CHAPTER 8

Configuring ATM Permanent Virtual Circuit Autoprovisioning

With the rapid growth in broadband customers, service providers need to provision service for subscribers in the most efficient and accurate way possible. The ATM PVC autoprovisioning feature automates the configuration of a large number of ATM permanent virtual circuits (PVCs) in DSL service provider networks using the PPPoA, PPPoE, and RBE protocols.

This chapter describes how to configure the ATM PVC Autoprovisioning feature by using a local configuration. It also describes the VBR-nrt Oversubscription feature for ATM VCs.

This chapter describes the following features

ATM PVC Autoprovisioning

The Cisco 10000 series router supports the ATM PVC Autoprovisioning feature. By using this feature, DSL wholesale service providers can use a local configuration to dynamically provision ATM service for subscribers.

Incoming traffic on the VPI/VCI pair triggers virtual circuit (VC) creation. The Cisco 10000 series router does not create the on-demand VC until incoming traffic arrives. For example:

- On-demand VCs configured on the interface remain in the inactive state until the first incoming packet arrives on the VC, triggering VC creation.
- If you use the **reload** command on the Cisco 10000 series router, the router does not establish the on-demand VCs until incoming traffic triggers VC creation.

The ATM PVC Autoprovisioning feature is described in the following topics:

Local Template-Based ATM PVC Provisioning

The Local Template-Based ATM PVC Provisioning feature supports PVC autoprovisioning for an infinite range of VPI/VCI combinations on an ATM interface.

The Local Template-Based ATM PVC Provisioning feature enables ATM permanent virtual circuits (PVCs) to be provisioned automatically as needed from a local configuration, making the provisioning of large numbers of digital subscriber line (DSL) subscribers easier, faster, and less prone to error. ATM PVC autoprovisioning can be configured on a PVC, an ATM PVC range, or a VC class. If a VC class configured with ATM PVC autoprovisioning is assigned to the *main* interface, all the PVCs on that main interface will be autoprovisioned; this configuration is sometimes referred to as an infinite range.

In releases earlier than Cisco IOS Release 12.3(7)XI2, a reassembly channel had to be opened to receive any incoming packets on a create-on-demand VC. In Cisco IOS Release 12.3(7)XI2, the SAR sends the cell header to the RP, thus removing the need to open the reassembly channel to receive cells. Any cells received on an unopened channel result in cell headers from the SAR until the VC is opened.

Autoprovisioned ATM PVCs are not created until there is activity on the virtual path identifier (VPI)/virtual channel identifier (VCI) pair. When the interface is disabled and re-enabled using the **shutdown** and **no shutdown** commands, autoprovisioned PVCs that are part of a PVC range or infinite range are removed upon shutdown and are not reestablished until the first incoming cell triggers PVC creation. During router reload, autoprovisioned PVCs are created when there is activity on the connection.

Feature History for Local Template-Based ATM PVC Provisioning

Cisco IOS Release	Description	Required PRE
12.3(7)XI2	This feature was introduced on the Cisco 10000 series router.	PRE2
12.2(28)SB	This feature was integrated into Cisco IOS Release 12.2(28)SB.	PRE2

ATM Interface Oversubscription

The Cisco 10000 series router allows you to create more on-demand PVCs than the chassis allows to be active at the same time. For example, the router chassis allows a total of 61,500 PVCs to be up at the same time, even though you can configure more than 61,500 on-demand PVCs on the chassis. In actuality, you can configure up to 32,000 PVCs on each line card. If you install ATM line cards in six of the eight available slots in the chassis, you can configure up to 128,000 on-demand PVCs instead of the 61,500 PVCs chassis limit.

When the number of ATM PVCs exceeds a port's active VC count, you can use the **idle-timeout** interface command to dynamically bring down on-demand PVCs. If you use CLI commands to explicitly configure a PVC, the router brings the PVC to the inactive state when the idle-timeout timer expires.

VC Class

A VC class is a set of preconfigured VC parameters that you configure and apply to a particular VC or ATM interface. The VC parameters that you can configure for a VC class include the following:

- Attach ATM VC class to an interface (**class-int** command)
- Constant bit rate (**cbr** command)
- Encapsulation type (**encapsulation aal5** command)
- Idle-timeout (**idle-timeout** command)
- Integrated Local Management Interface (ILMI) management (**ilmi manage** command)
- Inverse ARP broadcasts (**protocol** command)
- Inverse ARP time period (**inarp** command)
- OAM management on a PVC (**oam-pvc** command)
- OAM management parameters for re-establishing and removing a PVC connection (**oam retry** command)
- PVC autoprovisioning (**create on-demand** command)
- Queue depth (**queue-depth** command)
- Static map for an ATM PVC or VC (**protocol** command)
- Unspecified bit rate (**ubr** command)
- Variable Bit Rate-Non Real Time quality of service (**vbr-nrt** command)
- Weight (**weight** command)

For more information, see the Configuring ATM chapter in the *Cisco IOS Wide-Area Networking Configuration Guide*.

