RSVP Aggregation

The RSVP Aggregation feature allows the Resource Reservation Protocol (RSVP) state to be reduced within an RSVP/DiffServ network by aggregating many smaller reservations into a single, larger reservation at the edge.

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Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for RSVP Aggregation

You must configure at least two aggregating nodes (provider edge [PE] devices), one interior node (provider [P] device) and two end user nodes (customer edge [CE] devices) within your network.

You must configure your network to support the following Cisco IOS features:

- RSVP
- Class Based Weighted Fair Queuing (CBWFQ)
- RSVP Scalability Enhancements

Note You configure these features because Cisco IOS Release 12.2(33)SRC supports control plane aggregation only. Dataplane aggregation must be achieved by using the RSVP Scalability Enhancements.

Restrictions for RSVP Aggregation

Functionality Restrictions

The following functionality is not supported:

- Multilevel aggregation
- Multiple, adjacent aggregation regions
- Dynamic resizing of aggregate reservations
- Policing of end-to-end (E2E) reservations by the aggregator
- Policing of aggregate reservations by interior devices
- Differentiated Services Code Point (DSCP) marking by the aggregator
- Equal Cost Multiple Paths (ECMP) load-balancing within the aggregation region
- RSVP Fast Local Repair in case of a routing change resulting in a different aggregator or deaggregator, admission control is performed on E2E PATH refresh
- Multicast RSVP reservations
- RSVP policy servers including Common Open Policy Server (COPS)
- Dataplane aggregation

The following functionality is supported:

- Multiple, non-adjacent aggregation regions
- Control plane aggregation

Note RSVP/DiffServ using CBWFQ provides the dataplane aggregation.

Configuration Restrictions

- Sources should not send marked packets without an installed reservation.
- Sources should not send marked packets that exceed the reserved bandwidth.
- Sources should not send marked packets to a destination other than the reserved path.
- All RSVP capable devices within an aggregation region regardless of role must support the aggregation feature to recognize the RFC 3175 RSVP message formats properly.

- E2E reservations must be present to establish dynamic aggregates; aggregates cannot be established manually.
- Aggregates are established at a fixed bandwidth regardless of the number of current E2E reservations being aggregated.
- Aggregators and deaggregators must be paired to avoid blackholing of E2E reservations because of dynamic aggregate establishment.

Note Blackholing means that the reservation is never established. If an E2E reservation crosses from an exterior to an interior interface, the E2E reservation turns into an RSVP-E2E-IGNORE protocol packet. If there is no corresponding deaggregator, a device where this RSVP-E2E-IGNORE reservation crosses an interior to an exterior interface, then the RSVP-E2E-IGNORE reservation is never restored to an E2E reservation. The RSVP-E2E-IGNORE reservation eventually reaches its destination, which is the RSVP receiver; however, the RSVP receiver does not know what to do with the RSVP-E2E-IGNORE reservation and discards the packet.

Information About RSVP Aggregation

Feature Overview of RSVP Aggregation

High Level Overview

The establishment of a single RSVP reservation requires a large amount of resources including memory allocated for the associated data structures, CPU for handling signaling messages, I/O operations for datapath programming, interprocess communication, and signaling message transmission.

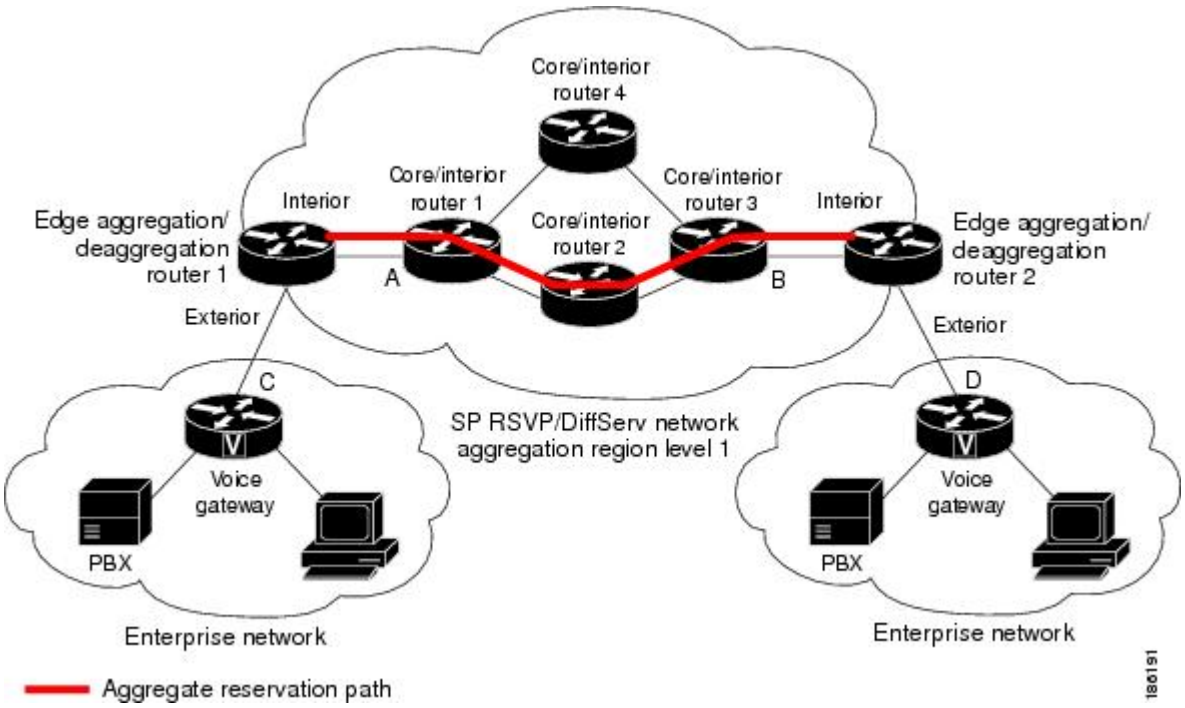
When a large number of small reservations are established, the resources required for setting and maintaining these reservations may exceed a node's capacity to the point where the node's performance is significantly degraded or it becomes unusable. The RSVP Aggregation feature addresses this scalability issue by introducing flow aggregation.

