CCAMP Working Group   Zafar Ali
Internet Draft   George Swallow
Intended status: Standard Track   Clarence Filsfils
Expires: January 14, 2014   Matt Hartley
                                                     Ori Gerstel
                                       Gabriele Maria Galimberti
                                                   Cisco Systems
                                                    Kenji Kumaki
                                                 KDDI Corporation
                                                 Ruediger Kunze
                                              Deutsche Telekom AG
                                                   Julien Meuric
                                            France Telecom Orange
                                                   July 15, 2013

        Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) Path
                   Diversity using Exclude Routes

                  draft-ietf-ccamp-lsp-diversity-02.txt

Status of this Memo

Copyright Notice

described in the Simplified BSD License.

Internet Draft   draft-ietf-ccamp-lsp-diversity-02.txt

Abstract

RFC 4874 specifies methods by which route exclusions may be
communicated during RSVP-TE signaling in networks where precise
explicit paths are not computed by the LSP source node. This
document specifies signaling for additional route exclusions based
on Paths currently existing or expected to exist within the network.

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

1. Introduction

   Path diversity is a well-known requirement from Service Providers.
   Such diversity is required to ensure Label-Switched Paths (LSPs)
   may be established without sharing resources, thus greatly
   reducing the probability of simultaneous connection failures.

Ali, Swallow, Filsfils, et al   Expires January 2014   [Page 2]

When route computation for paths that need to be diverse is
performed at the LSP's source node, this requirement can be met by
a local decision at that node. However, there are scenarios when
route computations are performed by remote nodes, thus there is a
need for relevant diversity requirements to be communicated to
those nodes. These 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
  (server layer) core node [RFC4208].

[RFC4874] introduced a means of specifying nodes and resources to
be excluded from a route, using the eXclude Route Object (XRO) and
Explicit Exclusion Route Subobject (EXRS).

[RFC4874] facilitates the calculation of diverse routes for LSPs
based on known properties of those paths including addresses of
links and nodes traversed, and Shared Risk Link Groups (SRLGs) of
traversed links. This requires that these properties of the
path(s) from which diversity is required be known to the source
node which initiates signaling. However, there are circumstances
under which this may not be possible or desirable, including (but
not limited to):

. Exclusion of a path which does not originate, terminate or
  traverse the source node signaling the diverse LSP, in which
  case the addresses and SRLGs of the path from which diversity
  is required are unknown to the source node.

. Exclusion of a path which, while known at the source node of
  the diverse LSP, has incomplete or unavailable route
  information, e.g. due to confidentiality of the path
  attributes. In other words, the scenario in which the reference
  path is hosted by the source / requesting node but the
  properties required to construct an XRO object are not known to
  source / requesting node. Inter-domain and GMPLS overlay
  networks may present such restrictions.

. If the source node knows the route of the reference path from
  which diversity is required, it can use this information to
  construct an XRO and send it in the path message during the
  signaling of a diverse LSP. However, if the route of the
  excluded path changes (e.g. due to re-optimization or failure
  in the network), the source node would need to change the

diverse path to ensure that it remains diverse from the
excluded path. It is preferable to have this decision made by
the node that performed the path-calculation for the diverse
path. For example, in the case of GMPLS-UNI, it is better to
have such responsibility at the server layer as opposed to at
the client layer so that the diversity requirements are
transparent to the client layer. Furthermore, in all networking
scenarios, if the node performing the route computation/
expansion is aware of the diversity requirements of the two
paths, it may consider joint re-optimization of the diverse
paths.

This document addresses such scenarios and defines procedures
that may be used to exclude the route taken by a particular LSP,
or the routes taken by all LSPs belonging to a single tunnel.
Note that this diversity requirement is different from the
diversity requirements of path protection where both the
reference and diverse LSPs belong to the same tunnel. The
diversity requirements considered in this document do not require
that the paths in question belonging to the same tunnel or share
the same source or destination node.