ATM VC Scaling and VC Assignment

The ATM line cards support the full range of VPI//VCI pairs (unidirection only)—8 bit VPI range and 16 bit VCI range. Table 8-1 lists the maximum number of active VCs supported on ATM line cards for Cisco IOS Release 12.3(7)XI2 or later releases.

Table 8-1 Active VCs on ATM Line Cards

Line Card	Max. VCs per Port	Maximum VCs per Module	No. VBR, CBR, Shaped UBR VCs
E3/DS3	4,096	32,768[1]	28,672[2]
OC-3	8,191	32,764[3]	28,672[4]
OC-12	16,384 (previously 14,436)	16,384	16,384

1. For 32,768 VCs per module, 4096 of them must be unshaped UBR VCs.
2. For 28,672 VBR, CBR, and shaped UBR VCs, no VCs can be in shaped VP tunnels. If VCs are in shaped VPs, the number of VBR, CBR, and shaped UBR VCs is 22,204.
3. For 32,764 VCs per module, 4096 of them must be unshaped UBR VCs.
4. For 28,672 VBR, CBR, and shaped UBR VCs, no VCs can be in shaped VP tunnels. If VCs are in shaped VPs, the number of VBR, CBR, and shaped UBR VCs is 22,204.

You can configure the maximum number of VCs across the ports in any fashion, provided that you do not exceed the per-port maximum.

Although the maximum number of VBR, CBR, and shaped UBR VCs per E3/DS3 and OC-3 ATM line card is 28,672 VCs, the router supports a maximum of 22,204 VBR, CBR, and shaped UBR VCs per line card that you can place within virtual path (VP) tunnels. If you attempt to bring up more than 22,204 VCs in a configuration that includes VP tunnels and VCs (hierarchical traffic shaping configuration), the VCs might not assign traffic correctly or the VCs might not come up at all. Be sure to limit the number of configured VBR, CBR, and shaped UBR VCs on an ATM card to less than 22,204 VCs if you place the VCs in VP tunnels.

For the OC-12 ATM line card, the router supports 16,384 VCs in VP tunnels.

A pair of unidirectional Segmentation and Reassembly (SAR) chips are used on the line cards, one for the transmit direction and the other for the receive direction. The architecture of the SAR places limits on the following values supported by the router's ATM interfaces:

- Maximum number of active VCs
- Maximum number of VPI combinations that can be configured
- Maximum number of VCI combinations that can be configured

To allow the SAR to support the same VPI/VCI values per interface and thus discriminate among the VCs, the SAR translates the external VPI/VCI values into an internal 32-bit logical header that includes bits for the port number. Router interfaces can support 510 (page 0 is unused due to a hardware limitation; page 511 is reserved for tunnels) unique combinations of the following bit fields:

- PHY bits to designate the physical interface of the PVC. The OC-3 line card requires 2 bits for the port number; the OC-12 line card doesn't require any bits; and the DS-2 line card requires 3 bits.
- 8 VPI bits (represents the entire VPI value)
- Upper 9 bits of VCI value (bits 7-15 of the VCI field)

For more information, see the *Understanding the Maximum Number of Active Virtual Circuits on Cisco ATM Router Interfaces* tech note.

When SAR the Page Limit is Reached

In releases earlier than Cisco IOS Release 12.3(7)XI2, if the SAR page limit was reached while you were creating ATM PVCs, the router continued to create ATM PVCs but they were inactive.

In Cisco IOS Release 12.3(7)XI2, the router checks the SAR page limit before creating an ATM PVC. If the SAR page limit has been reached, a message displays indicating that there are no more SAR pages available for the PVC. A message similar to the following message is displayed for both individual ATM PVCs and ATM PVCs that are configured within a range.

```
*Oct 28 21:09:26.535: SAR exhausted the number of pages available to create this VC
*Oct 28 21:09:26.535: %ATM-3-FAILCREATEVC: ATM failed to create VC(VCD=1173, VPI=147,
VCI=1408) on Interface ATM5/0/3, (Cause of the failure: VPI/VCI out of range.)
```

OC-12 ATM Line Card and VC Scaling

The SAR on the OC-12 ATM line card uses four priority levels, 0 through 3. Unspecified bit rate (UBR) and virtual protocol (VP) tunnel use priority 3; variable bit rate (VBR) uses priority 2; and constant bit rate (CBR) uses priority 0. Each priority level supports a maximum of 16,000 VCs.

