



Configuring RSVP-ATM QoS Interworking

This chapter describes how to configure the Resource Reservation Protocol (RSVP)-ATM Quality of Service (QoS) Interworking feature, which provides support for Controlled Load Service using RSVP over an ATM core network.

The RSVP-ATM QoS Interworking feature provides the ability to do the following:

- Preserve Interworking Layer 3 QoS over an ATM (Layer 2) backbone network by dynamically creating SVCs for each reserved Layer 3 flow.
- Identify and differentiate traffic that conforms to or exceeds reservation parameters.
- Set type of service (ToS) byte values in packets that exceed the reserved rate differently from those that conform to the reserved rate such that the two types of packets can be treated differently at downstream interfaces (hops).

This feature is supported on Cisco 7500 series routers with a VIP2-50 and Enhanced ATM port adapter (PA-A3). The hardware provides the traffic shaping required by the feature and satisfies the OC-3 rate performance requirement.

For complete conceptual information, see the section “RSVP-ATM QoS Interworking” in the chapter “Signalling Overview” in this book.

For a complete description of the RSVP-ATM QoS Interworking commands in this chapter, refer to the *Cisco IOS Quality of Service Solutions Command Reference*. To locate documentation of other commands that appear in this chapter, use the command reference master index, or search online.

RSVP-ATM QoS Interworking Configuration Task List

To configure RSVP-ATM QoS Interworking, perform the tasks in the following sections. The tasks in the first five sections are required; the remaining tasks are optional.

- Enabling RSVP and Limiting Reservable Bandwidth (Required)
- Enabling Creation of SVCs for Reserved Flows (Required)
- Limiting the Peak Rate Applied to the PCR for SVCs (Optional)
- Configuring per-VC DWRED (Required)
- Monitoring RSVP-ATM Configuration for an Interface (Optional)

Before you configure RSVP-ATM QoS Interworking, you must enable and configure the following features:

- Cisco Express Forwarding (CEF) switching (required for RSVP-ATM)
- Distributed CEF (dCEF) (required for per-SVC DWRED)

For information on how to configure these features, refer to the *Cisco IOS Switching Services Configuration Guide* and the *Cisco IOS Switching Services Command Reference*.

The RSVP-ATM QoS Interworking feature does not support RSVP with multicast.

See the end of this chapter for the section “RSVP-ATM QoS Interworking Configuration Examples.”

Enabling RSVP and Limiting Reservable Bandwidth

RSVP allows end systems or hosts on either side of a router network to establish a reserved-bandwidth path between them to predetermine and ensure QoS for their data transmission. By default, RSVP is disabled so that it is backward compatible with systems that do not implement RSVP.

To enable RSVP on an interface and restrict the total amount of bandwidth that can be reserved for RSVP as well as the amount that can be reserved for a single RSVP reservation or flow, use the following command in global configuration mode:

Command	Purpose
<code>ip rsvp bandwidth [interface-kbps] [single-flow-kbps]</code>	Enables RSVP for IP on an interface.

For RSVP over ATM, reservations are needed primarily between routers across the ATM backbone. To limit the number of locations where reservations are made, enable RSVP selectively only at subinterfaces corresponding to router-to-router connections across the backbone network. Preventing reservations being made between the host and the router both limits VC usage and reduces load on the router.

The default maximum bandwidth is up to 75 percent of the bandwidth available on the interface. By default, the amount reservable by a flow can be up to the entire reservable bandwidth.

On subinterfaces, the more restrictive of the available bandwidths of the physical interface and the subinterface is applied.

Enabling Creation of SVCs for Reserved Flows

Normally, reservations are serviced when RSVP classifies packets and a queueing mechanism polices the packet. To enable establishment of an SVC to service each new RSVP reservation on the interface, use the following command in interface configuration mode:

Command	Purpose
<code>ip rsvp svc-required</code>	Enables creation of an SVC for each new reservation made on the interface or subinterface.

To ensure defined QoS, SVCs created in response to RSVP reservation requests are established having QoS profiles consistent with the mapped RSVP flowspecs.