Flow aggregation is a mechanism wherein RSVP state can be reduced within a core device by aggregating many smaller reservations into a single, larger reservation at the network edge. This preserves the ability to perform connection admission control on core device links within the RSVP/DiffServ network while reducing signaling resource overhead.

How Aggregation Functions

Common segments of multiple end-to-end (E2E) reservations are aggregated over an aggregation region into a larger reservation that is called an aggregate reservation. An aggregation region is a connected set of nodes that are capable of performing RSVP aggregation as shown in the figure below.

Figure 1: RSVP Aggregation Network Overview



There are three types of nodes within an aggregation region:

- Aggregator--Aggregates multiple E2E reservations.
- Deaggregator--Deaggregates E2E reservations; provides mapping of E2E reservations onto aggregates.
- Interior--Neither aggregates or deaggregates, but is an RSVP core router that understands RFC 3175 formatted RSVP messages. Core/interior routers 1 through 4 are examples shown in the figure above.

There are two types of interfaces on the aggregator/deaggregator nodes:

- Exterior interface--The interface is not part of the aggregate region.
- Interior interface--The interface is part of the aggregate region.

Any router that is part of the aggregate region must have at least one interior interface and may have one or more exterior interfaces. Depending on the types of interfaces spanned by an IPv4 flow, a node can be an aggregator, a deaggregator, or an interior router with respect to that flow.

Aggregate RSVP DiffServ Integration Topology

RSVP aggregation further enhances RSVP scalability within an RSVP/DiffServ network as shown in the figure above by allowing the establishment of aggregate reservations across an aggregation region. This allows for aggregated connection admission control on core/interior device interfaces. Running RSVP on the core/interior devices allows for more predictable bandwidth use during normal and failure scenarios.

The voice gateways are running classic RSVP, which means RSVP is keeping a state per flow and also classifying, marking, and scheduling packets on a per-flow basis. The edge/aggregation devices are running RSVP with scalability enhancements for admission control on the exterior interfaces connected to the voice gateways and running RSVP aggregation on the interfaces connected to core/interior devices 1 and 3. The

core/interior devices in the RSVP/DiffServ network are running RSVP for the establishment of the aggregate reservations. The edge and core/interior devices inside the RSVP/DiffServ network also implement a specific per hop behavior (PHB) for a collection of flows that have the same DSCP.

The voice gateways identify voice data packets and set the appropriate DSCP in their IP headers so that the packets are classified into the priority class in the edge/aggregation devices and in core/interior devices 1, 2, 3 or 1, 4, 3.

The interior interfaces on the edge/aggregation/deaggregation devices (labeled A and B) connected to core/interior devices 1 and 3 are running RSVP aggregation. They are performing admission control only per flow against the RSVP bandwidth of the aggregate reservation for the corresponding DSCP.

Admission control is performed at the deaggregator because it is the first edge node to receive the returning E2E RSVP RESV message. CBWFQ is performing the classification, policing, and scheduling functions on all nodes within the RSVP/DiffServ network including the edge devices.

Aggregate reservations are dynamically established over an aggregation region when an E2E reservation enters an aggregation region by crossing from an exterior to an interior interface; for example, when voice gateway C initiates an E2E reservation to voice gateway D. The aggregation is accomplished by "hiding" the E2E RSVP messages from the RSVP nodes inside the aggregation region. This is achieved with a new IP protocol, RSVP-E2E-IGNORE, that replaces the standard RSVP protocol in E2E PATH, PATHTEAR, and RESVCONF messages. This protocol change to RSVP-E2E-IGNORE is performed by the aggregator when the message enters the aggregation region and later restored back to RSVP by the deaggregator when the message exits the aggregation region. Thus, the aggregator and deaggregator pairs for a given flow are dynamically discovered during the E2E PATH establishment.

The deaggregator device 2 is responsible for mapping the E2E PATH onto an aggregate reservation per the configured policy. If an aggregate reservation with the corresponding aggregator device 1 and a DSCP is established, the E2E PATH is forwarded. Otherwise a new aggregate at the requisite DSCP is established, and then the E2E PATH is forwarded. The establishment of this new aggregate is for the fixed bandwidth parameters configured at the deaggregator device 2. Aggregate PATH messages are sent from the aggregator to the deaggregator using RSVP’s normal IP protocol. Aggregate RESV messages are sent back from the deaggregator to the aggregator, thus establishing an aggregate reservation on behalf of the set of E2E flows that use this aggregator and deaggregator. All RSVP capable interior nodes process the aggregate reservation request following normal RSVP processing including any configured local policy.

The RSVP-E2E-IGNORE messages are ignored by the core/interior devices, no E2E reservation states are created, and the message is forwarded as IP. As a consequence, the previous hop/next hop (PHOP/ NHOP) for each RSVP-E2E-IGNORE message received at the deaggregator or aggregator is the aggregator or deaggregator node. Therefore, all messages destined to the next or previous hop (RSVP error messages, for example) do not require the protocol to be changed when they traverse the aggregation region.

