

CCAMP Working Group  
Internet Draft  
Intended status: Standard Track  
Expires: January 15, 2013

Zafar Ali  
George Swallow  
Clarence Filsfils  
Luyuan Fang  
Cisco Systems  
Kenji Kumaki  
KDDI Corporation  
Ruediger Kunze  
Deutsche Telekom AG  
July 16, 2012

Resource ReserVation Protocol-Traffic Engineering (RSVP-TE)  
extension for signaling Objective Function and Metric Bound  
draft-ali-ccamp-rc-objective-function-metric-bound-02.txt

#### Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <http://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on January 15, 2013.

#### Copyright Notice

Copyright (c) 2012 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document.

Code Components extracted from this document must include Simplified BSD License text as described in

Section 4.e of the [Trust Legal Provisions](#) and are provided without warranty as described in the Simplified BSD License.

ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)

This document may contain material from IETF Documents or IETF Contributions published or made publicly available before November 10, 2008. The person(s) controlling the copyright in some of this material may not have granted the IETF Trust the right to allow modifications of such material outside the IETF Standards Process. Without obtaining an adequate license from the person(s) controlling the copyright in such materials, this document may not be modified outside the IETF Standards Process, and derivative works of it may not be created outside the IETF Standards Process, except to format it for publication as an RFC or to translate it into languages other than English.

#### Abstract

In particular networks such as those used by financial institutions, network performance criteria such as latency are becoming as critical to data path selection. However cost is still an important consideration. This leads to a situation where path calculation involves multiple metrics and more complex objective functions.

When using GMPLS control plane, the ingress node may need to request remote node to perform path computation or expansion. In such cases, ingress node needs to convey the required objective function to the remote node, to enable it to perform the desired path computation. Similarly, there are cases the ingress needs to indicate a TE metric bound for a loose segment that is expanded by a remote node. This document defines extensions to the RSVP-TE Protocol to allow an ingress node to request the required objective function for the path computation, as well as a metric bound to influence route computation decisions at a remote node(s).

#### Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in

this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

## Table of Contents

ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)

Copyright Notice.....	<a href="#">1</a>
<a href="#">1.</a> Introduction.....	<a href="#">3</a>
<a href="#">2.</a> RSVP-TE signaling extensions.....	<a href="#">4</a>
<a href="#">2.1.</a> Objective Function (OF) Subobject.....	<a href="#">4</a>
<a href="#">2.1.1.</a> Minimum TE Metric Cost Path Objective Function....	<a href="#">6</a>
<a href="#">2.1.2.</a> Minimum IGP Metric Cost Path Objective Function...	<a href="#">6</a>
<a href="#">2.1.3.</a> Minimum Latency Path Objective Function.....	<a href="#">6</a>
2.1.4. Minimum Latency Variation Path Objective Function.	7
<a href="#">2.2.</a> Metric subobject.....	<a href="#">7</a>
<a href="#">2.3.</a> Processing Rules for the OF Subobjects.....	<a href="#">8</a>
<a href="#">2.4.</a> Processing Rules for the Metric subobject.....	<a href="#">9</a>
<a href="#">3.</a> Security Considerations.....	<a href="#">10</a>
<a href="#">4.</a> IANA Considerations.....	<a href="#">10</a>
<a href="#">5.</a> Acknowledgments.....	<a href="#">11</a>
<a href="#">6.</a> References.....	<a href="#">11</a>
<a href="#">6.1.</a> Normative References.....	<a href="#">11</a>
<a href="#">6.2.</a> Informative References.....	<a href="#">11</a>

## 1. Introduction

As noted in [OSPF-TE-METRIC] and [ISIS-TE-METRIC], in certain networks such as financial information networks (e.g. stock market data providers), performance criteria (e.g. latency) are becoming as critical to data path selection along with other metrics. Such networks may require selection of a path that minimizes end-to-end latency. Or a path may need to be found that minimizes some other TE metric, but subject a latency bound. Thus there is a requirement to be able to find end-to-end paths with different optimization criteria.

When the entire route for an LSP is computed at the ingress node, this requirement can be met by a local decision at that node. However, there are scenarios where partial or full route computations are performed by remote nodes. The scenarios include (but are not limited to):

- . LSPs with loose hops in the Explicit Route Object (ERO), e.g. inter-domain LSPs.
- . Generalized Multi-Protocol Label Switching (GMPLS) User-Network Interface (UNI) where route computation may be performed by the UNI-Network (server) node [[RFC 4208](#)];

In these scenarios, there is a need for the ingress node to convey the optimization criteria including the TE metrics (e.g., IGP metric, TE metric, hop counts, latency, etc.) to be used for the path computation to the node performing route computation or expansion. Similarly, there is a need for the ingress node to

ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)

indicate a TE metric bound for the loose segment being expanded by a remote node.

