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        **Resource ReserVation Protocol-Traffic Engineering (RSVP-TE)**
          **extension for recording TE Metric of a Label Switched Path**
               **draft-ietf-ccamp-te-metric-recording-02.txt**

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Abstract

There are many scenarios in which Traffic Engineering (TE) metrics
such as cost, latency and latency variation associated with a
Forwarding Adjacency (FA) or Routing Adjacency (RA) Label Switched
Path (LSP) are not available to the ingress and egress nodes. This
draft provides extensions for the Resource ReserVation Protocol-
Traffic Engineering (RSVP-TE) for the support of the discovery of
cost, latency and latency variation of an LSP.

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](#)].

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1. Introduction

    There are many scenarios in packet and optical networks where
    the route information of an LSP may not be provided to the
    ingress node for confidentiality reasons and/or the ingress node
    may not run the same routing instance as the intermediate nodes
    traversed by the path. In such scenarios, the ingress node
    cannot determine the cost, latency and latency variation
    properties of the LSP's route. Similarly, in Generalized Multi-
    Protocol Label Switching (GMPLS) networks signaling
    bidirectional LSP, the egress node cannot determine the cost,
    latency and latency variation properties of the LSP route.  A
    multi-domain or multi-layer network is an example of such
    networks. Similarly, a GMPLS User-Network Interface (UNI)
    [RFC4208] is also an example of such networks.

    In certain networks, such as financial information networks,
    network performance information (e.g. latency, latency
    variation) is becoming as critical to data path selection as
    other metrics [DRAFT-OSPF-TE-METRIC], [DRAFT-ISIS-TE-METRIC]. If
    cost, latency or latency variation associated with an FA or an
    RA LSP is not available to the ingress or egress node, it cannot
    be advertised as an attribute of the FA or RA. One possible way
    to address this issue is to configure cost, latency and latency
    variation values manually. However, in the event of an LSP being
    rerouted (e.g. due to re-optimization), such configuration
    information may become invalid. Consequently, in case where that
    an LSP is advertised as a TE-Link, the ingress and/or egress
    nodes cannot provide the correct latency, latency variation and
    cost attribute associated with the TE-Link automatically.

    In summary, there is a requirement for the ingress and egress
    nodes to learn the cost, latency and latency variation
    attributes of an FA or RA LSP. This draft provides extensions to
    the Resource ReserVation Protocol-Traffic Engineering (RSVP-TE)
    for the support of the automatic discovery of these attributes.

2. RSVP-TE Requirement

    This section outlines RSVP-TE requirements for the support of
    the automatic discovery of cost, latency and latency variation
    attributes of an LSP. These requirements are very similar to the
    requirement of discovering the Shared Risk Link Groups (SRLGs)

associated with the route taken by an LSP [DRAFT-SRLG-
RECORDING].

2.1. Cost, Latency and Latency Variation Collection Indication

    The ingress node of the LSP must be capable of indicating
   whether the cost, latency and latency variation attributes of
   the LSP should be collected during the signaling procedure of
   setting up the LSP. No cost, latency or latency variation
   information is collected without an explicit request being made
   by the ingress node.

2.2. Cost, Latency and Latency Variation Collection

    If requested, cost, latency and latency variation is
   collected during the setup of an LSP. The endpoints of the LSP
   may use the collected information for routing, flooding and TE
   link configuration and other purposes.

2.3. Cost, Latency and Latency Variation Update

    When the cost, latency and latency variation property of a TE
   link along the route of a LSP for which that property was
   collected changes, e.g., if the administrator changes cost of a
   TE link, the node where the change occurred needs to be capable
   of updating the cost, latency and latency variation information
   of the path and signaling this to the end-points. Similarly, if
   a path segment of the LSP is rerouted, the endpoints of the re-
   routed segment need to be capable of updating the cost, latency
   and latency variation information of the path. Any node, which
   adds cost, latency or latency variation information to an LSP
   during initial setup, needs to signal changes to these values to
   both endpoints.

3. RSVP-TE signaling extensions

3.1. Cost, Latency and Latency Variation Collection Flags

   Three Attribute flags are defined in the Attribute Flags TLV,
   which can be set and carried in either the LSP_ATTRIBUTES or
   LSP_REQUIRED_ATTRIBUTES Objects.

   - Cost Collection flag (to be assigned by IANA)

   - Latency Collection flag (to be assigned by IANA)

   - Latency Variation Collection flag (to be assigned by IANA)

   These flags are meaningful in a Path message. If the Cost
   Collection flag is set to 1, the transit nodes SHOULD report the
   cost information in the Record Route Objects (RRO) of both the
   Path and Resv messages.