Feature History for ATM PVC Autoprovisioning

Cisco IOS Release	Description	Required PRE
12.2(15)BX	This feature was integrated into Cisco IOS Release 12.2(15)BX.	PRE2
12.3(7)XI1	This feature was integrated into Cisco IOS Release 12.3(7)XI1.	PRE2
12.2(28)SB	This feature was integrated into Cisco IOS Release 12.2(28)SB.	PRE2

Restrictions for ATM PVC Autoprovisioning

The ATM PVC autoprovisioning feature has the following restriction:

- The Segmentation and Reassembly (SAR) chip on the OC-3 and OC-12 ATM line cards is responsible for all physical ports on the line card. Restrictions on how VCs are assigned might reduce the VC counts.
- The ATM line cards use a pair of unidirectional SAR chips to segment and reassemble cells based on priority levels. The architecture of the SAR limits the way in which you can assign VCs. In some configurations, the limitation of the SAR can reduce the VC counts from the maximum number typically support (for example, a maximum of 8000 VCs per port for the OC-3 and 16,000 per port for the OC-12). For more information, see the "ATM VC Scaling and VC Assignment" section on page 8-4.
- The SAR translates the external VPI/VCI values into an internal 32-bit logical header. Router interfaces can support *510* unique bit field combinations in the 32-bit logical header. While there are 512 total SAR pages, page 0 is unused due to a hardware limitation and page 511 is reserved for tunnels.
- On PRE3 and PRE4, to prevent LC SAR overflow, only 97 percent of the configured VC rate is used internally.

Note Note: The limit of 510 usable SAR pages in Cisco IOS Release 12.3(7)XI2 represents a reduction from the limit of 512 usable SAR pages in earlier releases.

- The Local Template-Based ATM PVC Provisioning feature (infinite range) can be configured only on a *main* ATM interface; that is, it cannot be configured on a subinterface. When you use the **class-int** command to attach an ATM VC class to a subinterface, the **create on-demand** command is ignored.
- PVCs or PVCs within a range specified as create on demand PVCs, count against the interface limit for configured PVCs, regardless of whether the PVCs become active. These PVCs count against the maximum number of VCs allowed per interface port.

Configuration Tasks for ATM PVC Autoprovisioning

To configure the ATM PVC autoprovisioning feature, perform one of the following tasks:

- Creating an On-Demand PVC Using a VC Class, page 8-6
- Creating an On-Demand PVC Directly, page 8-8
- Creating an On-Demand PVC With Infinite Range, page 8-11

Creating an On-Demand PVC Using a VC Class

To create an on-demand PVC using a VC class, perform the following tasks:

- Creating a VC Class with PVC Autoprovisioning Enabled, page 8-6
- Applying the VC Class, page 8-7

Creating a VC Class with PVC Autoprovisioning Enabled

To create a VC class with the ATM PVC autoprovisioning feature enabled, enter the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# vc-class atm name`	Creates a VC class and enters vc-class configuration mode.
Step 2	`Router(config-vc-class)# create on-demand`	Enables PVC autoprovisioning. **Note** Configure additional VC parameters as appropriate. For more information, see the "VC Class" section on page 8-3 or the "Creating a VC Class Examples" section in the *Cisco IOS Wide-Area Networking Configuration Guide*.
Step 3	`Router(config-vc-class)# idle-timeout [time-out-in-seconds] [minimum-traffic-in-kbps]`	(Optional) Enables the idle-timeout timer on the on-demand PVC. The default *time-out-in-seconds* is 0 (no idle-timeout). The Cisco 10000 series router waits until the traffic on a particular VC is processed before tearing down the VC, even if you specify the *minimum-traffic-in-kbps* option or if the VC is idle during the idle-timeout period.

Example 8-1 creates a VC class named *myclass*, enables PVC autoprovisioning on the class, and sets the idle-timeout timer for 300 seconds. The configuration of the idle-timeout timer is optional.

Example 8-1 Configuring a VC Class with PVC Autoprovisioning Enabled

```
Router(config)# vc-class atm myclass
Router(config-vc-class)# create on-demand
Router(config-vc-class)# idle-timeout 300
```

Applying the VC Class

To apply a VC class, perform the following tasks:

- Applying a VC Class to an Individual PVC, page 8-7
- Applying a VC Class to a Range of PVCs, page 8-7
- Applying a VC Class to a Specific PVC Within a PVC Range, page 8-8

Applying a VC Class to an Individual PVC

To apply a VC class to a specific PVC, enter the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface atm slot/0 [.subinterface-number {multipoint | point-to-point}]`	Specifies the ATM interface and enters interface or subinterface configuration mode.
Step 2	`Router(config-if)# pvc [name] vpi/vci`	Specifies the ATM PVC and enters atm-vc configuration mode.
Step 3	`Router(config-if-atm-vc)# class-vc vc-class-name`	Applies the VC class on the PVC.