By setting up a small number of aggregate reservations on behalf of a large number of E2E flows, the number of states stored at core/interior devices and the amount of signal processing within the aggregation region is reduced.

In addition, by using differentiated services mechanisms for classification and scheduling of traffic supported by aggregate reservations rather than performing per aggregate reservation classification and scheduling, the amount of classification and scheduling state in the aggregation region is further reduced. This reduction is independent of the number of E2E reservations and the number of aggregate reservations in the aggregation region. One or more RSVP/DiffServ DSCPs are used to identify the traffic covered by aggregate reservations, and one or more RSVP/DiffServ per hop behaviors (PHBs) are used to offer the required forwarding treatment to this traffic. There may be more than one aggregate reservation between the same pair of devices, each representing different classes of traffic and each using a different DSCP and a different PHB.

Integration with RSVP Features

RSVP aggregation has been integrated with many RSVP features, including the following:

- RSVP Fast Local Repair
- RSVP Local Policy Support
- RSVP Refresh Reduction and Reliable Messaging

Benefits of RSVP Aggregation

Enhanced Scalability

Aggregating a large number of small reservations into one reservation requires fewer resources for signaling, setting, and maintaining the reservation thereby increasing scalability.

Enhanced Bandwidth Usage within RSVP/DiffServ Core Network

Aggregate reservations across an RSVP/DiffServ network allow for more predictable bandwidth use of core links across RSVP/DiffServ PHBs. Aggregate reservations can use RSVP fast local repair and local policy preemption features for determining bandwidth use during failure scenarios.

How to Configure RSVP Aggregation

Configuring RSVP Scalability Enhancements

Perform these tasks on all nodes within the aggregation region including aggregators, deaggregators, and interior nodes.

Enabling RSVP on an Interface

Perform this task to enable RSVP on all the interfaces along the path from the sender to the receiver.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip routing**
4. **ip vrf** *vrf-name*
5. **exit**
6. **interface** *type number*
7. **ip vrf forwarding** *vrf-name*
8. **ip rsvp bandwidth** [*interface-kbps*] [*single-flow-kbps*]
9. Repeat the previous step for each interface that you want to enable.
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip routing** **Example:** `Device(config)# ip routing`	Enables IP routing.
Step 4	**ip vrf** *vrf-name* **Example:** `Device(config)# ip vrf vrf1`	Defines a VRF instance and enters VRF configuration mode.
Step 5	**exit** **Example:** `Device(config-vrf)# exit`	Exits VRF configuration mode and enters global configuration mode.
Step 6	**interface** *type number* **Example:** `Device(config)# interface Ethernet0/0`	Configures the interface type and enters interface configuration mode.
Step 7	**ip vrf forwarding** *vrf-name* **Example:** `Device(config-if)# ip vrf forwarding vrf1`	Associates a VRF instance with an interface or subinterface.
Step 8	**ip rsvp bandwidth** [*interface-kbps*] [*single-flow-kbps*] **Example:** `Device(config-if)# ip rsvp bandwidth 1158 100`	Enables RSVP bandwidth on an interface. • The optional *interface-kbps* and *single-flow-kbps* arguments specify the amount of bandwidth that can be allocated by RSVP flows or to a single flow, respectively. Values are from 1 to 10000000. **Note** Repeat this command for each interface that you want to enable.
Step 9	Repeat the previous step for each interface that you want to enable.	--

	Command or Action	Purpose
Step 10	**end** **Example:** `Device(config-if)# end`	(Optional) Returns to privileged EXEC mode.

Setting the Resource Provider

Note Resource provider was formerly called QoS provider.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp bandwidth** [*interface-kbps* [*single-flow-kbps*[**bc1** *kbps* | **sub-pool** *kbps*]/| **percent** *percent-bandwidth* [*single-flow-kbps*]]
4. **ip rsvp resource-provider** [**none** | **wfq-interface** | **wfq-pvc**]
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip rsvp bandwidth** [*interface-kbps* [*single-flow-kbps*[**bc1** *kbps*	**sub-pool** *kbps*]/	**percent** *percent-bandwidth* [*single-flow-kbps*]] **Example:** `Router(config-if)# ip rsvp bandwidth 500 500`	Configures the interface type and enters interface configuration mode.
Step 4	**ip rsvp resource-provider** [**none**	**wfq-interface**	**wfq-pvc**] **Example:** `Router(config-if)# ip rsvp resource-provider none`	Sets the resource provider. • Enter the optional **none** keyword to set the resource provider to none regardless of whether one is configured on the interface.

	Command or Action	Purpose
		Note Setting the resource provider to **none** instructs RSVP to *not* associate any resources, such as weighted fair queueing (WFQ) queues or bandwidth, with a reservation. • Enter the optional **wfq-interface** keyword to specify WFQ as the resource provider on the interface. • Enter the optional **wfq-pvc** keyword to specify WFQ as the resource provider on the permanent virtual circuit (PVC) or connection.
Step 5	**end** **Example:** `Router(config-if)# end`	(Optional) Returns to privileged EXEC mode.

Disabling Data Packet Classification

Note Disabling data packet classification instructs RSVP not to process every packet, but to perform admission control only.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot* / *subslot* / *port*
4. **ip rsvp data-packet classification none**
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface** *type slot / subslot / port* **Example:** `Router(config)# interface gigabitEthernet 0/0/0`	Configures the interface type and enters interface configuration mode.
Step 4	**ip rsvp data-packet classification none** **Example:** `Router(config-if)# ip rsvp data-packet classification none`	Disables data packet classification.
Step 5	**end** **Example:** `Router(config-if)# end`	(Optional) Returns to privileged EXEC mode.

