the configuration, only LSPs between edge LSRs are required to provide label switched paths. Other LSPs are not essential. The LSPs between LSCs and between the LSCs and the edge LSRs are often unused and required only for monitoring and maintaining the network. In such cases the IP forwarding path is sufficient.

**Figure 27** Sample MPLS Network



In networks that require connections only between edge LSRs, you can use the access list to eliminate the creation of unnecessary LSPs. This allows LVC resources to be conserved so that more edge LSR connections can be supported.

To prevent creation of LSPs between LSCs, create an access list that denies all 172.16.0.0/24 addresses. Then, to prevent creation of LVCs from the LSCs to the edge LSRs, create an access list that denies all 192.168.0.0/24 addresses. The configuration examples for LSC 1 and 2 show the commands for performing these tasks.

To prevent creation of LVCs from the edge LSRs to LSCs, create an access list at the edge LSRs that denies all 172.16.0.0/24 addresses. The configuration examples for edge LSR 1 and 2 show the commands for performing this task.

## Configuration for LSC 1

7200 LSC1:

```

ip cef
!
mpls request-labels for acl_lsc
ip access-list standard acl_lsc
deny 172.16.0.0 0.255.255.255
deny 192.168.0.0 0.255.255.255
permit any
!
interface loopback0
 ip address 172.16.0.1 255.255.255.255
!
interface ATM3/0
 no ip address
 label-control-protocol vsi
!
interface XTagATM13
 extended-port ATM3/0 bpx 1.3
 ip unnumbered loopback0
 mpls atm vpi 2-15
 mpls ip
!
interface XTagATM22
 extended-port ATM3/0 bpx 2.2
 ip unnumbered loopback0
 mpls atm vpi 2-5
 mpls ip

```

## Configuration for BPX1 and BPX2

BPX1 and BPX2:

```

uptrk 1.1
addshelf 1.1 v 1 1
cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 1.3
cnfrsrc 1.3 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 2.2
cnfrsrc 2.2 256 252207 y 1 e 512 4096 2 5 26000 100000

```



### Note

For the shelf controller, you must configure a VSI partition for the slave control port interface (**addshelf 1.1, cnfrsrc 1.1...**). However, do not configure an XTagATM port for the VSI partition (for instance, XTagATM11).

## Configuration for LSC 2

7200 LSC2:

```

ip cef
!
mpls request-labels for acl_lsc
ip access-list standard acl_lsc
deny 172.16.0.0 0.255.255.255
deny 192.168.0.0 0.255.255.255
permit any
!
interface loopback0
 ip address 172.16.0.2 255.255.255.255
!
interface ATM3/0
 no ip address
 label-control-protocol vsi
!
interface XTagATM13
 extended-port ATM3/0 bpx 1.3
 ip unnumbered loopback0
 mpls atm vpi 2-15
 mpls ip
!
interface XTagATM22
 extended-port ATM3/0 bpx 2.2
 ip unnumbered loopback0
 mpls atm vpi 2-5
 mpls ip
!

```

## Configuration for Edge LSR 1

LSR1:

```

ip cef distributed
!
mpls request-labels for acl_ler
ip access-list standard acl_ler
deny 172.16.0.0 0.255.255.255
permit any
!
interface loopback 0
 ip address 192.168.0.1 255.255.255.255
!
interface ATM2/0/0
 no ip address
!
interface ATM2/0/0.22 mpls
 ip unnumbered loopback 0
 mpls atm vpi 2-5
 mpls ip

```

## Configuration for Edge LSR 2

7200 LSR2:

```

ip cef
!
mpls request-labels for acl_ler
ip access-list standard acl_ler

```

```
deny 172.16.0.0 0.255.255.255
permit any
!
interface loopback 0
 ip address 192.168.0.2 255.255.255.255
!
interface ATM2/0
 no ip address
!
interface ATM2/0.22 mpls
 ip unnumbered loopback 0
 mpls atm vpi 2-5
 mpls ip
```

## Feature 4: Differentiated Services and MPLS QoS Multi-VCs

QoS refers to the ability of a network to provide better service to selected network traffic over various underlying technologies including Frame Relay, ATM, Ethernet and 802.1 networks, SONET, and IP-routed networks. In particular, QoS features provide better and more predictable network service by supporting dedicated bandwidth, improving loss characteristics, avoiding and managing network congestion, shaping network traffic, and setting traffic priorities across the network.

A service model, also called a level of service, describes a set of end-to-end QoS capabilities. End-to-end QoS is the ability of the network to deliver service required by specific network traffic from one end of the network to another. Differentiated services is a service model supported by Cisco IOS QoS software that can provide end-to-end QoS.

The Multiprotocol Label Switching quality of service (MPLS QoS) mechanism is a feature for performing differentiated services over ATM. The MPLS QoS Multi-VC mode enhances general MPLS QoS features by enabling users to map the experimental (EXP) field value of an MPLS label to an ATM virtual circuit (VC) to create sets of labeled virtual circuits (LVCs). Each set consists of multiple LVCs, and each LVC is treated as a member of the set.

## Differentiated Services and Quality of Service

Differentiated service (DiffServ) is a multiple service model that can satisfy differing QoS requirements. However, unlike the integrated service model, an application using differentiated service does not explicitly signal the router before sending data.

Two different acronyms are used for differentiated services and both are commonly used in other documents. “DiffServ” is used most commonly, and refers to differentiated services in general. “DS” is the name given specifically to the bits in the IP headers used by DiffServ.

For differentiated service, the network tries to deliver a particular kind of service based on the QoS specified by each packet. This specification can occur in different ways, for example, using the IP Precedence bit settings in IP packets. The network uses the QoS specification to classify, mark, shape, and police traffic, and to perform intelligent queuing.

The differentiated service model is used for several mission-critical applications and for providing end-to-end QoS. Typically, this service model is appropriate for aggregate flows because it performs a relatively coarse level of traffic classification.

Cisco IOS QoS includes the following features that support the differentiated service model:

- Committed access rate (CAR), which performs packet classification through IP Precedence and QoS group settings. CAR performs metering and policing of traffic, providing bandwidth management.
- Intelligent queuing schemes such as WRED and WFQ and their equivalent features on the Versatile Interface Processor (VIP), which are VIP-Distributed WRED and VIP-Distributed WFQ. These features can be used with CAR to deliver differentiated services.

The DiffServ approach to quality of service (QoS) divides network traffic into a small number of classes and allocates resources on a per-class basis. DiffServ can be viewed as an incremental approach to QoS.

## DiffServ Per-Hop Behaviors

DiffServ networks use queuing technologies such as weighted fair queuing (WFQ) to provide differential service to the different classes of service (CoS). Link-by-link engineering of WFQ parameters is the approach suggested by the IETF DiffServ Working Group.

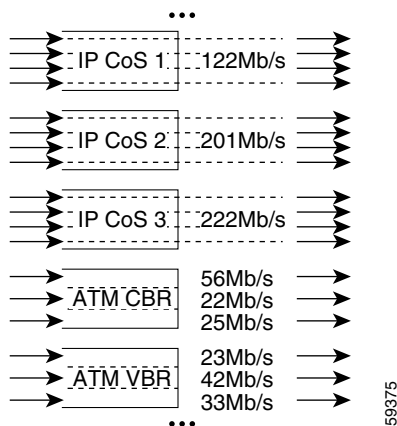
The treatment of a particular CoS on a particular link (or “hop”), using technologies such as weighted fair queuing, is referred to as a per-hop behavior (PHB). Cisco supports engineering of per-hop behaviors on links in both ATM MPLS and packet-based MPLS networks, as well as ordinary IP networks. The principles are the same in all network types, although there are differences in the way CoS information is carried in packets for different networks.

## DiffServ Classes and Cisco IP+ATM Switches

Engineering of DiffServ networks leads to specifications of required bandwidths for various classes of service on various links of the network. This is quite different from traditional per-VC bandwidth management in ATM networks.

As shown in [Figure 28](#), class-based queuing involves a separate queue in the ATM switch for each CoS. Cells from all LVCs of each CoS are queued in a single queue for that CoS. The bandwidth parameters of a CoS on a link are set directly on the CoS queue. The only parameter signalled for each LVC is the CoS for the LVC. This means that the ATM MPLS control component is used unchanged, except that multiple LVCs are set up for each destination: one LVC per destination per CoS.

**Figure 28** Per-VC Service and CoS in Cisco IP + ATM Switches



Cisco IP+ATM switches support DiffServ for MPLS traffic, alongside ATM Forum Traffic Management types for PVCs and SVCs. Each DiffServ or ATM Forum Traffic Management type gets its own “class of service buffer.” Per-VC queuing can be used in addition to the class of “class of service buffers” and this is done for ATM Forum Traffic Management types. Weighted fair queuing is used to assign bandwidths to the IP class of service buffers. This means that the IP classes share bandwidth.

Using class-based queuing instead of per-VC queuing for the IP traffic has several advantages:

- The number of parameters programmed into the network is much smaller with class-based queuing: if a network has  $N$  nodes, the number of parameters required is proportional to  $N^2$  with per-VC queuing, but proportional to  $N$  with class-based queuing.
- Class-based queuing is fairer, given approximate information. This is important because engineering of an IP network is based on estimates and models of customer traffic. With class-based queuing, premium-class traffic from any origin to any destination gets preferential access to a premium-class bandwidth left spare from other origin-destination pairs. This is much harder to achieve if bandwidths are assigned to individual origin-destination LVCs.
- Class-based queuing can be used on any link types. Link types include those that do not support virtual circuits: PPP-over-SDH and WDM. Use of class-based queuing helps make a network flexible and open to future changes in technology without major changes in operations, administration, and management. Cisco already makes switch-routers with ATM, PPP-over-SDH, and WDM interfaces.
- Class-based queuing works better with VC merge than per-VC queuing. Per-VC queuing negates the advantages of VC merge in improving signaling scale. If per-LVC queuing were used, each LVC in the tree of LVCs merging to a given destination would need a bandwidth assigned to it according to the sum of bandwidth requirements merging in from other branches. Any addition or change made to the bandwidths of the merging VCs would create a ripple of signaling through the network. This negates one of the important advantages of VC merge, namely that VC merge removes the requirement for end-to-end signaling for most LVCs.
- Even if class-based queuing is used, changes to class-based bandwidths will be required as bandwidth requirements change. However these can be dealt with as a network provisioning issue on a time-frame of at least hours or days. Class-based queuing does not require the real-time QoS signaling overheads of per-VC queuing. Furthermore, the granularity of changes with class-based queuing is per-link; with per-VC queuing, the granularity is per-VC. This is another example of how class-based queuing is more scalable.

For these reasons, Cisco strongly recommends that networks supporting IP services are engineered using class-based queuing.

## Requirements for Differential Services Approach to QoS

Good quality of service can be provided to connectionless IP traffic, on MPLS networks in particular. The process involves the following:

- Enforcement of access contracts at the edge of a network using Cisco CAR
- Using the access contracts as a basis for modeling traffic
- Optional refinement of traffic models based on operation of a network
- Setting of the links' queuing parameters according to the traffic models
- Offering SLAs of an appropriate form and strength for a connectionless IP service
- Service admission control

## Configuring Multi-VCs

The Multiprotocol Label Switching quality of service (MPLS QoS) mechanism is a feature for performing differentiated services over ATM. It allows the ATM network to treat different packets based on the EXP (experimental) field (also called CoS) of the MPLS header which has the same properties, and which can be mapped to IP precedence. You can configure multiple VCs that have different QoS characteristics between any pair of ATM-connected routers.

Every label switch router (LSR) has a corresponding number of VCs (from one to four) for the same destination, hence the term “multi-VC”. These parallel LVCs are set up automatically by the upstream edge router using the Label Distribution Protocol. Each set consists of multiple LVCs, and each LVC is treated as a member of the set.

For more detailed information on configuring multi-VCs, refer to the following document:

[MPLS QoS Multi-VC Mode for PA-A3](#)

## Setting Up LVCs

When you configure multi-VC support, four label virtual circuits (LVCs) for each destination are created by default that map to MPLS QoS. [Table 6](#) shows the LVC to MPLS QoS mapping.

**Table 6** LVC to MPLS QoS Mapping

Label Virtual Circuit Type	Class of Service	IP Type of Service
Available	0	0,4
Standard	1	1,5
Premium	2	2,6
Control	3	3, 7

To set up four default LVCs (with default mapping), you add the following instruction to the ATM subinterface configuration of the edge LSRs:

```
mpls atm multi-vc
```

The parallel LVCs are set up automatically on the ATM switches.

## Optionally Setting the MPLS Experimental Field Value

The ability to optionally set the MPLS EXP field of the label header upon entry of a customer IP packet into an MPLS network has no direct connection to the MPLS QoS multi-VC mode feature per se. However, the ability to manipulate the EXP field provides flexibility to preserve the IP precedence value in the IP type-of-service (ToS) byte in the header of an incoming IP packet. The service provider can manage queues or select LVCs based on the value of the EXP field.

You can set the MPLS experimental field (EXP) value in customer IP packets arriving at the provider edge router by means of modular QoS CLI commands or CAR commands executed on that edge router.

## Using Modular QoS CLI to Configure Ingress Label Switching Router

To use the modular QoS CLI to configure the ingress LSR appropriately for multi-VC mode functionality, perform the following steps:

- 
- Step 1** Configure a class map to classify IP packets according to their IP precedence.
- Step 2** Configure a policy map to mark MPLS packets (that is, to write their classification into the MPLS EXP field).
- Step 3** Configure the input interface of the ingress router to attach the service policy.
- 

In the following example, all packets that contain IP precedence 4 are matched by the class-map name IP\_prec4:

```
Router(config)# class-map IP_prec4
Router(config-c-map)# match ip precedence 4
Router(config-c-map)# end
```

In the following example, the MPLS EXP field of each IP packet that matches class-map IP\_prec4 is set to a value of 5:

```
Router(config)# policy-map set_experimental_5
Router(config-p-map)# class IP_prec4
Router(config-p-map-c)# set mpls experimental 5
Router(config-p-map-c)# end
```

In the following example, the service policy set\_experimental\_5 is attached to the specified Ethernet input interface (et 1/0/0):

```
Router(config)# interface et 1/0/0
Router(config-if)# service-policy input set_experimental_5
Router(config-if)# end
```

## Using CAR to Configure an Ingress Label Switching Router

To classify the packets on the ingress Edge LSR, you can use MPLS QoS committed access rate (CAR) service to set the EXP field of the MPLS header to the desired value. To use CAR to configure the ingress LSR for multi-VC mode functionality, perform the following steps:

- 
- Step 1** Configure an IP rate-limit access list for classifying IP packets according to their IP precedence.
- Step 2** Configure a rate-limit on an input interface to mark the MPLS packets (to write the packet's classification into the MPLS EXP field).
- 

In the following example, all packets containing IP precedence value 4 are matched by the rate-limit access list 24:

```
Router(config)# access-list rate-limit 24 4
Router(config)# end
```

In the following example, the MPLS EXP field is set to 4 on output of packets if input IP packets match the access-list and conform to the packet rate. The MPLS EXP field is set to 0 if packets match access list 24 and exceed the input rate.

```
Router(config)# interface et 1/0/0
Router(config-if)# rate-limit input access-group rate-limit 24 8000 8000 8000
conform-action set-mpls-exp-transmit 4 exceed-action set-mpls-exp-transmit 0
Router(config-if)# end
```

**Note**

You can also use the **mpls atm vpi 2-4** command, but it is not mandatory to specify which virtual path identifiers (VPIs) will be used for MPLS.

You need to configure **ip cef (ip cef distributed)** on a Cisco 7200) on the general configuration of the routers before you configure CAR.

## Configuring MPLS QoS in the Core of an ATM Network

To configure MPLS QoS in the core of an ATM network, perform the following steps:

- 
- Step 1** Configure an ATM MPLS subinterface on the core router and enable multi-VC mode on that subinterface.
  - Step 2** Optionally, create an MPLS QoS map and associate that map with the core router.
- 

The default for the multi-VC mode creates four LVCs (available, standard, premium, and control) for each MPLS destination.

If you do not choose to use the default for configuring LVCs, you can configure fewer LVCs by using the QoS map function.

## Configuring Queuing Functions on Router Output Interfaces

To configure class-based weighted fair queuing (CBWFQ) and weighted random early detection (WRED) functionality on a Cisco 7200 series router interface or a Cisco MGX 8850 or 8950 switch with the Cisco RPM-PR card interface, perform the following steps:

- 
- Step 1** Create a class map and associate it with an IP type of service to match on a packet.
  - Step 2** Create a policy map to match with the class map.
  - Step 3** Assign a CBWFQ to the policy map to act on the packet.
  - Step 4** Assign a WRED to the policy map to act on the packet.
  - Step 5** Specify an interface and assign the policy map on the interface.
-

## Setting the ATM-CLP Bit on Enhanced ATM Port Adapter Interfaces

To set the atm-clp bit in ATM cells exiting from an enhanced ATM port adapter interface incorporated into a Cisco 7200 series router or a Cisco MGX RPM-PR (in a Cisco MGX 8850 or 8890 switch), perform the following steps:

- 
- Step 1** Create a class map and associate it with an IP type of service to match on a packet.
  - Step 2** Create a policy map to match with the class map.
  - Step 3** Configure MPLS packets matching this class to have the CLP bit set in the outgoing ATM cells.
  - Step 4** Specify an interface and assign the policy map on the interface.
- 

## Verifying MPLS QoS Operation

To verify the operation of MPLS QoS, issue the following commands to view information about the switching interfaces, the specified QoS map used to assign a quantity of VCs, and the prefix map used to assign a QoS map to network prefixes that match a standard IP access list.

```
Router# show mpls interfaces interfaces
Router# show mpls cos-map cos-map
Router# show mpls prefix-map
```

## Configuration Examples

This section provides examples for the following configurations, based on the sample ATM LSR network configuration shown in [Figure 29](#):

- Configuration for a customer edge router (CE1)
- Configuration for LSC1
- Configuration for BPX1 and BPX2
- Configuration for LSC2
- Configuration for Edge LSR1
- Configuration for Edge LSR2

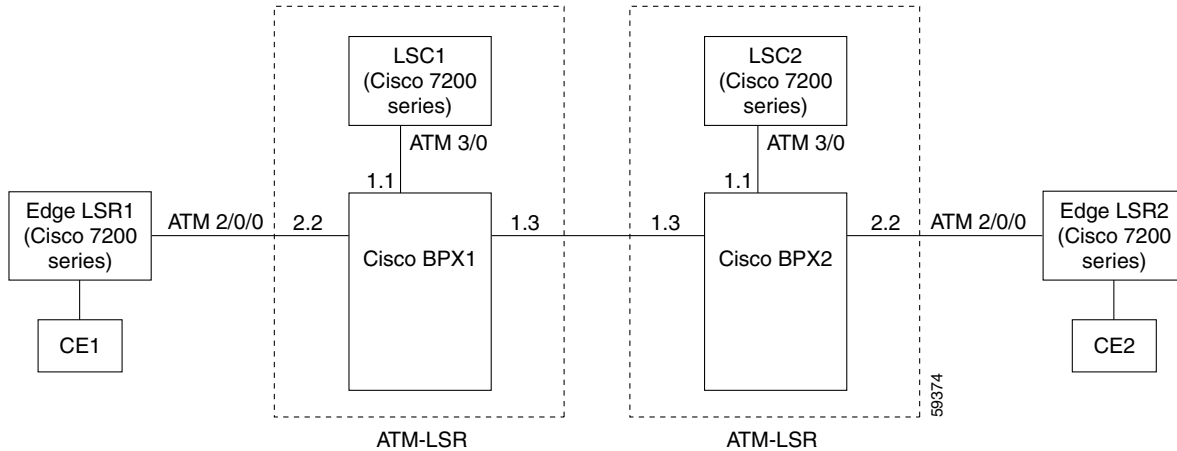
**Note**

---

The IGX series ATM switches do not support class of service (CoS).

