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Domain Subobjects for Resource ReserVation Protocol - Traffic Engineering (RSVP-TE)
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Abstract

The RSVP-TE specification, [RFC3209] and GMPLS extensions to RSVP-TE, [RFC3473] allow abstract nodes and resources to be explicitly included in a path setup. Further Exclude Routes Extension [RFC4874] allow abstract nodes and resources to be explicitly excluded in a path setup.

The use of Autonomous Number (AS) (2-Byte) as an abstract node representing domain is already defined in [RFC3209] and [RFC4874].

This document specifies new subobjects to include or exclude domains during path setup where domain is a collection of network elements within a common sphere of address management or path computational responsibility such as an IGP area or an Autonomous Systems (4-Byte).

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1. Introduction

The RSVP-TE specification [RFC3209] and GMPLS extensions [RFC3473] allow abstract nodes and resources to be explicitly included in a path setup, using the Explicit Route Object (ERO).

Further RSVP-TE specification [RFC4874] allows abstract nodes or resources to be excluded from the whole path using the Exclude Route object (XRO). To exclude certain abstract nodes or resources between a specific pair of abstract nodes present in an ERO, a subobject Explicit Exclusion Route Subobject (EXRS) is used.

[RFC3209] already describes the notion of abstract nodes, where an abstract node is a group of nodes whose internal topology is opaque to the ingress node of the LSP. It further defines a subobject for Autonomous Systems (AS) (2-Byte).

This document extends the notion of abstract nodes by adding new subobjects for IGP Areas and 4-byte AS numbers. These subobjects MAY be included in Explicit Route Object (ERO), Exclude Route object (XRO) or Explicit Exclusion Route Subobject (EXRS).

1.1. Requirements Language

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 [RFC2119].

2. Terminology

The following terminology is used in this document.

AS: Autonomous System.

Domain: Any collection of network elements within a common sphere of address management or path computational responsibility. Examples of domains include Interior Gateway Protocol (IGP) areas and Autonomous Systems (ASs).

ERO: Explicit Route Object

EXRS: Explicit Exclusion Route Subobject

IGP: Interior Gateway Protocol. Either of the two routing protocols, Open Shortest Path First (OSPF) or Intermediate System to Intermediate System (IS-IS).

IS-IS: Intermediate System to Intermediate System.

OSPF: Open Shortest Path First.

PCE: Path Computation Element. An entity (component, application, or network node) that is capable of computing a network path or route based on a network graph and applying computational constraints.

PCEP: Path Computation Element Protocol.

RSVP: Resource Reservation Protocol

TE LSP: Traffic Engineering Label Switched Path.

XRO: Exclude Route Object

3. Subobjects for Domains

3.1. Domains

[RFC4726] and [RFC4655] define domain as a separate administrative or geographic environment within the network. A domain may be further defined as a zone of routing or computational ability. Under these definitions a domain might be categorized as an Autonomous System (AS) or an Interior Gateway Protocol (IGP) area.

3.2. Explicit Route Object (ERO)'s Subobjects

As stated in [RFC3209], an explicit route is a particular path in the network topology. In addition to the ability to identify specific nodes along the path, an explicit route can identify a group of nodes (abstract nodes) that must be traversed along the path.

Some subobjects are defined in [RFC3209], [RFC3473], [RFC3477], [RFC4874] and [RFC5553] but new subobjects related to domains are needed.

The following subobject types are used in ERO.

Type	Subobject
1	IPv4 prefix
2	IPv6 prefix
3	Label
4	Unnumbered Interface ID
32	Autonomous system number (2 Byte)
33	Explicit Exclusion (EXRS)
34	SRLG
64	IPv4 Path Key
65	IPv6 Path Key

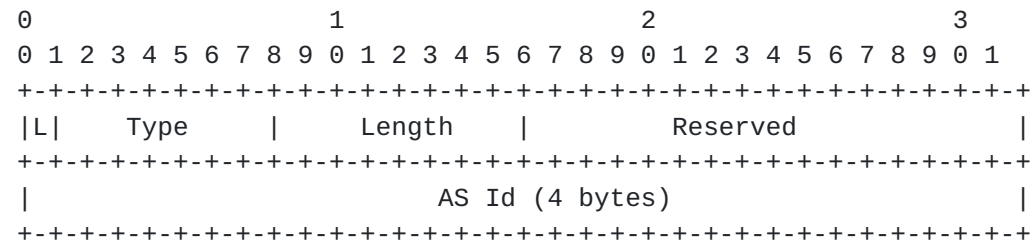
This document extends the above list to support 4-Byte AS numbers and IGP Areas.