Configuring Class and Policy Maps

To configure class and policy maps, use the following commands, beginning in global configuration mode:

SUMMARY STEPS

1. Device(config)# **class-map** *class-map-name*
2. Device(config)# **policy-map** *policy-map-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Device(config)# **class-map** *class-map-name*	Specifies the name of the class for which you want to create or modify class map match criteria.
Step 2	Device(config)# **policy-map** *policy-map-name*	Specifies the name of the policy map to be created, added to, or modified before you can configure policies for classes whose match criteria are defined in a class map.

Attaching a Policy Map to an Interface

Note If at the time you configure the RSVP scalability enhancements, there are existing reservations that use classic RSVP, no additional marking, classification, or scheduling is provided for these flows. You can also delete these reservations after you configure the RSVP scalability enhancements.

SUMMARY STEPS

1. **enable**
2. **configure terminal**

3. **interface** *type slot / subslot / port*
4. **service-policy** [**type access-control**] {**input** | **output**} *policy-map-name*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot / subslot / port* **Example:** `Router(config)# interface gigabitEthernet 0/0/0`	Configures the interface type and enters interface configuration mode.
Step 4	**service-policy** [**type access-control**] {**input** | **output**} *policy-map-name* **Example:** `Router(config-if)# service-policy output POLICY-ATM`	Specifies the name of the policy map to be attached to the input or output direction of the interface. **Note** Policy maps can be attached in the input or output direction of an interface. The direction and the router to which the policy map should be attached vary according to the network configuration. When using the **service-policy** command to attach the policy map to an interface, be sure to choose the router and the interface direction that are appropriate for the network configuration. • The optional **type access-control** keywords determine the exact pattern to look for in the protocol stack of interest. • Enter the *policy-map name*.
Step 5	**end** **Example:** `Router(config-if)# end`	(Optional) Returns to privileged EXEC mode.

Configuring Interfaces with Aggregation Role

Perform this task on aggregator and deaggregators to specify which interfaces are facing the aggregation region.

Note You do not need to perform this task on interior routers; that is, nodes having interior interfaces only.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot* / *subslot* / *port*
4. **ip rsvp aggregation role interior**
5. Repeat Step 4 as needed to configure additional aggregator and deaggregator interfaces.
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot* / *subslot* / *port* **Example:** `Router(config)# interface gigabitEthernet 0/0/0`	Configures the interface type and enters interface configuration mode.
Step 4	**ip rsvp aggregation role interior** **Example:** `Router(config-if)# ip rsvp aggregation role interior`	Enables RSVP aggregation on an aggregator or deaggregator's interface.
Step 5	Repeat Step 4 as needed to configure additional aggregator and deaggregator interfaces.	Configures additional aggregator and deaggregator interfaces.
Step 6	**end** **Example:** `Router(config-if)# end`	(Optional) Returns to privileged EXEC mode.

Configuring Aggregation Mapping on a Deaggregator

Note Typically, an edge router acts as both an aggregator and deaggregator because of the unidirectional nature of RSVP reservations. Most applications require bidirectional reservations. Therefore, these parameters are used by a deaggregator when mapping E2E reservations onto aggregates during the dynamic aggregate reservation process.

Before you begin

You should configure an access control list (ACL) to define a group of RSVP endpoints whose reservations will be aggregated onto a single aggregate reservation session identified by the specified DSCP. Then for each ACL, define a map configuration.

Note In classic (unaggregated) RSVP, a session is identified in the reservation message session object by the destination IP address and protocol information. In RSVP aggregation, a session is identified by the destination IP address and DSCP within the session object of the aggregate RSVP message. E2E reservations are mapped onto a particular aggregate RSVP session identified by the E2E reservation session object alone or a combination of the session object and sender template or filter spec.

Extended ACLs

The ACLs used within the **ip rsvp aggregation ip map** command match the RSVP message objects as follows for an extended ACL:

- Source IP address and port match the RSVP PATH message sender template or RSVP RESV message filter spec; this is the IP source or the RSVP sender.
- Destination IP address and port match the RSVP PATH/RESV message session object IP address; this is the IP destination address or the RSVP receiver.
- Protocol matches the RSVP PATH/RESV message session object protocol; if protocol = IP, then it matches the source or destination address as above.

Standard ACLs

The ACLs used within the **ip rsvp aggregation ip map** command match the RSVP message objects as follows for a standard ACL:

- IP address matches the RSVP PATH message sender template or RSVP RESV message filter spec; this is the IP source address or the RSVP sender.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp aggregation ip map** {**access-list** {*acl-number*} | **any**} **dscp** *value*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip rsvp aggregation ip map** {**access-list** {*acl-number*} | **any**} **dscp** *value* **Example:** `Router(config)# ip rsvp aggregation ip map any dscp af41`	Configures RSVP aggregation rules that tell a router how to map E2E reservations onto aggregate reservations. • The keywords and arguments specify additional information such as DSCP values.
Step 4	**end** **Example:** `Router(config)# end`	(Optional) Returns to privileged EXEC mode.

Configuring Aggregate Reservation Attributes on a Deaggregator

Perform this task on a deaggregator to configure the aggregate reservation attributes (also called token bucket parameters) on a per-DSCP basis.