---

Figure 29 Sample ATM LSR Network Configuration (CE1 to be added with connection to Edge LSR1)



### Configuration for CE1

2600 or 3600 CE1:

```
interface Loopback0
  ip address 7.7.7.7 255.255.255.0
!
interface FastEthernet0/1
  ip address 150.150.0.2 255.255.255.0
  duplex auto
  speed auto
!
router ospf 1
  network 7.7.7.7 0.0.0.0 area 0
  network 150.150.0.0 0.0.0.255 area 0
```

### Configuration for Edge LSR1

8850/8950 with RPM-PR LSR1:

```
ip cef distributed
!
class-map match-all exp0
  match mpls experimental 0 4
class-map match-all exp1
  match mpls experimental 1 5
class-map match-all exp2
  match mpls experimental 2 6
class-map match-all exp3
  match mpls experimental 3 7
class-map match-all acl101
  match access-group 101
class-map match-all acl102
  match access-group 102
!
policy-map atm_output
  class exp0
    bandwidth percent 10
  class exp1
    bandwidth percent 25
  class exp2
    bandwidth percent 20
```

```

        class exp3
        bandwidth percent 20
    !
    policy-map input_int
        class acl101
            police cir 64000 bc 2000 conform-action set-mpls-exp-transmit 2 exceed-action
            set-mpls-exp-transmit 1
        class acl102
            police cir 32000 bc 1500 conform-action set-mpls-exp-transmit 3 exceed-action drop
    !
    interface loopback 0
        ip address 142.6.132.2 255.255.255.255
    !
    interface Ethernet1/1
        ip address 150.150.0.1 255.255.255.0
        service-policy input input_int
    !
    interface ATM2/0/0
        no ip address
    !
    interface ATM2/0/0.5 mpls
        ip unnumbered loopback 0
        service-policy output atm_output
        mpls atm vpi 2-5
        mpls atm multi-vc
        mpls ip
    !
    access-list 101 permit ip host 7.7.7.7 any
    access-list 102 permit ip host 150.150.0.2 any

```

## Configuration for LSC1

7200 or 8850/8950 with PRM-PR LSC1:

```

    ip cef
    !
    interface loopback0
        ip address 192.103.210.5 255.255.255.255
    !
    interface ATM3/0
    no ip address
    tag-control-protocol vsi
    !
    interface XTagATM13
        ip unnumbered loopback 0
        extended-port ATM3/0 bpx 1.3
        mpls atm vpi 2-15
        mpls atm cos available 20
        mpls atm cos standard 30
        mpls atm cos premium 25
        mpls atm cos control 25
        mpls ip
    !
    interface XTagATM23
        ip unnumbered loopback 0
        extended-port ATM3/0 bpx 2.2
        mpls atm vpi 2-5
        mpls atm cos available 20
        mpls atm cos standard 30
        mpls atm cos premium 25
        mpls atm cos control 25
        mpls i

```

**Configuration for BPX1 and BPX2**

BPX1 and BPX2:

```

uptrk 1.1
addshelf 1.1 v 1 1
cnfrsrc 1.1 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 1.3
cnfrsrc 1.3 256 252207 y 1 e 512 6144 2 15 26000 100000
uptrk 2.2
cnfrsrc 2.2 256 252207 y 1 e 512 4096 2 5 26000 100000

```

**Configuration for LSC2**

7200 or 8850/8950 with RPM-PR LSC2:

```

ip cef
!
interface loopback0
 ip address 142.2.143.22 255.255.255.255
!
interface ATM3/0
 no ip address
 tag-control-protocol vsi
!
interface XTagATM13
ip unnumbered loopback 0
 extended-port ATM3/0 bpx 1.3
 mpls atm vpi 2-15
 mpls atm cos available 20
 mpls atm cos standard 30
 mpls atm cos premium 25
 mpls atm cos control 25
 mpls ip
!
interface XTagATM23
 ip unnumbered loopback 0
 extended-port ATM3/0 bpx 2.2
 mpls atm vpi 2-5
 mpls atm cos available 20
 mpls atm cos standard 30
 mpls atm cos premium 25
 mpls atm cos control 25
 mpls ip

```

**Configuration for Edge LSR2**

7200 or 8850/8950 with RPM-PR LSR2:

```

ip cef
!
class-map match-all exp0
 match mpls experimental 0 4
class-map match-all exp1
 match mpls experimental 1 5
class-map match-all exp2
 match mpls experimental 2 6
class-map match-all exp3
 match mpls experimental 3 7
class-map match-all acl101
 match access-group 101
class-map match-all acl102
 match access-group 102

```

```

!
policy-map atm_output
  class exp0
    bandwidth percent 10
  class exp1
    bandwidth percent 25
  class exp2
    bandwidth percent 20
  class exp3
    bandwidth percent 20
!
policy-map input_int
  class acl101
    police cir 64000 bc 2000 conform-action set-mpls-exp-transmit 2 exceed-action
    set-mpls-exp-transmit 1
  class acl102
    police cir 32000 bc 1500 conform-action set-mpls-exp-transmit 3 exceed-action drop
!
interface loopback 0
  ip address 142.2.142.2 255.255.255.255
!
interface Ethernet1/1
  ip address 160.160.0.1 255.255.255.0
  service-policy input input_int
!
interface ATM2/0
  no ip address
!
interface ATM2/0.9 mpls
  ip unnumbered loopback 0
  service-policy output atm_output
  mpls atm vpi 2-5
  mpls atm multi-vc
  mpls ip
!
access-list 101 permit ip host 8.8.8.8 any
access-list 102 permit ip host 160.160.0.1 any

```

## Configuration for CE2

2600 or 3600 CE1:

```

interface Loopback0
  ip address 8.8.8.8 255.255.255.0
!
interface FastEthernet0/1
  ip address 160.160.0.1 255.255.255.0
  duplex auto
  speed auto
!
router ospf 1
  network 8.8.8.8 0.0.0.0 area 0
  network 160.160.0.0 0.0.0.255 area 0

```

## QoS Support

If LSC1 supports QoS, but LSC2 does not, LSC1 makes VC requests for the following default classes:

- Control = CoS3
- Standard = CoS1

LSC2 ignores the call field in the request and allocates two UBR label VCs.

If LSR1 supports QoS, but LSR2 does not, LSR2 receives the request to create multiple label VCs, but by default, creates class 0 only (UBR).

## Starting Up the Cisco MGX 8850 PXM-45 and Cisco MGX AXSM

The Cisco MGX 8850 AXSM Broadband ATM Switching Module is a high-density, high-speed module used in the Cisco MGX 8850 combined with the high-capacity PXM-45 processor switching module to deliver connectivity from T3/E3 to OC-48c/STM-16.

This section contains the following topics:

- [Before Startup, page 102](#)
- [Copying the Images from the TFTP Server, page 104](#)
- [Upgrading the PXM-45 and AXSM Images, page 107](#)
- [Verifying the IOS Files on the PXM-45 E:Drive, page 110](#)

## Before Startup

This section contains information about the following:

- [Access Privileges, page 102](#)
- [Booting Order and Cautions, page 103](#)
- [File and Directory Names Are Case Sensitive, page 103](#)
- [Flash Command vs. Bootflash Command, page 103](#)
- [Upgrade Cisco MGX 8850 PXM-45 Card First, page 103](#)
- [Set Boot IP Address in Every Switch, page 103](#)
- [Image File Formats, page 104](#)

## Access Privileges

The default username and password for access to the switch is **cisco**. In this mode, a limited set of commands are available for troubleshooting. If you log in during stage 1 and the card progresses to the “active” or “standby” state, the card logs out the stage 1 user and prompts you to log in again. At this point, you must log in as a user with configuration privileges and the corresponding password. The stage 1 username and password are not supported on active and standby cards.

To perform some startup procedures, you need to log in as a user with SUPER\_GP privileges (default username and password: superuser, superuser).

To display detailed command lists, you must establish a session using a username with SERVICE\_GP privileges or higher.

For more information on access privileges on the Cisco MGX 8850 switch, see the *Cisco MGX 8850 Routing Switch Command Reference, Release 2.1*.

## Booting Order and Cautions

Make sure that you boot the Cisco 8850 PXM-45 Processor Switch Module properly with the correct PXM image. If the PXM-45 is not fully booted properly, you cannot reach any cards in the Cisco 8850 MGX switch. With a proper boot, you should get the “unknown.7.PXM.a>” prompt, or if you have already given the card a name, you should get a “*name*.7.PXM.a>” prompt. With either prompt, you can reach other cards.

The PXM-45 needs to be booted before you bring up the Cisco MGX 8850 RPM-PRs. Make sure that all RPM-PRs are booted properly with the correct image. Otherwise, the PXM does not recognize the RPM-PRs.

## File and Directory Names Are Case Sensitive

You must use a capital E when referencing the E: drive in switch commands. File and directory names in the switch file system are case sensitive.

## Flash Command vs. Bootflash Command

Although you can display directory contents with the **dir bootflash:** command, the **show flash:** command provides more detail. The terms *bootflash* and *flash* refer to the same entity on the RPM-PR; on other Cisco routers, bootflash and flash are separate entities.

## Upgrade Cisco MGX 8850 PXM-45 Card First

Pay attention to the following if you plan to upgrade PXM-45 and AXSM cards:

- Upgrade the PXM-45 cards first. Wait until the PXM-45 cards are operating in active and standby modes with the correct software before upgrading AXSM cards.
- The software version used by the PXM-45/B cards should be equal to or later than the version used on the AXSM, AXSM/B, and AXSM-E cards.
- Upgrade the AXSM boot software before you upgrade the run-time software.
- If you are upgrading software on more than one AXSM card in the switch at the same time, wait until one AXSM card upgrade is complete before starting the upgrade on another AXSM card.

## Set Boot IP Address in Every Switch

Because the LAN IP address is stored on the PXM-45 hard disk and is not used until after the run-time software loads, Cisco recommends that the boot IP address be set in every switch. This enables switch management over Ethernet when the boot software has loaded.

## Image File Formats

Figure 30 illustrates the filename format for released software.

**Figure 30** *Filename Format for Release Software*

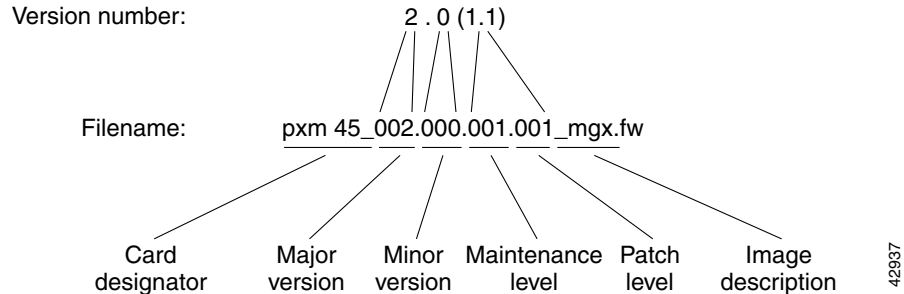
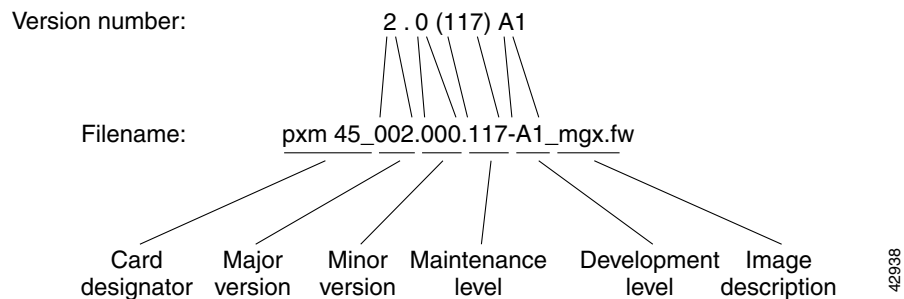


Figure 31 illustrates the filename format for prereleased firmware.

**Figure 31** *Filename Format for Prereleased Software*



## Copying the Images from the TFTP Server

To copy the software images for the Cisco MGX 8850 PXM-45 and Cisco MGX 8850 AXSM from the TFTP server to the Cisco MGX 8850 switch, perform the following steps:

- Step 1** On the PXM-45, set the node name for the switch using the **cnfname** command:

```
unknown.7.PXM.a > cnfname <node name>
```

Enter up to 32 characters for the *node name*. The Cisco MGX 8850 switch node name is case sensitive. Be sure to enter the name correctly. For example:

```
unknown.7.PXM.a > cnfname Switch
```

```
This node name will be changed to Switch. Please Confirm
cnfname: Do you want to proceed (Yes/No)? y
cnfname: Configured this node name to Switch Successfully.
SWITCH.7.PXM.a >
```

The new node name appears immediately in the next CLI prompt.

- Step 2** Verify the IP address of the Ethernet interface before you copy the image files from the TFTP server. Use the **dspipif interface** display command.



**Note** Make sure that you have a network connection from the PXM-45 card before trying to copy the image files.

For example:

```
SWITCH.7.PXM.a > dspipif lnPci0
SWITCH                          System Rev: 02.01 Sep. 13, 2001 16:19:43 GMT
MGX8850                          Node Alarm: MAJOR
IP INTERFACE CONFIGURATION
lnPci (unit number 0):
  Flags: (0x63) UP BROADCAST ARP RUNNING
  Internet address: 10.0.6.105
  Broadcast address: 0.255.255.255
  Netmask 0xff000000 Subnetmask 0xffff0000
  Ethernet address is 00:01:42:26:5f:b2
  Metric is 0
  Maximum Transfer Unit size is 1500
  20 packets received; 0 packets sent
  0 input errors; 0 output errors
  0 collisions
  DISK IP address: 10.0.6.105
SWITCH.7.PXM.a >
```

If the IP address is not configured, then you can configure the IP address, using the following command:

```
ipifconfig <interface> [ <ip_address> ] [ netmask <mask> ] [ broadcast <broad_addr> ]
[ up | down ] [ arp | noarp ] [ svc | nosvc ] [ pvc | nopvc ]
[ default | nodefault ] [ clrstats ]
```

Where:

- **<interface>** = the interface name—use **dspipif** to see valid values, for example, atm0, lnPci0, sl0
- **<ip\_address>** = IP address for interface—**<ip\_address>** has format a.b.c.d, e.g. 172.29.21.96
- **netmask <mask>** = interface network mask—**netmask** is a keyword and **<mask>** has a format of a.b.c.d, for example, 255.255.0.0
- **broadcast <broad\_addr>** = interface broadcast address—**broadcast** is a keyword and **<broad\_addr>** has a format of a.b.c.d, for example, 172.29.255.255

For example:

```
SWITCH.7.PXM.a > ipifconfig lnPci0 10.0.6.105 netmask 255.255.0.0 up
```

You can verify the IP address of the Ethernet interface, using the **dspipif lnPci0** command.

**Step 3** Save the existing configuration with the **saveallcnf** command. This command saves the configuration to a file in the C:/CNF directory. The file is named using the switch name and the current date as follows: *Name\_01\_DateTime.zip*.

```
SWITCH.7.PXM.a > saveallcnf
```

The 'saveallcnf' command can be time-consuming. The shelf must not provision new circuits while this command is running.

Do not run this command unless the shelf configuration is stable or you risk corrupting the saved configuration file.

```
Do you want to proceed (Yes/No)? y
saveallcnf: shelf configuration saved in C:/CNF/Switch_01_200109151550.zip.
```



**Caution** Avoid making configuration changes while upgrading PXM-45 software. Configuration changes can be lost when the PXM45 is reset during the upgrade.

- Step 4** Go to the directory where the images are located, `/tftpboot/mpls/atm_mpls/MGX/pxm_axsm_images`, and identify the PXM and AXSM images to be loaded in the Cisco MGX 8850 switch.

```
Workstation> ls

002.001.060.008-P2.tar          pxm1_001.001.060.008-P1_bt
002.001.060.008-P2.tar.txt     pxm1_001.001.060.008-P1_bt.fw
2.01.60.8-P2.catcs             pxm1_001.001.060.008-P1_bt.hex
CWM_UPGRD                      pxm1_001.001.060.008-P1_bt.map
axsm_002.001.060.008-A_bt      pxm1_001.001.060.008-P1_ses
axsm_002.001.060.008-A_bt.fw  pxm1_001.001.060.008-P1_ses.fw
axsm_002.001.060.008-A_bt.hex pxm1_001.001.060.008-P1_ses.map
axsm_002.001.060.008-A_bt.map pxm45_002.001.060.008-P1_bt
axsm_002.001.060.008-P2       pxm45_002.001.060.008-P1_bt.fw
axsm_002.001.060.008-P2.fw    pxm45_002.001.060.008-P1_bt.hex
axsm_002.001.060.008-P2.map   pxm45_002.001.060.008-P1_bt.map
axsme_002.001.060.008-A_bt    pxm45_002.001.060.008-P1_mgx
axsme_002.001.060.008-A_bt.fw pxm45_002.001.060.008-P1_mgx.fw
axsme_002.001.060.008-A_bt.hex pxm45_002.001.060.008-P1_mgx.map
axsme_002.001.060.008-A_bt.map release.notes
axsme_002.001.060.008-P1      rpm-boot-mz.122-3.4.T
axsme_002.001.060.008-P1.fw   rpm-js-mz.122-3.4.T
axsme_002.001.060.008-P1.map
```

- Step 5** Copy the PXM-45 and the AXSM images from the TFTP server to the C:/FW directory on the Cisco MGX 8850 switch using the `ftp <destination-address>` command.



**Note** You cannot start the File Transfer Protocol (FTP) process from the Cisco MGX 8850 switch.

```
Workstation> ftp 10.0.6.105
Connected to 10.0.6.105.
220 VxWorks FTP server (VxWorks 5.3.1) ready.
Name (10.0.6.105:username): cisco
331 Password required
Password:
230 User logged in
ftp> bin
200 Type set to I, binary mode
ftp> cd FW
250 Changed directory to "C:FW"
ftp> put pxm45_002.001.060.008-P1_bt.fw
200 Port set okay
150 Opening BINARY mode data connection
226 Transfer complete
local: pxm45_002.001.060.008-P1_bt.fw remote: pxm45_002.001.060.008-P1_bt.fw
897616 bytes sent in 9.2 seconds (96 Kbytes/s)
Hash mark printing on (8192 bytes/hash mark).
ftp> put pxm45_002.001.060.008-P1_mgx.fw
200 Port set okay
150 Opening BINARY mode data connection
226 Transfer complete
local: pxm45_002.001.060.008-P1_mgx.fw remote: pxm45_002.001.060.008-P1_mgx.fw
4889196 bytes sent in 49 seconds (97 Kbytes/s)
ftp> put axsm_002.001.060.008-P2.fw
200 Port set okay
150 Opening BINARY mode data connection
```

```

226 Transfer complete
local: axsm_002.001.060.008-P2.fw remote: axsm_002.001.060.008-P2.fw
2651752 bytes sent in 27 seconds (97 Kbytes/s)
ftp> put axsm_002.001.060.008-A_bt.fw
200 Port set okay
150 Opening BINARY mode data connection
226 Transfer complete
local: axsm_002.001.060.008-A_bt.fw remote: axsm_002.001.060.008-A_bt.fw
634528 bytes sent in 6.5 seconds (96 Kbytes/s)
ftp> bye
221 Bye...see you later
Workstation>

```

- Step 6** Verify that the PXM-45 and AXSM images are in the C:/FW directory on the Cisco MGX 8850 switch. Your current directory is C. You first need to change the directory to C:/FW using the **cd** command.

```
SWITCH.7.PXM.a > cd FW
```

Then, you can list the files on this directory using the **ls** or **dir** command.

```

SWITCH.7.PXM.a > ls
.
..
pxm45_002.000.002.000_mgx.fw
pxm45_002.000.002.000_bt.fw
axsm_002.000.002.000.fw
axsm_002.000.002.000_bt.fw
pxm45_002.001.000.235-A_bt.fw
rpm-boot-mz_002.001.000.040
rpm-js-mz_002.001.000.040
axsm_002.001.000.040-A.fw
axsm_002.001.000.210-A_bt.fw
pxm45_002.001.000.040-P1_mgx.fw
pxm45_002.001.060.008-P1_bt.fw
pxm45_002.001.060.008-P1_mgx.fw
axsm_002.001.060.008-P2.fw
axsm_002.001.060.008-A_bt.fw
In the file system :
  total space : 819200 K bytes
  free space  : 755677 K bytes

```

The files copied from the server are highlighted in the example.