Example 8-2 applies the VC class *myclass* to PVC 100/100.

Example 8-2 Applying a VC Class to an Individual PVC

```
Router(config)# interface atm 3/0/0.1 multipoint
Router(config-subif)# atm pppatm passive
Router(config-subif)# pvc 100/100
Router(config-subif-atm-vc)# class-vc myclass
```

Applying a VC Class to a Range of PVCs

To apply a VC class to a range of PVCs, enter the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface atm slot/0 [.subinterface-number {multipoint | point-to-point}]`	Specifies the ATM interface and enters interface or subinterface configuration mode.

	Command	Purpose
Step 2	`Router(config-if)# range [range-name] pvc start-vpi/start-vci end-vpi/end-vci`	Specifies the range of PVCs and enters atm-range configuration mode.
Step 3	`Router(config-if-atm-range)# class-range class-name`	Applies the VC class on the range of PVCs.

Example 8-3 applies the VC class *myclass* to the PVC range 100/100 to 100/200.

Example 8-3 Applying a VC Class to a PVC Range

```
Router(config)# int atm 3/0/0.1 multipoint
Router(config-subif)# atm pppatm passive
Router(config-subif)# range pvc 100/100 100/200
Router(config-subif-atm-range)# class-range myclass
```

Applying a VC Class to a Specific PVC Within a PVC Range

To apply a VC class to a specific PVC within a PVC range, enter the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface atm slot/0 [.subinterface-number {multipoint | point-to-point}]`	Specifies the ATM interface and enters interface or subinterface configuration mode.
Step 2	`Router(config-if)# range [range-name] pvc start-vpi/start-vci end-vpi/end-vci`	Specifies the range of PVCs and enters atm-range configuration mode.
Step 3	`Router(config-if-atm-range)# pvc-in-range [pvc-name] [vpi/vci]`	Specifies an individual PVC within a PVC range.
Step 4	`Router(config-if-atm-range-pvc)# class-vc vc-class-name`	Applies the VC class on the individual PVC within the PVC range.

Example 8-4 applies the VC class *myclass* to PVC 100/100 in the PVC range 100/100 to 100/200.

Example 8-4 Applying a VC Class to a Specific PVC Within a PVC Range

```
Router(config)# int atm 3/0/0.1 multipoint
Router(config-subif)# atm pppatm passive
Router(config-subif)# range pvc 100/100 100/200
Router(config-subif-atm-range)# pvc-in-range 100/100
Router(config-subif-atm-range-pvc)# class-vc myclass
```

Creating an On-Demand PVC Directly

To configure an on-demand PVC directly on an individual PVC, a PVC range, or a specific PVC within PVC range, perform the following tasks:

- Enabling ATM PVC Autoprovisioning on an Individual PVC, page 8-9
- Enabling ATM PVC Autoprovisioning on a Range of PVCs, page 8-9
- Enabling ATM PVC Autoprovisioning on a Specific PVC Within a PVC Range, page 8-10

Enabling ATM PVC Autoprovisioning on an Individual PVC

To enable ATM PVC autoprovisioning on an individual PVC, enter the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# interface atm slot/0 [.subinterface-number {multipoint | point-to-point}]`	Specifies the ATM interface and enters interface or subinterface configuration mode.
Step 2	`Router(config-if)# pvc [name] vpi/vci`	Specifies the ATM PVC and enters atm-vc configuration mode.
Step 3	`Router(config-if-atm-vc)# create on-demand`	Enables PVC autoprovisioning on the individual PVC.
Step 4	`Router(config-if-atm-vc)# idle-timeout [time-out-in-seconds] [minimum-traffic-in-kbps]`	(Optional) Enables the idle-timeout timer on the individual on-demand PVC. The default *time-out-in-seconds* is 0 (no idle-timeout). The Cisco 10000 series router waits until the traffic on a particular VC is processed before tearing down the VC, even if you specify the *minimum-traffic-in-kbps* option or if the VC is idle during the idle-timeout period.

Example 8-5 enables autoprovisioning on PVC 100/100 and sets the idle-timeout timer for 300 seconds.

Example 8-5 Enabling ATM PVC Autoprovisioning on a PVC

```
Router(config)# int atm 3/0/0.1 multipoint
Router(config-subif)# atm pppatm passive
Router(config-subif)# pvc 100/100
Router(config-subif-atm-vc)# create on-demand
Router(config-subif-atm-vc)# idle-timeout 300
```

Enabling ATM PVC Autoprovisioning on a Range of PVCs

To enable ATM PVC autoprovisioning on a range of PVCs, enter the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router(config)# interface atm slot/0 [.subinterface-number {multipoint | point-to-point}]`	Specifies the ATM interface and enters interface or subinterface configuration mode.
Step 2	`Router(config-if)# range [range-name] pvc start-vpi/start-vci end-vpi/end-vci`	Specifies the range of PVCs and enters atm-range configuration mode.