Note Typically, an edge device acts as both an aggregator and deaggregator because of the unidirectional nature of RSVP reservations. Most applications require bidirectional reservations. Therefore, these parameters are used by a deaggregator when mapping E2E reservations onto aggregates during the dynamic aggregate reservation process.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp aggregation ip reservation dscp** *value* [**aggregator** *agg-ip-address*] **traffic-params static rate** *data-rate* [**burst** *burst-size*] [**peak** *peak-rate*]
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip rsvp aggregation ip reservation dscp** *value* [**aggregator** *agg-ip-address*] **traffic-params static rate** *data-rate* [**burst** *burst-size*] [**peak** *peak-rate*] **Example:** `Device(config)# ip rsvp aggregation ip reservation dscp af11 aggregator 10.10.10.10 traffic-params static rate 10 burst 8 peak 10`	Configures RSVP aggregate reservation attributes (also called token bucket parameters) on a per-DSCP basis. • The keywords and arguments specify additional information.
Step 4	**end** **Example:** `Device(config)# end`	(Optional) Returns to privileged EXEC mode.

Configuring an RSVP Aggregation Device ID

Perform this task on aggregators and deaggregators to configure an RSVP aggregation device ID.

Note Both aggregators and deaggregators need to be identified with a stable and routable IP address. This is the RFC 3175 device ID, which is also the IP address of the loopback interface with the lowest number. If there is no loopback interface configured or all those configured are down, then there will be no device ID assigned for the aggregating/deaggregating function and aggregate reservations will not be established.

Note The device ID may change if the associated loopback interface goes down or its IP address is removed. In this case, the E2E and aggregate sessions are torn down. If a new device ID is determined, new E2E and aggregate sessions will use the new device ID.

SUMMARY STEPS

1. **enable**

2. **configure terminal**
3. **interface loopback** *number*
4. **ip address** *ip-address subnet-mask/prefix*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface loopback** *number* **Example:** `Device(config)# interface loopback 1`	Creates a loopback interface and enters interface configuration mode. • Enter a value for the *number* argument. The range is 0 to 2147483647.
Step 4	**ip address** *ip-address subnet-mask/prefix* **Example:** `Device(config-if)# ip address 192.168.50.1 255.255.255.0`	Configures an IP address and subnet mask or prefix on the loopback interface.
Step 5	**end** **Example:** `Device(config-if)# end`	(Optional) Returns to privileged EXEC mode.

Enabling RSVP Aggregation

Perform this task on aggregators and deaggregators to enable RSVP aggregation globally after you have completed all the previous aggregator and deaggregator configurations.

Note This task registers a device to receive RSVP-E2E-IGNORE messages. It is not necessary to perform this task on interior devices because they are only processing RSVP aggregate reservations. If you do so, you may decrease performance because the interior device will then unnecessarily process all the RSVP-E2E-IGNORE messages.

Note If you enable RSVP aggregation globally on an interior device, then you should configure all interfaces as interior.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp aggregation ip**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip rsvp aggregation ip** **Example:** `Device(config)# ip rsvp aggregation ip`	Enables RSVP aggregation globally on an aggregator or deaggregator.
Step 4	**end** **Example:** `Device(config)# end`	(Optional) Returns to privileged EXEC mode.

Configuring RSVP Local Policy

Perform this task to apply a local policy to an RSVP aggregate reservation.

Note In classic (unaggregated) RSVP, a session is identified in the reservation message session object by the destination IP address and protocol information. In RSVP aggregation, a session is identified by the destination IP address and DSCP within the session object of the aggregate RSVP message. The **dscp-ip** keyword matches the DSCP within the session object.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip rsvp policy local** {**acl** *acl1*[*acl2...acl8*] | **dscp-ip** *value1* [*value2 ... value8*] | **default** | **identity** *alias1* [*alias2...alias4*] | **origin-as** *as1*[*as2...as8*]}
4. {**accept** | **forward** [**all** | **path**| **path-error** | **resv**| **resv-error**] | **default** | **exit** | **fast-reroute** | **local-override** | **maximum** {**bandwidth** [**group** *x*] [**single** *y*] | **senders** *n*}| **preempt-priority** [**traffic-eng** *x*] *setup-priority* [*hold-priority*]}
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Step 3	**ip rsvp policy local** {**acl** *acl1*[*acl2...acl8*]	**dscp-ip** *value1* [*value2 ... value8*]	**default**	**identity** *alias1* [*alias2...alias4*]	**origin-as** *as1*[*as2...as8*]}
					Example:
					`Router(config)# ip rsvp policy local dscp-ip 46`
						Creates a local policy to determine how RSVP resources are used in a network and enters local policy configuration mode.
						• Enter the **dscp-ip** *value*keyword and argument combination to specify a DSCP for matching the session object DCSP within the aggregate reservations. Values can be the following:
						  • 0 to 63--Numerical. The default value is 0.
						  • af11 to af43--Assured forwarding (AF).
						  • cs1 to cs7--Type of service (ToS) precedence.
						  • default--Default DSCP.
						  • ef--Expedited Forwarding (EF).
						Note You must associate at least one DSCP with a DSCP-based policy. However, you can associate as many as eight.

Step 4	{**accept**	**forward** [**all**	**path**| **path-error**	**resv**| **resv-error**]	**default**	**exit**	**fast-reroute**	**local-override**	**maximum** {**bandwidth** [**group** *x*] [**single** *y*]	**senders** *n*}| **preempt-priority** [**traffic-eng** *x*] *setup-priority* [*hold-priority*]} **Example:**	(Optional) Defines the properties of the dscp-ip local policy that you are creating. (These are the submode commands.) **Note** This is an optional step. An empty policy rejects everything, which may be desired in some cases. See the **ip rsvp policy local** command for more detailed information on submode commands.