**Note**

For more details on these procedures, refer to the Cisco MGX 8850 switch documentation for the current release.

## Upgrading the PXM-45 and AXSM Images

To upgrade the software images for the Cisco MGX 8850 PXM-45 and Cisco MGX 8850 AXSM cards, perform the following steps:

- Step 1** Change to the C directory on the PXM-45 card.



**Note**

You need to be in the C directory to perform an upgrade on either a PXM-45 or AXSM card.

```
SWITCH.7.PXM.a > cd ..
SWITCH.7.PXM.a > sh
```

Wait until the display is complete before continuing to the next step.

- Step 2** Enter the **sysBackupBoot** command. At the `pxm45bkup>` prompt burn the boot software on the PXM-45 using the **sysFlashBootBurn** *filename* command. Replace *filename* with the complete path to the boot file on the PXM-45 hard drive.

```
pxm45>sysBackupBoot
pxm45bkup> sysFlashBootBurn "C:FW/pxm45_002.001.060.008-P1_bt.fw"
Burning backup boot from file=C:FW/pxm45_002.001.060.008-P1_bt.fw
Please confirm: [y/n] y
ImgHdr: image_type=2,shelf_type=5,card_type=3000
Checksum size is 897616 ...
Simulating PXM Card removal.
Downloading C:FW/pxm45_002.001.060.008-P1_bt.fw into the flash ...
QUERY TABLE: flash_size=8388608 block_size=131072 write_buf_size=32
             buf_wr_time=2048 write_time=2048 erase_time=16384000
burning 0xbfc00000 verify ... ok
burning 0xbfc20000 verify ... ok
burning 0xbfc40000 verify ... ok
burning 0xbfc60000 verify ... ok
burning 0xbfc80000 verify ... ok
burning 0xbfca0000 verify ... ok
burning 0xbfcc0000 verify ... ok
Verify checksum: addr=0xbfc00000 chksum=0x91ce90e3 size=(0xdb250,897616)...ok
Flash download completed ...
value = 0 = 0x0
pxm45bkup>reboot
Login: Entering rvtAct...
BertCtcAppEventHandler
Attaching network interface sl0... done.
Login: Cisco
password:
```

- Step 3** Verify that the boot software is on the PXM-45 hard drive using the **dspcd slot** command:

```
SWITCH.7.PXM.a > dspcd 7
SWITCH                               System Rev: 02.01 Sep. 13, 2001 16:48:18 GMT
MGX8850                               Node Alarm: MAJOR
Slot Number 7 Redundant Slot: 8
Front Card      Upper Card      Lower Card
-----
Inserted Card: PXM45             UI Stratum3      PXM HardDiskDrive
Reserved Card: PXM45             UI Stratum3      PXM HardDiskDrive
State:           Active-U         Active           Active
Serial Number:  SBK0447009D      SBK044200XM      SBK043600GV
Prim SW Rev:    2.1(0.40)P1       ---              ---
Sec SW Rev:    2.1(0.40)P1       ---              ---
Cur SW Rev:    2.1(0.40)P1       ---              ---
Boot FW Rev:   2.1(60.8)P1       ---              ---
800-level Rev: B0                 A0                A0
800-level Part#: 800-06147-07     800-05787-02     800-05052-04
CLEI Code:     BAA5KMZCAA         BA7IBCLAAA       BA7IADNAAA
Reset Reason:  On Power up
Card Alarm:    NONE
Failed Reason: None
Miscellaneous Information:
Type <CR> to continue, Q<CR> to stop: q
```

The new boot firmware is highlighted in the example.

- Step 4** Load the image in the PXM-45 in slot using the **loadrev slot revision** command.



**Note** Loading the upgrade run-time software version on a PXM-45 or AXSM card uses the same **loadrev slot revision** command.

```
SWITCH.7.PXM.a > loadrev 7 2.1(60.8)P1
one or more card(s) in the logical slot may be reset.
loadrev: Do you want to proceed (Yes/No)? y
```

**Step 5** Verify that the image was loaded into slot 7 in the PXM-45 using the **dspcd slot** command.

```
SWITCH.7.PXM.a > dspcd 7
SWITCH                               System Rev: 02.01 Sep. 13, 2001 18:24:20 GMT
MGX8850                               Node Alarm: MAJOR
Slot Number 7 Redundant Slot: 8
```

	Front Card	Upper Card	Lower Card
	-----	-----	-----
Inserted Card:	PXM45	UI Stratum3	PXM HardDiskDrive
Reserved Card:	PXM45	UI Stratum3	PXM HardDiskDrive
State:	Active-U	Active	Active
Serial Number:	SBK0447009D	SBK044200XM	SBK043600GV
Prim SW Rev:	2.1(0.40)P1	---	---
<b>Sec SW Rev:</b>	<b>2.1(60.8)P1</b>	---	---
Cur SW Rev:	2.1(0.40)P1	---	---
<b>Boot FW Rev:</b>	<b>2.1(60.8)P1</b>	---	---
800-level Rev:	B0	A0	A0
800-level Part#:	800-06147-07	800-05787-02	800-05052-04
CLEI Code:	BAA5KMZCAA	BA7IBCLAAA	BA7IADNAAA
Reset Reason:	On Power up		
Card Alarm:	NONE		
Failed Reason:	None		
Miscellaneous Information:			
Type <CR> to continue, Q<CR> to stop:	q		

The new firmware and software images are highlighted in this example.

**Step 6** Start the new run-time software version on a PXM-45 (or on an AXSM card), by entering the **runrev slot revision** command.

```
SWITCH.7.PXM.a > runrev 7 2.1(60.8)P1
one or more card(s) in the logical slot may be reset.
runrev: Do you want to proceed (Yes/No)? y
```

**Step 7** Enter the **burnboot slot revision** command to burn the boot software on the standby AXSM card. You need to specify the slot number of the standby card, in this case slot 11.

```
SWITCH.7.PXM.a > burnboot 11 2.1(60.8)A
The card in slot 11 will be reset.
burnboot: Do you want to proceed (Yes/No)? y
```

**Step 8** Load the image in the AXSM in slot 11 using the **loadrev slot revision** command. Then start using the new run-time software version by entering the **runrev slot revision** command.

```
SWITCH.7.PXM.a > loadrev 11 2.1(60.8)A
one or more card(s) in the logical slot may be reset.
loadrev: Do you want to proceed (Yes/No)? y
```

```
SWITCH.7.PXM.a > runrev 11 2.1(60.8)P2
one or more card(s) in the logical slot may be reset.
runrev: Do you want to proceed (Yes/No)? y
```

The card goes through many states, but should settle in the **Active-U** state.

**Step 9** Verify that the AXSM image loaded properly using the **dspcd slot** command.



**Note** If you have multiple AXSM or other cards, make sure you have loaded the image properly on all the cards. Use the **dspcd slot** command to verify the image status.

```
SWITCH.7.PXM.a > dspcd 11
SWITCH                      System Rev: 02.01 Sep. 13, 2001 18:40:26 GMT
MGX8850                      Node Alarm: MAJOR
Slot Number: 11 Redundant Slot: NONE
      Front Card           Upper Card           Lower Card
      -----
Inserted Card: AXSM_16OC3      MMF_8_OC3_MT        ---
Reserved Card: UnReserved      UnReserved          UnReserved
State:           Active-U      Active              Empty
Serial Number:  SBK044200H5     SBK044301MQ         ---
Prim SW Rev:    2.1(60.8)P2     ---                 ---
Sec SW Rev:     ---             ---                 ---
Cur SW Rev:    2.1(60.8)P2     ---                 ---
Boot FW Rev:    2.1(60.8)A      ---                 ---
800-level Rev:  ---             ---                 ---
800-level Part#: 800-05776-06   800-04819-01       ---
CLEI Code:      BAA5HLXCAA      BAA5Z8UCAA         ---
Reset Reason:   On Power up
Card Alarm:     NONE
Failed Reason:  None
Miscellaneous Information:
Type <CR> to continue, Q<CR> to stop:
Switch          System Rev: 02.01 Sep. 13, 2001 18:40:26 GMT
MGX8850         Node Alarm: MAJOR
Crossbar Slot Status: Present
Alarm Causes
-----
NO ALARMS
```



**Note** For more details on these procedures, refer to the Cisco MGX 8850 switch documentation for the current release.

## Verifying the IOS Files on the PXM-45 E:Drive

The IOS image can be stored on the PXM-45 hard drive. To confirm this, make sure you are in the E:RPM directory and enter the **ll** command to list the contents of the directory. You should see a file named **rpm-js-mz\_002.001.000.057**, or with a similar name beginning with rpm-js-mz, which is the IOS image.



**Tip** Copy the RPM-PR Cisco IOS image into the RPM directory of the PXM-45 hard disk with the filename specified in the RPM-PR boot command.

The following screen displays the PXM E:RPM content listing:

```
SWITCH.7.PXM.a > cd E:RPM
SWITCH.7.PXM.a >

size          date          time          name
-----
    512      FEB-23-2001  17:59:54      .                <DIR>
    512      FEB-23-2001  17:59:54      ..               <DIR>
 2452288      FEB-23-2001  11:13:10      rpm-boot-mz_002.001.000.057
 7934768      FEB-23-2001  11:15:24      rpm-js-mz_002.001.000.057
    744      FEB-27-2001  10:24:22      auto_config_slot11

In the file system :
  total space : 102400 K bytes
  free  space : 91984 K bytes
```

# Command Reference

This section describes the CLI commands that you can use in conjunction with the MPLS LSC:

- **extended-port**
- **interface xtagatm**
- **mpls atm control-vc**
- **mpls atm cos**
- **mpls atm disable-headend-vc**
- **mpls atm vpi**
- **mpls atm vp-tunnel**
- **mpls request-labels for**
- **show atm vc**
- **show controllers vsi control-interface**
- **show controllers vsi descriptor**
- **show controllers vsi session**
- **show controllers vsi status**
- **show controllers vsi traffic**
- **show controllers xtagatm**
- **show mpls atm-ldp bindings**
- **show mpls atm-ldp bindings**
- **show mpls atm-ldp bindwait**
- **show mpls atm-ldp capability**
- **show mpls atm-ldp summary**
- **show xtagatm cos-bandwidth-allocation xtagatm**
- **show xtagatm cross-connect**
- **show xtagatm vc**

All other commands used with this feature are documented in the command reference publications.

## Command Conventions

<b>boldface</b> font	Commands and keywords are in <b>boldface</b> type.
<i>italic</i> font	Arguments for which you supply values are in <i>italics</i> . In a context that does not allow <i>italics</i> , arguments are enclosed in angle brackets < >.
[ ]	Elements in square brackets are optional.
{ x   y   z }	Alternative keywords are grouped in braces and separated by vertical bars.
[ x   y   z ]	Optional keywords are grouped in brackets and separated by vertical bars.

## CLI Command Summary

Table 7 summarizes the MPLS commands that evolved from existing tag-switching commands.

**Table 7 Summary of MPLS Commands That Changed from Tag-Switching Commands**

MPLS Command	Old Tag-Switching Command	Description
<code>interface xtagatm</code>	<code>interface xtagatm</code>	Creates an XtagATM interface and enters the interface configuration mode, which allows you to enter commands to configure the interface.
<code>mpls atm control-vc</code>	<code>tag-control-protocol vsi</code>	Configures the use of the VSI on a particular master control port.
<code>mpls atm cos</code>	<code>tag-switching atm cos</code>	Changes the value of configured bandwidth allocation for CoS.
<code>mpls atm disable-headend-vc</code>	<code>tag-switching atm disable-headend-vc</code>	Removes all headend VCs from the MPLS LSC and disables its ability to function as an edge LSR.
<code>mpls atm vpi</code>	<code>tag-switching atm vpi</code>	Configures the range of values to use in the VPI field for label VCs.
<code>mpls atm vp-tunnel</code>	<code>tag-switching atm vp-tunnel</code>	Specifies an interface or a subinterface as a VP tunnel.
<code>mpls request-labels for</code>	<code>tag-switching request-tags for</code>	Restricts the creation of LVCs through the use of access lists on the LSC or label edge router.
<b>Show Commands</b>		
<code>show controllers xtagatm</code>	<code>show controllers xtagatm</code>	Displays information about an extended MPLS ATM interface controlled through the VSI protocol. (If an interface is not specified, this command displays information about all extended MPLS ATM interfaces controlled through the VSI protocol.)
<code>show mpls atm-ldp bindings</code>	<code>show interface xtagatm</code>	Displays information about an extended MPLS ATM interface.
<code>show mpls atm-ldp bindings</code>	<code>show tag-switching atm-tdp bindings</code>	Displays the requested entries from the ATM LDP label bindings database.
<code>show mpls atm-ldp bindwait</code>	<code>show tag-switching atm-tdp bindwait</code>	Displays the number of bindings waiting for label assignments from a remote MPLS ATM switch.
<code>show xtagatm cos-bandwidth-allocation xtagatm</code>	<code>show xtagatm cos-bandwidth-allocation xtagatm</code>	Displays information about CoS bandwidth allocation on extended MPLS ATM interfaces.
<code>show xtagatm cross-connect</code>	<code>show xtagatm cross-connect</code>	Displays information about the LSC view of the cross-connect table on the remotely controlled ATM switch.
<code>show xtagatm vc</code>	<code>show xtagatm vc</code>	Displays information about terminating VCs on extended MPLS ATM (XtagATM) interfaces.
<b>Debug Commands</b>		
<code>debug mpls xtagatm cross-connect</code>	<code>debug tag-switching xtagatm cross-connect</code>	Displays requests and responses for establishing and removing cross-connects on a controlled ATM switch.

**Table 7** Summary of MPLS Commands That Changed from Tag-Switching Commands (continued)

<b>MPLS Command</b>	<b>Old Tag-Switching Command</b>	<b>Description</b>
<b>debug mpls xtagatm errors</b>	<b>debug tag-switching xtagatm errors</b>	Displays information about errors and abnormal conditions that occur on XtagATM interfaces.
<b>debug mpls xtagatm events</b>	<b>debug tag-switching xtagatm events</b>	Displays information about major events on XtagATM interfaces, except for VCs and cross-connects.
<b>debug mpls xtagatm vc</b>	<b>debug tag-switching xtagatm vc</b>	Displays information about events that affect XtagATM terminating VCs.

## extended-port

To associate an extended MPLS ATM (XTagATM) interface with an external interface on the remotely controlled ATM switch, use the **extended-port** command in interface configuration mode.

```
extended-port ctrl-if { bpx bpx-port-number | igx igx-port-number | descriptor vsi-descriptor |
vsi vsi-port-number }
```

```
no extended-port ctrl-if { bpx bpx-port-number | igx igx-port-number | descriptor vsi-descriptor |
vsi vsi-port-number }
```

Syntax Description		
<i>ctrl-if</i>		The XtagATM interface used to control the remote ATM switch. You must configure VSI on this interface using the <b>label-control-protocol</b> command.
<b>bp</b> x <i>bp</i> x-port-number		The associated Cisco BPX switch interface. To specify the interface, use the native BPX syntax.  <i>slot.port</i> [.virtual port]  You can only use this form of the command with a Cisco BPX switch.
<b>ig</b> x <i>ig</i> x-port-number		The associated Cisco IGX switch interface. To specify the interfaces, use the native BPX syntax.  <i>slot.port</i> [.virtual port]  You can only use this form of the command with a Cisco IGX switch.
<b>descriptor</b> <i>vsi-descriptor</i>		The VSI physical descriptor of the associated port .  The <i>vsi-descriptor</i> string must exactly match the corresponding VSI physical descriptor.
<b>vsi</b> <i>vsi-port-number</i>		VSI logical interface number (hex) of the associated port.

**Defaults** No default behavior or values.

**Command Modes** Interface configuration

Command History	Release	Modification
	12.0(3)T	This command was introduced.

**Usage Guidelines** The **extended-port** interface configuration command associates an XtagATM interface with an external interface on the remotely controlled ATM switch. The three alternate forms of the command permit the external interface on the controlled ATM switch to be specified in three different ways.

**Examples** The following examples create an XtagATM interface, using different command qualifiers.  
The following example creates an XtagATM interface and binds it to BPX switch port 2.3:

```
interface xtagatm23
extended-port atm0/0 bpx 2.3
```

The following example creates an XtagATM interface and binds it to port 2.4:

```
interface Xtagatm24
extended-port atm0/0 descriptor 0.2.4.0
```

The following example creates an XtagATM interface and binds it to port 1622:

```
interface Xtagatm1622
extended-port atm0/0 vsi 0x00010614
```

---

**Related Commands**

Command	Description
<a href="#">interface xtagatm</a>	Creates an XtagATM interface.
<a href="#">show controllers vsi status</a>	Displays a summary of each VSI-controlled interface.

---

# interface xtagatm

To create an extended MPLS ATM (XTagATM) interface, use the **interface xtagatm** command in global configuration mode. The interface is created the first time this command is issued for a particular interface number.

**interface xtagatm** *if-num*

<b>Syntax Description</b>	<i>if-num</i>	The interface number.
---------------------------	---------------	-----------------------

<b>Defaults</b>	No default behavior or values.	
-----------------	--------------------------------	--

<b>Command Modes</b>	Global configuration	
----------------------	----------------------	--

<b>Command History</b>	<b>Release</b>	<b>Modification</b>
	12.0(5)T	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology.	

<b>Usage Guidelines</b>	XtagATM interfaces are virtual interfaces that are created on reference-like tunnel interfaces. XtagATM interfaces are similar to ATM interfaces, except that the former only supports LC-ATM encapsulation.
-------------------------	--

<b>Examples</b>	In the following example, an XtagATM interface is created with interface number 62:
-----------------	---

```
(config)# interface xtagatm62
```

<b>Related Commands</b>	<b>Command</b>	<b>Description</b>
	<a href="#">extended-port</a>	Associates the currently selected extended XTagATM interface with a remotely controlled switch.

## mpls atm control-vc

To configure the control-VC virtual path identifier (VPI) and virtual circuit identifier (VCI) values for the initial link to the MPLS peer, use the **mpls atm control-vc** command in interface configuration mode. Use this command to establish the LDP session and to carry non-IP traffic.

**mpls atm control-vc** *vpi vci*

**no mpls atm control-vc** *vpi vci*

Syntax Description		
	<i>vpi</i>	Virtual path identifier, in the range from 0 to 4095.
	<i>vci</i>	Virtual circuit identifier, in the range from 0 to 65535.

Defaults	
	0/32

Command Modes	
	Interface configuration

Command History	Release	Modification
	12.0(5)T	This command was introduced.
	12.2(4)T	This command was updated to reflect the MPLS IETF terminology. The VPI range of values was extended to 4095.

Usage Guidelines	
	The default VPI VCI for the control VC is (3, 32). If for any reason you need to have a different control-VC, use the <b>mpls atm control-vc</b> command to configure any VPI VCI allowed by the <i>vpi vci</i> argument for the control VC.

Examples	
	The following example creates an MPLS subinterface on a router and selects VPI 1 and VCI 34 as the control VC.

```
interface atm4/0.1 mpls
mpls ip
mpls atm control-vc 1 34
```

Related Commands	Command	Description
	<b>mpls ip (interface)</b>	Enables label switching of IPv4 packets on an interface.