The means by which the node calculating or expanding the route of
the signaled LSP discovers the route of the path(s) from which
the signaled LSP requires diversity are beyond the scope of this
document.

This document addresses only the exclusion of point-to-point
paths; point-to-multipoint paths will be addressed in a future
version.

If mutually diverse routes are desired for two LSPs belonging to
different tunnels, it is recommended that they be signaled with
XRO LSP subobjects referencing each other. The processing rules
specified in this document cover this case.

2. RSVP-TE signaling extensions

This section describes the signaling extensions required to
address the aforementioned requirements. Specifically, this
document defines a new LSP subobject to be signaled in the
EXCLUDE_ROUTE object (XRO) and/ or Explicit Exclusion Route
Subobject (EXRS) defined in [RFC4874]. Inclusion of the LSP
subobject in any other RSVP object is not defined.

2.1. Terminology

In this document, the following terminology is adopted:

Excluded path: the path from which diversity is required.

Diverse LSP: the LSP being signaled with XRO/ EXRS containing the
path subobject referencing the excluded path(s).

Processing node: the node performing a path-calculation involving
an exclusion specified in an XRO or EXRS.

Destination node: in the context of an XRO, this is the
destination of the LSP being signaled. In the context of an EXRS,
the destination node is the last explicit node to which the loose
hop is expanded.

Penultimate node: in the context of an XRO, this is the
penultimate hop of the LSP being signaled. In the context of an
EXRS, the penultimate node is the penultimate node of the loose
hop undergoing expansion.

2.2. Path XRO Subobjects

New IPv4 and IPv6 Point-to-Point (P2P) Path XRO subobjects are
defined by this document as follows.

2.2.1. IPv4 Point-to-Point Path subobject

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|L|   Type     |    Length    |Attribute Flags|Exclusion Flags|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 IPv4 tunnel end point address                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Must Be Zero        |         Tunnel ID             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Extended Tunnel ID                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   IPv4 tunnel sender address                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Must Be Zero        |            LSP ID             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

L

>   The L-flag is used as for the other XRO subobjects defined
>   in [RFC4874].
>
>   0 indicates that the attribute specified MUST be excluded.
>
>   1 indicates that the attribute specified SHOULD be
>   avoided.

Type

>   IPv4 Point-to-Point Path subobject
>   (to be assigned by IANA; suggested value: 36).

Length

>   The length contains the total length of the subobject in
>   bytes, including the type and length fields. The length is
>   always 24.

Attribute Flags

>   The Attribute Flags are used to communicate desirable
>   attributes of the LSP being signaled. The following flags
>   are defined. None, all or multiple attribute flags MAY be
>   set within the same subobject.
>
>   0x01 = LSP ID to be ignored
>
>   This flag is used to indicate tunnel level exclusion.
>   Specifically, this flag is used to indicate that the
>   lsp-id field of the subobject is to be ignored and the
>   exclusion applies to any LSP matching the rest of the
>   supplied FEC.
>
>   0x02 = Destination node exception
>
>   This flag is used to indicate that the destination node
>   of the LSP being signaled MAY be shared with the
>   excluded path even when this violates the exclusion
>   flags.

0x04 = Processing node exception

   This flag is used to indicate that the processing node
   MAY be shared with the excluded path even when this
   violates the exclusion flags.

0x08 = Penultimate node exception

   This flag is used to indicate that the penultimate node
   of the LSP being signaled MAY be shared with the
   excluded path even when this violates the exclusion
   flags.

Exclusion Flags

   The Exclusion-Flags are used to communicate desirable
   types of exclusion. The following flags are defined.

   0x01 = SRLG exclusion

      This flag is used to indicate that the route of the
      LSP being signaled is requested to be SRLG diverse
      from the excluded path specified by the LSP
      subobject.

   0x02 = Node exclusion

      This flag is used to indicate that the route of the
      LSP being signaled is requested to be node diverse
      from the excluded path specified by the LSP
      subobject.