	Command or Action	Purpose
	`Router(config-rsvp-policy-local)# forward all`	
Step 5	**end** **Example:** `Router(config-rsvp-policy-local)# end`	(Optional) Exits local policy configuration mode and returns to privileged EXEC mode.

Verifying the RSVP Aggregation Configuration

Note You can use the following **show** commands in user EXEC or privileged EXEC mode.

SUMMARY STEPS

1. **enable**
2. **show ip rsvp aggregation ip** [**endpoints** | **interface** [*if-name*] | **map** [**dscp** *value*]| **reservation** [**dscp** *value*[**aggregator** *ip-address*]]
3. **show ip rsvp aggregation ip endpoints** [**role**{**aggregator**| **deaggregator**}] [*ip-address*] [**dscp** *value*] [**detail**]
4. **show ip rsvp** [**atm-peak-rate-limit**| **counters**| **host**| **installed**| **interface**| **listeners**| **neighbor**| **policy**| **precedence**| **request**| **reservation**| **sbm**| **sender**| **signalling**| **tos**]
5. **show ip rsvp reservation** [**detail**] [**filter**[**destination** *ip-address* | *hostname*] [**dst-port** *port-number*] [**source** *ip-address* | *hostname*][**src-port** *port-number*]]
6. **show ip rsvp sender** [**detail**] [**filter**[**destination** *ip-address* | *hostname*] [**dst-port** *port-number*] [**source** *ip-address* | *hostname*][**src-port** *port-number*]]
7. **show ip rsvp installed** [*interface-type interface-number*] [**detail**]
8. **show ip rsvp interface** [**detail**] [*interface-type interface-number*]
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	(Optional) Enables privileged EXEC mode. • Enter your password if prompted. **Note** Skip this step if you are using the **show** commands in user EXEC mode.
Step 2	**show ip rsvp aggregation ip** [**endpoints**	**interface** [*if-name*]	**map** [**dscp** *value*]| **reservation** [**dscp** *value*[**aggregator** *ip-address*]] **Example:**	(Optional) Displays RSVP summary aggregation information. • The optional keywords and arguments display additional information.

	Command or Action	Purpose
	`Device# show ip rsvp aggregation ip`	
Step 3	**show ip rsvp aggregation ip endpoints** [**role**{**aggregator**| **deaggregator**}] [*ip-address*] [**dscp** *value*] [**detail**] **Example:** `Device# show ip rsvp aggregation ip endpooints`	(Optional) Displays RSVP information about aggregator and deaggregator devices for currently established aggregate reservations. • The optional keywords and arguments display additional information.
Step 4	**show ip rsvp** [**atm-peak-rate-limit**| **counters**| **host**| **installed**| **interface**| **listeners**| **neighbor**| **policy**| **precedence**| **request**| **reservation**| **sbm**| **sender**| **signalling**| **tos**] **Example:** `Device# show ip rsvp`	(Optional) Displays specific information for RSVP categories. • The optional keywords display additional information.
Step 5	**show ip rsvp reservation** [**detail**] [**filter**[**destination** *ip-address* | *hostname*] [**dst-port** *port-number*] [**source** *ip-address* | *hostname*][**src-port** *port-number*]] **Example:** `Device# show ip rsvp reservation detail`	(Optional) Displays RSVP-related receiver information currently in the database. • The optional keywords and arguments display additional information. **Note** The optional **filter** keyword is supported in Cisco IOS Releases 12.0S and 12.2S only.
Step 6	**show ip rsvp sender** [**detail**] [**filter**[**destination** *ip-address* | *hostname*] [**dst-port** *port-number*] [**source** *ip-address* | *hostname*][**src-port** *port-number*]] **Example:** `Device# show ip rsvp sender detail`	(Optional) Displays RSVP PATH-related sender information currently in the database. • The optional keywords and arguments display additional information. **Note** The optional **filter** keyword is supported in Cisco IOS Releases 12.0S and 12.2S only.
Step 7	**show ip rsvp installed** [*interface-type interface-number*] [**detail**] **Example:** `Device# show ip rsvp installed detail`	(Optional) Displays RSVP-related installed filters and corresponding bandwidth information. • The optional keywords and arguments display additional information.
Step 8	**show ip rsvp interface** [**detail**] [*interface-type interface-number*] **Example:** `Device# show ip rsvp interface detail`	(Optional) Displays RSVP-related interface information. • The optional keywords and arguments display additional information.
Step 9	**end** **Example:**	(Optional) Exits privileged EXEC mode and returns to user EXEC mode.

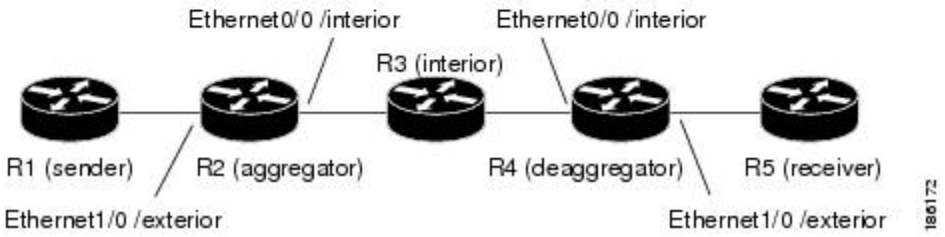
	Command or Action	Purpose
	`Device# end`	

Configuration Examples for RSVP Aggregation

Examples Configuring RSVP Aggregation

The figure below shows a five-router network in which RSVP aggregation is configured.

Figure 2: Sample RSVP Aggregation Network



Configuring RSVP and DiffServ Attributes on an Interior Router

The following example configures RSVP/DiffServ attributes on an interior router (R3 in the figure above).