# mpls atm cos

To change the configured bandwidth allocation for CoS, use the **mpls atm cos** command in xtagatm interface configuration mode.

**mpls atm cos** { **available** | **standard** | **premium** | **control** } *weight*

Syntax Description		
	<b>available</b>	The weight for the <b>available</b> class. This is the lowest class priority.
	<b>standard</b>	The weight for the <b>standard</b> class. This is the next lowest class priority.
	<b>premium</b>	The weight for the <b>premium</b> class. This is the next highest class priority.
	<b>control</b>	The weight for the <b>control</b> class. This is the highest class priority.
	<i>weight</i>	The total weight for all CoS traffic classes. This value ranges from 0 to 100.

**Defaults** Available 50%, control 50%

**Command Modes** xtagatm interface configuration

Command History	Release	Modifications
	12.0(5)T	This command was introduced.
	12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

**Examples** In the following example, the XtagATM interface is configured for CoS traffic.

```
Router(config)# interface Xtagatm12
Router(config-if)# extended-port atm1/0 descriptor 1.2
Router(config-if)# mpls ip
Router(config-if)# mpls atm cos available 49
Router(config-if)# mpls atm cos standard 50
Router(config-if)# mpls atm cos premium 0
Router(config-if)# mpls atm cos control 1
```

## mpls atm disable-headend-vc

To remove all headend VCs from the MPLS LSC and disable its ability to function as an edge LSR, use the **mpls atm disable-headend-vc** command in global configuration mode. To restore the headend VCs of the MPLS LSC and restores full edge LSR functionality, use the **no** form of the command.

**mpls atm disable-headend-vc**

**no mpls atm disable-headend-vc**

**Syntax Description** This command has no arguments or keywords.

**Defaults** No default behavior or values.

**Command Modes** Global configuration

### Command History

Release	Modification
12.0(7)DC	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

### Usage Guidelines

This command prevents the LSC from initiating headend LVCs, and thus reduces the number of LVCs used in the network.

### Examples

In the following example, the MPLS LSC is disabled from acting like an edge LSR and therefore cannot create headend LVCs.

```
mpls atm disable-headend-vc
```

# mpls atm vpi

To configure the range of values to use in the virtual path identifier (VPI) field for label VCs, use the **mpls atm vpi** command in interface configuration mode. To clear the range of values, use the **no** form of this command.

```
mpls atm vpi vpi [- vpi] [vci-range low - high]
```

```
no mpls atm vpi vpi [- vpi] [vci-range low - high]
```

## Syntax Description

<i>vpi</i>	Virtual path identifier, low end of range (0 to 4095).
- <i>vpi</i>	(Optional) Virtual path identifier, high end of range (0 to 4095).
<b>vci-range</b> <i>low - high</i>	(Optional) Range of VCI values the subinterface can use for the VPI(s).

## Defaults

The default VPI range is 1-1.

The default VCI range is 33- 65535.

## Command Modes

Interface configuration

## Command History

Release	Modification
12.0(5)T	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology. The <b>vci-range</b> keyword was added. The VPI range of values was extended to 4095.

## Usage Guidelines

You might need to change the default tag virtual path identifier (VPI) range on the switch if:

- It is an administrative policy to use a VPI value other than 1, the default VPI.
- There are many LVCs on an interface.

To configure ATM MPLS on a router interface (for example, an ATM Interface Processor), you must enable an MPLS subinterface.



### Note

The **mpls atm control-vc** and **mpls atm vpi** subinterface level configuration commands are available on any interface that can support ATM labeling.

Use this command to select an alternate range of VPI values for ATM label assignment on this interface. The two ends of the link negotiate a range defined by the intersection of the range configured at each end.

- To configure the VPI range for an edge label switch router (edge LSR) subinterface connected to another router or to an LSC, limit the range to four VPIs.
- For an ATM-LSR, the VPI range specified must lie within the range that was configured on the ATM switch for the corresponding ATM switch interface.

- If the LDP neighbor is a router, the VPI range can be no larger than two. For example, you can specify from 5 to 6 (a range of two), not 5 to 7 (a range of three). If the LDP neighbor is a switch, the maximum VPI range is 0 to 255.

If you use the **vci-range** keyword, you must specify a VPI value.

### Examples

The following example creates a subinterface and selects a VPI range from VPI 1 to VPI 3:

```
(config)# interface atm4/0.1 mpls
(config-if)# mpls ip
(config-if)#mpls atm vpi 1-3
```

The following example creates a subinterface with a VPI of 240 and a VCI range between 33 and 4090:

```
(config)# interface atm4/0.1 mpls
(config-if)# mpls ip
(config-if)# mpls atm vpi 240 vci-range 33-4090
```

### Related Commands

Command	Description
<a href="#">mpls atm control-vc</a>	Configures VPI and VCI values for the initial link to an MPLS peer.

# mpls atm vp-tunnel

To specify an interface or a subinterface as a VP tunnel, use the **mpls atm vp-tunnel** command in interface configuration mode. To remove the VP tunnel from an interface or subinterface, use the **no** form of this command.

```
mpls atm vp-tunnel vpi [vci-range low - high]
```

```
no mpls atm vp-tunnel vpi [vci-range low - high]
```

## Syntax Description

<i>vpi</i>	The VPI value for the local end of the tunnel (0 to 4095).
<b>vci-range</b> <i>low - high</i>	Range of VCI values the VP tunnel can use.

## Defaults

If you do not specify a VCI range for the VP tunnel, the tunnel uses the default VCI range of 33 to 65535.

## Command Modes

Interface configuration

## Command History

Release	Modification
12.0(5)T	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology. The <b>vci-range</b> keyword was added. The VPI range of values was extended to 4095.

## Usage Guidelines

The **mpls atm vp-tunnel** and **mpls atm vpi** commands are mutually exclusive.

This command is available on both extended MPLS ATM (XTagATM) interfaces and on LC-ATM subinterfaces of router ATM interfaces. The command is not available on the LS1010, where all subinterfaces are automatically VP tunnels.

It is not necessary to use the **mpls atm vp-tunnel** command on an XTagATM interface in most applications. The switch learns (through VSI interface discovery) whether the XTagATM interface is a tunnel, the VPI value of the tunnel, and tunnel status.

## Examples

The following example creates an MPLS subinterface VP tunnel with a VPI value of 4:

```
(config-if)#mpls atm vp-tunnel 4
```

The following example creates a VP tunnel with a value of 240 and a VCI range of 33 to 4090:

```
(config-if)#mpls atm vp-tunnel 240 vci-range 33-4090
```

# mpls request-labels for

To restrict the creation of LSPs through the use of access lists on the LSC or label edge router, use the **mpls request-labels for** command in global configuration mode. To disable this feature, use the **no** form of this command.

**mpls request-labels for** *access list*

**no mpls request-labels for**

## Syntax Description

<i>access list</i>	A named or numbered standard IP access list.
--------------------	--

## Defaults

No default behavior or values

## Command Modes

Global configuration

## Command History

Release	Modification
12.1(5)T	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

## Usage Guidelines

The command includes the following usage guidelines:

- You can specify either an access list number or name.
- When you create an access list, the end of the access list contains an implicit deny statement for everything if it did not find a match before reaching the end.
- If you omit the mask from an IP host address access list specification, 0.0.0.0 is assumed to be the mask.

## Examples

In the following example, headend LVCs are prevented from being established from the LSC to all 192.168.x.x destinations. The following commands are added to the LSC configuration:

```
(config)# mpls request-labels for 1
(config)# access-list 1 deny 192.168.0.0 0.255.255.255
(config)# access-list 1 permit any
```

## Related Commands

Command	Description
<b>access list</b>	Creates access lists.
<b>ip access-list</b>	Permits or denies access to IP addresses.

## show atm vc

To display information about private ATM virtual circuits (VCs), use the **show atm vc** command in privileged EXEC mode.

```
show atm vc [vcd]
```

<b>Syntax Description</b>	<i>vcd</i>	(Optional) The virtual circuit descriptor (VCD) about which to display information.
<b>Defaults</b>	No default behavior or values.	
<b>Command Modes</b>	Privileged EXEC	
<b>Command History</b>	<b>Release</b>	<b>Modification</b>
	12.0(5)T	This command was introduced.

**Usage Guidelines** Private VCs exist on the control interface of an MPLS LSC to support corresponding VCs on an extended MPLS ATM interface.

VCs on the extended MPLS ATM interfaces do not appear in the **show atm vc** command output. Instead, the **show xtagatm vc** command provides similar output that shows information only on extended MPLS ATM VCs.

### Examples

In the following example, no VCD is specified and private VCs are present:

```
Router# show atm vc
AAL /      Peak  Avg.  Burst
Interface  VCD   VPI   VCI  Type  Encapsulation  Kbps  Kbps  Cells  Status
ATM1/0     1     0    40   PVC   AAL5-SNAP      0     0     0     ACTIVE
ATM1/0     2     0    41   PVC   AAL5-SNAP      0     0     0     ACTIVE
ATM1/0     3     0    42   PVC   AAL5-SNAP      0     0     0     ACTIVE
ATM1/0     4     0    43   PVC   AAL5-SNAP      0     0     0     ACTIVE
ATM1/0     5     0    44   PVC   AAL5-SNAP      0     0     0     ACTIVE
ATM1/0    15     1    32   PVC   AAL5-XTAGATM   0     0     0     ACTIVE
ATM1/0    17     1    34   TVC   AAL5-XTAGATM   0     0     0     ACTIVE
ATM1/0    26     1    43   TVC   AAL5-XTAGATM   0     0     0     ACTIVE
ATM1/0    28     1    45   TVC   AAL5-XTAGATM   0     0     0     ACTIVE
ATM1/0    29     1    46   TVC   AAL5-XTAGATM   0     0     0     ACTIVE
ATM1/0    33     1    50   TVC   AAL5-XTAGATM   0     0     0     ACTIVE
```

When you specify a VCD that corresponds to that of a private VC on a control interface, the display output appears as follows:

```
Router# show atm vc 15
ATM1/0 33    1    50   TVC   AAL5-XTAGATM   0     0     0     ACTIVE
ATM1/0: VCD: 15, VPI: 1, VCI: 32, etype:0x8, AAL5 - XTAGATM, Flags: 0xD38
```

```

PeakRate: 0, Average Rate: 0, Burst Cells: 0, VCmode: 0x0
XTagATM1, VCD: 1, VPI: 0, VCI: 32
OAM DISABLED, InARP DISABLED
InPkts: 38811, OutPkts: 38813, InBytes: 2911240, OutBytes: 2968834
InPRoc: 0, OutPRoc: 0, Broadcasts: 0
InFast: 0, OutFast: 0, InAS: 0, OutAS: 0
OAM F5 cells sent: 0, OAM cells received: 0
Status: ACTIVE

```

Table 8 describes the significant fields in the sample output.

**Table 8** *show atm vc Command Field Descriptions*

Field	Description
ATM1/0	Interface slot and number.
VCD	Virtual circuit descriptor (virtual circuit number).
VPI	Virtual path identifier.
VCI	Virtual circuit identifier.
etype	Ethernet type.
AAL5 - XTAGATM	Type of ATM adaptation layer (AAL) and encapsulation. A private VC has AAL5 and encapsulation XtagATM.
Flags	Bit mask describing virtual circuit information. The flag values are summed to result in the displayed value.  0x10000 ABR VC 0x20000 CES VC 0x40000 TVC 0x100 TEMP (automatically created) 0x200 MULTIPOINT 0x400 DEFAULT_RATE 0x800 DEFAULT_BURST  0x10 ACTIVE 0x20 PVC 0x40 SVC 0x0 AAL5-SNAP 0x1 AAL5-NLPID 0x2 AAL5-FRNLPIID 0x3 AAL5-MUX 0x4 AAL3/4-SMDS 0x5 QSAAL  0x6 AAL5-ILMI 0x7 AAL5-LANE 0x8 AAL5-XTAGATM 0x9 CES-AAL1 0xA F4-OAM
PeakRate	Number of packets transmitted at the peak rate.
Average Rate	Number of packets transmitted at the average rate.
Burst Cells	Value that, when multiplied by 32, equals the maximum number of ATM cells the virtual circuit can transmit at the peak rate of the virtual circuit.

**Table 8** *show atm vc Command Field Descriptions (continued)*

Field	Description
VCmode	AIP-specific or NPM-specific register describing the usage of the virtual circuit. Contains values such as rate queue, peak rate, and AAL mode, which are also displayed in other fields.
XTagATM1	Interface of corresponding extended MPLS ATM VC.
VCD	Virtual circuit descriptor (virtual circuit number) of the corresponding extended MPLS ATM VC.
VPI	Virtual path identifier of the corresponding extended MPLS ATM VC.
VCI	Virtual channel identifier of the corresponding extended MPLS ATM VC.
OAM frequency	Seconds between OAM loopback messages or DISABLED if OAM is not in use on this VC.
InARP frequency	Minutes between InARP messages, or DISABLED if InARP is not in use on this VC.
InPkts	Total number of packets received on this virtual circuit. This number includes all silicon-switched, fast-switched, autonomous-switched, and process-switched packets.
OutPkts	Total number of packets sent on this virtual circuit. This number includes all silicon-switched, fast-switched, autonomous-switched, and process-switched packets.
InBytes	Total number of bytes received on this virtual circuit. This number includes all silicon-switched, fast-switched, autonomous-switched, and process-switched packets.
OutBytes	Total number of bytes sent on this virtual circuit. This number includes all silicon-switched, fast-switched, autonomous-switched, and process-switched packets.
InPRoc	Number of process-switched input packets.
OutPRoc	Number of process-switched output packets.
Broadcasts	Number of process-switched broadcast packets.
InFast	Number of fast-switched input packets.
OutFast	Number of fast-switched output packets.
InAS	Number of autonomous-switched or silicon-switched input packets.
OutAS	Number of autonomous-switched or silicon-switched output packets.
OAM F5 cells sent	Number of OAM cells sent on this virtual circuit.
OAM cells received	Number of OAM cells received on this virtual circuit.
Status	Displays the current state of the specified ATM interface.

# show controllers vsi control-interface

To display information about an ATM interface that controls an external switch, use the **show controllers vsi control-interface** command in EXEC mode.

```
show controllers vsi control-interface [interface]
```

<b>Syntax Description</b>	<i>interface</i> (Optional) The interface number.
---------------------------	---

<b>Defaults</b>	No default behavior or values.
-----------------	--------------------------------

<b>Command Modes</b>	EXEC
----------------------	------

<b>Command History</b>	<b>Release</b>	<b>Modification</b>
	12.0(5)T	This command was introduced.

**Examples** The following is sample output from the **show controllers vsi control-interface** command:

```
Router# show controllers vsi control-interface
```

```
Interface:          ATM2/0          Connections:          14
```

The display shows the number of cross-connects currently on the switch that were established by the MPLS LSC through the VSI over the control interface.

<b>Related Commands</b>	<b>Command</b>	<b>Description</b>
	<a href="#">mpls atm control-vc</a>	Configures the use of VSI on a control port.

# show controllers vsi descriptor

To display information about a switch interface discovered by the MPLS LSC through VSI, use the **show controllers vsi descriptor** command in EXEC mode. You can specify an interface by its (switch-supplied) physical descriptor.

**show controllers vsi descriptor** [*descriptor*]

<b>Syntax Description</b>	<i>descriptor</i>	(Optional) Physical descriptor. For the Cisco BPX switch, the physical descriptor has the following form: <i>slot.port.0</i>
---------------------------	-------------------	--

**Defaults** No default behavior or values.

**Command Modes** EXEC

<b>Command History</b>	<b>Release</b>	<b>Modification</b>
	12.0(5)T	This command was introduced.

**Usage Guidelines** Per-interface information includes the following:

- Interface name
- Physical descriptor
- Interface status
- Physical interface state (supplied by the switch)
- Acceptable VPI and VCI ranges
- Maximum cell rate
- Available cell rate (forward/backward)
- Available channels

Similar information is displayed when you enter the **show controllers xtagatm** command. However, you must specify an IOS interface name instead of a physical descriptor.

**Examples** The following is sample output from the **show controllers vsi descriptor** command:

```
Router# show controllers vsi descriptor 12.2.0

Phys desc: 12.2.0
Log intf: 0x000C0200 (0.12.2.0)
Interface: XTagATM0
IF status: up                    IFC state: ACTIVE
Min VPI: 1                       Maximum cell rate: 10000
Max VPI: 259                     Available channels: 2000
```

## show controllers vsi descriptor

```

Min VCI: 32 Available cell rate (forward): 10000
Max VCI: 65535 Available cell rate (backward): 10000

```

Table 9 describes the significant fields in the sample command output shown above.

**Table 9** *show controllers vsi descriptor Command Field Descriptions*

Field	Description
Phys desc	Physical descriptor. A string learned from the switch that identifies the interface.
Log intf	Logical interface ID. This 32-bit entity, learned from the switch, uniquely identifies the interface.
Interface	The (IOS) interface name.
IF status	Overall interface status. Can be “up,” “down,” or “administratively down.”
Min VPI	Minimum virtual path identifier. Indicates the low end of the VPI range configured on the switch.
Max VPI	Maximum virtual path identifier. Indicates the high end of the VPI range configured on the switch.
Min VCI	Minimum virtual channel identifier. Indicates the low end of the VCI range configured on the switch.
Max VCI	Maximum virtual channel identifier. Indicates the high end of the VCI range configured on, or determined by, the switch.
IFC state	Operational state of the interface, according to the switch. Can be one of the following: <ul style="list-style-type: none"> <li>FAILED_EXT (that is, an external alarm)</li> <li>FAILED_INT (indicates the inability of the MPLS LSC to communicate with the VSI slave controlling the interface, or another internal failure)</li> <li>REMOVED (administratively removed from the switch)</li> </ul>
Maximum cell rate	Maximum cell rate for the interface, which has been configured on the switch, in cells per second.
Available channels	Indicates the number of channels (endpoints) that are currently free to be used for cross-connects.
Available cell rate (forward)	Cell rate that is currently available in the forward (that is, ingress) direction for new cross-connects on the interface.
Available cell rate (backward)	Cell rate that is currently available in the backward (that is, egress) direction for new cross-connects on the interface.

## Related Commands

Command	Description
<a href="#">show controllers xtatm</a>	Displays information about an extended MPLS ATM interface.

# show controllers vsi session

To display information about all sessions with VSI slaves, use the **show controllers vsi session** command in EXEC mode.

**show controllers vsi session** [*session-num* [interface *interface*]]



## Note

A session consists of an exchange of VSI messages between the VSI master (the LSC) and a VSI slave (an entity on the switch). There can be multiple VSI slaves for a switch. On the BPX switch, each port or trunk card assumes the role of a VSI slave.

## Syntax Description

<i>session-num</i>	(Optional) The session number.
interface <i>interface</i>	(Optional) The VSI control interface.

## Defaults

No default behavior or values.

## Command Modes

EXEC

## Command History

Release	Modification
12.0(5)T	This command was introduced.

## Usage Guidelines

If a session number and an interface are specified, detailed information on the individual session is presented. If the session number is specified, but the interface is omitted, detailed information on all sessions with that number is presented.

## Examples

The following is sample output from the **show controllers vsi session** command:

Router# **show controllers vsi session**

Interface	Session	VCD	VPI/VCI	Switch/Slave Ids	Session State
ATM0/0	0	1	0/40	0/1	ESTABLISHED
ATM0/0	1	2	0/41	0/2	ESTABLISHED
ATM0/0	2	3	0/42	0/3	DISCOVERY
ATM0/0	3	4	0/43	0/4	RESYNC-STARTING
ATM0/0	4	5	0/44	0/5	RESYNC-STOPPING
ATM0/0	5	6	0/45	0/6	RESYNC-UNDERWAY
ATM0/0	6	7	0/46	0/7	UNKNOWN
ATM0/0	7	8	0/47	0/8	UNKNOWN
ATM0/0	8	9	0/48	0/9	CLOSING
ATM0/0	9	10	0/49	0/10	ESTABLISHED
ATM0/0	10	11	0/50	0/11	ESTABLISHED
ATM0/0	11	12	0/51	0/12	ESTABLISHED

Table 10 describes the significant fields in the sample command output shown above.