The SCR of an ATM SVC is equal to the RSVP reservation rate; the MBS of an ATM SVC is equal to the RSVP burst size. RSVP attempts to compensate for the cell tax when establishing the reservation so that the requested bandwidth is actually available for IP data traffic.

The sustained cell rate formula is given by the following equation:

$$r_{\text{atm}} = r_{\text{rsvp}} * (53/48) * (MPS + DLE + (MPS + DLE) \% 48) / MPS$$

The formula terms used in the equation (and subsequent equations) are described in Table 9, followed by an explanation of how the formula was derived.

Table 9 *SCR Formula Terms*

Term	Definition
r_{atm}	ATM rate (SCR).
r_{rsvp}	RSVP rate.
MPS	Minimum IP packet size, including the IP headers (300 bytes minimum).
DLE	Data-link encapsulation overhead. For RSVP ATM SVCs, AAL5 SNAP encapsulation is used, which imposes a 5-byte encapsulation header on each PDU.
%	Modulus operator. It yields the integer remainder from an integer division operation. For example, $57 \% 53$ results in 4.
CPS	Cell payload size. The total number of bytes in all the payloads of all the cells required to send a single packet with encapsulation.
UCO	Unused cell overhead (0 to 47).
COMP	Compensation factor. CPS divided by MPS.

There are two reasons for converting from RSVP rate to the ATM cell rate:

- To account for the ATM encapsulation header overhead and cell header overhead
- To account for the fact that ATM cell sizes are fixed

Because a portion of the last cell is unused, it is possible that a certain IP packet size requires more ATM cell layer bytes.

$MPS + DLE$ is the length of the data packet that needs to be segmented into a number of fixed-length (48-byte payload) pieces that would then be put into a cell and sent.

Because the CPS needs to be greater than or equal to $MPS + DLE$, CPS must be larger than MPS.

CPS can be calculated by the following expression:

$$CPS = \text{ceil}((MPS + DLE) / 48) * 48$$

where $\text{ceil}(x)$ is the ceiling operator that returns the smallest integer greater than or equal to the real number x . Upon expanding the implementation of the $\text{ceil}(x)$ operator, the above expression can be arithmetically transformed into the following equation:

$$CPS = MPS + DLE + (MPS + DLE) \% 48$$

where $(MPS + DLE) \% 48$ yields the integer remainder when $MPS + DLE$ is divided by 48. Because $(MPS + DLE) \% 48$ is equal to the UCO, the equation for CPS can be rewritten as follows:

$$CPS = MPS + DLE + UCO$$

Because the IP bit rate was calculated by considering only the IP data and header (that is, packets of length MPS or larger), the IP bit rate (r_{rsvp}) needs to be multiplied by COMP. From Table 9 we see that $COMP = CPS/MPS$. Thus:

$$\text{ATM cell payload bit rate} = r_{rsvp} * COMP = r_{rsvp} * CPS/MPS$$

When expanded, the ATM cell payload bit rate is given by the equation:

$$\text{ATM cell payload bit rate} = r_{rsvp} * (MPS + DLE + UCO)/MPS$$

Each ATM cell has a 5-byte header and a 48-byte payload, resulting in a 53-byte cell. Because the entire cell needs to be accounted for (not just the payload), we need to multiply the above equation by a compensation factor of 53/48. This yields the desired equation:

$$r_{atm} = r_{rsvp} * (53/48) * (MPS + DLE + UCO)/MPS$$

Thus, the SCR of the SVC created to carry the RSVP flow is calculated by the following formula:

$$r_{atm} = r_{rsvp} * (53/48) * (MPS + DLE + (MPS + DLE) \% 48)/MPS$$

The ATM PCR is derived using the same formula as the cell rate formula. It is either based on the maximum line rate of the ATM interface or on a configured maximum.

The maximum burst size of the SVC is derived by the following formula:

$$r_{atm} = r_{rsvp} * (MPS + DLE + UCO) / (MPS * 48)$$

Note that the actual PCR, SCR, and MBS will be slightly larger than these formulas indicate.

See the task “Limiting the Peak Rate Applied to the PCR for SVCs” for information on setting the PCR of the ATM SVC.