- GigabitEthernet interface 0/0/0 is enabled for RSVP and the amount of bandwidth available for reservations is configured.
- A resource provider is configured and data packet classification is disabled because RSVP aggregation supports control plane aggregation only.

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet 0/0/0

Router(config-if)# ip rsvp bandwidth 400
```

```
Router(config-if)# ip rsvp resource-provider none

Router(config-if)# ip rsvp data-packet classification none

Router(config-if)# end
```

Configuring RSVP Aggregation on an Aggregator or Deaggregator

The following example configures RSVP aggregation attributes on an aggregator or deaggregator (R2 and R4 in the figure above):

- Loopback 1 is configured to establish an RSVP aggregation router ID.
- Ethernet interface 0/0 is enabled for RSVP and the amount of bandwidth available for reservations is configured.
- Ethernet interface 0/0 on an aggregator or deaggregator is configured to face an aggregation region.
- A resource provider is configured and data packet classification is disabled because RSVP aggregation supports control plane aggregation only.

```
Router# configure terminal

Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface Loopback 1
Router(config)# ip address 192.168.50.1 255.255.255.0
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# ip rsvp bandwidth 400
Router(config-if)# ip rsvp aggregation role interior
Router(config-if)# ip rsvp resource-provider none
Router(config-if)# ip rsvp data-packet classification none
Router(config-if)# end
```

Configuring RSVP Aggregation Attributes and Parameters

The following example configures additional RSVP aggregation attributes, including a global rule for mapping all E2E reservations onto a single aggregate with DSCP AF41 and the token bucket parameters for aggregate reservations, because dynamic resizing is not supported. This configuration is only required on nodes performing the deaggregation function (R4 in the figure above).

```
Router# configure terminal

Enter configuration commands, one per line. End with CNTL/Z.

Router(config)# ip rsvp aggregation ip map any dscp af41

Router(config)# ip rsvp aggregation ip reservation dscp af41 aggregator
10.10.10.10 traffic-params static rate 10 burst 8 peak 10

Router(config)# end
```

Configuring an Access List for a Deaggregator

In the following example, access list 1 is defined for all RSVP messages whose RSVP PATH message sender template source address is in the 10.1.0.0 subnet so that the deaggregator (R4 in the figure above) maps those reservations onto an aggregate reservation for the DSCP associated with the AF41 PHB:

```
Router# configure terminal

Enter configuration commands, one per line. End with CNTL/Z.

Router(config)# access-list 1 permit 10.1.0.0 0.0.255.255

Router(config)# ip rsvp aggregation ip map access-list 1 dscp af41

Router(config)# end
```

Configuring RSVP Aggregation

After you configure your RSVP aggregation attributes, you are ready to enable aggregation globally.

When you enable aggregation on a router, the router can act as an aggregator or a deaggregator. To perform aggregator and deaggregator functions, the RSVP process must see messages with the RSVP-E2E-IGNORE protocol type (134) on a router; otherwise, the messages are forwarded as data by the router's data plane. The **ip rsvp aggregation ip** command enables RSVP to identify messages with the RSVP-E2E-IGNORE protocol.

Note This registers a router to receive RSVP-E2E-IGNORE messages. It is not necessary to configure this command on interior nodes that are only processing RSVP aggregate reservations and forwarding RSVP-E2E-IGNORE messages as IP datagrams). Since the router is loaded with an image that supports aggregation, the router will process aggregate (RFC 3175 formatted) messages correctly. Enabling aggregation on an interior mode may decrease performance because the interior node will then unnecessarily process all RSVP-E2E-IGNORE messages.

Note If you enable aggregation on an interior node, you must configure all its interfaces as interior. Otherwise, all the interfaces have the exterior role, and any E2E PATH (E2E-IGNORE) messages arriving at the router are discarded.

In summary, there are two options for an interior router (R3 in the figure above):

- No RSVP aggregation configuration commands are entered.
- RSVP aggregation is enabled and all interfaces are configured as interior.

Configuring RSVP Local Policy

You can configure a local policy optionally on any RSVP capable node. In this example, a local policy is configured on a deaggregator to set the preemption priority values within the RSVP RESV aggregate messages based upon matching the DSCP within the aggregate RSVP messages session object. This allows the bandwidth available for RSVP reservations to be used first by reservations of DSCP EF over DSCP AF41 on interior or

aggregation nodes. Any aggregate reservation for another DSCP will have a preemption priority of 0, the default.

Note Within the RSVP RESV aggregate message at the deaggregator, this local policy sets an RFC 3181 "Signaled Preemption Priority Policy Element" that can be used by interior nodes or the aggregator that has **ip rsvp preemption** enabled.

The following example sets the preemption priority locally for RSVP aggregate reservations during establishment on an interior router (R3 in the figure above):

```
Router# configure terminal

Enter configuration commands, one per line. End with CNTL/Z.

