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Techniques to Improve the Scalability of RSVP Traffic Engineering  
Deployments  
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Abstract

At the time of writing, networks which utilize RSVP Traffic Engineering (RSVP-TE) Label Switched Paths (LSPs) are encountering limitations in the ability of implementations to support the growth in the number of LSPs deployed.

This document defines two techniques, "Refresh-Interval Independent RSVP (RI-RSVP)" and "Per-Peer Flow-Control", that reduce the number of processing cycles required to maintain RSVP-TE LSP state in Label Switching Routers (LSRs) and hence allow implementations to support larger scale deployments.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

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## 1. Introduction

At the time of writing, networks which utilize RSVP Traffic Engineering (RSVP-TE) [RFC3209] Label Switched Paths (LSPs) are encountering limitations in the ability of implementations to support the growth in the number of LSPs deployed.

The set of RSVP Refresh Overhead Reduction procedures [RFC2961] serves as a powerful toolkit for RSVP-TE implementations to help cover a majority of the concerns about soft-state scaling. However, even with these tools in the toolkit, analysis of existing implementations [RFC5439] indicates that the processing required beyond a certain scale may still cause significant disruption to a Label Switching Router (LSR).

This document builds on the scaling work and analysis that has been done so far and defines protocol extensions to help RSVP-TE deployments push the envelope further on scaling by increasing the threshold above which an LSR struggles to achieve sufficient processing to maintain LSP state.

This document defines two techniques, "Refresh-Interval Independent RSVP (RI-RSVP)" and "Per-Peer Flow-Control", that cut down the number of processing cycles required to maintain LSP state. "RI-RSVP" helps completely eliminate RSVP's reliance on refreshes and refresh-timeouts while "Per-Peer Flow-Control" enables a busy RSVP speaker to apply back pressure to its peer(s). This document defines a unique RSVP Capability [RFC5063] for each technique (Support for CAPABILITY object is a prerequisite for implementing these techniques). Note that the "Per-Peer Flow-Control" technique requires the "RI-RSVP" technique as a prerequisite. In order to reap maximum scaling benefits, it is strongly recommended that implementations support both the techniques and have them enabled by default. Both the techniques are fully backward compatible and can be deployed incrementally.

## 2. Requirement for RFC2961 Support

The techniques defined in Section 3 and Section 4 are based on proposals made in [RFC2961]. Implementations of these techniques will need to support the RSVP messages and procedures defined in [RFC2961] with some minor modifications and alterations to recommended time intervals and iteration counts (see Appendix A for the set of recommended defaults).

### 2.1. Required Functionality from RFC2961 to be Implemented

An implementation that supports the techniques discussed in Section 3 and Section 4 must support the functionality described in [RFC2961] as follows:

- o It MUST indicate support for RSVP Refresh Overhead Reduction extensions (as specified in Section 2 of [RFC2961]).
- o It MUST support receipt of any RSVP Refresh Overhead Reduction message as defined in [RFC2961].
- o It MUST initiate all RSVP Refresh Overhead Reduction mechanisms as defined in [RFC2961] (including the SRefresh message) with the default behavior being to initiate the mechanisms but offering a configuration override.
- o It MUST support reliable delivery of Path/Resv and the corresponding Tear/Err messages (as specified in Section 4 of [RFC2961]).
- o It MUST support retransmission of all unacknowledged RSVP-TE messages using exponential-backoff (as specified in Section 6 of [RFC2961]).

### 2.2. Making Acknowledgements Mandatory

The reliable message delivery mechanism specified in [RFC2961] states that "Nodes receiving a non-out of order message containing a MESSAGE\_ID object with the ACK\_Desired flag set, SHOULD respond with a MESSAGE\_ID\_ACK object."

In an implementation that supports the techniques discussed in Section 3 and Section 4, nodes receiving a non-out of order message containing a MESSAGE\_ID object with the ACK-Desired flag set, MUST respond with a MESSAGE\_ID\_ACK object. This MESSAGE\_ID\_ACK object can be packed along with other MESSAGE\_ID\_ACK or MESSAGE\_ID\_NACK objects and sent in an Ack message (or piggy-backed in any other RSVP message). This improvement to the predictability of the system in terms of reliable message delivery is key for being able to take any action based on a non-receipt of an ACK.