	Command	Purpose
Step 3	`Router(config-if-atm-range)# create on-demand`	Enables PVC autoprovisioning on the range of PVCs.
Step 4	`Router(config-if-atm-range)# idle-timeout [time-out-in-seconds] [minimum-traffic-in-kbps]`	(Optional) Enables the idle-timeout timer on the on-demand PVC range. The default *time-out-in-seconds* is 0 (no idle-timeout). The Cisco 10000 series router waits until the traffic on a particular VC is processed before tearing down the VC, even if you specify the *minimum-traffic-in-kbps* option or if the VC is idle during the idle-timeout period.

Example 8-6 enables autoprovisioning on PVC range 100/100 to 100/200 and sets the idle-timeout timer for 300 seconds.

Example 8-6 Enabling ATM PVC Autoprovisioning on a PVC Range

```
Router(config)# int atm 3/0/0.1 multipoint
Router(config-subif)# atm pppatm passive
Router(config-subif)# range pvc 100/100 100/200
Router(config-subif-atm-range)# create on-demand
Router(config-subif-atm-range)# idle-timeout 300
```

Enabling ATM PVC Autoprovisioning on a Specific PVC Within a PVC Range

To enable ATM PVC autoprovisioning on a specific PVC within a PVC range, enter the following commands beginning in global configuration mode.

	Command	Purpose
Step 1	`Router(config)# interface atm slot/0 [.subinterface-number {multipoint | point-to-point}]`	Specifies the ATM interface and enters interface or subinterface configuration mode.
Step 2	`Router(config-if)# range [range-name] pvc start-vpi/start-vci end-vpi/end-vci`	Specifies the range of PVCs and enters atm-range configuration mode.
Step 3	`Router(config-if-atm-range)# pvc-in-range [pvc-name] [vpi/vci]`	Specifies an individual PVC within the PVC range.
Step 4	`Router(config-if-atm-range-pvc)# create on-demand`	Enables PVC autoprovisioning on the individual PVC within the PVC range.
Step 5	`Router(config-if-atm-range-pvc)# idle-timeout [time-out-in-seconds] [minimum-traffic-in-kbps]`	(Optional) Enables the idle-timeout timer on the on-demand PVC within the PVC range. The default *time-out-in-seconds* is 0 (no idle-timeout). The Cisco 10000 series router waits until the traffic on a particular VC is processed before tearing down the VC, even if you specify the *minimum-traffic-in-kbps* option or if the VC is idle during the idle-timeout period.

Example 8-7 enables autoprovisioning on PVC 100/100 in PVC range 100/100 to 100/200.

Example 8-7 Enabling ATM PVC Autoprovisioning on a PVC Within a PVC Range

```
Router(config)# int atm 3/0/0.1 multipoint
Router(config-subif)# atm pppatm passive
Router(config-subif)# range pvc 100/100 100/200
Router(config-subif-atm-range)# pvc-in-range 100/100
Router(config-subif-atm-range-pvc)# create on-demand
Router(config-subif-atm-range-pvc)# idle-timeout 300
```

Creating an On-Demand PVC With Infinite Range

To create an on-demand PVC with infinite range, enter the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# vc-class atm` *name*	Creates a VC class and enters vc-class configuration mode.
Step 2	`Router(config-vc-class)# create on-demand`	Enables PVC autoprovisioning. **Note** Configure additional VC parameters as appropriate. For more information, see the "VC Class" section on page 8-3 or the "Creating a VC Class Examples" section in the *Cisco IOS Wide-Area Networking Configuration Guide*.
Step 3	`Router(config-vc-class)# idle-timeout` [*time-out-in-seconds*] [*minimum-traffic-in-kbps*]	(Optional) Enables the idle-timeout timer on the on-demand PVC. The default *time-out-in-seconds* is 0 (no idle-timeout). The Cisco 10000 series router waits until the traffic on a particular VC is processed before tearing down the VC, even if you specify the *minimum-traffic-in-kbps* option or if the VC is idle during the idle-timeout period.
Step 4	`Router(config)# interface atm` *slot*`/0`	Specifies the ATM interface. You can configure infinite range only on a main ATM interface. When you use the **class-int** command to attach an ATM VC class to a subinterface, the **create on-demand** command is ignored.
Step 5	`Router(config-if)# class-int` *name*	Attaches a VC class to an ATM interface.