      (Note: the meaning of this flag may be modified by
      the value of the Attribute-flags.)

   0x04 = Link exclusion

      This flag is used to indicate that the route of the
      LSP being signaled is requested to be link diverse
      from the path specified by the LSP subobject.

The remaining fields are as defined in [RFC3209].

2.2.2. IPv6 Point-to-Point Path subobject

```
   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
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |L|   Type     |   Length    |Attribute Flags|Exclusion Flags|
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |               IPv6 tunnel end point address                  |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |           IPv6 tunnel end point address (cont.)              |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |           IPv6 tunnel end point address (cont.)              |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |           IPv6 tunnel end point address (cont.)              |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |         Must Be Zero        |         Tunnel ID              |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |                     Extended Tunnel ID                       |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |                  Extended Tunnel ID (cont.)                  |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |                  Extended Tunnel ID (cont.)                  |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |                  Extended Tunnel ID (cont.)                  |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |                   IPv4 tunnel sender address                 |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |               IPv4 tunnel sender address (cont.)             |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |               IPv4 tunnel sender address (cont.)             |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |               IPv4 tunnel sender address (cont.)             |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  |         Must Be Zero        |             LSP ID             |
  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   L

        The L-flag is used as for the other XRO subobjects defined
        in [RFC4874].

        0 indicates that the attribute specified MUST be excluded.

1 indicates that the attribute specified SHOULD be
avoided.

Type

IPv6 Point-to-Point Path subobject
(to be assigned by IANA; suggested value: 37).

Length

The length contains the total length of the subobject in
bytes, including the type and length fields. The length is
always 48.

The Attribute Flags and Exclusion Flags are as defined for the
IPv4 Point-to-Point LSP XRO subobject.

The remaining fields are as defined in [RFC3209].

2.3. Processing rules for the Path XRO subobjects

XRO processing as described in [RFC4874] is unchanged.

If the processing node is the destination for the LSP being
signaled, it SHOULD NOT process a Path XRO subobject.

If the L-flag is not set, the processing node follows the
following procedure:

- The processing node MUST ensure that any route calculated for
  the signaled LSP respects the requested exclusion flags with
  respect to the excluded path referenced by the subobject,
  including local resources.

- If the processing node fails to find a route that meets the
  requested constraint, the processing node MUST return a PathErr
  with the error code "Routing Problem" (24) and error sub-code
  "Route blocked by Exclude Route" (67).

- If the excluded path referenced in the LSP subobject is unknown
  to the processing node, the processing node SHOULD ignore the
  LSP subobject in the XRO and SHOULD proceed with the signaling
  request. After sending the Resv for the signaled LSP, the

processing node SHOULD return a PathErr with the error code
"Notify Error" (25) and error sub-code "Route of XRO path
unknown" (value to be assigned by IANA, suggested value: 13)
for the signaled LSP.

If the L-flag is set, the processing node follows the following
procedure:

- The processing node SHOULD respect the requested exclusion
  flags with respect to the excluded path as far as possible.

- If the processing node fails to find a route that meets the
  requested constraint, it SHOULD proceed with signaling using a
  suitable route that meets the constraint as far as possible.
  After sending the Resv for the signaled LSP, it SHOULD return a
  PathErr message with error code "Notify Error" (25) and error