### 3. Refresh-Interval Independent RSVP (RI-RSVP)

The RSVP protocol relies on periodic refreshes for state synchronization between RSVP neighbors and for recovery from lost RSVP messages. It relies on refresh timeout for stale state cleanup. The primary motivation behind introducing the notion of "Refresh

Interval Independent RSVP" (RI-RSVP) is to completely eliminate RSVP's reliance on refreshes and refresh timeouts. This is done by simply increasing the refresh interval to a fairly large value. [RFC2961] and [RFC5439] do talk about increasing the value of the refresh interval to provide linear improvement of transmission overhead, but also point out the degree of functionality that is lost by doing so. This section revisits this notion, but also sets out additional requirements to make sure that there is no loss of functionality incurred by increasing the value of the refresh interval.

An implementation that supports RI-RSVP:

- o MUST support all the requirements specified in Section 2.
- o MUST make the default value of the configurable refresh interval (R) be a large value (10s of minutes). A default value of 20 minutes is RECOMMENDED by this document.
- o MUST use a separate shorter refresh interval for refreshing state associated with unacknowledged Path/Resv messages (uR). A default value of 30 seconds is RECOMMENDED by this document.
- o MUST implement coupling the state of individual LSPs with the state of the corresponding RSVP-TE signaling adjacency. When an RSVP-TE speaker detects RSVP-TE signaling adjacency failure, the speaker MUST act as if all the Path and Resv states learnt via the failed signaling adjacency have timed out.
- o MUST make use of Node-ID based Hello Session ([RFC3209], [RFC4558]) for detection of RSVP-TE signaling adjacency failures; A default value of 9 seconds is RECOMMENDED by this document for the configurable node hello interval (as opposed to the 5ms default value proposed in Section 5.3 of [RFC3209]).
- o MUST indicate support for RI-RSVP via the CAPABILITY object [RFC5063] in Hello messages.

### 3.1. Capability Advertisement

An implementation supporting the RI-RSVP technique MUST set a new flag "RI-RSVP Capable" in the CAPABILITY object signaled in Hello messages.

Bit Number TBA1 (TBA2) - RI-RSVP Capable (I-bit):

Indicates that the sender supports RI-RSVP.

Any node that sets the new I-bit in its CAPABILITY object MUST also set the Refresh-Reduction-Capable bit in the common header of all RSVP-TE messages. If a peer sets the I-bit in the CAPABILITY object but does not set the Refresh-Reduction-Capable bit, then the RI-RSVP functionality MUST NOT be activated for that peer.

### 3.2. Compatibility

The RI-RSVP functionality MUST NOT be activated with a peer that does not indicate support for this functionality. Inactivation of the RI-RSVP functionality MUST result in the use of the traditional smaller refresh interval [RFC2205].

### 4. Per-Peer RSVP Flow-Control

The functionality discussed in this section provides an RSVP speaker with the ability to apply back pressure to its peer(s) to reduce/eliminate a significant portion of the RSVP-TE control message load.

An implementation that supports "Per-Peer RSVP Flow-Control":

- o MUST support all the requirements specified in Section 2.
- o MUST support "RI-RSVP" (Section 3).
- o MUST treat lack of ACKs from a peer as an indication of peer's RSVP-TE control plane congestion. If congestion is detected, the local system MUST throttle RSVP-TE messages to the affected peer. This MUST be done on a per-peer basis. (Per-peer throttling MAY be implemented by a traffic shaping mechanism that proportionally reduces the RSVP signaling packet rate as the number of outstanding Acks increases. And when the number of outstanding Acks decreases, the send rate would be adjusted up again.)
- o SHOULD use a Retry Limit (Rl) value of 7 (Section 6.2 of [RFC2961], suggests using 3).
- o SHOULD prioritize Hello messages and messages carrying Acknowledgements over other RSVP messages.
- o SHOULD prioritize Tear/Error over trigger Path/Resv (messages that bring up new LSP state) sent to a peer when the local system detects RSVP-TE control plane congestion in the peer.
- o MUST indicate support for this technique via the CAPABILITY object [RFC5063] in Hello messages.