If the Cost Collection flag is set to 1, the transit nodes
SHOULD report latency variation information in the Record Route
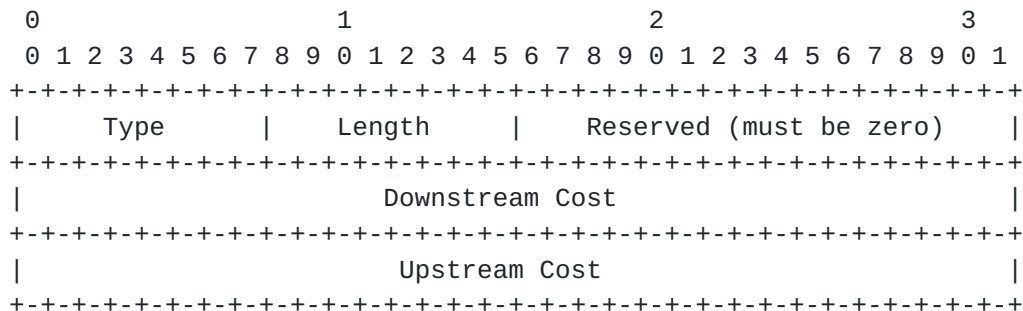Objects (RRO) of both the Path and Resv messages.

If the Latency Collection flag is set to 1, the transit nodes
SHOULD report latency variation information in the Record Route
Objects (RRO) of both the Path and Resv messages.

If the Latency Variation Collection flag is set to 1, the
transit nodes SHOULD report latency variation information in the
Record Route Objects (RRO) of both the Path and Resv messages.

The procedure for the processing the Attribute Flags TLV follows
[RFC5420].

3.2. Cost Subobject

The cost subobject is defined for the RRO to record the cost
information of the LSP. Its format is similar to the RRO
subobjects (ROUTE_RECORD sub-object) defined in [RFC3209].

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |     Length    |      Reserved (must be zero)  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Downstream Cost                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Upstream Cost                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type: TBA1 - Cost subobject (to be assigned by IANA).

Length: The Length value is set to 8 or 12 depending on the
presence of Upstream Cost information.

Reserved: This field is reserved for future use. It MUST be
set to 0 when sent and MUST be ignored when received.

Downstream Cost: Cost of the local link along the route of
the LSP in the direction of the tail-end node, encoded as a
32-bit integer. Based on the policy at the recording node,
the cost value can be set to the Interior Gateway Protocol
(IGP) metric or TE metric of the link in question. This
approach has been taken to avoid defining a flag for each
cost type in the Attribute-Flags TLV. It is assumed that,
based on policy, all nodes report the same cost-type and that

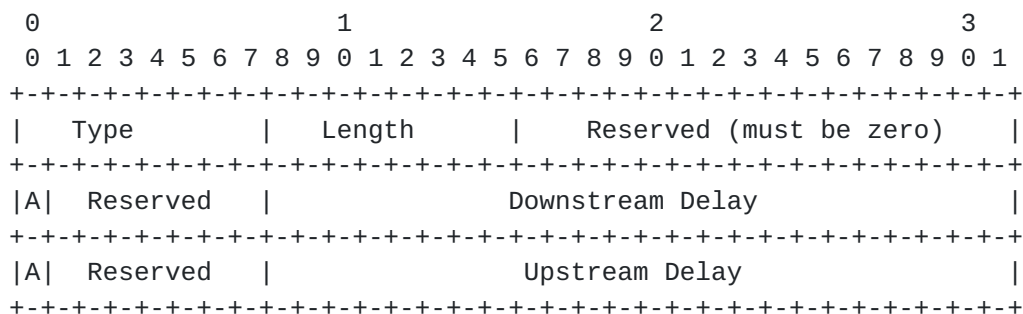the ingress and egress nodes know the cost type reported in
the RRO.

Upstream Cost: Cost of the local link along the route of the
LSP in the direction of the head-end node, encoded as a 32-
bit integer. Based on the policy at the recording node, the
cost value can be set to the Interior Gateway Protocol (IGP)
metric or TE metric of the link in question. This approach
has been taken to avoid defining a flag for each cost type in
the Attribute-Flags TLV. It is assumed that, based on policy,
all nodes report the same cost-type and that the ingress and
egress nodes know the cost type reported in the RRO.

## 3.3. Latency Subobject

The Latency subobject is defined for RRO to record the latency
information of the LSP. Its format is similar the RRO subobjects
defined in [RFC3209].

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type       |   Length      |    Reserved (must be zero)    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|A|  Reserved  |               Downstream Delay                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|A|  Reserved  |                Upstream Delay                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type: TBA2 -  Latency subobject (to be assigned by IANA).