Example 8-8 creates a VC class named *myclass*, enables PVC autoprovisioning on the class, and attaches the class to the main ATM interface. All the PVCs on the main interface will be autoprovisioned; this configuration is also known as infinite range.

Example 8-8 Configuring an On-Demand PVC With Infinite Range

```
Router(config)# vc-class atm myclass
Router(config-vc-class)# create on-demand
Router(config-vc-class)# idle-timeout 300
Router(config)# int atm 3/0/0
Router(config-if)# class-int myclass
```

Monitoring and Maintaining ATM PVC Autoprovisioning

To monitor and maintain the ATM PVC autoprovisioning feature, enter any of the following commands in privileged EXEC mode.

Command	Purpose
`Router# show atm pvc`	Displays information about ATM PVCs, such as the interface, VPI/VCI, type, and encapsulation. PVC-A (PVC-Automatic) listed in the Type field indicates that the PVC is an on-demand PVC.
`Router# show atm vc`	Displays information about ATM VCs, including if the VC is an on-demand VC as indicated by VC-A (VC-Automatic) in the Type field.
`Router# show atm pvc` *VPI/VCI*	Displays information about a specific PVC, including if VC autoprovisioning is enabled.
`Router# debug atm autovc {event | error | all]`	Displays on-demand VC events and errors. Use the **event** option to display all on-demand VC events. Use the **error** option to display all on-demand VC errors. Use the **all** option to display both on-demand VC events and errors. **Note** Using the **debug atm autovc** command for a large range of PVCs can result in a large display of messages to the console window.

Caution Because debugging output is assigned high priority in the CPU process, it can render the system unusable. For this reason, use debug commands only to troubleshoot specific problems or during troubleshooting sessions with Cisco Systems technical support personnel. Moreover, it is best to use debug commands during periods of lower network traffic and fewer users. Debugging during these periods decreases the likelihood that increased debug command processing overhead will affect system use.

Example 8-9 indicates that autoprovisioning is enabled on PVCs 0/50, 0/51, and 0/52.

Example 8-9 show atm pvc Command

```
Router# show atm pvc

VCD /                                          Peak Avg/Min  Burst
Interface Name  VPI  VCI  Type  Encaps  SC  Kbps  Kbps    Cells  Sts
5/0.111    7     0    50  PVC-A  SNAP   UBR   149760             UP
5/0.111    8     0    51  PVC-A  SNAP   UBR   149760             UP
5/0.111    9     0    52  PVC-A  SNAP   UBR   149760             UP
```

Example 8-10 displays information about PVC 0/51 and indicates that autoprovisioning is enabled on the PVC.

Example 8-10 show atm pvc Command for a Specific PVC

```
Router# show atm pvc 0/51

ATM5/0.1: VCD: 118, VPI: 0, VCI: 51
UBR, PeakRate: 149760
AAL5-LLC/SNAP, etype:0x0, Flags: 0x20000C20, VCmode: 0x0
OAM frequency: 0 second(s), OAM retry frequency: 1 second(s), OAM retry frequency: 1
second(s)
OAM up retry count: 3, OAM down retry count: 5
OAM Loopback status: OAM Disabled
OAM VC state: Not Managed
ILMI VC state: Not Managed
InARP frequency: 15 minutes
Transmit priority 4
InPkts: 0, OutPkts: 0, InBytes: 0, OutBytes: 0
InPRoc: 0, OutPRoc: 0, Broadcasts: 0
InFast: 0, OutFast: 0, InAS: 0, OutAS: 0
InPktDrops: 0, OutPktDrops: 0
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0, LengthViolation: 0, CPIErrors: 0
Out CLP=1 Pkts: 0
OAM cells received: 0
F5 InEndloop: 0, F5 InSegloop: 0, F5 InAIS: 0, F5 InRDI: 0
F4 InEndloop: 0, F4 InSegloop: 0, F4 InAIS: 0, F4 InRDI: 0
OALM cells sent: 0
F5 OutEndloop: 0, F5 OutSegloop: 0, F5 OutRDI: 0
F4 OutEndloop: 0, F4 OutSegloop: 0, F4 OutRDI: 0
OAM cell drops: 0
Status: UP
PPP: Virtual-Access3 from Virtual-Template1
VC Auto Creation Enabled
```

Configuration Example for ATM PVC Autoprovisioning

The following example enables autoprovisioning on PVC range 100/100 to 100/3000 and applies the virtual template interface named *Virtual-Template1* to the PVC range.

```
ip local pool pool-1 10.1.1.2 10.1.12.255
!
interface Virtual-Template1
 ip address 10.1.1.1 255.255.0.0
 peer default ip address pool pool-1
 ip mtu 1492
 keepalive 60
 ppp timeout idle 65
 ppp direction callin
!
interface ATM7/0/0.1 point-to-multipoint
 atm pppatm passive
 range pvc 100/100 100/3000
  create on-demand
  idle-timeout 70
  encapsulation aal5mux ppp Virtual-Template1
```

Variable Bit Rate Non-Real Time Oversubscription

The Variable Bit Rate Non-Real Time (VBR-nrt) Oversubscription feature enables service providers to improve network utilization of otherwise underutilized shared networks by leveraging statistical multiplexing on ATM networks. Instead of supporting only unconditional reservation of network bandwidth to VCs, the router offers VC oversubscription to statistically guarantee bandwidth to VCs.