#### 4.1. Capability Advertisement

An implementation supporting the "Per-Peer Flow-Control" technique MUST set a new flag "Per-Peer Flow-Control Capable" in the CAPABILITY object signaled in Hello messages.

Bit Number TBA3 (TBA4) - Per-Peer Flow-Control Capable (F-bit):

Indicates that the sender supports Per-Peer RSVP Flow-Control.

Any node that sets the new F-bit in its CAPABILITY object MUST also set Refresh-Reduction-Capable bit in common header of all RSVP-TE messages. If a peer sets the F-bit in the CAPABILITY object but does not set the Refresh-Reduction-Capable bit, then the Per-Peer Flow-Control functionality MUST NOT be activated for that peer.

#### 4.2. Compatibility

The Per-Peer Flow-Control functionality MUST NOT be activated with a peer that does not indicate support for this functionality. If a peer hasn't indicated that it is capable of participating in "Per-Peer Flow-Control", then it SHOULD NOT be assumed that the peer would always acknowledge a non-out of order message containing a MESSAGE\_ID object with the ACK-Desired flag set.

#### 5. Acknowledgements

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## 7. IANA Considerations

### 7.1. Capability Object Values

IANA maintains all the registries associated with "Resource Reservation Protocol (RSVP) Parameters" (see <http://www.iana.org/assignments/rsvp-parameters/rsvp-parameters.xhtml>). "Capability Object Values" Registry (introduced by [RFC5063]) is one of them.

IANA is requested to assign two new Capability Object Value bit flags as follows:

Bit Number	Hex Value	Name	Reference
TBA1	TBA2	RI-RSVP Capable (I)	Section 3
TBA3	TBA4	Per-Peer Flow-Control Capable (F)	Section 4

## 8. Security Considerations

This document does not introduce new security issues. The security considerations pertaining to the original RSVP protocol [RFC2205] and RSVP-TE [RFC3209] and those that are described in [RFC5920] remain relevant.

## 9. References

### 9.1. Normative References

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- [RFC5920] Fang, L., Ed., "Security Framework for MPLS and GMPLS Networks", RFC 5920, DOI 10.17487/RFC5920, July 2010, <<https://www.rfc-editor.org/info/rfc5920>>.

## Appendix A. Recommended Defaults

### (a) Refresh-Interval (R)- 20 minutes (Section 3):

Given that an implementation supporting RI-RSVP doesn't rely on refreshes for state sync between peers, the function of RSVP refresh interval is analogous to that of IGP refresh interval (the default of which is typically in the order of 10s of minutes). Choosing a default of 20 minutes allows the refresh timer to be randomly set to a value in the range [10 minutes (0.5R), 30 minutes (1.5R)].

### (b) Node Hello-Interval - 9 Seconds (Section 3):

[RFC3209] defines the hello timeout as 3.5 times the hello interval. Choosing 9 seconds for the node hello-interval gives a hello timeout of  $3.5 \times 9 = 31.5$  seconds. This puts the hello timeout value in the vicinity of the IGP hello timeout value.

(c) Retry-Limit (Rl) - 7 (Section 4):

Choosing 7 as the retry-limit results in an overall rapid retransmit phase of 31.5 seconds. This matches up with the 31.5 seconds hello timeout.

(d) Refresh-Interval for refreshing state associated with unacknowledged Path/Resv messages (uR) - 30 seconds (Section 3): The recommended refresh interval (R) value of 20 minutes (for an implementation supporting RI-RSVP) can not be used for refreshing state associated with unacknowledged Path/Resv messages. This document recommends the use of the traditional default refresh interval value of 30 seconds for uR.

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