Length: 8 or 12 depending on the presence of Upstream Cost
information.

A-bit: These fields represent the Anomalous (A) bit
associated with the Downstream and Upstream Delay
respectively, as defined in [DRAFT-OSPF-TE-METRIC].

Reserved: These fields are reserved for future use. They MUST
be set to 0 when sent and MUST be ignored when received.

Downstream Delay: Delay of the local link along the route of
the LSP in the direction of the tail-end node, encoded as 24-
bit integer.  When set to 0, it has not been measured. When
set to the maximum value 16,777,215 (16.777215 sec), the
delay is at least that value and may be larger.

Upstream Delay: Delay of the local link along the route of

the LSP in the direction of the head-end node, encoded as 24-

bit integer. When set to 0, it has not been measured. When
set to the maximum value 16,777,215 (16.777215 sec), the
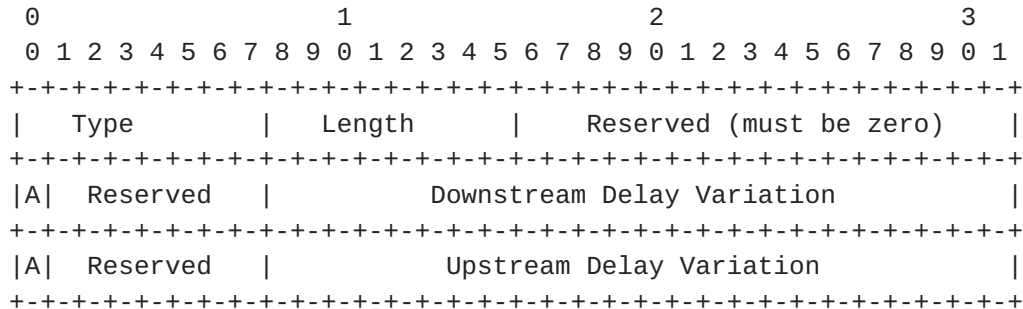delay is at least that value and may be larger.

3.4. Latency Variation Subobject

  The Latency Variation subobject is defined for RRO to record the
  Latency Variation information of the LSP. Its format is similar
  to the RRO subobjects defined in [RFC3209].

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |   Type      |   Length     |     Reserved (must be zero)    |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |A|  Reserved  |           Downstream Delay Variation         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |A|  Reserved  |            Upstream Delay Variation          |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

    Type: TBA3 - Latency Variation subobject (to be assigned by
    IANA).

    Length: 8 or 12 depending on the presence of Upstream Latency
    Variation information.

    A-bit: These fields represent the Anomalous (A) bit
    associated with the Downstream and Upstream Delay
    respectively, as defined in [DRAFT-OSPF-TE-METRIC].

    Reserved: These fields are reserved for future use. It MUST
    be set to 0 when sent and MUST be ignored when received.

    Downstream Delay Variation: Delay Variation of the local link
    along the route of the LSP in the direction of the tail-end
    node, encoded as 24-bit integer.  When set to 0, it has not
    been measured. When set to the maximum value 16,777,215
    (16.777215 sec), the delay is at least that value and may be
    larger.

    Upstream Delay Variation: Delay Variation of the local link
    along the route of the LSP in the direction of the head-end
    node, encoded as 24-bit integer. When set to 0, it has not
    been measured. When set to the maximum value 16,777,215
    (16.777215 sec), the delay is at least that value and may be
    larger.

3.5. Signaling Procedures

   Typically, the ingress node learns the route of an LSP by adding
   a RRO in the Path message. If an ingress node also desires cost,
   latency and/or latency variation recording, it sets the
   appropriate flag(s) in the Attribute Flags TLV of the
   LSP_ATTRIBUTES (if recording is desired but not mandatory) or
   LSP_REQUIRED_ATTRIBUTES (if recording in mandatory) Object.
   None, all or any of the Cost Collection, Latency Collection or
   Latency Variation Collection flags may be set in the Attribute
   Flags TLV of the LSP_ATTRIBUTES or LSP_REQUIRED_ATTRIBUTES
   Object.  The rules for processing the LSP_ATTRIBUTES and
   LSP_REQUIRED_ATTRIBUTES Objects and RRO are not changed. The
   corresponding sub-objects MUST be included in the RRO, with the
   Downstream (only) information filled in.

   When a node receives a Path message which carries an
   LSP_REQUIRED_ATTRIBUTES Object and the Cost, Latency and/or
   Latency Variation Collection Flag(s) is (are) set, if local
   policy disallows providing the requested information to the
   endpoints, the node MUST return a Path Error message with error
   code "Policy Control Failure (2)" and one of the following error
   subcodes:

   . "Cost Recoding Rejected" (value to be assigned by IANA,
     suggested value 105) if Cost Collection Flag is set.