The VBR-nrt Oversubscription feature assumes that congestion at the physical port never or rarely occurs. For example, assume 10 VCs are configured to use 25 percent of the physical network bandwidth. The full capacity of the network is reached if only four VCs attempt to transmit traffic. The VBR-nrt Oversubscription feature is intended only for networks with low utilization in which congestion is unlikely to exist.

In releases earlier than Cisco IOS Release Cisco IOS Release 12.3(7)XI1, a call admission check (CAC) prevented you from assigning more bandwidth to virtual circuits (VCs) than a port's total bandwidth. The Cisco 10000 series router supported unconditional reservation of network bandwidth to VCs. When the sum of the transmission capacities of VCs falls within the bandwidth of the physical network, the network does not congest. Each VC receives its bandwidth reservation regardless of the traffic pattern of any other VC on that network. However, VCs receive this unconditional service at the expense of underutilization of the physical capacity of the network. Because each VC uses a fraction of the physical capacity, unless a large number of VCs remain busy, the overall network utilization remains low.

In Cisco IOS Release Cisco IOS Release 12.3(7)XI1 or later, the VBR-nrt Oversubscription feature enables you to specify the amount of oversubscription (oversubscription factor) you want to allow. The CAC check is based on the oversubscription factor you specify and evaluated separately for both VCs and VP tunnels into the port, and VCs into VP tunnels.

The oversubscription factor is also used to evaluate the amount of bandwidth allocated for unspecified bit rate (UBR) VCs. Prior to Cisco IOS Release Cisco IOS Release 12.3(7)XI1, UBR VCs received the bandwidth remaining after other VCs had been allocated bandwidth. The CAC check now adjusts the bandwidth for UBR VCs based on the oversubscription factor. For example:

port speed- sum of the VBR VCs = aggregate UBR bandwidth

Note You can apply a nested policy map to the main ATM interface to override this default equation and set a specific bandwidth for the aggregate UBR queues.

Whenever the oversubscription factor is reduced, less bandwidth is available for VC creation. As a result, a warning message appears indicating that some VCs might not be created. The VCs are not explicitly removed from the configuration and remain up and functional until you reboot the router or reset the slot. At this point, the VCs remain in the configuration but they are not up.

For optimal performance, configure the oversubscription factor as closely as possible to the sum of all VCs. The system allows VCs to be added provided the total subscribed rate is less than or equal to the port speed * over-subscription-factor.

CAC checks are disabled when the **no atm pxf queuing** command is configured on an interface.

For QoS-related information, see Chapter 13, "Oversubscribing Physical and Virtual Links" in the *Cisco 10000 Series Router Quality of Service Configuration Guide*.

The VBR-nrt Oversubscription feature is described in the following topics:

Feature History for VBR-nrt Oversubscription

Cisco IOS Release	Description	Required PRE
12.2(16)BX3	This feature was introduced on the Cisco 10000 series router.	PRE2
12.3(7)XI1	This feature was integrated into Cisco IOS Release 12.3(7)XI1.	PRE2
12.2(28)SB	This feature was integrated into Cisco IOS Release 12.2(28)SB.	PRE2

Restrictions for VBR-nrt Oversubscription

The VBR-nrt Oversubscription feature has the following restrictions:

Congestion

- Due to congestion on the physical interface, the accuracy of priority queuing (PQ) and class-based weighted fair queuing (CBWFQ) on individual VCs degrades. For example, if you configure each of three queues at a distribution of 50, 30, and 20 percent, the actual distribution might be 45, 40, and 15 percent.
- The distribution of bandwidth for each VC might be less than expected based on the speed of the VC. Typically, low speed VCs are allocated the expected bandwidth while high speed VCs share the remaining bandwidth equally.
- The amount of bandwidth allocated for the PQ or latency might be less than expected.

Oversubscription Feature

- Oversubscription of the ATM interfaces is off by default. Oversubscription of the tunnels (the number and bandwidth of VCs that can be in a tunnel) is on by default and is not subject to any oversubscription factor. Oversubscription of the tunnels cannot be adjusted or turned off.
- Use the **atm over-subscription-factor** command to enable the oversubscription feature for a particular interface or tunnel.