[RFC5541] defines extensions to the Path Computation Element communication Protocol (PCEP) to allow a Path Computation Client (PCC) indicate in a path computation request the desired objective function. [[RFC5440](#)] defines extension to the PCEP to allow a PCC indicate in a path computation request a bound on given TE metric(s). This draft defines similar mechanisms for the RSVP-TE protocol allowing an ingress node to indicate in a Path request the desired objective function along with any associated TE metric bound(s). This information is used by the nodes performing route expansion to find the "best" candidate route.

## 2. RSVP-TE signaling extensions

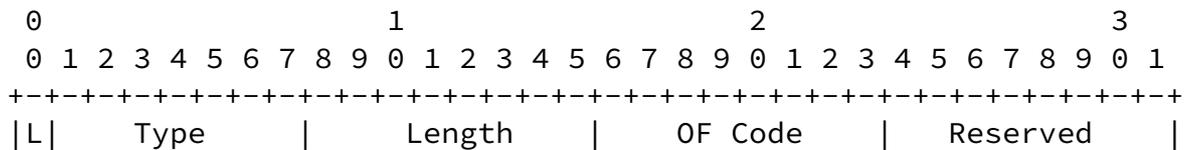
This section defines RSVP-TE signaling extensions required to address the above-mentioned requirements. Two new ERO subobject types, Objective Function (OF) and Metric, are defined for this purpose. Their purpose is as follows.

- . OF subobject conveys a set of one or more specific optimization criteria that MUST be followed in expanding route of a TE-LSP in MultiProtocol Label Switching (MPLS) and GMPLS networks.
- . Metric subobject indicates the bound on the path metric that MUST NOT be exceeded for the loose segment to be considered as acceptable by the ingress node.

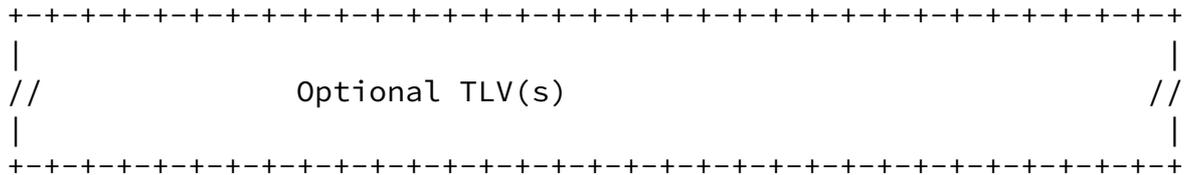
The scope of the Metric and OF subobjects is the node performing the expansion for loose ERO and the subsequent ERO subobject that identifies an abstract node. The following subsection provides the details.

## 2.1. Objective Function (OF) Subobject

A new ERO subobject type Objective Function (OF) is defined in order for the ingress node to indicate the required objective function on a loose hop. The ERO subobject type OF is optional. It MAY be carried within an ERO object of RSVP-TE Path message. The OF subobject has the following format:



ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)



The fields of OF subobject are defined as follows:

**L bit:** The L bit SHOULD be set, so that the subobject represents a loose hop in the explicit route.

**Type:** The Type is to be assigned by IANA (suggested value: 66).

**Length:** The Length contains the total length of the subobject in bytes, including the Type field, the Length field and the length of the optional TLV(s). When there is no optional TLV, the Length is 4.

**OF Code (1 byte):** The identifier of the objective function. The following OF code values are suggested. These values are to be assigned by IANA.

\* OF code value 0 is reserved.

\* OF code value 1 (to be assigned by IANA) is for Minimum TE Metric Cost Path (MTMCP) OF defined in this document. See definition of MTCP OF in the following.

\* OF code value 2 (to be assigned by IANA) is for Minimum Interior Gateway Protocol (IGP) Metric Cost Path (MIMCP) OF defined in the following.

\* OF code value 3 (to be assigned by IANA) is for Minimum Load Path (MLP) OF as defined in [RFC5541](#).

\* OF code value 4 (to be assigned by IANA) is for Maximum Residual Bandwidth Path (MBP) OF as defined in [RFC5541](#).

