



VPI Range Enhancement for the Cisco ATM IMA

This document describes the Virtual Path Identifier (VPI) range enhancement for the Cisco IOS Inverse Multiplexing for ATM (IMA) feature running on T1/E1 Multiflex ATM modules. It contains the following sections:

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Feature Overview

The Asynchronous Transfer Mode (ATM) Inverse Multiplexing for ATM (IMA) feature for Cisco 2600 and Cisco 3600 series routers is used for applications that require increased bandwidth flexibility without any change to the underlying transport layer using the same T1 and E1 lines for video on demand and VoIP. This new feature increases the ranges available for the Virtual Path Identifier (VPI).

Benefits

The benefits of ATM IMA:

- You can get higher bandwidth without changing the physical medium.
- You get bandwidth flexibility as you can add and delete links from an IMA group without any disruption.
- You can use the traffic management and QoS of ATM IMA.
- T3/E3 lines are too costly and the excess bandwidth may be unnecessary; aggregating T1/E1 lines is a much cheaper option.
- This feature provides more ranges of VPI. Before this feature was introduced you could only use VPI values from 1-15. Now you have the ranges 0-15, 64-79, 128-143, and 192-207. The ranges are fragmented because the 4th and 5th bits of the VPI field are used to identify the IMA group.

Related Documents

The following Cisco IOS Release 12.0 documents provide information about ATM configuration:

- *Cisco IOS Wide-Area Networking Configuration Guide*
- *Cisco IOS Wide-Area Networking Command Reference*

For information about the physical characteristics of the ATM T1/E1 IMA network modules, or for instructions on how to install the network or modem modules, either see the Cisco 2600 or 3600 series *Network Module Hardware Installation Guide* that came with your ATM T1/E1 IMA network module or view the up-to-date information on CCO.

Supported Platforms

- Cisco 2600 routers
- Cisco 3620 routers
- Cisco 3640 routers
- Cisco 3660 routers

Supported Standards, MIBs, and RFCs

This feature supports the following MIBs:

- IMA MIB (ATM Forum, AF-PHY-0086.001)
- DS1/E1 MIB (as defined in RFC 1406)
- Chassis MIB

For descriptions of supported MIBs and how to use MIBs, see Cisco's MIB website on CCO at <http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml>.

This feature supports the following RFCs:

- RFC 1573—`ifGeneralGroup` and `ifStackGroup` from the Interfaces Group of MIB-II
- RFC 1577
- RFC 1483

Prerequisites

Before you can configure a Cisco 2600 or 3600 series router to provide ATM IMA T1/E1 service, you must perform the following tasks:

- Obtain T1 or E1 service from your telecommunications provider.
- Install a multiport T1/E1 ATM network module with IMA into your Cisco router. One of the following multiport T1/E1 ATM network modules with IMA is required to support inverse multiplexed ATM on the Cisco 2600 and 3600 series routers:
 - NM-4T-IMA—Four-port ATM network module providing T1 connectivity.
 - NM-8T-IMA—Eight-port ATM network module providing T1 connectivity.

- NM-4E-IMA—Four-port ATM network module providing E1 connectivity.
- NM-8E-IMA—Eight-port ATM network module providing E1 connectivity.

Configuration Tasks

This section describes the configuration tasks required for setting up ATM IMA groups. You can also configure ATM links individually, but this feature description only includes those individual configuration steps that may pertain to ATM IMA groups.

Perform the following configuration tasks:

- Using the `atm pvc` command to set up an ATM PVC
- Using the `pvc` command to set up an ATM PVC

Using the `atm pvc` command to set up an ATM PVC

	Command	Purpose
Step 1	<code>Router(config)#interface atm 3/0</code>	Specifies the ATM interface. To determine the correct form of the interface atm command, consult your ATM network module or router documentation.
Step 2	<code>Router(config-if)#atm pvc 65 65 65 aal34smds</code>	Enters interface-ATM-VC configuration mode. Configure a new ATM PVC by assigning a name (optional) and VPI/VCI numbers. Optionally, configure ILMI, QSAAL, or SMDS encapsulation.
Step 3	<code>Router(config-if-atm-vc)#exit</code>	Exits the interface-ATM-VC configuration mode.