**Table 10** *show controllers vsi session Command Field Descriptions*

Field	Description
Interface	Control interface name.
Session	Session number (from 0 to <n-1>), where n is the number of sessions on the control interface.
VCD	Virtual circuit descriptor (virtual circuit number). Identifies the VC carrying the VSI protocol between the master and the slave for this session.
VPI/VCI	Virtual path identifier/virtual channel identifier (for the VC used for this session).
Switch/Slave Ids	Switch and slave identifiers supplied by the switch.
Session State	Indicates the status of the session between the master and the slave. <ul style="list-style-type: none"> <li>• ESTABLISHED is the fully operational steady state.</li> <li>• UNKNOWN indicates that the slave is not responding.</li> </ul> Other possible states include the following: CONFIGURING RESYNC_STARTING RESYNC_UNDERWAY RESYNC_ENDING DISCOVERY SHUTDOWN_STARTING SHUTDOWN_ENDING INACTIVE

In the following example, session number 9 is specified with the **show controllers vsi session** command:

```
Router# show controllers vsi session 9
```

```
Interface:          ATM1/0      Session number:      9
VCD:                10          VPI/VCI:             0/49
Switch type:        BPX         Switch id:            0
Controller id:      1           Slave id:             10
Keepalive timer:    15          Powerup session id:  0x0000000A
Cfg/act retry timer: 8/8       Active session id:   0x0000000A
Max retries:        10          Ctrl port log intf:  0x000A0100
Trap window:        50          Max/actual cmd wndw: 21/21
Trap filter:        all         Max checksums:       19
Current VSI version: 1           Min/max VSI version: 1/1
Messages sent:      2502        Inter-slave timer:   4.000
Messages received:  2502        Messages outstanding: 0
```

Table 11 describes the significant fields in the sample command output shown above.

**Table 11** *show controllers vsi session Command Field Descriptions*

Field	Description
Interface	Name of the control interface on which this session is configured.
Session number	A number from 0 to <n-1>, where n is the number of slaves. Configured on the MPLS LSC with the <b>slaves</b> option of the <b>label-control-protocol vsi</b> command.
VCD	Virtual circuit descriptor (virtual circuit number). Identifies the VC that carries VSI protocol messages for this session.
VPI/VCI	Virtual path identifier or virtual channel identifier for the VC used for this session.
Switch type	Switch device (for example, the BPX switch).
Switch id	Switch identifier (supplied by the switch).
Controller id	Controller identifier. Configured on the LSC, as well as on the switch, with the <b>id</b> option of the <b>label-control-protocol vsi</b> command.
Slave id	Slave identifier (supplied by the switch).
Keepalive timer	VSI master keepalive timeout period, in seconds. Configured on the MPLS LSC through the <b>keepalive</b> option of the <b>label-control-protocol-vsi</b> command. If no valid message is received by the MPLS LSC within this time period, it sends a keepalive message to the slave.
Powerup session id	Session ID (supplied by the slave) used at powerup time.
Cfg/act retry timer	Configured and actual message retry timeout period, in seconds. If no response is received for a command sent by the master within the actual retry timeout period, the message is re-sent. This applies to most message transmissions. The configured retry timeout value is specified through the <b>retry</b> option of the <b>label-control-protocol vsi</b> command. The actual retry timeout value is the larger of the configured value and the minimum retry timeout value permitted by the switch.
Active session id	Session ID for the currently active session (supplied by the slave).
Max retries	Maximum number of times that a particular command transmission will be retried by the master. That is, a message may be sent up to <max_retries+1> times. Configured on the MPLS LSC through the <b>retry</b> option of the <b>label-control-protocol vsi</b> command.
Ctrl port log intf	Logical interface identifier for the control port, as supplied by the switch.
Trap window	Maximum number of outstanding trap messages permitted by the master. This is advertised, but not enforced, by the LSC.
Max/actual cmd wndw	Maximum command window is the maximum number of outstanding (that is, unacknowledged) commands that may be sent by the master before waiting for acknowledgments. This number is communicated to the master by the slave.  The command window is the maximum number of outstanding commands that are permitted by the master, before it waits for acknowledgments. This is always less than the maximum command window.

**Table 11** *show controllers vsi session Command Field Descriptions (continued)*

<b>Field</b>	<b>Description</b>
Trap filter	This is always “all” for the LSC, indicating that it wants to receive all traps from the slave. This is communicated to the slave by the master.
Max checksums	Maximum number of checksum blocks supported by the slave. (In this release, the MPLS LSC uses only one checksum block.)
Current VSI version	VSI protocol version currently in use by the master for this session. (In the first release, this is always 1.)
Min/max VSI version	Minimum and maximum VSI versions supported by the slave, as last reported by the slave. If both are zero, the slave has not yet responded to the master.
Messages sent	Number of commands sent to the slave.
Inter-slave timer	Timeout value associated by the slave for messages it sends to other slaves.  On a VSI-controlled switch with a distributed slave implementation (such as the BPX switch), VSI messages may be sent between slaves to complete their processing.  For the MPLS LSC VSI implementation to function properly, the value of its retry timer is forced to be at least two times the value of the inter-slave timer. (See “Cfg/act retry timer” in this table.)
Messages received	Number of responses and traps received by the master from the slave for this session.
Messages outstanding	Current number of outstanding messages (that is, commands sent by the master for which responses have not yet been received).

**Related Commands**

<b>Command</b>	<b>Description</b>
<a href="#">mpls atm control-vc</a>	Configures the use of VSI on a control port.

# show controllers vsi status

To display a one-line summary of each VSI-controlled interface, use the **show controllers vsi status** command in EXEC mode.

## show controllers vsi status

**Syntax Description** This command has no arguments or keywords.

**Defaults** No default behavior or values.

**Related Commands** EXEC

Command History	Release	Modification
	12.0(5)T	This command was introduced.

**Usage Guidelines** If an interface has been discovered by the LSC, but no extended MPLS ATM interface has been associated with it through the **extended-port** interface configuration command, then the interface name is marked <unknown>, and interface status is marked n/a.

**Examples** The following is sample output from the **show controllers vsi status** command:

```
Router# show controllers vsi status

Interface Name          IF Status  IFC State  Physical Descriptor
switch control port    n/a       ACTIVE    12.1.0
XTagATM0                up        ACTIVE    12.2.0
XTagATM1                up        ACTIVE    12.3.0
<unknown>              n/a       FAILED-EXT 12.4.0
```

[Table 12](#) describes the significant fields in the sample command output shown above.

**Table 12** *show controllers vsi status Command Field Descriptions*

Field	Description
Interface Name	The (IOS) interface name.
IF Status	Overall interface status. Can be “up,” “down,” or “administratively down.”

**Table 12** *show controllers vsi status Command Field Descriptions (continued)*

<b>Field</b>	<b>Description</b>
IFC State	The operational state of the interface, according to the switch. Can be one of the following: <ul style="list-style-type: none"><li>• ACTIVE (indicated the interface is up)</li><li>• FAILED_EXT (that is, an external alarm)</li><li>• FAILED_INT (indicates the inability of the MPLS LSC to communicate with the VSI slave controlling the interface, or another internal failure)</li><li>• REMOVED (administratively removed from the switch)</li></ul>
Physical Descriptor	A string learned from the switch that identifies the interface.

## show controllers vsi traffic

To display traffic information about VSI-controlled interfaces, VSI sessions, or VCs on VSI-controlled interfaces, use the **show controllers vsi traffic** command in EXEC mode.

```
show controllers vsi traffic [{descriptor descriptor | session session-num | vc [descriptor
descriptor [vpi vci ]]}]
```

### Syntax Description

<b>descriptor</b> <i>descriptor</i>	Specifies the interface.
<b>session</b> <i>session-num</i>	Specifies a session number.
<i>vpi</i>	Virtual path identifier (0 to 4095).
<i>vci</i>	Virtual circuit identifier (0 to 65535).

### Defaults

No default behavior or values.

### Command Modes

EXEC

### Command History

Release	Modification
12.0(5)T	This command was introduced.
12.2(4)T	The VPI range of values was extended to 4095.

### Usage Guidelines

If none of the keywords is specified, traffic for all interfaces is displayed. You can specify a single interface by its (switch-supplied) physical descriptor. For the BPX switch, the physical descriptor has the form:

```
slot.port. 0
```

If a session number is specified, the output displays VSI protocol traffic by message type. The VC traffic display is also displayed by the **show xtagatm vc cross-connect traffic descriptor** command.

**Examples**

The following is sample output from the **show controllers vsi traffic** command:

```
Router# show controllers vsi traffic

Phys desc: 10.1.0
Interface: switch control port
IF status: n/a
Rx cells: 304250           Rx cells discarded: 0
Tx cells: 361186           Tx cells discarded: 0
Rx header errors: 4294967254 Rx invalid addresses (per card): 80360
Last invalid address: 0/53

Phys desc: 10.2.0
Interface: XTagATM0
IF status: up
Rx cells: 202637           Rx cells discarded: 0
Tx cells: 194979           Tx cells discarded: 0
Rx header errors: 4294967258 Rx invalid addresses (per card): 80385
Last invalid address: 0/32

Phys desc: 10.3.0
Interface: XTagATM1
IF status: up
Rx cells: 182295           Rx cells discarded: 0
Tx cells: 136369           Tx cells discarded: 0
Rx header errors: 4294967262 Rx invalid addresses (per card): 80372
Last invalid address: 0/32
```

[Table 13](#) describes the significant fields in the sample command output shown above.

**Table 13** *show controllers vsi traffic Command Field Descriptions*

<b>Field</b>	<b>Description</b>
Phys desc	Physical descriptor of the interface.
Interface	The (IOS) interface name.
Rx cells	Number of cells received on the interface.
Tx cells	Number of cells transmitted on the interface.
Rx cells discarded	Number of cells received on the interface that were discarded due to traffic management.
Tx cells discarded	Number of cells that could not be transmitted on the interface due to traffic management and which were therefore discarded.
Rx header errors	Number of cells that were discarded due to ATM header errors.
Rx invalid addresses	Number of cells received with an invalid address (that is, an unexpected VPI/VCI combination). With the Cisco BPX switch, this count is of all such cells received on all interfaces in the port group of this interface.
Last invalid address	Number of cells received on this interface with ATM cell header errors.

The following sample output is displayed when you enter the **show controllers vsi traffic session 9** command:

```
Router# show controllers vsi traffic session 9
                                     Sent                               Received
Sw Get Cnfg Cmd:                     3656           Sw Get Cnfg Rsp:           3656
Sw Cnfg Trap Rsp:                     0             Sw Cnfg Trap:              0
Sw Set Cnfg Cmd:                       1             Sw Set Cnfg Rsp:           1
Sw Start Resync Cmd:                   1             Sw Start Resync Rsp:       1
Sw End Resync Cmd:                     1             Sw End Resync Rsp:         1
Ifc Getmore Cnfg Cmd:                  1             Ifc Getmore Cnfg Rsp:     1
Ifc Cnfg Trap Rsp:                     4             Ifc Cnfg Trap:             4
Ifc Get Stats Cmd:                     8             Ifc Get Stats Rsp:         8
Conn Cmt Cmd:                          73            Conn Cmt Rsp:              73
Conn Del Cmd:                          50            Conn Del Rsp:              0
Conn Get Stats Cmd:                    0             Conn Get Stats Rsp:        0
Conn Cnfg Trap Rsp:                    0             Conn Cnfg Trap:           0
Conn Bulk Clr Stats Cmd:                0             Conn Bulk Clr Stats Rsp:   0
Gen Err Rsp:                           0             Gen Err Rsp:               0
unused:                                0             unused:                     0
unknown:                                0             unknown:                    0
TOTAL:                                 3795          TOTAL:                      3795
```

Table 14 describes the significant fields in the sample command output shown above.

**Table 14** *show controllers vsi traffic session Command Field Descriptions*

Field	Description
Sw Get Cnfg Cmd	Number of VSI “get switch configuration command” messages sent.
Sw Cnfg Trap Rsp	Number of VSI “switch configuration asynchronous trap response” messages sent.
Sw Set Cnfg Cmd	Number of VSI “set switch configuration command” messages sent.
Sw Start Resync Cmd	Number of VSI “set resynchronization start command” messages sent.
Sw End Resync Cmd	Number of VSI “set resynchronization end command” messages sent.
Ifc Getmore Cnfg Cmd	Number of VSI “get more interfaces configuration command” messages sent.
Ifc Cnfg Trap Rsp	Number of VSI “interface configuration asynchronous trap response” messages sent.
Ifc Get Stats Cmd	Number of VSI “get interface statistics command” messages sent.
Conn Cmt Cmd	Number of VSI “set connection committed command” messages sent.
Conn Del Cmd	Number of VSI “delete connection command” messages sent.
Conn Get Stats Cmd	Number of VSI “get connection statistics command” messages sent.
Conn Cnfg Trap Rsp	Number of VSI “connection configuration asynchronous trap response” messages sent.
Conn Bulk Clr Stats Cmd	Number of VSI “bulk clear connection statistics command” messages sent.
Gen Err Rsp	Number of VSI “generic error response” messages sent or received.
Sw Get Cnfg Rsp	Number of VSI “get connection configuration command response” messages received.
Sw Cnfg Trap	Number of VSI “switch configuration asynchronous trap” messages received.

**Table 14** *show controllers vsi traffic session Command Field Descriptions (continued)*

<b>Field</b>	<b>Description</b>
Sw Set Cnfg Rsp	Number of VSI “set switch configuration response” messages received.
Sw Start Resync Rsp	Number of VSI “set resynchronization start response” messages received.
Sw End Resync Rsp	Number of VSI “set resynchronization end response” messages received.
Ifc Getmore Cnfg Rsp	Number of VSI “get more interfaces configuration response” messages received.
Ifc Cnfg Trap	Number of VSI “interface configuration asynchronous trap” messages received.
Ifc Get Stats Rsp	Number of VSI “get interface statistics response” messages received.
Conn Cmt Rsp	Number of VSI “set connection committed response” messages received.
Conn Del Rsp	Number of VSI “delete connection response” messages received.
Conn Get Stats Rsp	Number of VSI “get connection statistics response” messages received.
Conn Cnfg Trap	Number of VSI “connection configuration asynchronous trap” messages received.
Conn Bulk Clr Stats Rsp	Number of VSI “bulk clear connection statistics response” messages received.
unused, unknown	<p>“Unused” messages are those whose function codes are recognized as being part of the VSI protocol, but which are not used by the MPLS LSC and, consequently, are not expected to be received or sent.</p> <p>“Unknown” messages have function codes that the MPLS LSC does not recognize as part of the VSI protocol.</p>
TOTAL	Total number of VSI messages sent or received.

# show controllers xtagatm

To display information about an extended MPLS ATM interface controlled through the VSI protocol, use the **show controllers xtagatm** command in EXEC mode.

**show controllers xtagatm** *if-num*

Syntax Description	<i>if-num</i>	The interface number.
--------------------	---------------	-----------------------

**Defaults** No default behavior or values.

**Command Modes** EXEC

Command History	Release	Modification
	12.0(5)T	This command was introduced.
	12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

**Usage Guidelines** Per-interface information includes the following:

- Interface name
- Physical descriptor
- Interface status
- Physical interface state (supplied by the switch)
- Acceptable VPI and VCI ranges
- Maximum cell rate
- Available cell rate (forward/backward)
- Available channels

**Examples** In this example, the sample output is from the **show controllers xtagatm** command specifying interface 0.

```
Router# show controllers xtagatm 0

Interface XTagATM0 is up
Hardware is Tag-Controlled ATM Port (on BPX switch BPX-VSI1)
Control interface ATM1/0 is up
Physical descriptor is 10.2.0
Logical interface 0x000A0200 (0.10.2.0)
Oper state ACTIVE, admin state UP
VPI range 1-255, VCI range 32-65535
VPI is not translated at end of link
Tag control VC need not be strictly in VPI/VCI range
Available channels: ingress 30, egress 30
```

```

Maximum cell rate: ingress 300000, egress 300000
Available cell rate: ingress 300000, egress 300000
Endpoints in use: ingress 7, egress 8, ingress/egress 1
Rx cells 134747
rx cells discarded 0, rx header errors 0
rx invalid addresses (per card): 52994
last invalid address 0/32
Tx cells 132564
tx cells discarded: 0

```

Table 15 describes the significant fields in the sample command output shown above.

**Table 15** show controllers xtagatm Command Field Descriptions

Field	Description
Interface XTagATM0 is up	The overall status of the interface, which can be “up,” “down,” or “administratively down.”
Hardware is Tag-Controlled ATM Port	<p>The hardware type.</p> <p>If the XtagATM interface is assigned to a switch port, the following text is displayed as well:</p> <p><i>on switch-type switch switch-name</i></p> <p>The string indicates the type of switch and the switch name learned from the switch.</p> <p>If the XtagATM interface not assigned to a switch interface, the following text is displayed:</p> <p><i>Not bound to a control interface and switch port</i></p> <p>If the XtagATM interface is assigned to a switch interface, but the target switch interface has not been discovered by the LSC, the following text is displayed:</p> <p><i>Bound to undiscovered switch port (id number)</i></p> <p>The variable <i>number</i> is the logical interface ID in hexadecimal notation.</p>
Control interface ATM1/0 is up	The XtagATM interface was assigned to the VSI master, whose control interface is ATM1/0. This control interface is up.
Physical descriptor is...	A string identifying the interface that was learned from the switch.
Logical interface	A 32-bit entity, learned from the switch, that identifies the interface. It appears in both hexadecimal and dotted quad notation.
Oper state	<p>Operational state of the interface, according to the switch. The state can be one of the following:</p> <ul style="list-style-type: none"> <li>ACTIVE</li> <li>FAILED_EXT (that is, an external alarm)</li> <li>FAILED_INT (indicates the inability of the MPLS LSC to communicate with the VSI slave controlling the interface, or another internal failure)</li> <li>REMOVED (administratively removed from the switch)</li> </ul>
admin state	Administrative state of the interface, which can be either Up or Down.

**Table 15** *show controllers xtagatm Command Field Descriptions (continued)*

Field	Description
VPI range 1 to 4095	The allowable VPI range for the interface that was configured on the switch.
VCI range 32 to 65535	The allowable VCI range for the interface that was configured on, or determined by, the switch.
LSC control VC need not be strictly in VPI or VCI range	The label control VC does not need to be within the range specified by VPI range, but may be on VPI 0 instead.
Available channels	The number of channels (endpoints) that are currently free to be used for cross-connects.
Maximum cell rate	Maximum cell rate for the interface, which was configured on the switch.
Available cell rate	Cell rate that is currently available for new cross-connects on the interface.
Endpoints in use	Number of endpoints (channels) in use on the interface, broken down by anticipated traffic flow, as follows: <ul style="list-style-type: none"> <li>• Ingress—Endpoints carry traffic into the switch</li> <li>• Egress—Endpoints carry traffic away from the switch</li> <li>• Ingress/egress—Endpoints carry traffic in both directions</li> </ul>
Rx cells	Number of cells received on the interface.
rx cells discarded	Number of cells received on the interface that were discarded due to traffic management actions (rx header errors).
rx header errors	Number of cells received on the interface with cell header errors.
rx invalid addresses (per card)	Number of cells received with invalid addresses (that is, unexpected VPI or VCI). On the BPX switch, this counter is maintained per port group (not per interface).
last invalid address	Address of the last cell received on the interface with an invalid address (for example, 0/32).
Tx cells	Number of cells transmitted from the interface.
tx cells discarded	Number of cells intended for transmission from the interface that were discarded due to traffic management actions.