Note Do *not* use the **atm oversubscribe** command to enable oversubscription, as this can cause undesirable results.

The following configuration enables the oversubscription feature and configures the interface with an over-subscription-factor of 50.

```
Router(config)# interface atm 4/0/0
Router(config-if)# atm over-subscription-factor 50
Router(config-if)# exit
```

- To prevent oversubscription of the interface, use the **no atm oversubscribe** command. For example, the following configuration disables oversubscription of the ATM 4/0/0 interface. The previously configured factor 50 is configured on the interface, but the router does not allow the oversubscription.

```
Router(config)# interface atm 4/0/0
Router(config-if)# no atm oversubscribe
Router(config-if)# exit
```

- It is recommended that the **atm over-subscription-factor** command be applied to all ports of an ATM line card. This command controls the allocation of resources that are managed on a line card. Enabling oversubscription on one port alone could result in other ports taking up more resources than they were supposed to use. This could result in starving other ports for resources, which could cause VC creation to fail.
- In **atm pxf queuing** mode, the number of active VCs the ATM line cards support for Cisco IOS Release 12.3(7)XI2 or later releases is shown in Table 8-2.

Table 8-2 Active VCs on ATM Line Cards

Line Card	Max. VCs per Port	Maximum VCs per Module	No. VBR, CBR, Shaped UBR VCs
E3/DS3	4,096	32,768[1]	28,672[2]
OC-3	8,191	32,764[3]	28,672[4]
OC-12	16,384 (previously 14,436)	16,384	16,384

1. For 32,768 VCs per module, 4096 of them must be unshaped UBR VCs.
2. For 28,672 VBR, CBR, and shaped UBR VCs, no VCs can be in shaped VP tunnels. If VCs are in shaped VPs, the number of VBR, CBR, and shaped UBR VCs is 22,204.
3. For 32,764 VCs per module, 4096 of them must be unshaped UBR VCs.
4. For 28,672 VBR, CBR, and shaped UBR VCs, no VCs can be in shaped VP tunnels. If VCs are in shaped VPs, the number of VBR, CBR, and shaped UBR VCs is 22,204.

You can configure the maximum number of VCs across the ports in any fashion, provided that you do not exceed the per-port maximum.

Although the maximum number of VBR, CBR, and shaped UBR VCs per E3/DS3 and OC-3 ATM line card is 28,672 VCs, the router supports a maximum of 22,204 VBR, CBR, and shaped UBR VCs per line card that you can place within virtual path (VP) tunnels. If you attempt to bring up more than 22,204 VCs in a configuration that includes VP tunnels and VCs (hierarchical traffic shaping configuration), the VCs might not assign traffic correctly or the VCs might not come up at all. Be sure to limit the number of configured VBR, CBR, and shaped UBR VCs on an ATM card to less than 22,204 VCs if you place the VCs in VP tunnels.

For the OC-12 ATM line card, the router supports 16,384 VCs in VP tunnels.

Configuration Tasks for VBR-nrt Oversubscription

To configure the VBR-nrt Oversubscription feature, perform the following configuration tasks:

- Configuring VBR-nrt Oversubscription, page 8-17
- Verifying ATM PVC Oversubscription, page 8-17

Configuring VBR-nrt Oversubscription

To enable oversubscription of ATM VCs, enter the following command in interface configuration mode:

Command	Purpose
`Router(config-if)# atm over-subscription-factor {1-500}`	Oversubscribes an ATM VC. *1-500* specifies the amount of oversubscription. The default value is 1. **Note** Use this command for each ATM interface that you want to oversubscribe.

Note You do not need to use the **service-policy** command to specify the ATM VC oversubscription because a variable bit rate (VBR) ATM VC uses sustained cell rate (SCR) to define the VC average transmission rate.

Example 8-11 oversubscribes an ATM interface by five times the physical transmission capacity.

Example 8-11 Oversubscribing an ATM VC

```
Router(config)# interface atm 4/0/0
Router(config-if)# atm over-subscription-factor 5
```

Verifying ATM PVC Oversubscription

To verify the configuration of ATM PVC oversubscription, enter any of the following commands in privileged EXEC mode:

Command	Purpose
`Router# show controllers interface`	Displays the total subscribed rate of all VCs on the port. The system allows VCs to be added provided the total subscribed rate is less than or equal to: port speed * over-subscription-factor.
`Router# show running-config`	Displays the contents of the currently running configuration file. Indicates that oversubscription is on.

Configuration Example for ATM PVC Oversubscription

The following example oversubscribes an ATM interface by 10 times the physical transmission capacity:

```
interface atm 4/0/0
 atm over-subscription-factor 10
```