Using the `pvc` command to set up an ATM PVC

	Command	Purpose
Step 1	<code>Router(config)#interface atm 2/0</code>	Specifies the ATM interface. To determine the correct form of the interface atm command, consult your ATM network module or router documentation.
Step 2	<code>Router(config-if)#pvc 0/14</code>	Enters interface-ATM-VC configuration mode. Configure a new ATM PVC by assigning a name (optional) and VPI/VCI numbers. Optionally, configure ILMI, QSAAL, or SMDS encapsulation.
Step 3	<code>Router(config-if-atm-vc)#exit</code>	Exits the interface-ATM-VC configuration mode.

Configuration Examples

The following example shows a PVC called `cisco` created with VPI 0 and VCI 15, and communication is set up with the ILMI:

```
Router(config-if)#pvc cisco 0/15 ilmi
Router(config-if-atm-vc)#exit
```

The following example shows a PVC called “cisco” used for ATM signalling created for an SVC. It specifies VPI 0 and VCI 5:

```
Router(config-if)#pvc cisco 0/5 qsaal
Router(config-if-atm-vc)#exit
```

The following example shows the PVC called “cisco” configured to use class-based weighted fair queueing (CBWFQ). It attaches a policy map called “policy1” to the PVC. The classes comprising “policy1” determine the service policy for the PVC:

```
Router(config-if)#pvc cisco 0/5
Router(config-if-atm-vc)#service-policy output policy1
Router(config-if-atm-vc)#vbr-nrt 2000 2000
Router(config-if-atm-vc)#encap aal5snap
```

If you enter an incorrect range for the VPI, the CLI will display error messages such as the examples below:

```
Router(config)#interface atm 1/6
Router(config-if)#atm pvc 17 17 17 aal5snap
%Invalid VPI of 17 requested:(ATM1/6):Not creating vc:17:17:17
Legal VPI sub-ranges are 0-15, 64-79, 128-143, 192-207!
```

```
Router(config)#interface atm 1/6
Router(config-if)#pvc 18/18
%Invalid VPI of 18 requested:(ATM1/6):Not creating vc:18:18
Legal VPI sub-ranges are 0-15, 64-79, 128-143, 192-207!
```

Command Reference

- atm pvc
- pvc

atm pvc

To create a permanent virtual circuit (PVC) used to multiplex (or bundle) one or more VCs (especially CES and data VCs), use the **atm pvc** interface configuration command. To remove a permanent virtual circuit, use the **no** form of this command.

```
atm pvc vpi [peak-rate]
```

```
no atm pvc
```

Syntax Description

<i>vpi</i>	ATM network virtual path identifier (VPI) of the VC to multiplex on the permanent virtual path. The ranges are 0-15, 64-79, 128-143, and 192-207. The ranges are fragmented because the 4th and 5th bits of the VPI field are used to identify the IMA group. The VPI is an 8-bit field in the header of the ATM cell. The VPI value is unique only on a single link, not throughout the ATM network because it has local significance only. The VPI value must match that of the switch. The number specified for the vpi must not already exist. If the number specified for the vpi is already being used by an existing VC, this command is rejected.
<i>peak-rate</i>	(Optional) Maximum rate in kbps at which the PVC can transmit data. The range is 84 kbps to line rate. The default is the line rate.

Defaults

PVC is not configured.

Command Modes

Interface configuration

Command History

Release	Modification
11.1CA	This command was introduced.
12.1(2)T	The ranges for the VPI were increased for additional flexibility in configuration.

Usage Guidelines

The ATM-CES supports multiplexing of one or more VCs over a virtual path that is shaped at a constant bandwidth. For example, you can buy a virtual path service from an ATM service provider and multiplex both the CES and data traffic over the virtual path.

All subsequently created VCs with a VPI matching the VPI specified with the **atm pvc** command are multiplexed onto this PVC. This PVC connection is an ATM connection where switching is performed on the VPI field of the cell only. A PVC is created and left up indefinitely. All VCs that are multiplexed over a PVC share and are controlled by the traffic parameters associated with the PVC.

Changing the peak-rate causes the ATM-CES to go down and then back up.

When you create a PVC, two VC are created (VCI 3 and 4) by default. These VCs are created for VP end-to-end loopback and segment loopback OAM support.

To verify the configuration of a PVC, use the **show atm PVC EXEC** command.