   . "Latency Recording Rejected" (value to be assigned by IANA,
     suggested value 106) if Latency Collection Flag is set.

   . "Latency Variation Recording Rejected" (value to be assigned
     by IANA, suggested value 107) if Latency Variation Collection
     Flag is set.

   When a node receives a Path message which carries an
   LSP_ATTRIBUTES Object and the Cost, Latency and/or Latency
   Variation Collection Flag(s) is (are) set, if local policy
   disallows providing the requested information to the endpoints,
   the Path message SHOULD NOT rejected due to Metric recording
   restriction and the Path message is forwarded without the
   appropriate sub-object(s) in the Path RRO.

   If local policy permits the recording of the requested
   information, the processing node SHOULD add the requested
   subobject(s) with the cost, latency and/or latency variation
   metric value(s) associated with the local hop to the Path RRO.
   If the LSP being setup is bidirectional, both Downstream and
   Upstream information SHOULD be included.  If the LSP is
   unidirectional, only Downstream information SHOULD be included.

Following the steps described above, the intermediate nodes of
the LSP provide the requested metric value(s) associated with

the local hop in the Path RRO. When the egress node receives the
Path message, it can calculate the end-to-end cost, latency
and/or latency variation properties of the LSP.

Before the Resv message is sent to the upstream node, the egress
node adds the requested subobject(s) with the downstream cost,
latency and/or latency variation metric value(s) associated with
the local hop to the Resv RRO in a similar manner to that
specified above for the addition of Path RRO sub-objects by
transit nodes.

Similarly, the intermediate nodes of the LSP provide the
requested metric value(s) associated with the local hop in the
Resv RRO. When the ingress node receives the Resv message, it can
calculate the end-to-end cost, latency and/or latency variation
properties of the LSP.

Typically, cost and latency are additive metrics, but latency
variation is not an additive metric. The means by which the
ingress and egress nodes compute the end-to-end cost, latency
and latency variation metric from information recorded in the
RRO is beyond the scope of this document.

Based on the local policy, the ingress and egress nodes can
advertise the calculated end-to-end cost, latency and/or latency
variation properties of the FA or RA LSP in TE link
advertisement to the routing instance based on the procedure
described in [DRAFT-OSPF-TE-METRIC], [DRAFT-ISIS-TE-METRIC].

Based on the local policy, a transit node (e.g. the edge node of
a domain) may edit a Path or Resv RRO to remove route
information (e.g. node or interface identifier information)
before forwarding it. A node that does this SHOULD summarize the
cost, latency and latency variation data removed as a single
value for each for the loose hop that is summarized by the
transit node. How a transit node calculates the cost, latency o
and/or latency variation metric for the segment summarized by
the transit node is beyond the scope of this document.

4. Security Considerations

This document does not introduce any additional security issues
above those identified in [RFC5920], [RFC5420], [RFC2205],
[RFC3209], and [RFC3473].

5. IANA Considerations

5.1. RSVP Attribute Bit Flags

The IANA has created a registry and manages the space of

attributes bit flags of Attribute Flags TLV as described in
[section 11.3 of [RFC5420]](). It is requested that the IANA makes

assignments from the Attribute Bit Flags defined in this
document.

This document introduces the following three new Attribute
Bit Flag:

    - Bit number: TBD (recommended bit position 11)

    - Defining RFC: this I-D

    - Name of bit: Cost Collection Flag


    - Bit number: TBD (recommended bit position 12)

    - Defining RFC: this I-D

    - Name of bit: Latency Collection Flag


    - Bit number: TBD (recommended bit position 13)

    - Defining RFC: this I-D

    - Name of bit: Latency Variation Flag


5.2. ROUTE_RECORD subobject

This document introduces the following three new RRO
subobject:

| Type | Name | Reference |
| --------- | --------------------- | --------- |
| TBD (35) | Cost subobject | This I-D |
| TBD (36) | Latency subobject | This I-D |
| TBD (37) | Latency Variation subobject | This I-D |

5.2. New RSVP error sub-code

For Error Code = 2 "Policy Control Failure" (see [RFC2205]) the
following sub-code is defined.

    Sub-code                                Value

    Cost Recoding Rejected                To be assigned by IANA.
                                          Suggested Value: 105.

    Latency Recoding Rejected             To be assigned by IANA.
                                          Suggested Value: 106.

    Latency Variation Recoding Rejected    To be assigned by
IANA.
                                          Suggested Value: 107.

6. Acknowledgments

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

7. References

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