\* OF code value 5 (to be assigned by IANA) is for Minimize Aggregate Bandwidth Consumption (MBC) OF as defined in [RFC5541](#).

\* OF code value 6 (to be assigned by IANA) is for Minimize the Load of the most loaded Link (MLL) OF as defined in [RFC5541](#).

\* OF code value 7 is skipped (to keep the objective function code values consistent between [[RFC5541](#)] and this draft.

---

ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)

\* OF code value 8 (to be assigned by IANA) is for Minimum Latency Path (MLP) OF defined in this document. See definition of MLP OF in the following.

\* OF code value 9 (to be assigned by IANA) is for Minimum Latency Variation Path (MLVP) OF defined in this document. See definition of MLVP OF in the following.

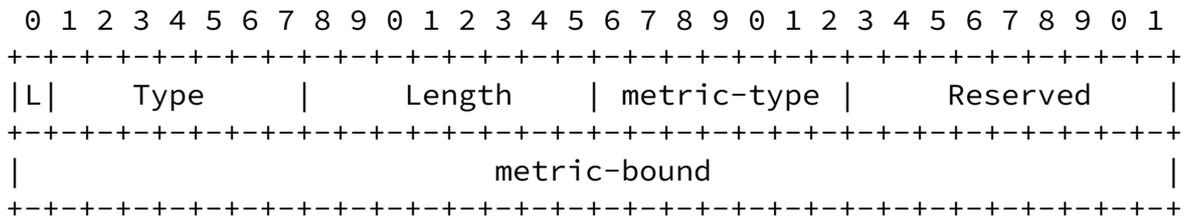
Other objective functions may be defined in future.

Reserved (1 byte): This field MUST be set to zero on transmission and MUST be ignored on receipt.

Optional TLVs may be defined in the future to encode objective function parameters.

### 2.1.1. Minimum TE Metric Cost Path Objective Function





The fields of the Metric subobject are defined as follows:

**L bit:** The L bit SHOULD be set, so that the subobject represents a loose hop in the explicit route.

**Type:** The Type is to be assigned by IANA (suggested value: 67).

**Length:** The Length is 8.

**Metric-type (8 bits):** Specifies the metric type associated with the partial route expended by the node processing the loose ERO. The following values are currently defined:

- \* T=1: cumulative IGP cost
- \* T=2: cumulative TE cost
- \* T=3: Hop Counts
- \* T=4: Cumulative Latency
- \* T=5: Cumulative Latency Variation

ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)

**Reserved:** This field MUST be set to zero on transmission and MUST be ignored on receipt.

**Metric-bound (32 bits):** The metric-bound indicates an upper bound for the path metric that MUST NOT be exceeded for the ERO expending node to consider the computed path as acceptable. The metric bound is encoded in 32 bits using IEEE floating point format as defined in [[IEEE.754.1985](#)]).

### 2.3. Processing Rules for the OF Subobjects

The basic processing rules of an ERO are not altered. Please refer to [\[RFC3209\]](#) for details.

The scope of the OF subobject is the previous ERO subobject that identifies an abstract node, and the subsequent ERO subobject that identifies an abstract node. Multiple OF subobjects may be present between any pair of abstract nodes.

The following conditions SHOULD result in Path Error with error code "Routing Problem" and error subcode "Bad EXPLICIT\_ROUTE object":

- . If the first OF subobject is not preceded by a subobject identifying the next hop.
- . If the OF subobject follows a subobject that does not have the L-bit set.

If the processing node does not understand the OF subobject, it SHOULD send a PathErr with the error code "Routing Error" and error value of "Bad Explicit Route Object" toward the sender [\[RFC3209\]](#).

If the processing node understands the OF subobject and the ERO passes the above mentioned sanity check and any other sanity checks associated with other ERO subobjects local to the node, the node takes the following actions:

- . If the node supports the requested OF(s), the node expands the loose hop using the requested Objective Functions(s) as minimization criterion (criteria) for computing the route to the next abstract node. After processing, the OF subobjects

are removed from the ERO. The rest of the steps for the loose ERO processing follow procedures outlined in [\[RFC3209\]](#).

- . If the node understands the OF subobject but does not support any or all of the requested OF(s), it SHOULD send a Path Error with error code "Routing Problem" and a new error subcode "Unsupported Objective Function". The error subcode "Unsupported Objective Function" for Path Error code "Routing Problem" is to be assigned by IANA (Suggested Value: 107).
- . If the node understands the OF subobject and supports all of

the requested OF(s) but cannot perform route computation with all objective functions considered together as optimization criteria for the path computation, it SHOULD send a Path Error with error code "Routing Problem" and a new error subcode "Objective Function too complex". The error subcode "Objective Function too complex" for Path Error code "Routing Problem" is to be assigned by IANA (Suggested Value: 108).