Examples

The following example creates a permanent virtual circuit with a peak rate of 2000 kbps. The subsequent VC created are multiplexed onto this virtual circuit.

```
Router(config)#interface atm 6/0
Router(config-if)#atm pvp 1 2000
Router(config-if)#atm pvc 13 1 13 aal5snap
Router(config-if-atm-vc)#exit
Router(config)#interface cbr 6/1
Router(config-if)#ces circuit 0
Router(config-if)#ces pvc 9 interface atm6/0 vpi 1 vci 100
Router(config-if)#exit
```

Related Commands

Command	Description
show atm pvc	Displays all active ATM PVCs and traffic information.

pvc

To create or assign a name to an ATM permanent virtual circuit (PVC), specify the encapsulation type on an ATM PVC, or enter interface-ATM-VC configuration mode, use the **pvc** command in interface configuration mode. To remove an ATM PVC, use the **no** form of this command.

```
pvc [name] vpi/vci [ilmi | qsaal | smds]
```

```
no pvc [name] vpi/vci [ilmi | qsaal | smds]
```

Syntax Description	
name	(Optional) The name of the PVC or map. The name can be up to 16 characters long.
vpi/	ATM network virtual path identifier (VPI) for this PVC. The absence of the "/" and a <i>vpi</i> value defaults the <i>vpi</i> value to 0. On the Cisco 7200 and 7500 series routers, this value ranges from 0 to 255; on the Cisco 4500 and 4700 routers, this value ranges from 0 to 1 less than the quotient of 8192 divided by the value set by the atm vc-per-vc command. A value that is out of range is interpreted as a string and is treated as the connection ID. The arguments <i>vpi</i> and <i>vci</i> cannot both be set to 0; if one is 0, the other cannot be 0.
vci	ATM network virtual channel identifier (VCI) for this PVC. This value ranges from 0 to 1 less than the maximum value set for this interface by the atm vc-per-vc command. Typically, lower values 0 to 31 are reserved for specific traffic (for example, F4 OAM, SVC signalling, ILMI, and so on) and should not be used. The VCI is a 16-bit field in the header of the ATM cell. The VCI value is unique only on a single link, not throughout the ATM network, because it has local significance only. A value that is out of range causes an "unrecognized command" error message. The arguments <i>vpi</i> and <i>vci</i> cannot both be set to 0; if one is 0, the other cannot be 0.
ilmi	(Optional) Interim Local Management Interface. Used to set up communication with the ILMI; the associated <i>vpi</i> and <i>vci</i> values ordinarily are 0 and 16, respectively.
qsaal	(Optional) Quality of Service ATM Adaptation Layer. A signalling-type PVC used for setting up or tearing down SVCs; the associated <i>vpi</i> and <i>vci</i> values ordinarily are 0 and 5, respectively.
smds	(Optional) Switched Multimegabit Data Service. Encapsulation for SMDS networks. If you are configuring an ATM PVC on the ATM Interface Processor (AIP), you must configure AAL3/4SMDS using the atm aal aal3/4 command before specifying SMDS encapsulation. If you are configuring an ATM network processor module (NPM), the atm aal aal3/4 command is not required. SMDS encapsulation is not supported for ATM.

Defaults

No PVC is defined. When a PVC is defined, the global default of the encapsulation command applies (aal-encap = aal5snap).

Command Modes

Interface or subinterface configuration

Command History	Release	Modification
	11.3T	This command was introduced.
	12.1(2)T	Ranges for the VPI were increased for more flexibility with configuration.

Usage Guidelines

Creating and Configuring PVCs

The **pvc** command replaces the **atm pvc** command, which, although still supported and available, will become obsolete in the near future. Use the **pvc** command to configure a single ATM VC only, not a VC that is a bundle member. We recommend that you use the **pvc** command in conjunction with the **encapsulation** and **random-detect attach** commands instead of the **atm pvc** command.

The **pvc** command creates a PVC and attaches it to the VPI and VCI specified. Both the *vpi* and *vci* arguments cannot be simultaneously specified as 0; if one is 0, the other cannot be 0.

When configuring an SVC, use the **pvc** command to configure the PVC that handles SVC call setup and termination. In this case, specify the **qsaal** keyword. See the second example that follows.

ATM PVC Names

Once you specify a name for a PVC, you can reenter interface-ATM-VC configuration mode by entering the **pvc name** command. You can remove a PVC and any associated parameters by entering **no pvc name** or **no pvc vpi/vci**.

After configuring the parameters for an ATM PVC, you must exit the interface-ATM-VC configuration mode to create the PVC and enable the settings.

Encapsulation Types on ATM PVCs

Specify ILMI, QSAAL, or SMDS as the encapsulation type on an ATM PVC. (To configure other encapsulations types, see the encapsulation command.)

Rate Queues

The Cisco IOS software dynamically creates rate queues as necessary to satisfy the requests of the **pvc** commands.