Router(config)# ip rsvp policy local dscp-ip ef

Router(config-rsvp-local-policy)# 5 5

Router(config-rsvp-local-policy)# exit

Router(config)# ip rsvp policy local dscp-ip af41

Router(config-rsvp-local-policy)# 2 2

Router(config-rsvp-local-policy)# end
```

Example Verifying the RSVP Aggregation Configuration

Verifying RSVP Aggregation and Configured Reservations

The following example verifies that RSVP aggregation is enabled and displays information about the reservations currently established and configured map and reservation policies:

```
Router# show ip rsvp aggregation ip
RFC 3175 Aggregation:  Enabled
  Level: 1
  Default QoS service: Controlled-Load
  Number of signaled aggregate reservations:  2
  Number of signaled E2E reservations:        8
  Number of configured map commands:          4
  Number of configured reservation commands:  1
```

Verifying Configured Interfaces and Their Roles

The following example displays the configured interfaces and whether they are interior or exterior in regard to the aggregation region:

```
Router# show ip rsvp aggregation ip interface
```

```
Interface Name       Role
-------------------- --------
Ethernet0/0          interior
Serial2/0            exterior
Serial3/0            exterior
```

Verifying Aggregator and Deaggregator Reservations

The following example displays information about the aggregators and deaggregators when established reservations are present:

```
Router# show ip rsvp aggregation ip endpoints detail
Role  DSCP Aggregator      Deaggregator    State  Rate    Used    QBM PoolID
----- ---- --------------- --------------- ------ ------- ------- ----------
Agg   46   10.3.3.3         10.4.4.4         ESTABL 100K    100K    0x00000003
   Aggregate Reservation for the following E2E Flows (PSBs):
To             From          Pro DPort Sport  Prev Hop       I/F      BPS
10.4.4.4       10.1.1.1       UDP 1     1     10.23.20.3     Et1/0    100K
   Aggregate Reservation for the following E2E Flows (RSBs):
To             From          Pro DPort Sport  Next Hop       I/F      Fi Serv BPS
10.4.4.4       10.1.1.1       UDP 1     1     10.4.4.4       Se2/0    FF RATE 100K
   Aggregate Reservation for the following E2E Flows (Reqs):
To             From          Pro DPort Sport  Next Hop       I/F      Fi Serv BPS
10.4.4.4       10.1.1.1       UDP 1     1     10.23.20.3     Et1/0    FF RATE 100K
```

Additional References

The following sections provide references related to the RSVP Application ID Support feature.

Related Documents

Related Topic	Document Title
QoS commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS Quality of Service Solutions Command Reference*
QoS configuration tasks related to RSVP	"Configuring RSVP" module
Cisco United Communications Manager (CallManager) and related features	"Overview of Cisco Unified Communications Manager and Cisco IOS Interoperability" module
Regular expressions	"Using the Cisco IOS Command-Line Interface" module
Cisco IOS commands	Cisco IOS Master Commands List, All Releases

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIB	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 2205	Resource ReSerVation Protocol (RSVP)
RFC 2872	Application and Sub Application Identity Policy Element for Use with RSVP
RFC 3181	Signaled Preemption Priority Policy Element
RFC 3182	Identity Representation for RSVP

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for RSVP Aggregation

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for RSVP Aggregation

Feature Name	Releases	Feature Information
RSVP Aggregation	Cico IOS XE Release 2.6 Cisco IOS XE Release 3.8S	The RSVP Aggregation feature allows the Resource Reservation Protocol (RSVP) state to be reduced within an RSVP/DiffServ network by aggregating many smaller reservations into a single, larger reservation at the edge. The following commands were introduced or modified: **debug ip rsvp aggregation**, **debug qbm**, **ip rsvp aggregation ip**, **ip rsvp aggregation ip map**, **ip rsvp aggregation**, **ip reservation dscp traffic-params static rate**, **ip rsvp aggregation ip role interior**, **ip rsvp policy local**, **show ip rsvp**, **show ip rsvp aggregation ip**, **show ip rsvp aggregation ip endpoints**, **show ip rsvp installed**, **show ip rsvp interface**, **show ip rsvp policy local**, **show ip rsvp request**, **show ip rsvp reservation**, **show ip rsvp sender**, **show qbm client**, **show qbm pool**. In Cisco IOS XE Release 3.8S, support was added for the Cisco ASR 903 Router.

Glossary

admission control --The process by which an RSVP reservation is accepted or rejected on the basis of end-to-end available network resources.

aggregate --AnRSVP flow that represents multiple end-to-end (E2E) flows; for example, a Multiprotocol Label Switching Traffic Engineering (MPLS-TE) tunnel may be an aggregate for many E2E flows.

aggregation region --An area where E2E flows are represented by aggregate flows, with aggregators and deaggregators at the edge; for example, an MPLS-TE core, where TE tunnels are aggregates for E2E flows. An aggregation region contains a connected set of nodes that are capable of performing RSVP aggregation.

aggregator --The device that processes the E2E PATH message as it enters the aggregation region. This device is also called the TE tunnel head-end device; it forwards the message from an exterior interface to an interior interface.

bandwidth --The difference between the highest and lowest frequencies available for network signals. The term is also used to describe the rated throughput capacity of a given network medium or protocol.

deaggregator --The device that processes the E2E PATH message as it leaves the aggregation region. This device is also called the TE tunnel tail-end device; it forwards the message from an interior interface to an exterior interface.

E2E --end-to-end. An RSVP flow that crosses an aggregation region, and whose state is represented in aggregate within this region, such as a classic RSVP unicast flow crossing an MPLS-TE core.

LSP --label-switched path. A configured connection between two devices, in which label switching is used to carry the packets. The purpose of an LSP is to carry data packets.

QoS --quality of service. A measure of performance for a transmission system that reflects its transmission quality and service availability.

RSVP --Resource Reservation Protocol. A protocol that supports the reservation of resources across an IP network. Applications running on IP end systems can use RSVP to indicate to other nodes the nature (bandwidth, jitter, maximum burst, and so on) of the packet streams that they want to receive.

state --Information that a device must maintain about each LSP. The information is used for rerouting tunnels.

TE --traffic engineering. The techniques and processes used to cause routed traffic to travel through the network on a path other than the one that would have been chosen if standard routing methods had been used.

tunnel --Secure communications path between two peers, such as two devices.