- . If the objective function is supported but policy does not permit applying it, the processing node SHOULD send a Path Error with error code "Policy control failure" (value 2) and subcode "objective function not allowed". The error subcode "objective function not allowed" for Path Error code "Policy control failure" is to be assigned by IANA (Suggested Value: 105).

#### 2.4. Processing Rules for the Metric subobject

The basic processing rules of an ERO are not altered. Please refer to [\[RFC3209\]](#) for details.

The scope of the Metric subobject is between the previous ERO subobject that identifies an abstract node, and the subsequent ERO subobject that identifies an abstract node. Multiple Metric subobjects may be present between any pair of abstract nodes.

The following conditions SHOULD result in Path Error with error code "Routing Problem" and error subcode "Bad EXPLICIT\_ROUTE object":

- . If the first Metric subobject is not preceded by a subobject identifying the next hop.

---

ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)

- . If the Metric subobject follows a subobject that does not have the L-bit set.

If the processing node does not understand the Metric subobject, it SHOULD send a PathErr with the error code "Routing Error" and error value of "Bad Explicit Route Object" toward the sender [\[RFC3209\]](#).

If the processing node understands the Metric subobject and the

ERO passes the above mentioned sanity check and any other sanity checks associated with other ERO subobjects local to the node, the node takes the following actions:

- . For all the Metric subobject(s), the node expands the loose hop such that the requested metric bound(s) are met for the route between the two abstract nodes in the ERO. After processing, the Metric subobjects are removed from the ERO. The rest of the steps for the loose ERO processing follow procedure outlined in [RFC3209].
- . If the node understands the Metric subobject but cannot find a route to the next abstract node such that the requested metric bound(s) can be satisfied, it SHOULD send a Path Error with error code "Routing Problem" and a new error subcode "No route available toward destination with the requested metric bounds". The error subcode "No route available toward destination with the requested metric bounds" for Path Error code "Routing Problem" is to be assigned by IANA (Suggested Value: 109).

### 3. Security Considerations

This document does not introduce any additional security issues above those identified in [RFC5920], [RFC2205], [RFC3209], and [RFC3473].

### 4. IANA Considerations

This document adds the following two new subobject of the existing entry for ERO (20, EXPLICIT\_ROUTE):

Value	Description
-----	-----

---

ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)

TBA (suggest value: 66) Objective Function (OF) subobject

TBA (suggest value: 67) Metric subobject

These subobject may be present in the Explicit Route Object, but not in the Route Record Object.

OF Code values carried in OF subobject requires an IANA entry

with suggested values as defined in [section 2.1](#).

## 5. Acknowledgments

Authors would like to thank Matt Hartley, Ori Gerstel, Gabriele Maria Galimberti, Luyuan Fang and Walid Wakim for their review comments.

## 6. References

### 6.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC3209] Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP Tunnels", [RFC 3209](#), December 2001.
- [RFC3473] Berger, L., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) Extensions", [RFC 3473](#), January 2003.
- [IEEE.754.1985] IEEE Standard 754, "Standard for Binary Floating-Point Arithmetic", August 1985.

### 6.2. Informative References

- [RFC2209] Braden, R. and L. Zhang, "Resource ReSerVation Protocol (RSVP) -- Version 1 Message Processing Rules", [RFC 2209](#), September 1997.
- [RFC5920] Fang, L., Ed., "Security Framework for MPLS and GMPLS Networks", [RFC 5920](#), July 2010.

## Authors' Addresses

Ali, Swallow, Filsfils

Expires January 2013

[Page 11]

---

ID [draft-ali-ccamp-rc-objective-function-metric-bound-02.txt](#)

Zafar Ali

Cisco Systems.  
Email: zali@cisco.com

George Swallow  
Cisco Systems.  
swallow@cisco.com

Clarence Filsfils  
Cisco Systems.  
cfilsfil@cisco.com

Luyuan Fang  
Cisco Systems.  
lufang@cisco.com

Kenji Kumaki  
KDDI Corporation  
Email: ke-kumaki@kddi.com

Rudiger Kunze  
Deutsche Telekom AG  
Ruediger.Kunze@telekom.de