Default Configurations

If ILMI, QSAAL, or SMDS encapsulation is not explicitly configured on the ATM PVC, the PVC inherits the following default configuration (listed in order of next highest precedence):

- Configuration of the encapsulation command in a VC class assigned to the PVC itself.
- Configuration of the encapsulation command in a VC class assigned to the ATM subinterface of the PVC.
- Configuration of the encapsulation command in a VC class assigned to the ATM main interface of the PVC.
- Global default: The global default of the encapsulation command applies (aal-encap = aal5snap).

Examples

The following example shows a PVC created with VPI 0 and VCI 16, and communication is set up with the ILMI:

```
Router(config-if)#pvc cisco 0/16 ilmi
Router(config-if-atm-vc)#exit
```

The following example shows a PVC used for ATM signalling created for an SVC. It specifies VPI 0 and VCI 5:

```
Router(config-if)#pvc cisco 0/5 qsaal
Router(config-if-atm-vc)#exit
```

The following example shows the PVC called cisco configured to use class-based weighted fair queueing (CBWFQ). It attaches a policy map called policy1 to the PVC. The classes comprising policy1 determine the service policy for the PVC:

```
Router(config-if)#pvc cisco 0/5
Router(config-if-atm-vc)#service-policy output policy1
Router(config-if-atm-vc)#exit
Router(config-if)#vbr-nrt 2000 2000
Router(config-if)#encap aal5snap
```

Related Commands

Command	Description
<code>show atm pvc</code>	Displays all active ATM PVCs and traffic information.

Glossary

AAL—ATM Adaptation Layer. Service-dependent sublayer of the data link layer. The AAL accepts data from different applications and presents it to the ATM layer in the form of 48-byte ATM payload segments. AALs consist of two sublayers: convergence sublayer (CS) and segmentation and reassembly (SAR). AALs differ on the basis of the source-destination timing used, whether they use constant bit rate (CBR) or variable bit rate (VBR), and whether they are used for connection-oriented or connectionless mode data transfer. At present, the four types of AAL recommended by the ITU-T are AAL1, AAL2, AAL3/4, and AAL5.

AAL1—ATM adaptation layer 1. One of four AALs recommended by the ITU-T. AAL1 is used for connection-oriented, delay-sensitive services requiring constant bit rates, such as uncompressed video and other isochronous traffic.

AAL5—ATM adaptation layer 5. One of four AALs recommended by the ITU-T. AAL5 supports connection-oriented VBR services and is used predominantly for the transfer of classical IP over ATM and LANE traffic. AAL5 uses simple and efficient AAL (SEAL) and is the least complex of the current AAL recommendations. It offers low bandwidth overhead and simpler processing requirements in exchange for reduced bandwidth capacity and error-recovery capability.

ABR—available bit rate. QoS class defined by the ATM Forum for ATM networks. ABR is used for connections that do not require timing relationships between source and destination. ABR provides no guarantees in terms of cell loss or delay, providing only best-effort service. Traffic sources adjust their transmission rate in response to information they receive describing the status of the network and its capability to successfully deliver data.

AIP—ATM Interface Processor.

AIS—alarm indication signal. In a T1 transmission, an all-ones signal transmitted in lieu of the normal signal to maintain transmission continuity and to indicate to the receiving terminal that there is a transmission fault that is located either at, or upstream from, the transmitting terminal.

ATM—Asynchronous Transfer Mode. International standard for cell relay in which multiple service types (such as voice, video, or data) are conveyed in fixed-length (53-byte) cells. Fixed-length cells allow cell processing to occur in hardware, thereby reducing transit delays. ATM is designed to take advantage of high-speed transmission media such as E3, SONET, and T3.

B8ZS—binary 8-zero substitution. Line-code type, used on T1 and E1 circuits, in which a special code is substituted whenever 8 consecutive zeros are sent over the link. This code is then interpreted at the remote end of the connection. This technique guarantees ones density independent of the data stream.

CBR—constant bit rate. QoS class defined by the ATM Forum for ATM networks. CBR is used for connections that depend on precise clocking to ensure undistorted delivery.

CPCS—common part convergence sublayer. One of the two sublayers of any AAL. The CPCS is service-independent and is further divided into the CS and the SAR sublayers. The CPCS is responsible for preparing data for transport across the ATM network, including the creation of the 48-byte payload cells that are passed to the ATM layer.