**Related Commands**

Command	Description
<a href="#">show controllers vsi descriptor</a>	Displays information about a switch interface discovered by the MPLS LSC through the VSI.

## show interface xtagatm

To display information about an extended Multiprotocol Label Switching (MPLS) ATM interface, use the **show interface xtagatm** command in user EXEC or privileged EXEC mode.

**show interface xtagatm** *if-number*

### Syntax Description

<i>if-number</i>	Specifies the MPLS ATM interface number.
------------------	--

### Command Modes

User EXEC  
Privileged EXEC

### Command History

Release	Modification
12.0(5)T	This command was introduced.
12.3T	Sample command output was added for when an interface is down.

### Usage Guidelines

Extended MPLS ATM interfaces are virtual interfaces that are created on first reference like tunnel interfaces. Extended MPLS ATM interfaces are similar to ATM interfaces except that the former only supports LC-ATM encapsulation.

### Examples

The following is sample command output when an interface is down:

Router# **show interface xt92**

```
XTagATM92 is down, line protocol is down
Hardware is Tag-Controlled Switch Port
Interface is unnumbered. Using address of Loopback1 (15.15.15.15)
MTU 4470 bytes, BW 4240 Kbit, DLY 80 used,
reliability 186/255, txload 1/255, rxload 1/255
Encapsulation ATM, loopback not set
Keepalive set (10 sec) [00:00:08/4]
Encapsulation(s): AAL5
Control interface: not configured
0 terminating VCs
Switch port traffic:
  ? cells input, ? cells output
Last input 00:00:10, output never, output hang never
Last clearing of "show interface" counters never
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue: 0/0 (size/max)
Terminating traffic:
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
138 packets input, 9193 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 i
00:05:46: %SYS-5-CONFIG_I: Configured from console by consolegnored, 0 abort
142 packets output, 19686 bytes, 0 underruns
```

```

0 output errors, 0 collisions, 0 interface resets
0 output buffer failures, 0 output buffers swapped out

```

The following is sample command output when an interface is up:

**Router# show interface xt92**

```

XTagATM92 is up, line protocol is up
Hardware is Tag-Controlled Switch Port
Interface is unnumbered. Using address of Loopback1 (15.15.15.15)
MTU 4470 bytes, BW 4240 Kbit, DLY 80 used,
reliability 174/255, txload 1/255, rxload 1/255
Encapsulation ATM, loopback not set
Keepalive set (10 sec)
Encapsulation(s): AAL5
Control interface: ATM3/0, switch port: bpx 9.2
3 terminating VCs, 7 switch cross-connects
Switch port traffic:
275 cells input, 273 cells output
Last input 00:00:00, output never, output hang never
Last clearing of "show interface" counters never
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue: 0/0 (size/max)
Terminating traffic:
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
127 packets input, 8537 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
131 packets output, 18350 bytes, 0 underruns
0 output errors, 0 collisions, 0 interface resets
0 output buffer failures, 0 output buffers swapped out

```

Table 16 describes the significant fields shown in the displays.

**Table 16** *show interface xtagatm Field Descriptions*

Field	Description
XTagATM0 is up XTagATM0 is down	Interface is currently active (up) or inactive (down).
line protocol is up line protocol is down	Displays the line protocol as up or down.
Hardware is Tag-Controlled Switch Port	Specifies the hardware type.
Interface is unnumbered	Specifies that this is an unnumbered interface.
MTU	Maximum transmission unit of the extended MPLS ATM interface.
BW	Bandwidth of the interface (in kbps).
DLY	Delay of the interface in microseconds.
reliability	Reliability of the interface as a fraction of 255 (255/255 is 100% reliability), calculated as an exponential average over 5 minutes.
Encapsulation ATM	Encapsulation method.
loopback not set	Indicates that loopback is not set.

**Table 16** *show interface xtagatm Field Descriptions (continued)*

Field	Description
Keepalive set (10 sec) [00:00:08/4]	Indicates why the Xtag line is down. Valid values are: 1—Internal usage. 2—Administratively down. 3—Internal usage. 4—No extended port is configured. 5—Some cross-connects from an old session have been left operational. 6—No extended port or a wrong extended port was configured. 7—No control port was configured. 8—Internal usage. 9—Internal usage. 10—Internal usage. 11—Internal usage. 12—External port. The XTag is mapped to an invalid port on the switch. 13—External port. The XTag is mapped to a port that is down. 14—External port is mapped to the control panel on the switch. 15—OAM is being used to track the link state. The neighbor may be down or it is not responding to the OAM calls.
Encapsulation(s)	Identifies the ATM adaptation layer.
Control interface	Identifies the control port switch port with which the extended MPLS ATM interface has been associated through the <b>extended-port</b> interface configuration command.
<i>n</i> terminating VCs	Number of terminating VCs with an endpoint on this extended MPLS ATM interface. Packets are sent or received by the MPLS LSC on a terminating VC, or are forwarded between an LSC-controlled switch port and a router interface.
7 switch cross-connects	Number of switch cross-connects on the external switch with an endpoint on the switch port that corresponds to this interface. This includes cross-connects to terminating VCs that carry data to and from the LSC, and cross-connects that bypass the MPLS LSC and switch cells directly to other ports.
Switch port traffic	Number of cells received and sent on all cross-connects associated with this interface.
Terminating traffic	Indicates that counters below this line apply only to packets sent or received on terminating VCs.
5-minute input rate, 5-minute output rate	Average number of bits and packets sent per second in the last 5 minutes.
packets input	Total number of error-free packets received by the system.
bytes	Total number of bytes, including data and MAC encapsulation, in the error-free packets received by the system.

**Table 16** *show interface xtagatm Field Descriptions (continued)*

Field	Description
no buffer	Number of received packets discarded because there was no buffer space in the main system. Compare with ignored count. Broadcast storms on Ethernet systems and bursts of noise on serial lines are often responsible for no input buffer events.
broadcasts	Total number of broadcast or multicast packets received by the interface.
runts	Number of packets that are discarded because they are smaller than the medium's minimum packet size.
giants	Number of packets that are discarded because they exceed the medium's maximum packet size.
input errors	Total number of no buffer, runts, giants, CRCs, frame, overrun, ignored and abort counts. Other input-related errors can also increment the count, so that this sum may not balance with other counts.
CRC	<p>Cyclic redundancy checksum generated by the originating LAN station or far-end device does not match the checksum calculated from the data received.</p> <p>On a LAN, this usually indicates noise or transmission problems on the LAN interface or the LAN bus. A high number of CRCs is usually the result of traffic collisions or a station sending bad data.</p> <p>On a serial link, CRCs usually indicate noise, gain hits, or other transmission problems on the data link.</p>
frame	Number of packets received incorrectly having a CRC error and a noninteger number of octets.
overrun	Number of times the serial receiver hardware was unable to hand received data to a hardware buffer because the input rate exceeded the receiver's ability to handle the data.
ignored	Number of received packets ignored by the interface because the interface hardware ran low on internal buffers. These buffers are different from the system buffers mentioned previously in the buffer description. Broadcast storms and bursts of noise can cause the ignored count to be incremented.
abort	Illegal sequence of one bits on the interface. This usually indicates a clocking problem between the interface and the data-link equipment.
packets output	Total number of messages sent by the system.
bytes	Total number of bytes, including data and MAC encapsulation, sent by the system.
underruns	Number of times that the sender has been running faster than the router can handle data. This condition may never be reported on some interfaces.
output errors	Sum of all errors that prevented the final transmission of datagrams out of the interface being examined. Note that this may not balance with the sum of the enumerated output errors, because some datagrams may have more than one error, and others may have errors that do not fall into any of the specifically tabulated categories.

**Table 16** *show interface xtagatm Field Descriptions (continued)*

<b>Field</b>	<b>Description</b>
collisions	Number of messages re-sent due to an Ethernet collision. This is usually the result of an overextended LAN (Ethernet or transceiver cable too long, more than two repeaters between stations, or too many cascaded multiport transceivers). A packet that collides is counted only one time in output packets.
interface resets	Number of times an interface has been completely reset. Resets occur if packets queued for transmission were not sent within several seconds. On a serial line, this can be caused by a malfunctioning modem that is not supplying the transmit clock signal, or by a cable problem. If the system notices that the carrier detect line of a serial interface is up, but the line protocol is down, it periodically resets the interface in an effort to restart it. Interface resets can also occur when an interface is looped back or shut down.

**Related Commands**

<b>Command</b>	<b>Description</b>
<b>interface xtagatm</b>	Enters configuration mode for an extended MPLS ATM (XTagATM) interface.

# show mpls atm-ldp bindings

To display the requested entries from the ATM LDP label bindings database, use the **show mpls atm-ldp bindings** command in EXEC mode.

```
show mpls atm-ldp bindings [A.B.C.D {mask | length}]
[local-label vpi vci] [remote-label vpi vci] [neighbor atm slot/subslot/port]
```

Syntax	Description
<i>A.B.C.D</i>	(Optional) Destination of prefix.
<i>mask</i>	(Optional) Destination netmask prefix.
<i>length</i>	(Optional) Netmask length, in the range from 1 to 32.
<b>local-label</b> <i>vpi vci</i>	(Optional) Matches locally assigned label values. (VPI range is 0 to 4095. VCI range is 0 to 65535.)
<b>remote-label</b> <i>vpi vci</i>	(Optional) Matches remotely assigned label values. (VPI range is 0 to 4095. VCI range is 0 to 65535.)
<b>neighbor atm</b> <i>slot/subslot/port</i>	(Optional) Matches labels assigned by a neighbor on the specified ATM interface.

**Defaults** Displays all database entries.

**Command Modes** EXEC

Command History	Release	Modification
	12.0(5)T	This command was introduced.
	12.2(4)T	This command was updated to reflect the MPLS IETF terminology. The VPI range of values was extended to 4095.

**Usage Guidelines** The display output can show the entire database or a subset of entries based on the prefix, the VC label value, or an assigning interface.

**Examples** The following is sample output from this command:

```
Switch# show mpls atm-ldp bindings
Destination: 10.13.13.6/32
Headend Router ATM1/0.1 (2 hops) 1/33 Active, VCD=8, CoS=available
Headend Router ATM1/0.1 (2 hops) 1/34 Active, VCD=9, CoS=standard
Headend Router ATM1/0.1 (2 hops) 1/35 Active, VCD=10, CoS=premium
Headend Router ATM1/0.1 (2 hops) 1/36 Active, VCD=11, CoS=control

Destination: 192.168.0.0/8
Headend Router ATM1/0.1 (1 hop) 1/37 Active, VCD=4, CoS=available
Headend Router ATM1/0.1 (1 hop) 1/34 Active, VCD=5, CoS=standard
Headend Router ATM1/0.1 (1 hop) 1/35 Active, VCD=6, CoS=premium
Headend Router ATM1/0.1 (1 hop) 1/36 Active, VCD=7, CoS=control
```

## ■ show mpls atm-ldp bindings

Destination: 10.0.0.18/32  
 Tailend Router ATM1/0.1 1/33 Active, VCD=8

Table 17 describes the significant fields in the sample command output shown above.

**Table 17** *show mpls atm-ldp bindings Command Field Descriptions*

Field	Description
Destination:	Destination IP address/length of netmask
Headend Router	VC type: <ul style="list-style-type: none"> <li>• Headend—VC that originates at this router</li> <li>• Tailend—VC that terminates at this router</li> </ul>
ATM1/0.1	ATM interface
1/33	VPI/VCI
Active	LVC state: <ul style="list-style-type: none"> <li>• Active—Set up and working</li> <li>• Bindwait—Waiting for response</li> </ul>

### Related Commands

Command	Description
<a href="#">show mpls atm-ldp bindwait</a>	Displays the number of bindings waiting for label assignments for a remote MPLS ATM switch.

# show mpls atm-ldp bindwait

To display the number of bindings waiting for label assignments from a remote MPLS ATM switch, use the **show mpls atm-ldp bindwait** command in EXEC mode.

**show mpls atm-ldp bindwait**

**Syntax Description** This command has no keywords or arguments.

**Defaults** No default behavior or values.

**Command Modes** EXEC

Command History	Release	Modification
	12.0(5)T	This command was introduced.
	12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

**Examples** The following shows a sample display using this command:

```
Router# show mpls atm-ldp bindwait
```

If everything is working properly, this command does not display any output.

Related Commands	Command	Description
	<a href="#">show mpls atm-ldp bindings</a>	Displays requested entries from the ATM LDP label binding database.

## show mpls atm-ldp capability

To display the Multiprotocol Label Switching (MPLS) ATM capabilities negotiated with Label Distribution Protocol (LDP) neighbors for label-controlled ATM (LC-ATM) interfaces, use the **show mpls atm-ldp capability** command in privileged EXEC mode.

### show mpls atm-ldp capability

**Syntax Description** This command has no arguments or keywords.

**Command Modes** Privileged EXEC

Command History	Release	Modification
	11.1CT	This command was introduced.
	12.0(10)ST	This command was modified to reflect Multiprotocol Label Switching (MPLS) Internet Engineering Task Force (IETF) command syntax and terminology.
	12.1(8a)E	This command was integrated into Cisco IOS Release 12.1(8a)E.
	12.2(2)T	This command was integrated into Cisco IOS Release 12.2(2)T.

**Usage Guidelines** When two label switch routers (LSRs) establish an LDP session, they negotiate parameters for the session, such as the range of virtual path identifiers (VPIs) and virtual channel identifiers (VCIs) that will be used as labels.

This command displays the MPLS ATM capabilities negotiated by LDP or the Tag Distribution Protocol (TDP).

**Examples** The following is sample output from the **show mpls atm-ldp capability** command:

```
Router# show mpls atm-ldp capability

ATM0/1/0          VPI          VCI          Alloc  Odd/Even  VC Merge
                  Range        Range        Scheme Scheme    IN   OUT
Negotiated       [100 - 101]  [33 - 1023]  UNIDIR          -   -
Local            [100 - 101]  [33 - 16383] UNIDIR          EN   EN
Peer             [100 - 101]  [33 - 1023]  UNIDIR          -   -

ATM0/1/1          VPI          VCI          Alloc  Odd/Even  VC Merge
                  Range        Range        Scheme Scheme    IN   OUT
Negotiated       [201 - 202]  [33 - 1023]  BIDIR          -   -
Local            [201 - 202]  [33 - 16383] UNIDIR  ODD          NO   NO
Peer             [201 - 202]  [33 - 1023]  BIDIR  EVEN          -   -
```

Table 18 describes the fields shown in the display.

**Table 18** show mpls atm-ldp capability Field Descriptions

Field	Description
VPI Range	Minimum and maximum numbers of VPIs supported on this interface.
VCI Range	Minimum and maximum numbers of VCIs supported on this interface.
Alloc Scheme	<p>Indicates the applicable allocation scheme, as follows:</p> <ul style="list-style-type: none"> <li>• UNIDIR—Unidirectional capability indicates that the peer can, within a single VPI, support binding of the same VCI to different prefixes on different directions of the link.</li> <li>• BIDIR—Bidirectional capability indicates that within a single VPI, a single VCI can appear in one binding only. In this case, one peer allocates bindings in the even VCI space, and the other in the odd VCI space. The system with the lower LDP identifier assigns even-numbered VCIs.</li> </ul> <p>The negotiated allocation scheme is UNIDIR, only if, both peers have UNIDIR capability. Otherwise, the allocation scheme is BIDIR.</p> <p><b>Note</b> These definitions for <i>unidirectional</i> and <i>bidirectional</i> are consistent with normal ATM usage of the terms; however, they are exactly opposite from the definitions for them in the IETF LDP specification.</p>
Odd/Even Scheme	Indicates whether the local device or the peer is assigning an odd- or even-numbered VCI when the negotiated scheme is BIDIR. It does not display any information when the negotiated scheme is UNIDIR.
VC Merge	<p>Indicates the type of virtual circuit merge support available on this interface. There are two possibilities, as follows:</p> <p>IN—Indicates the input interface merge capability. IN displays the following values:</p> <ul style="list-style-type: none"> <li>• EN—The hardware interface supports virtual circuit merge, and virtual circuit merge is enabled on the device.</li> <li>• DIS—The hardware interface supports virtual circuit merge and virtual circuit merge is disabled on the device.</li> <li>• NO—The hardware interface does not support virtual circuit merge.</li> </ul> <p>OUT—Indicates the output interface merge capability. OUT displays the same values as the input merge side.</p> <p>The virtual circuit merge capability is meaningful only on ATM switches. This capability is not negotiated.</p>
Negotiated	Indicates the set of options that both LDP peers have agreed to share on this interface. For example, the VPI or VCI allocation on either peer remains within the negotiated range.
Local	Indicates the options supported locally on this interface.
Peer	Indicates the options supported by the remote LDP peer on this interface.

■ show mpls atm-ldp capability

Related Commands	Command	Description
	mpls ldp atm vc-merge	Controls whether ATM-virtual circuit merge (multipoint-to-point) is supported for unicast label virtual circuits.

# show mpls atm-ldp summary

To display summary information about all the entries in the ATM label binding database, use the **show mpls atm-ldp summary** command in privileged EXEC mode.

## show mpls atm-ldp summary

**Syntax Description** This command has no arguments or keywords.

**Defaults** This command has no default behavior or values.

**Command Modes** Privileged EXEC

Command History	Release	Modification
	11.1CT	This command was introduced.
	12.0(10)ST	This command was modified to reflect MPLS IETF command syntax and terminology.
	12.2(2)T	This command was integrated into Cisco IOS Release 12.2(2)T.
	12.0(22)S	This command was integrated into Cisco IOS Release 12.0(22)S.

**Usage Guidelines** Use this command to display dynamic ATM accounting information.

**Examples** The following shows sample output from the **show mpls atm-ldp summary** command:

```
Router# show mpls atm-ldp summary

Total number of destinations: 406

ATM label bindings summary
interface      total  active  local  remote  Bwait  Rwait  IFwait
ATM0/0/0       406   406    404    2        0      0      0
ATM0/0/1       406   406     3    403        0      0      0
```

[Table 19](#) describes the significant fields shown in the display.

**Table 19** *show mpls atm-ldp summary Field Descriptions*

Field	Description
Total number of destinations	Number of destination address prefixes in the LC-ATM database.
interface	Name of an interface with associated ATM label bindings.
total	Total number of ATM labels on this interface.

**Table 19** *show mpls atm-ldp summary Field Descriptions (continued)*

<b>Field</b>	<b>Description</b>
active	Number of ATM labels in an “active” state that are ready to use for data transfer.
local	Number of ATM labels on this interface assigned by this label-switch router (LSR).
remote	Number of ATM labels on this interface assigned by the neighbor LSR.
Bwait	Number of bindings that are waiting for a label assignment from the downstream neighbor LSR.
Rwait	Number of bindings that are waiting for resources (VPI/VCI space) to be available on the downstream device.
IFwait	Number of bindings that are waiting for learned labels to be installed for switching use. For an ATM label switch router, this value is 0.

**Related Commands**

<b>Command</b>	<b>Description</b>
<b>show mpls atm-ldp bindings</b>	Displays the requested entries from the ATM LDP label binding database.

## show xtagatm cos-bandwidth-allocation xtagatm

To display information about CoS bandwidth allocation on extended MPLS ATM (XtagATM) interfaces, use the **show xtagatm cos-bandwidth-allocation xtagatm** command in EXEC mode.