Each new RSVP reservation causes establishment of a new SVC. If an existing reservation is refreshed, no new signalling is needed. If the reservation is not refreshed and it times out, the SVC is torn down. If the reservation is refreshed but the RSVP flowspec has changed, the existing SVC is torn down and a new one with the correct QoS parameters is established.

Limiting the Peak Rate Applied to the PCR for SVCs

To set a limit on the PCR of reservations for all new RSVP SVCs established on the current interface or any of its subinterfaces, use the following command in interface configuration mode:

Command	Purpose
<code>ip rsvp atm-peak-rate-limit limit</code>	Configures the peak rate limit for new RSVP SVCs on an interface or subinterface.

For Controlled Load Service, the nominal peak rate is not defined and is taken as infinity. Consequently, the PCR is set to the available line rate. However, you can use the `ip rsvp atm-peak-rate-limit` command to further limit the PCR to a specific value on a per-interface basis.

Configuring per-VC DWRED

To configure DWRED with per-VC DWRED enabled as a drop policy at the interface level for a specific DWRED group, use the following command in interface configuration mode:

Command	Purpose
<code>random-detect [attach group-name]</code>	Configures interface-level per-VC DWRED for a specific DWRED group.

The per SVC-DWRED drop policy ensures that packets that match reservations and conform to the appropriate token bucket have the highest priority. Attaching DWRED group definitions to the interface to support per-VC DWRED drop policy ensures that if packets must be dropped, then best-effort packets are dropped first and not those that conform to the appropriate QoS determined by the RSVP's token bucket. This drop policy meets the loss requirements of controlled load called for by the Controlled Load Service class.

To meet the loss goals of controlled load, it is necessary to ensure that if packets must be dropped, best-effort packets are dropped first. Given that packets matching reservations and conforming to the appropriate token bucket will have the highest precedence, per-SVC DWRED is used as the drop policy.

**Note**

In order to use per-SVC DWRED, dCEF must be configured on the router. For information on how to configure dCEF, refer to the *Cisco IOS Switching Services Configuration Guide* and the *Cisco IOS Switching Services Command Reference*.

Monitoring RSVP-ATM Configuration for an Interface

To display the peak rate limit for the interface, the IP Precedence and ToS bit values configured for packets that conform to and exceed the flowspec, and other RSVP-related information for the interface, such as whether the interface has been configured to establish SVCs to service reservation request messages, use one or more of the following commands in EXEC mode:

Command	Purpose
<code>show ip rsvp atm-peak-rate-limit [interface]</code>	Displays the current peak rate limit set for an interface, if any.
<code>show ip rsvp interface [interface-type interface-number]</code>	Displays RSVP-related interface information.
<code>show ip rsvp {precedence tos} [interface]</code>	Displays the IP Precedence bit values and ToS bit values to be used to mark the ToS byte of the IP headers of all packets in an RSVP reserved path that conform to or exceed the RSVP flowspec for a given interface.

RSVP-ATM QoS Interworking Configuration Examples

The following example configures two Cisco 7500 series routers that connect over an ATM core network through a PVC and multiple SVCs. As depicted in Figure 14, Router A is connected to the ATM core network downstream; upstream it is connected across an Ethernet connection to the RSVP sender host system. Router B is connected upstream to the ATM core network and downstream across an Ethernet connection to the RSVP receiver host.

The example configuration shows three PVCs, two of which are required by ATM. One of the PVCs is used for RSVP-ATM Interworking. It is used for transmission of best-effort traffic and control traffic such as routing and RSVP messages. The ATM SVCs are established in response to reservation request messages in order to service those requests.

Figure 14 Example RSVP-ATM QoS Interworking Configuration



Router A

The following portion of the example configures Router A in global configuration mode. It enables CEF which must be turned on before the RSVP-ATM QoS Interworking feature can be enabled at the interface configuration level.

```

RouterA# config terminal
RouterA(config)# ip routing
RouterA(config)# ip cef
RouterA(config)#
  
```

The following segment of the configuration for Router A configures the ATM2/1/0 interface. The optional **ip route-cache flow** command enables NetFlow on the interface.