CS—convergence sublayer. One of the two sublayers of the AAL common part convergence sublayer (CPCS), which is responsible for padding and error checking. PDUs passed from the service specific convergence sublayer (SSCS) are appended with an 8-byte trailer (for error checking and other control information) and padded, if necessary, so that the length of the resulting PDU is divisible by 48. These PDUs are then passed to the SAR sublayer of the CPCS for further processing.

E1—European digital carrier facility used for transmitting data through the telephone hierarchy. The transmission rate for E1 is 2.048 megabits per second (Mbps).

E3—Wide-area digital transmission scheme used predominantly in Europe that carries data at a rate of 34.368 Mbps. E3 lines can be leased for private use from common carriers.

ESF—Extended Superframe. Framing type used on T1 circuits that consists of 24 frames of 192 bits each, with the 193rd bit providing timing and other functions. ESF is an enhanced version of SF.

FDL—Facility Data Link. A 4-Kbps channel, provided by the Extended SuperFrame (ESF) T1 framing format. The FDL performs outside the payload capacity and allows a service provider to check error statistics on terminating equipment, without intrusion.

ICP—IMA control protocol

ICMP—Internet Control Message Protocol. Network layer Internet protocol that reports errors and provides other information relevant to IP packet processing. Documented in RFC 792.

ILMI—Interim Local Management Interface. Specification developed by the ATM Forum for incorporating network-management capabilities into the ATM User-Network Interface (UNI).

IMA—Inverse Multiplexing for ATM, a standard protocol defined by the ATM Forum in 1997.

IMA group—Physical links grouped to form a higher-bandwidth logical link whose rate is approximately the sum of the individual link rates.

ISDN—Integrated Services Digital Network. Communication protocol, offered by telephone companies, that permits telephone networks to carry data, voice, and other source traffic.

MID—Message Identifier.

NM—Network module.

NPM—Network Processor Module.

OAM cell—Operation, Administration, and Maintenance cell. ATM Forum specification for cells used to monitor virtual circuits. OAM cells provide a virtual circuit-level loopback in which a router responds to the cells, demonstrating that the circuit is up, and the router is operational.

PDU—protocol data unit.

PVC—permanent virtual circuit. Virtual circuit that is permanently established. PVCs save bandwidth associated with circuit establishment and tear down in situations where certain virtual circuits must exist all the time. In ATM terminology, called a permanent virtual connection.

PVP—Permanent Virtual Path.

QoS—quality of service. Measure of performance for a transmission system that reflects its transmission quality and service availability.

SAR—segmentation and reassembly. One of the two sublayers of the AAL CPCS, responsible for dividing (at the source) and reassembling (at the destination) the PDUs passed from the CS. The SAR sublayer takes the PDUs processed by the CS and, after dividing them into 48-byte pieces of payload data, passes them to the ATM layer for further processing.

SF—Super Frame. Common framing type used on T1 circuits. SF consists of 12 frames of 192 bits each, with the 193rd bit providing error checking and other functions. SF is superseded by ESF, but is still widely used. Also called D4 framing.

SMDS—Switched Multimegabit Data Service.

SONET—Synchronous Optical Network. High-speed (up to 2.5 Gbps) synchronous network specification developed by Bellcore and designed to run on optical fiber. STS-1 is the basic building block of SONET.

SSCS—service specific convergence sublayer. One of the two sublayers of any AAL. SSCS, which is service dependent, offers assured data transmission. The SSCS can be null as well, in classical IP over ATM or LAN emulation implementations.

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. Called a switched virtual connection in ATM terminology.

T3—Digital WAN carrier facility. T3 transmits DS-3-formatted data at 44.736 Mbps through the telephone switching network.

UBR—unspecified bit rate. Quality of Service (QoS) class defined by the ATM Forum for ATM networks. UBR allows any amount of data up to a specified maximum to be sent across the network, but there are no guarantees in terms of cell loss rate and delay.

UNI—User-Network Interface. ATM Forum specification that defines an interoperability standard for the interface between ATM-based products (a router or an ATM switch) located in a private network and the ATM switches located within the public carrier networks. Also used to describe similar connections in Frame Relay networks.

VBR—variable bit rate. QoS class defined by the ATM Forum for ATM networks. VBR is subdivided into a real time (RT) class and non-real time (NRT) class. VBR (RT) is used for connections in which there is a fixed timing relationship between samples. VBR (NRT) is used for connections in which there is no fixed timing relationship between samples, but that still need a guaranteed QoS.

VC—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, a virtual circuit is called a virtual channel.

VCD—Virtual Circuit Descriptor.

VCI—Virtual Channel Identifier.

VPI—Virtual Path Identifier.