**show xtagatm cos-bandwidth-allocation xtagatm** [*interface number*]

<b>Syntax Description</b>	<i>interface number</i> (Optional) The XtagATM interface number.
---------------------------	--

<b>Defaults</b>	Available 50%, control 50%.
-----------------	-----------------------------

<b>Command Modes</b>	EXEC
----------------------	------

<b>Command History</b>	<b>Release</b>	<b>Modification</b>
	12.0(5)T	This command was introduced.
	12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

<b>Usage Guidelines</b>	Use this command to display CoS bandwidth allocation information for the following CoS traffic categories:
-------------------------	--

- Available
- Standard
- Premium
- Control

<b>Examples</b>	The following example shows output from this command:
-----------------	---

```
Router# show xtagatm cos-bandwidth-allocation xtagatm 123
```

```
CoS           Bandwidth allocation
available     25%
standard      25%
premium       25%
control       25%
```

## show xtagatm cross-connect

To display information about the LSC view of the cross-connect table on the remotely controlled ATM switch, use the following **show xtagatm cross-connect** command in EXEC mode.

```
show xtagatm cross-connect [traffic] [{interface interface [vpi vci] |
descriptor descriptor [vpi vci]]
```

### Syntax Description

<b>traffic</b>	The receive and transmit cell counts for each connection.
<b>interface interface</b>	Connections with an endpoint of the specified interface.
<i>vpi vci</i>	Displays only detailed information on the endpoint with the specified VPI/VCI on the specified interface. (VPI range is 0 to 4095. VCI range is 0 to 65535.)
<b>descriptor descriptor</b>	Displays only connections with an endpoint on the interface with the specified physical descriptor.

### Defaults

No default behavior or values.

### Related Commands

EXEC

### Command History

Release	Modification
12.0(5)T	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

### Examples

Each connection is listed twice in the output from the **show xtagatm cross-connect** command, because it shows each interface that is linked by the connection.

The following is sample output from the **show xtagatm cross-connect** command:

```
Router# show xtagatm cross-connect
```

Phys Desc	VPI/VCI	Type	X-Phys Desc	X-VPI/VCI	State
10.1.0	1/37	->	10.3.0	1/35	UP
10.1.0	1/34	->	10.3.0	1/33	UP
10.1.0	1/33	<->	10.2.0	0/32	UP
10.1.0	1/32	<->	10.3.0	0/32	UP
10.1.0	1/35	<-	10.3.0	1/34	UP
10.2.0	1/57	->	10.3.0	1/49	UP
10.2.0	1/53	->	10.3.0	1/47	UP
10.2.0	1/48	<-	10.1.0	1/50	UP
10.2.0	0/32	<->	10.1.0	1/33	UP
10.3.0	1/34	->	10.1.0	1/35	UP
10.3.0	1/49	<-	10.2.0	1/57	UP
10.3.0	1/47	<-	10.2.0	1/53	UP
10.3.0	1/37	<-	10.1.0	1/38	UP

```

10.3.0      1/35      <-   10.1.0      1/37      UP
10.3.0      1/33      <-   10.1.0      1/34      UP
10.3.0      0/32      <->  10.1.0      1/32      UP

```

Table 20 describes the significant fields in the sample command output shown above.

**Table 20** *show xtagatm cross-connect Command Field Descriptions*

Field	Description
Phys desc	Physical descriptor. A switch-supplied string identifying the interface on which the endpoint exists.
VPI/VCI	Virtual path identifier and virtual channel identifier for this endpoint.
Type	The type can be one of the following: A right arrow (->) indicates an ingress endpoint, where traffic is received into the switch. A left arrow (<-) indicates an egress endpoint, where traffic is transmitted from the interface. A bidirectional arrow (<->) indicates that traffic is both transmitted and received at this endpoint.
X-Phys Desc	Physical descriptor for the interface of the other endpoint belonging to the cross-connect.
X-VPI/VCI	Virtual path identifier and virtual channel identifier of the other endpoint belonging to the cross-connect.
State	Indicates the status of the cross-connect to which this endpoint belongs. The state is typically UP; other values, all of which are transient, include the following: DOWN ABOUT_TO_DOWN ABOUT_TO_CONNECT CONNECTING ABOUT_TO_RECONNECT RECONNECTING ABOUT_TO_RESYNC RESYNCING NEED_RESYNC_RETRY ABOUT_TO_RESYNC_RETRY RETRYING_RESYNC ABOUT_TO_DISCONNECT DISCONNECTING

A sample of the detailed command output provided for a single endpoint is shown below.

```

Router# show xtagatm cross-connect descriptor 12.1.0 1 42

Phys desc:  12.1.0
Interface:   n/a
Intf type:   switch control port
VPI/VCI:    1/42
X-Phys desc: 12.2.0
X-Interface: XTagATM0
X-Intf type: extended tag ATM
X-VPI/VCI:   2/38
Conn-state:  UP

```

```
show xtagatm cross-connect
```

```
Conn-type:   input/output
Cast-type:   point-to-point
Rx service type:  MPLS COS 0
Rx cell rate:    n/a
Rx peak cell rate: 10000
Tx service type:  MPLS COS 0
Tx cell rate:    n/a
Tx peak cell rate: 10000
```

Table 21 describes the significant fields in the sample command output shown above.

**Table 21** *show xtagatm cross-connect Descriptor Field Descriptions*

Field	Description
Phys desc	Physical descriptor. A switch-supplied string identifying the interface on which the endpoint exists.
Interface	The (IOS) interface name.
Intf type	Interface type. Can be either extended MPLS ATM or switch control port.
VPI/VCI	Virtual path identifier and virtual channel identifier for this endpoint.
X-Phys desc	Physical descriptor for the interface of the other endpoint belonging to the cross-connect.
X-Interface	The (IOS) name for the interface of the other endpoint belonging to the cross-connect.
X-Intf type	Interface type for the interface of the other endpoint belonging to the cross-connect.
X-VPI/VCI	Virtual path identifier and virtual channel identifier of the other endpoint belonging to the cross-connect.
Conn-state	Indicates the status of the cross-connect to which this endpoint belongs. The cross-connect state is typically UP; other values, all of which are transient, include the following:  DOWN ABOUT_TO_DOWN ABOUT_TO_CONNECT CONNECTING ABOUT_TO_RECONNECT RECONNECTING ABOUT_TO_RESYNC RESYNCING NEED_RESYNC_RETRY ABOUT_TO_RESYNC_RETRY RETRYING_RESYNC ABOUT_TO_DISCONNECT DISCONNECTING
Conn-type	Input—Indicates an ingress endpoint where traffic is only expected to be received into the switch  Output—Indicates an egress endpoint, where traffic is only expected to be transmitted from the interface  Input/output—Indicates that traffic is expected to be both transmitted and received at this endpoint
Cast-type	Indicates whether or not the cross-connect is multicast. In the first release, this is always point-to-point.

**Table 21** *show xtagatm cross-connect Descriptor Field Descriptions (continued)*

<b>Field</b>	<b>Description</b>
Rx service type	Class of service type for the receive, or ingress, direction. This is MPLS COS <n>, (MPLS Class of Service <n>), where n is in the range 0-7 for input and input/output endpoints; this will be n/a for output endpoints. (In the first release, this is either 0 or 7.)
Rx cell rate	(Guaranteed) cell rate in the receive, or ingress, direction. In the first release, this is always n/a.
Rx peak cell rate	Peak cell rate in the receive, or ingress, direction, in cells per second. This is n/a for an output endpoint.
Tx service type	Class of service type for the transmit, or egress, direction. This is MPLS COS <n>, (MPLS Class of Service <n>), where n is in the range 0-7 for output and input/output endpoints; this will be n/a for input endpoints. (In the first release, n will be either 0 or 7.)
Tx cell rate	(Guaranteed) cell rate in the transmit, or egress, direction. In the first release, this is always N/A.
Tx peak cell rate	Peak cell rate in the transmit, or egress, direction, in cells per second. This is N/A for an input endpoint.

## show xtagatm vc

To display information about terminating VCs on extended MPLS ATM (XtagATM) interfaces, use the **show xtagatm vc** command in EXEC mode.

```
show xtagatm vc [vcd [interface]]
```

Syntax Description	
<i>vcd</i>	(Optional) Virtual circuit descriptor (virtual circuit number). If you specify the <i>vcd</i> argument, information displays about all VCs with that VCD.
<i>interface</i>	(Optional) Interface number. If you specify the <i>interface</i> and the <i>vcd</i> arguments, information displays about the specified VC on the specified <i>interface</i> .

**Defaults** No default behavior or values.

**Command Modes** EXEC

Command History	Release	Modifications
	12.0(5)T	This command was introduced.
	12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

**Usage Guidelines** The columns marked VCD, VPI, and VCI display information for the corresponding private VC on the control interface. The private VC connects the XtagATM VC to the external switch. It is termed private because its VPI and VCI are only used for communication between the MPLS LSC and the switch, and it is different from the VPI and VCI seen on the XtagATM interface and the corresponding switch port.

**Examples** The following is sample output from the **show xtagatm vc** command.

```
Router# show xtagatm vc
AAL / Control Interface
Interface      VCD  VPI  VCI Type  Encapsulation  VCD  VPI  VCI Status
XTagATM0      1    0   32 PVC   AAL5-SNAP     2    0   33 ACTIVE
XTagATM0      2    1   33 TVC   AAL5-MUX     4    0   37 ACTIVE
XTagATM0      3    1   34 TVC   AAL5-MUX     6    0   39 ACTIVE
```

Table 22 describes the significant fields in the sample command output shown above.

**Table 22** *show xtagatm vc Command Field Descriptions*

Field	Description
VCD	Virtual circuit descriptor (virtual circuit number).
VPI	Virtual path identifier.
VCI	Virtual circuit identifier.
Control Interf. VCD	VCD for the corresponding private VC on the control interface.
Control Interf. VPI	VPI for the corresponding private VC on the control interface.
Control Interf. VCI	VCI for the corresponding private VC on the control interface.
Encapsulation	Displays the type of connection on the interface.
Status	Displays the current state of the specified ATM interface.

#### Related Commands

Command	Description
<a href="#">show atm vc</a>	Displays information about private ATM VCs.
<a href="#">show xtagatm cross-connect</a>	Displays information about remotely connected ATM switches.

## Debug Commands

This section describes the following new **debug** commands related to the MPLS LSC feature:

- [debug mpls xtagatm cross-connect](#)
- [debug mpls xtagatm errors](#)
- [debug mpls xtagatm events](#)
- [debug mpls xtagatm vc](#)
- [debug vsi api](#)
- [debug vsi errors](#)
- [debug vsi events](#)
- [debug vsi packets](#)
- [debug vsi param-groups](#)

# debug mpls xtagatm cross-connect

To display requests and responses for establishing and removing cross-connects on the controlled ATM switch, use the **debug mpls xtagatm cross-connect** command. To disable debugging output, use the **no** form of this command.

**debug mpls xtagatm cross-connect**

**no debug mpls xtagatm cross-connect**

## Syntax Description

This command has no arguments or keywords.

## Defaults

No default behavior or values.

## Command History

Release	Modification
12.0(5)T	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

## Usage Guidelines

This command monitors requests to establish or remove cross-connects from XtagATM interfaces to the VSI master, as well as the VSI master's responses to these requests.



### Note

Use this command with care, because it generates output for each cross-connect operation performed by the LSC. In a network configuration with many label virtual circuits (LVCs), the volume of output generated can interfere with system timing and the proper operation of other router functions. Use this command only in situations in which the LVC setup or teardown rate is low.

## Examples

The following is sample output from the **debug mpls xtagatm cross-connect** command:

```
Router# debug mpls xtagatm cross-connect

XTagATM: cross-conn request; SETUP, userdata 0x17, userbits 0x1, prec 7
          0xC0100 (Ctl-If) 1/32 <-> 0xC0200 (XTagATM0) 0/32
XTagATM: cross-conn response; DOWN, userdata 0x60CDCB5C, userbits 0x2, result
OK
          0xC0200 1/37 --> 0xC0300 1/37
```

Table 23 describes the significant fields in the sample command output shown above.

**Table 23** *debug mpls xtagatm cross-connect Command Field Descriptions*

Field	Description
XTagATM	The source of the debug message as an XtagATM interface.
cross-conn	An indicator that the debug message pertains to a cross-connect setup or teardown operation.
request	A request from an XtagATM interface to the VSI master to set up or tear down a cross-connect.
response	Response from the VSI master to an XtagATM interface that a cross-connect was set up or removed.
SETUP	A request for the setup of a cross-connect.
TEARDOWN	A request for the teardown of a cross-connect.
UP	The cross-connect is established.
DOWN	The cross-connect is not established.
userdata, userbits	Values passed with the request that are returned in the corresponding fields in the matching response.
prec	The precedence for the cross-connect.
result	The status of the completed request.
0xC0100 (Ctl-If) 1/32	Information about the interface: <ul style="list-style-type: none"> <li>• One endpoint of the cross-connect is on the interface whose logical interface number is 0xC0100.</li> <li>• The interface is the VSI control interface.</li> <li>• The VPI value at this endpoint is 1.</li> <li>• The VCI value at this end of the cross-connect is 32.</li> </ul>
<->	The type of cross-connect (unidirectional or bidirectional).
0xC0200 (XTagATM0) 0/32	Information about the interface: <ul style="list-style-type: none"> <li>• The other endpoint of the cross-connect is on the interface whose logical interface number is 0xC0200.</li> <li>• The interface is associated with XtagATM interface 0.</li> <li>• The VPI value at this endpoint is 0.</li> <li>• The VCI value at this end of the cross-connect is 32.</li> </ul>
->	The response pertains to a unidirectional cross-connect.

#### Related Commands

Command	Description
<a href="#">show xtagatm cross-connect</a>	Displays information about remotely connected ATM switches.

# debug mpls xtagatm errors

To display information about error and abnormal conditions that occur on XtagATM interfaces, use the **debug mpls xtagatm errors** command. To disable debugging output, use the **no** form of this command.

**debug mpls xtagatm errors**

**no debug mpls xtagatm errors**

---

**Syntax Description** This command has no arguments or keywords.

---

**Defaults** No default behavior or values.

---

Command History	Release	Modification
	12.0(5)T	This command was introduced.
	12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

---



---

**Usage Guidelines** Use the **debug mpls xtagatm errors** command to display information about abnormal conditions and events that occur on XtagATM interfaces.

---

**Examples** The following is sample output from the **debug mpls xtagatm errors** command:

```
Router# debug mpls xtagatm errors
```

```
XTagATM VC: XTagATM0 1707 2/352 (ATM1/0 1769 3/915): Cross-connect setup
failed NO_RESOURCES
```

This message indicates a failed attempt to set up a cross-connect for a terminating VC on XtagATM0. The reason for the failure was a lack of resources on the controlled ATM switch.

## debug mpls xtagatm events

To display information about major events that occur on XtagATM interfaces, not including events for specific XtagATM VCs and switch cross-connects, use the **debug mpls xtagatm events** command. To disable debugging output, use the **no** form of this command.

**debug mpls xtagatm events**

**no debug mpls xtagatm events**

### Syntax Description

This command has no arguments or keywords.

### Defaults

No default behavior or values.

### Command History

Command	Modification
12.0(5)T	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

### Usage Guidelines

Use the **debug mpls xtagatm events** command to monitor major events that occur on XtagATM interfaces. This command monitors events that pertain only to XtagATM interfaces as a whole and does not include any events that pertain to individual XtagATM VCs or individual switch cross-connects. The specific events that are monitored when the **debug mpls xtagatm events** command is in effect include the following:

- Receiving asynchronous notifications that the VSI master sent through the external ATM API (ExATM API) to an XtagATM interface.
- Resizing of the table that is used to store switch cross-connect information. This table is resized automatically as the number of cross-connects increases.
- Marking of XtagATM VCs as stale when an XtagATM interface shuts down, thereby ensuring that the stale interfaces are refreshed before new XtagATM VCs can be created on the interface.

### Examples

The following is sample output from the **debug mpls xtagatm events** command:

```
Router# debug mpls xtagatm events

XTagATM: desired cross-connect table size set to 256
XTagATM: ExATM API intf event Up, port 0xA0100 (None)
XTagATM: ExATM API intf event Down, port 0xA0100 (None)
XTagATM: marking all VCs stale on XTagATM0
```

Table 24 describes the significant fields in the sample command output shown above.

**Table 24** *debug mpls xtagatm events Command Field Descriptions*

Field	Description
XTagATM	The source of the debug message.
desired cross-connect table size set to 256	The table of cross-connect information has been set to hold 256 entries. A single cross-connect table is shared among all XtagATM interfaces. The cross-connect table is automatically resized as the number of cross-connects increases.
ExATM API	The information in the debug output pertains to an asynchronous notification sent by the VSI master to the XtagATM driver.
event Up/Down	The specific event that was sent by the VSI master to the XtagATM driver.
port 0xA0100 (None)	The event pertains to the VSI interface whose logical interface number is 0xA0100, and that this logical interface is not bound to an XtagATM interface.
marking all VCs stale on XTagATM0	All existing XtagATM VCs on interface XtagATM0 are marked as stale, and that XtagATM0 remains down until all of these VCs are refreshed.

# debug mpls xtagatm vc

To display information about events that affect individual XtagATM terminating VCs, use the **debug mpls xtagatm vc** command. To disable debugging output, use the **no** form of this command.

```
debug mpls xtagatm vc
```

```
no debug mpls xtagatm vc
```

## Syntax Description

This command has no arguments or keywords.

## Defaults

No default behavior or values

## Command History

Release	Modification
12.0(5)T	This command was introduced.
12.2(4)T	This command was updated to reflect the MPLS IETF terminology.

## Usage Guidelines

Use the **debug mpls xtagatm vc** command to display detailed information about all events that affect individual XtagATM terminating VCs.



### Note

Use this command with care, because it results in extensive output when many XtagATM VCs are set up or torn down. This output can interfere with system timing and normal operation of other router functions. Use the **debug mpls xtagatm vc** command only when a few XtagATM VCs are created or removed.

## Examples

The following is sample output from the **debug mpls xtagatm vc** command:

```
Router# debug mpls xtagatm vc

XTagATM VC: XTagATM1 18 0/32 (ATM1/0 0 0/0): Setup, Down --> UpPend
XTagATM VC: XTagATM1 18 0/32 (ATM1/0 88 1/32): Complete, UpPend --> Up
XTagATM VC: XTagATM1 19 1/33 (ATM1/0 0 0/0): Setup, Down --> UpPend
XTagATM VC: XTagATM0 43 0/32 (ATM1/0 67 1/84): Teardown, Up --> DownPend
```

Table 25 describes the significant fields in the sample command output shown above.

**Table 25** *debug mpls xtagatm vc Command Field Descriptions*

<b>Field</b>	<b>Description</b>
XTagATM VC	The source of the debug message.
XTagATM <ifnum>	The particular XtagATM interface number for the terminating VC.
vcd vpi/vci	The VCD and VPI/VCI values for the terminating VC.
(ctl-if vcd vpi/vci)	The control interface, the VCD, and the VPI and VCI values for the private VC corresponding to the XtagATM VC on the control interface.
Setup, Complete, Teardown	The name of the event that occurred for the indicated VC.
oldstate -> newstate	The state of the terminating VC before and after the processing of the event.

# debug vsi api

To display information on events associated with the external ATM API interface to the VSI master, use the **debug vsi api** command. To disable debugging output, use the **no** form of this command.

**debug vsi ap**

**no debug vsi api**

## Syntax Description

This command has no arguments or keywords.

## Defaults

No default behavior or values.

## Command History

Release	Modification
12.0(5)T	This command was introduced.

## Usage Guidelines

Use the **debug vsi api** command to monitor the communication between the VSI master and the XtagATM component regarding interface changes and cross-connect requests.

## Examples

The following is sample output from the **debug vsi api** command:

```
Router# debug vsi api

VSI_M: vsi_exatm_conn_req: 0x000C0200/1/35 -> 0x000C0100/1/50
        desired state up, status OK
VSI_M: vsi_exatm_conn_resp: 0x000C0200/1/33 -> 0x000C0100/1/49
        curr state up, status OK
```

[Table 26](#) describes the significant fields in the sample command output shown above.