Note

The **ip route-cache flow** command is not required for RSVP over ATM SVCs beginning in Cisco IOS Release 12.2(13)T. However, using the command can improve ATM SVC switching performance, but has no impact on ATM over SVC functionality.

If you do not enter the **ip rsvp bandwidth** command before the **ip rsvp svc-required** command, a warning is issued requesting that you change the order of the commands.

The **ip rsvp bandwidth** command enables RSVP on the interface with default values for bandwidth allocation to RSVP. The **ip rsvp svc-required** command enables establishment of an SVC to service each new RSVP reservation on the interface. The **ip rsvp tos** and **ip rsvp precedence** commands configure conform and exceed values to be used for setting the ToS and IP Precedence bits of packets that either conform to or exceed the RSVP flowspec. (Note that once set, the ToS and IP Precedence bit values remain for the duration of the packet.)

You should configure the **ip route-cache flow** command only on the input interfaces of a router on whose output interfaces you configured the **ip rsvp svc-required** command.

**Note**

The **ip route-cache flow** command is not required for RSVP over ATM SVCs beginning in Cisco IOS Release 12.2(13)T. However, using the command can improve ATM SVC switching performance, but has no impact on ATM over SVC functionality.

```
RouterA(config)# interface ATM2/1/0
RouterA(config-if)# no shut
RouterA(config-if)# ip address 145.5.5.1 255.255.255.0
RouterA(config-if)# no ip proxy
RouterA(config-if)# no ip redirects
RouterA(config-if)# ip route-cache
RouterA(config-if)# ip mroute-cache
RouterA(config-if)# ip route-cache flow
RouterA(config-if)# no ip mroute-cache
RouterA(config-if)# ip route-cache cef
RouterA(config-if)# atm pvc 1 0 5 qsaal
RouterA(config-if)# atm pvc 2 0 16 ilmi
RouterA(config-if)# atm esi-address 11111111151.00
RouterA(config-if)# pvc pvc12 0/51
RouterA(config-if-atm-vc)# inarp 5
RouterA(config-if-atm-vc)# broadcast
RouterA(config-if-atm-vc)# exit
RouterA(config-if)# ip rsvp bandwidth
RouterA(config-if)# ip rsvp svc-required
RouterA(config-if)# ip rsvp tos conform 4
RouterA(config-if)# ip rsvp precedence conform 3 exceed 2
```

The following portion of the configuration configures the Ethernet interface named Ethernet0/1 on Router A that is used for the connection between the sender host and Router A. RSVP is enabled on the interface with default bandwidth allocations. (Note that this is the input interface; therefore, you must configure the **ip route-cache flow** command, or the feature will not function.)

**Note**

The **ip route-cache flow** command is not required for RSVP over ATM SVCs beginning in the Cisco IOS 12.2(13)T Release. However, using the command can improve ATM SVC switching performance, but has no impact on ATM over SVC functionality.

```
RouterA(config)# interface Ethernet0/1
RouterA(config-if)# ip address 145.1.1.1 255.255.255.0
RouterA(config-if)# no ip proxy
RouterA(config-if)# no ip redirects
RouterA(config-if)# no shut
RouterA(config-if)# ip route-cache
RouterA(config-if)# ip mroute-cache
RouterA(config-if)# ip route-cache flow
RouterA(config-if)# no ip mroute-cache
RouterA(config-if)# ip route-cache cef
RouterA(config-if)# fair
RouterA(config-if)# ip rsvp bandwidth
```

The following section displays the configuration for Router A after the preceding commands were used to configure it:

```
RouterA# write terminal

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname RouterA
boot system tftp rsp-jv-mz 171.69.209.28
enable password
!
ip subnet-zero
ip cef
interface Ethernet0/1
 ip address 145.1.1.1 255.255.255.0
 no ip redirects
 no ip directed-broadcast
 no ip proxy-arp
 ip rsvp bandwidth 7500 7500
 no ip route-cache cef
 no ip mroute-cache
 fair-queue 64 256 1000
!
interface ATM2/1/0
 ip address 145.5.5.1 255.255.255.0
 no ip redirects
 no ip directed-broadcast
 no ip proxy-arp
 ip rsvp bandwidth 112320 112320
 ip rsvp svc-required
 ip route-cache flow
 ip rsvp tos conform 4
 ip rsvp precedence conform 3 exceed 2
 no ip route-cache cef
 no ip route-cache distributed
 no ip mroute-cache
 atm pvc 1 0 5 qsaal
 atm pvc 2 0 16 ilmi
 atm esi-address 111111111151.00
 pvc pvc12 0/51
  inarp 5
  broadcast
!
```