Type	Subobject
TBD	Autonomous system number (4 Byte)
TBD	OSPF Area id
TBD	ISIS Area id

3.2.1. Autonomous system

[RFC3209] already defines 2-Byte AS number.

To support 4-Byte AS number as per [RFC4893] following subobject is defined:



L: The L bit is an attribute of the subobject as define in [RFC3209].

Type: (TBA by IANA) indicating a 4-Byte AS Number.

Length: 8 (Total length of the subobject in bytes).

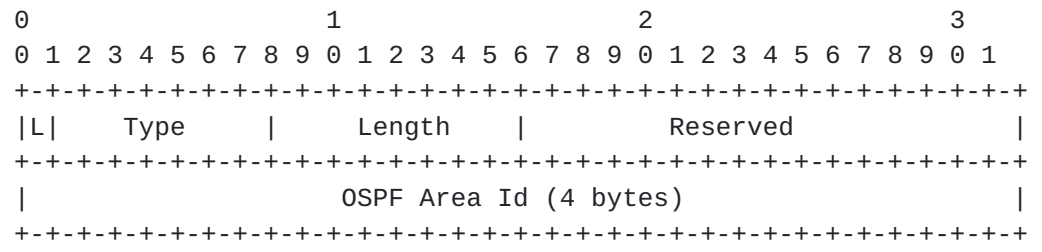
Reserved: Zero at transmission, Ignored at receipt.

AS-ID: The 4-Byte AS Number. Note that if 2-Byte AS numbers are in use, the low order bits (16 through 31) should be used and the high order bits (0 through 15) should be set to zero.

3.2.2. IGP Area

Since the length and format of Area-id is different for OSPF and ISIS, the following two subobjects are defined:

For OSPF, the area-id is a 32 bit number. The subobject is encoded as follows:



L: The L bit is an attribute of the subobject as define in [RFC3209].

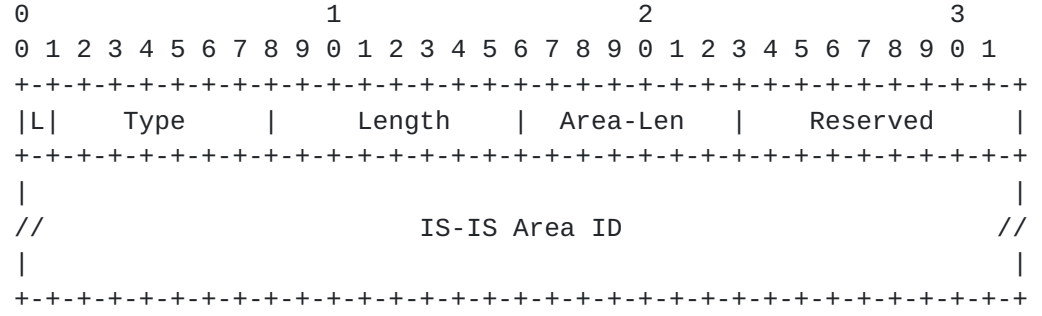
Type: (TBA by IANA) indicating 4-Byte OSPF Area ID.

Length: 8 (Total length of the subobject in bytes).

Reserved: Zero at transmission, Ignored at receipt.

OSPF Area Id: The 4-Byte OSPF Area ID.

For IS-IS, the area-id is of variable length and thus the length of the subobject is variable. The Area-id is as described in IS-IS by ISO standard [ISO 10589]. The subobject is encoded as follows:



L: The L bit is an attribute of the subobject as define in [RFC3209].

Type: (TBA by IANA) indicating IS-IS Area ID.

Length: Variable (Total length of the subobject in bytes including padding). The Length MUST be at least 4, and MUST be a multiple of

4.

Area-Len: Variable (Length of the actual (non-padded) IS-IS Area Identifier in bytes; Valid values are from 2 to 11 inclusive).