  sub-code "Failed to respect Exclude Route" (value: to be
  assigned by IANA, suggest value: 14) to the source node.

- If the excluded path referenced in the LSP subobject is unknown
  to the processing node, the processing node SHOULD ignore the
  LSP subobject in the XRO and SHOULD proceed with the signaling
  request. After sending the Resv for signaled LSP, the
  processing node SHOULD return a PathErr message with the error
  code "Notify Error" (25) and error sub-code "Route of XRO path
  unknown" for the signaled LSP.

If, subsequent to the initial signaling of a diverse LSP:

- an excluded path referenced in the diverse LSP's XRO subobject
   becomes known to the processing node (e.g. when the excluded
   path is signaled), or

- A change in the excluded path becomes known to the processing
   node,

the processing node SHOULD re-evaluate the exclusion and
diversity constraints requested by the diverse LSP to determine
whether they are still satisfied.

- If the requested exclusion constraints for the diverse LSP are
   no longer satisfied and an alternative route for the diverse
   LSP that can satisfy those constraints exists, the processing
   node SHOULD send a PathErr message for the diverse LSP with the
   error code "Notify Error" (25) and error sub-code "Preferable
   path exists" (6). A source node receiving a PathErr message

with this error code and sub-code combination MAY try to
reoptimize the diverse tunnel to the new compliant path.

- If the requested exclusion constraints for the diverse LSP are
   no longer satisfied and no alternative path for the diverse LSP
   that can satisfy those constraints exists, then:

     o If the L-flag was not set in the original exclusion, the
        processing node MUST send a PathErr message for the
        diverse LSP with the error code "Routing Problem" (24) and
        error sub-code "Route blocked by Exclude Route" (67). The
        PSR flag SHOULD NOT be set.

     o If the L-flag was set in the original exclusion, the
        processing node SHOULD send a PathErr message for the
        diverse LSP with the error code error code "Notify Error"
        (25) and error sub-code "Failed to respect Exclude Route"
        (value: to be assigned by IANA, suggest value: 14).

  The following rules apply whether or not the L-flag is set:

  - An XRO object MAY contain multiple path subobjects.

  - As specified in [RFC4874], a node receiving a Path message
    carrying an XRO MAY reject the message if the XRO is too large
    or complicated for the local implementation or the rules of
    local policy. In this case, the node MUST send a PathErr
    message with the error code "Routing Error" (24) and error sub-
    code "XRO Too Complex" (68). A source node receiving this
    error code/sub-code combination MAY reduce the complexity of
    the XRO or route around the node that rejected the XRO.

  - A source node receiving a PathErr message with the error code
    "Notify Error" (25) and error sub-codes "Route of XRO path
    unknown" or "Failed to respect Exclude Route" MAY take no
    action.

  - The attribute-flags affect the processing of the XRO subobject
    as follows:

     o When the "LSP ID to be ignored" flag is set, the
        processing node MUST calculate a route based on exclusions
        from the routes of all known LSPs matching the tunnel-id,
        source, destination and extended tunnel-id specified in
        the subobject. When this flag is not set, the lsp-id is
        not ignored and the exclusion applies only to the
        specified LSP (i.e., LSP level exclusion).

   o When the "destination node exception" flag is not set, the
      exclusion flags SHOULD also be respected for the
      destination node.

   o When the "processing node exception" flag is not set, the
      exclusion flags SHOULD also be respected for the
      processing node.

   o When the "penultimate node exception" flag is not set, the
      exclusion flags SHOULD also be respected for the
      penultimate node.

2.4. Path EXRS Subobject

   [RFC4874] defines the EXRS ERO subobject. An EXRS is used to
   identify abstract nodes or resources that must not or should not
   be used on the path between two inclusive abstract nodes or
   resources in the explicit route. An EXRS contains one or more
   subobjects of its own, called EXRS subobjects [RFC4874].

   An EXRS MAY include an IPv4 Point-to-Point (P2P) Path subobject
   as specified in section 2.2.1. In this case, the EXRS format
   would be as follows:

```
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|L|   Type      |    Length     |            Reserved           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|L|   Type      |    Length     |Attribute Flags|Exclusion Flags|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               IPv4 tunnel end point address                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Must Be Zero         |           Tunnel ID           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Extended Tunnel ID                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    IPv4 tunnel sender address                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Must Be Zero         |            LSP ID             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   The meaning of respective fields in EXRS header are as defined in
   [RFC4874]. The meaning of respective fields in IPv4 P2P Path
   subobject is as defined earlier in this document.

The processing rules for the EXRS object are unchanged from
[RFC4874]. When the EXRS contains one or more Path subobject(s),
the processing rules specified in Section 2.3 apply to the node
processing the ERO with the EXRS subobject.

If a loose-hop expansion results in the creation of another
loose-hop in the outgoing ERO, the processing node MAY include
the EXRS in the newly-created loose hop for further processing by
downstream nodes.

The processing node exception for the EXRS subobject applies to
the node processing the ERO.

The destination node exception for the EXRS subobject applies to
the explicit node identified by the ERO subobject that identifies
the next abstract node. This flag is only processed if the L bit
is set in the ERO subobject that identifies the next abstract
node.

The penultimate node exception for the EXRS subobject applies to
the node before the explicit node identified by the ERO subobject
that identifies the next abstract node. This flag is only
processed if the L bit is set in the ERO subobject that
identifies the next abstract node.

3. Security Considerations

This document does not introduce any additional security issues
above those identified in [RFC5920], [RFC2205], [RFC3209],
[RFC3473] and [RFC4874].

4. IANA Considerations

4.1. New XRO subobject types

IANA registry: RSVP PARAMETERS
Subsection: Class Names, Class Numbers, and Class Types

This document introduces two new subobjects for the EXCLUDE_ROUTE
object [RFC4874], C-Type 1.

Subobject Type
                    Subobject Description

To be assigned by IANA   IPv4 P2P Path subobject
   (suggested value: 36)

   To be assigned by IANA   IPv6 P2P Path subobject
     (suggested value: 37)

4.2. New EXRS subobject types

   The IPv4 and IPv6 P2P Path subobjects are also defined as new
   EXRS subobjects.

4.3. New RSVP error sub-codes

   IANA registry: RSVP PARAMETERS
   Subsection: Error Codes and Globally-Defined Error Value Sub-
   Codes

   For Error Code "Notify Error" (25) (see [RFC3209]) the following
   sub-codes are defined.

      Sub-code   Value
      --------   -----

      Route of XRO path unknown   To be assigned by IANA.
                                        Suggested Value: 13.

      Failed to respect Exclude Route   To be assigned by IANA.
                                        Suggested Value: 14.

5. Acknowledgements

   The authors would like to thank 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.

[RFC4874] Lee, CY., Farrel, A., and S. De Cnodder, "Exclude
          Routes - Extension to Resource ReserVation Protocol-
          Traffic Engineering (RSVP-TE)", RFC 4874, April 2007.

6.2. Informative References

[RFC4208] Swallow, G., Drake, J., Ishimatsu, H., and Y. Rekhter,
          "Generalized Multiprotocol Label Switching (GMPLS)
          User-Network Interface (UNI): Resource ReserVation
          Protocol-Traffic Engineering (RSVP-TE) Support for the
          Overlay Model", RFC 4208, October 2005.

[RFC2205] Braden, R. (Ed.), Zhang, L., Berson, S., Herzog, S. and
          S. Jamin, "Resource ReserVation Protocol -- Version 1
          Functional Specification", RFC 2205, September 1997.

[RFC5920] Fang, L., Ed., "Security Framework for MPLS and GMPLS
          Networks", RFC 5920, July 2010.

Authors' Addresses

   Zafar Ali
   Cisco Systems.
   Email: zali@cisco.com

   George Swallow
   Cisco Systems
   swallow@cisco.com

   Clarence Filsfils
   Cisco Systems, Inc.
   cfilsfil@cisco.com

Matt Hartley
Cisco Systems
Email: mhartley@cisco.com

Ori Gerstel
Cisco Systems
ogerstel@cisco.com

Gabriele Maria Galimberti
Cisco Systems
ggalimbe@cisco.com

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

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

Julien Meuric
France Telecom Orange
Email: julien.meuric@orange.com