Router B

Router B is configured similarly to Router A. In the following global configuration portion of the example, Router B is configured so that CEF is enabled, before the RSVP-ATM QoS Interworking feature can be enabled.

```
RouterB# config terminal
RouterB(config)# ip routing
RouterB(config)# ip cef
RouterB(config)#
```

The following segment of the configuration for Router B configures the interface named ATM3/0/0. The **ip rsvp bandwidth** command enables RSVP and the optional **ip route-cache flow** command enables NetFlow on the interface.

**Note**

The **ip route-cache flow** command is not required for RSVP over ATM SVCs beginning in Cisco IOS Release 12.2(13)T. However, using the command can improve ATM SVC switching performance, but has no impact on ATM over SVC functionality.

The **ip rsvp svc-required** command enables the RSVP-ATM QoS Interworking feature, allowing for the establishment of an SVC to service each new RSVP reservation on the interface.

```
RouterB(config)# interface ATM3/0/0
RouterB(config-if)# atm pvc 1 0 5 qsaal
RouterB(config-if)# atm pvc 2 0 16 ilmi
RouterB(config-if)# atm esi-address 11111111152.00
RouterB(config-if)# pvc pvc12 0/52
RouterB(config-if-atm-vc)# inarp 5
RouterB(config-if-atm-vc)# broadcast
RouterB(config-if-atm-vc)# exit
RouterB(config-if)# ip rsvp bandwidth
RouterB(config-if)# ip route-cache flow
RouterB(config-if)# ip rsvp svc-required
```

The following portion of the configuration configures the Ethernet interface on Router B. This interface is used for the connection between the receiver host and Router B. RSVP is enabled on the interface.

```
RouterB(config)# interface Ethernet0/2
RouterB(config-if)# no shut
RouterB(config-if)# ip address 145.4.4.2 255.255.255.0
RouterB(config-if)# no ip proxy
RouterB(config-if)# no ip redirects
RouterB(config-if)# ip route-cache
RouterB(config-if)# ip mroute-cache
RouterB(config-if)# ip route-cache flow
RouterB(config-if)# no ip mroute-cache
RouterB(config-if)# ip route-cache cef
RouterB(config-if)# fair
RouterB(config-if)# ip rsvp bandwidth
RouterB(config-if)# end
RouterB(config)# ip routing
RouterB(config)# router eigrp 17
RouterB(config-router)# network 145.5.5.0
RouterB(config-router)# network 145.4.4.0
```

The following section displays configuration for Router B after the preceding commands were used to configure it:

```
RouterB# write terminal
Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname RouterB
!
!
boot system tftp rsp-jv-mz 171.69.209.28
enable password
!
```

```
ip subnet-zero
ip cef distributed
interface Ethernet0/2
 ip address 145.4.4.2 255.255.255.0
 no ip redirects
 no ip directed-broadcast
 no ip proxy-arp
 ip rsvp bandwidth 7500 7500
 ip route-cache flow
 no ip mroute-cache
 fair-queue 64 256 1000
!
interface ATM3/0/0
 ip address 145.5.5.2 255.255.255.0
 no ip redirects
 no ip directed-broadcast
 no ip proxy-arp
 ip rsvp bandwidth 112320 112320
 ip rsvp svc-required
 ip route-cache flow
 no ip route-cache cef
 no ip route-cache distributed
 no ip mroute-cache
 atm pvc 1 0 5 qsaal
 atm pvc 2 0 16 ilmi
 atm esi-address 11111111152.00
 pvc pvc12 0/52
  inarp 5
  broadcast
!
```