**Table 26** *debug vsi api Command Field Descriptions*

Field	Description
vsi_exatm_conn_req	The type of connection request (connect or disconnect) that was submitted to the VSI master.
0x000C0200	The logical interface identifier of the primary endpoint, in hexadecimal form.
1/35	VPI and VCI of the primary endpoint.
->	The type of traffic flow. A right arrow (->) indicates that the expected traffic flow is unidirectional (from the primary endpoint to the secondary endpoint). A bidirectional arrow (<->) indicates bidirectional traffic flow.
0x000C0100	Logical interface identifier of the secondary endpoint.
1/50	VPI and VCI of the secondary endpoint.

**Table 26** *debug vsi api Command Field Descriptions (continued)*

<b>Field</b>	<b>Description</b>
desired state	The status of a connect request. Up indicates a connect request; Down indicates a disconnect request.
status (in vsi_exatm_conn_req output)	<p>The status of a request. One of following status indications appears:</p> <p>OK  INVALID_ARGS  NONEXIST_INTF  TIMEOUT  NO_RESOURCES  FAIL</p> <p>OK means only that the request is successfully queued for transmission to the switch; it does not indicate completion of the request.</p>

# debug vsi errors

To display information about errors encountered by the VSI master, use the **debug vsi errors** command. To disable debugging output, use the **no** form of this command.

**debug vsi errors** [**interface** *interface* [**slave number**]]

**no debug vsi errors** [**interface** *interface* [**slave number**]]

## Syntax Description

<b>interface</b> <i>interface</i>	Specifies the interface number.
<b>slave number</b>	Specifies the slave number (beginning with 0).

## Defaults

No default behavior or values.

## Command History

Release	Modification
12.0(5)T	This command was introduced.

## Usage Guidelines

Use the **debug vsi errors** command to display information about errors encountered by the VSI master when parsing received messages, as well as information about unexpected conditions encountered by the VSI master.

If the interface parameter is specified, output is restricted to errors associated with the indicated VSI control interface. If the slave number is specified, output is further restricted to errors associated with the session with the indicated slave.



### Note

Slave numbers are the same as the session numbers discussed under the **show controllers vsi session** command.

Multiple commands that specify slave numbers allow multiple slaves to be debugged immediately. For example, the following commands display errors associated with sessions 0 and 1 on control interface atm2/0, but for no other sessions.

```
Router# debug vsi errors interface atm2/0 slave 0
Router# debug vsi errors interface atm2/0 slave 1
```

Some errors are not associated with any particular control interface or session. Messages associated with these errors are printed, regardless of the **interface** or **slave** options currently in effect.

## Examples

The following is sample output from the **debug vsi errors** command:

```
Router# debug vsi errors
```

```
VSI Master: parse error (unexpected param-group contents) in GEN ERROR RSP rcvd on
ATM2/0:0/51 (slave 0)
    errored section is at offset 16, for 2 bytes:
    01.01.00.a0 00.00.00.00 00.12.00.38 00.10.00.34
*00.01*00.69 00.2c.00.00 01.01.00.80 00.00.00.08
```

```
00.00.00.00 00.00.00.00 00.00.00.00 0f.a2.00.0a
00.01.00.00 00.00.00.00 00.00.00.00 00.00.00.00
00.00.00.00
```

Table 27 describes the significant fields in the sample command output shown above.

**Table 27** *debug vsi errors Command Field Descriptions*

Field	Description
parse error	An error was encountered during the parsing of a message received by the VSI master.
unexpected param-group contents	The type of parsing error. In this case, a parameter group within the message contained invalid data.
GEN ERROR RSP	The function code in the header of the error message.
ATM2/0	The control interface on which the error message was received.
0/51	VPI or VCI of the VC (on the control interface) on which the error message is received.
slave	Number of the session on which the error message is received.
offset <n>	The number of bytes between the start of the VSI header and the start of that portion of the message in error.
<n> bytes	Length of the error section.
00.01.00.a0 [...]	The entire error message, as a series of hexadecimal bytes. Note that the error section is between asterisks (*).

## debug vsi events

To display information about events that affect entire sessions, as well as events that affect only individual connections, use the **debug vsi events** command. To disable debugging output, use the **no** form of this command.

**debug vsi events** [**interface** *interface* [**slave number**]]

**no debug vsi events** [**interface** *interface* [**slave number**]]

### Syntax Description

<b>interface</b> <i>interface</i>	The interface number.
<b>slave number</b>	The slave number (beginning with zero).

### Defaults

No default behavior or values.

### Command History

Release	Modification
12.0(5)T	This command was introduced.

### Usage Guidelines

Use the **debug vsi events** command to display information about events associated with the per-session state machines of the VSI master, as well as the per-connection state machines. If you specify an interface, the output is restricted to events associated with the indicated VSI control interface. If you specify the slave number, output is further restricted to events associated with the session with the indicated slave.



#### Note

Slave numbers are the same as the session numbers discussed under the **show controllers vsi session** command.

Multiple commands that specify slave numbers allow multiple slaves to be debugged at once. For example, the following commands restrict output to events associated with sessions 0 and 1 on control interface atm2/0, but for no other sessions. Output associated with all per-connection events are displayed, regardless of the **interface** or **slave** options currently in effect.

```
Router# debug vsi events interface atm2/0 slave 0
Router# debug vsi events interface atm2/0 slave 1
```

### Examples

The following is sample output from the **debug vsi events** command:

```
Router# debug vsi events

VSI Master: conn 0xC0200/1/37->0xC0100/1/51:
      CONNECTING -> UP
VSI Master(session 0 on ATM2/0):
      event CONN_CMT_RSP, state ESTABLISHED -> ESTABLISHED
VSI Master(session 0 on ATM2/0):
      event KEEPALIVE_TIMEOUT, state ESTABLISHED -> ESTABLISHED
VSI Master(session 0 on ATM2/0):
```

```

event SW_GET_CNFG_RSP, state ESTABLISHED -> ESTABLISHED
debug vsi packets

```

Table 28 describes the significant fields in the sample command output shown above.

**Table 28** *debug vsi events Command Field Descriptions*

Field	Description
conn	The event applies to a particular connection.
0xC0200	Logical interface identifier of the primary endpoint, in hexadecimal form.
1/37	VPI or VCI of the primary endpoint.
->	The type of traffic flow. A right arrow (->) indicates unidirectional traffic flow (from the primary endpoint to the secondary endpoint). A bidirectional arrow <->, indicates bidirectional traffic flow.
0xC0100	Logical interface identifier of the secondary endpoint.
1/51	VPI or VCI of the secondary endpoint.
<state1> -> <state2>	<state1> is a mnemonic for the state of the connection before the event occurred.  <state2> represents the state of the connection after the event occurred.
session	The number of the session with which the event is associated.
ATM2/0	The control interface associated with the session.
event	The event that has occurred. This includes mnemonics for the function codes of received messages (for example, CONN_CMT_RSP), as well as mnemonics for other events (for example, KEEPALIVE_TIMEOUT).
state <state1> -> <state2>	Mnemonics for the session states associated with the transition triggered by the event. <state1> is a mnemonic for the state of the session before the event occurred; <state2> is a mnemonic for the state of the session after the event occurred.

# debug vsi packets

To display a one-line summary of each VSI message sent and received by the LSC, use the **debug vsi packets** command. To disable debugging output, use the **no** form of this command

```
debug vsi packets [interface interface [slave number]]
```

```
no debug vsi packets [interface interface [slave number]]
```

## Syntax Description

<b>interface</b> <i>interface</i>	The interface number.
<b>slave number</b>	The slave number (beginning with zero).

## Defaults

No default behavior or values.

## Command History

Release	Modification
12.0(5)T	This command was introduced.

## Usage Guidelines

If you specify an interface, output is restricted to messages sent and received on the indicated VSI control interface. If you specify a slave number, output is further restricted to messages sent and received on the session with the indicated slave.



### Note

Slave numbers are the same as the session numbers discussed under the **show controllers vsi session** command.

Multiple commands that specify slave numbers allow multiple slaves to be debugged at once. For example, the following commands restrict output to messages received on atm2/0 for sessions 0 and 1, but for no other sessions.

```
Router# debug vsi packets interface atm2/0 slave 0
Router# debug vsi packets interface atm2/0 slave 1
```

## Examples

The following is sample output from the **debug vsi packets** command:

```
Router# debug vsi packets

VSI master(session 0 on ATM2/0): sent msg SW GET CNFG CMD on 0/51
VSI master(session 0 on ATM2/0): rcvd msg SW GET CNFG RSP on 0/51
VSI master(session 0 on ATM2/0): sent msg SW GET CNFG CMD on 0/51
VSI master(session 0 on ATM2/0): rcvd msg SW GET CNFG RSP on 0/51
```

Table 29 describes the significant fields in the sample command output shown above.

**Table 29** *debug vsi packets Command Field Descriptions*

<b>Field</b>	<b>Description</b>
session	Session number identifying a particular VSI slave. Numbers begin with zero. See the <b>show controllers vsi session</b> command.
ATM2/0	Identifier for the control interface on which the message is sent or received.
sent	The message is sent by the VSI master.
rcvd	The message is received by the VSI master.
msg	The function code from the message header.
0/51	VPI or VCI of the VC (on the control interface) on which the message is sent or received.

## debug vsi param-groups

To display the first 128 bytes of each VSI message sent and received by the MPLS LSC (in hexadecimal form), use the **debug vsi param-groups** command. To disable debugging output, use the **no** form of this command.

```
debug vsi param-groups [interface interface [slave number]]
```

```
no debug vsi param-groups [interface interface [slave number]]
```



### Note

**param-groups** stands for parameter groups. A parameter group is a component of a VSI message.

### Syntax Description

<b>interface</b> <i>interface</i>	The interface number.
<b>slave</b> <i>number</i>	The slave number (beginning with zero).

### Defaults

No default behavior or values.

### Command History

Release	Modification
12.0(5)T	This command was introduced.

### Usage Guidelines

This command is most commonly used with the **debug vsi packets** command to monitor incoming and outgoing VSI messages.

If you specify an interface, output is restricted to messages sent and received on the indicated VSI control interface.

If you specify a slave, output is further restricted to messages sent and received on the session with the indicated slave.



### Note

Slave numbers are the same as the session numbers discussed under the **show controllers vsi session** command.

Multiple commands that specify a slave numbers allows multiple slaves to be debugged at once. For example, the following commands restrict output for messages received on atm2/0 for sessions 0 and 1, but for no other sessions.

```
Router# debug vsi param-groups interface atm2/0 slave 0
Router# debug vsi param-groups interface atm2/0 slave 1
```

### Examples

The following is sample output from the **debug vsi param-groups** command:

```
Router# debug vsi param-groups

Outgoing VSI msg of 12 bytes (not including encap):
01.02.00.80 00.00.95.c2 00.00.00.00
```

```

Incoming VSI msg of 72 bytes (not including encap):
01.02.00.81 00.00.95.c2 00.0f.00.3c 00.10.00.08
00.01.00.00 00.00.00.00 01.00.00.08 00.00.00.09
00.00.00.09 01.10.00.20 01.01.01.00 0c.08.80.00
00.01.0f.a0 00.13.00.15 00.0c.01.00 00.00.00.00
42.50.58.2d 56.53.49.31
Outgoing VSI msg of 12 bytes (not including encap):
01.02.00.80 00.00.95.c3 00.00.00.00
Incoming VSI msg of 72 bytes (not including encap):
01.02.00.81 00.00.95.c3 00.0f.00.3c 00.10.00.08
00.01.00.00 00.00.00.00 01.00.00.08 00.00.00.09
00.00.00.09 01.10.00.20 01.01.01.00 0c.08.80.00
00.01.0f.a0 00.13.00.15 00.0c.01.00 00.00.00.00
42.50.58.2d 56.53.49.31

```

Table 30 describes the significant fields in the sample command output shown above.

**Table 30** *debug vsi param-groups Command Field Descriptions*

Field	Description
Outgoing	The message is sent by the VSI master.
Incoming	The message is received by the VSI master.
bytes	Number of bytes in the message, starting at the VSI header, and excluding the link layer encapsulation.
01.02...	The first 128 bytes of the message, in hexadecimal form.

# Glossary

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The terms in this glossary are defined in an MPLS context, rather than a general usage context.

**AIP**—ATM Interface Processor. An ATM interface for Cisco 7000 series routers designed to minimize performance bottlenecks at the user-network interface (UNI).

**alien port adapter**—A dual-wide port adapter for the Cisco 7200 router. The Alien port adapter is ABR-ready and supports traffic shaping.

**ATM Edge LSR**—A router that is connected to the ATM-LSR cloud through LSC-ATM interfaces. The ATM edge LSR adds labels to unlabeled packets and strips labels from labeled packets.

**ATM Lite**—Entry-level port adapter (higher performance than the AIP) for Cisco 7200 routers. The ATM Lite does not support traffic shaping or ABR.

**ATM-LSR**—A label switch router with several LSC-ATM interfaces. The router forwards the cells among these interfaces using labels carried in the VPI/VCI field of the cells.

**BPX**—Broadband Packet Exchange. A carrier-quality switch with trunk and CPU hot standby redundancy.

**BXM**—Broadband switch module. An ATM port card for the Cisco BPX switch.

**CAR**—committed access rate. CAR is the main feature supporting packet classification. CAR uses the type of service (TOS) bits in the IP header to classify packets. You can use the CAR classification commands to classify and reclassify a packet.

**Controlled ATM Switch**—An ATM switch that is controlled by an LSC.

**CoS**—class of service. A feature that provides scalable, differentiated types of service across an MPLS network.

**Downstream on demand**—Indicates that the downstream-on-demand method of label distribution is being used for this LDP session. When the downstream-on-demand method is used, an LSR advertises its locally assigned (incoming) labels to its LDP peer device only when the peer device asks for them.

**DWFQ**—VIP-Distributed WFQ (Weighted Fair Queuing).

**DWRED**—VIP-Distributed WRED (Weighted Random Early Detection).

**Extended label ATM interface**—A type of interface supported by the remote ATM switch driver and a particular switch-specific driver that supports MPLS over an ATM interface on a remotely controlled switch.

**External ATM interface**—One of the interfaces on the controlled ATM switch other than the switch control port. It is also referred to as an exposed ATM interface, because it is available for connections outside of the label-controlled switch.

**IP Precedence**—A 3-bit value in the Type of Service (ToS) byte used for assigning precedence to IP packets.

**label**—A short fixed-length label that tells switching nodes how the data (packets or cells) should be forwarded.

**label controlled switch**—The label switch controller and the controlled ATM switch that it controls, viewed together as a unit.

**label imposition**—The act of putting the first label on a packet.

**label switch**—A node that forwards units of data (packets or cells) on the basis of labels.

**LSC**—label switch controller. An IOS platform that runs the generic MPLS software and that can control the operation of an external ATM (or other type of) switch, making the interfaces of the latter appear externally as XtagATM interfaces.

**LSP**—label switched path. A configured connection between two routers, using MPLS to carry the packets.

**LSR**—label switching router. A Layer 3 router that forwards a packet based on the value of a label encapsulated in the packet.

**LVC**—label virtual circuit. An ATM virtual circuit that is set up through ATM LSR label distribution procedures.

**LBR**—label bit rate. Service category defined by this document for label-VC traffic. Link and per-VC bandwidth sharing may be controlled by relative bandwidth configuration at the edge and each switch along a label-VC. No ATM traffic-related parameters specified.

**LC-ATM (label-controlled ATM) interface**—An MPLS interface in which labels are carried in the VPI or VCI fields of the ATM cells and in which VC connections are established under the control of MPLS software.

**LFIB**—Label forwarding information base. A data structure and way of managing forwarding in which destinations and incoming labels are associated with outgoing interfaces and labels.

**LVC**—label virtual circuit. A virtual circuit (VC) established under the control of MPLS. An LVC is neither a PVC nor an SVC. The LVC must traverse only a single hop in a label-switched path (LSP), but the LVC may traverse several ATM hops only if the LVC exists within a VP tunnel.

**Master control port**—A physical interface on an MPLS LSC that is connected to one end of a slave control link.

**MPLS**—Multiprotocol Label Switching. An emerging industry standard on which label switching is based.

**PNNI**—Private Network-Network Interface.

**PVC**—permanent virtual circuit. Permanent path that consists of PVCs. See also PVC and virtual path.

**QoS**—quality of service. A measurement of performance for a transmission system that reflects its transmission quality and service availability.

**RED**—random early detection. Congestion avoidance algorithm in which a small percentage of packets are dropped when congestion is detected and before the queue in question overflows completely.

**Remote ATM switch driver**—A set of interfaces that allows IOS software to control the operation of a remote ATM switch through a control protocol, such VSI.

**Ships in the night**—The ability to support both MPLS functions and ATM forum protocols on the same physical interface, or on the same router or switch platform. In this mode, the two protocol stacks operate independently.

**Switch control port**—An interface that uses an MPLS LSC to control the operation of a controlled ATM switch (for example, VSI). The protocol runs on an ATM link.

**SVC**—switched virtual circuit. Virtual circuit that is dynamically established on demand and is torn down when transmission is complete. SVCs are used in situations where data transmission is sporadic. See also virtual circuit. Called a switched virtual connection in ATM terminology. Compare with PVC.

**ToS**—type of service. A byte in the IPv4 header.

**VCC**—virtual channel circuit. Logical circuit, made up of VCLs, that carries data between two end points in an ATM network. Sometimes called a virtual circuit connection. See also VCL and VPI.

**VCI**—virtual channel identifier. 16-bit field in the header of an ATM cell. The VCI, together with the VPI, is used to identify the next destination of a cell as it passes through a series of ATM switches on its way to its destination. ATM switches use the VPI/VCI fields to identify the next network VCL that a cell needs to transit on its way to its final destination. The function of the VCI is similar to that of the DLCI in Frame Relay. Compare with DLCI.

**VCL**—virtual channel link. A connection between two ATM devices.

**virtual circuit**—Logical circuit created to ensure reliable communication between two network devices. A virtual circuit is defined by a VPI/VCI pair, and can be either permanent (PVC) or switched (SVC). Virtual circuits are used in Frame Relay and X.25. In ATM, VCI, and VPI.

**VNNI**—Virtual Network-Network Interface.

**VPC**—virtual path connection. Grouping of VCCs that share one or more contiguous VPL. See also VCC and VPL.

**VPI**—virtual path identifier. An 8-bit field in the header of an ATM cell. The VPI, together with the VCI, is used to identify the next destination of a cell as it passes through a series of ATM switches on its way to its destination. ATM switches use the VPI/VCI fields to identify the next VCL that a cell needs to transit on its way to its final destination. The function of the VPI is similar to that of the DLCI in Frame Relay.

**VPN**—virtual private network. A network that enables IP traffic to use tunneling to travel securely over a public TCP/IP network.

**VSI**—Virtual Switch Interface. The protocol that enables an MPLS LSC to control an ATM switch over an ATM link.

**VSI master**—A VSI master process implementing the master side of the VSI protocol in a VSI controller. Sometimes the whole VSI controller is referred to as a “VSI Master,” but this is not strictly correct.

1. A device that controls a VSI switch, for example, a VSI Label Switch Controller.
2. A process implementing the master side of the VSI protocol.

**VSI slave**—A VSI slave is either of the following definitions:

1. A switch (in the “Single Slave model”) or a port card (in the “Multiple Slave Model”) that implements the VSI.
2. A process implementing the slave side of the VSI protocol.

**WEPD**—Weighted Early Packet Discard. A variant of EPD used by some ATM switches for discarding a complete AAL5 frame when a threshold condition, such as imminent congestion, is met. EPD prevents congestion that would otherwise jeopardize the ability of the switch to properly support existing connections with a guaranteed service.

**WRED**—weighted random early detection. A variant of RED in which the probability of a packet being dropped depends on its IP Precedence, CAR marking, or MPLS CoS (as well as other factors in the RED algorithm).

**WFQ**—weighted fair queuing. A queue management algorithm that provides a certain fraction of link bandwidth to each of several queues, based on relative bandwidth applied to each of the queues.