Reserved: Zero at transmission, Ignored at receipt.

IS-IS Area Id: The variable-length IS-IS area identifier. Padded with trailing zeroes to a four-byte boundary.

3.2.3. Mode of Operation

The new subobjects to support 4-Byte AS and IGP (OSPF / ISIS) Area MAY also be used in the ERO to specify an abstract node (a group of nodes whose internal topology is opaque to the ingress node of the LSP).

All the rules of processing (for example Next Hop Selection, L bit processing, unrecognized subobjects etc) are as per the [RFC3209].

3.3. Exclude Route Object (XRO)'s Subobjects

As stated in [RFC4874], the exclude route identifies a list of abstract nodes that should not be traversed along the path of the LSP being established.

Some subobjects are defined in [RFC3209], [RFC3477], [RFC4874] and [RFC6001] but new subobjects related to domains are needed.

The following subobject types are used in XRO.

Type	Subobject
1	IPv4 prefix
2	IPv6 prefix
3	Label
4	Unnumbered Interface ID
32	Autonomous system number (2 Byte)
34	SRLG

This document extends the above list to support 4-Byte AS numbers and IGP Areas.

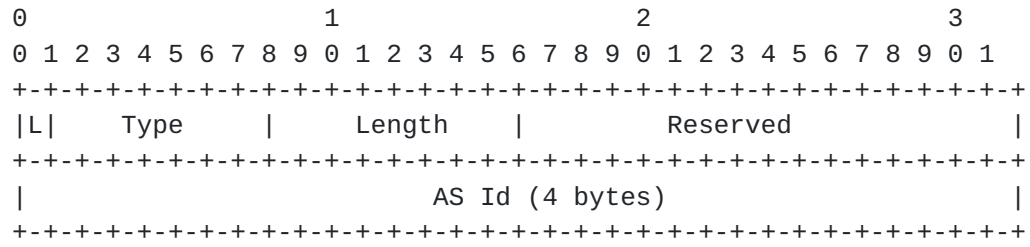
Type	Subobject
TBD	Autonomous system number (4 Byte)
TBD	OSPF Area id

TBD ISIS Area id

3.3.1. Autonomous system

[RFC3209] and and [RFC4874] already defines a 2-Byte AS number.

To support 4-Byte AS number as per [RFC4893], the following subobject is defined:



The meaning of the L bit, similar to [RFC4874], is as follows:

0 indicates that the abstract node (AS) specified MUST be excluded.

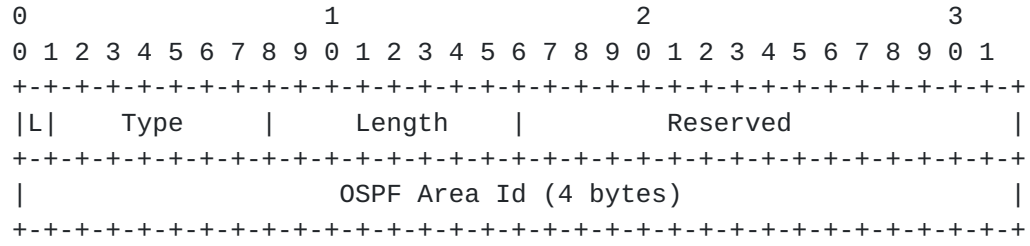
1 indicates that the abstract node (AS) specified SHOULD be avoided.

The meaning of all the other elements (Type, Length, Reserved and 4-Byte AS Id) is same as explained above in Section 3.2.1.

3.3.2. IGP Area

Since the length and format of Area-id is different for OSPF and ISIS, following two subobjects are defined:

For OSPF, the area-id is a 32 bit number. The subobject is encoded as follows:



The meaning of the L bit, similar to [RFC4874], is as follows:

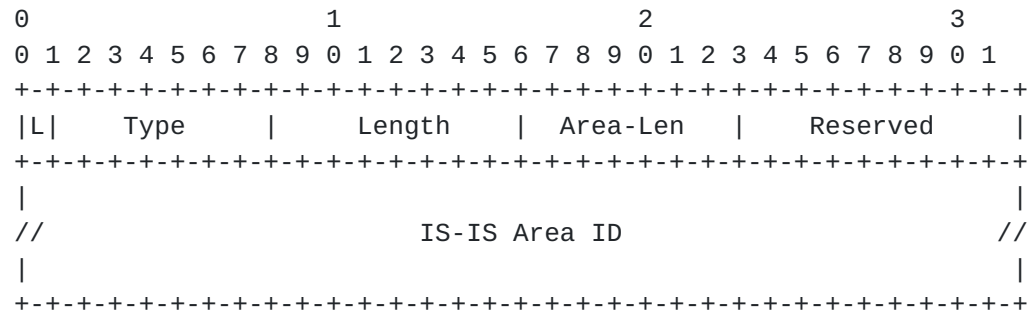
0 indicates that the abstract node (OSPF Area) specified MUST be

excluded.

1 indicates that the abstract node (OSPF Area) specified SHOULD be avoided.

The meaning of all the other elements (Type, Length, Reserved and OSPF Area Id) is same as explained above in Section 3.2.2.

For IS-IS, the area-id is of variable length and thus the length of the subobject is variable. The Area-id is as described in IS-IS by ISO standard [ISO 10589]. The subobject is encoded as follows:



The meaning of the L bit, similar to [RFC4874], is as follows:

0 indicates that the abstract node (IS-IS Area) specified MUST be excluded.

1 indicates that the abstract node (IS-IS Area) specified SHOULD be avoided.

The meaning of all the other elements (Type, Length, Reserved and IS-IS Area Id) is same as explained above in Section 3.2.2.

3.3.3. Mode of Operation

The new subobjects to support 4-Byte AS and IGP (OSPF / ISIS) Area MAY also be used in the XRO to specify exclusion of an abstract node (a group of nodes whose internal topology is opaque to the ingress node of the LSP).

All the rules of processing are as per the [RFC4874].

3.4. Explicit Exclusion Route Subobject

As stated in [RFC4874], the Explicit Exclusion Route defines 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. EXRS is an ERO subobject that contains one or more subobjects of its own, called EXRS subobjects.

The EXRS subobject may carry any of the subobjects defined for XRO, thus the new subobjects to support 4-Byte AS and IGP (OSPF / ISIS) Area MAY also be used in the EXRS. The meanings of the fields of the new XRO subobjects are unchanged when the subobjects are included in an EXRS, except that scope of the exclusion is limited to the single hop between the previous and subsequent elements in the ERO.

All the rules of processing are as per the [RFC4874].

4. Interaction with Path Computation Element (PCE)

The domain subobjects to be used in Path Computation Element Protocol (PCEP) are referred to in [PCE-DOMAIN]. Note that the new domain subobjects follow the principle that subobjects used in PCEP [RFC5440] are identical to the subobjects used in RSVP-TE.

5. IANA Considerations

5.1. New Subobjects

IANA registry: RSVP PARAMETERS

Subsection: Class Names, Class Numbers, and Class Types

IANA is requested to add further subobjects to the existing entry for:

20 EXPLICIT_ROUTE
232 EXCLUDE_ROUTE

Subobject Type		Reference
TBA	4-Byte AS number	[This I.D.]
TBA	OSPF Area ID	[This I.D.]
TBA	IS-IS Area ID	[This I.D.]

6. Security Considerations

Security considerations for MPLS-TE and GMPLS signaling are covered in [RFC3209] and [RFC3473]. This document does not introduce any new messages or any substantive new processing, and so those security considerations continue to apply.

The route exclusion security consideration are covered in [RFC4874]

and continue to apply.

7. Acknowledgments

We would like to thank Reeja Paul and Sandeep Boina for their useful comments and suggestions.

8. References

8.1. Normative References

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8.2. Informative References

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[RFC4655] Farrel, A., Vasseur, J., and J. Ash, "A Path Computation Element (PCE)-Based Architecture", RFC 4655, August 2006.

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[RFC5553] Farrel, A., Bradford, R., and JP. Vasseur, "Resource Reservation Protocol (RSVP) Extensions for Path Key Support", RFC 5553, May 2009.

[RFC6001] Papadimitriou, D., Vigoureux, M., Shiomoto, K., Brungard, D., and JL. Le Roux, "Generalized MPLS (GMPLS) Protocol Extensions for Multi-Layer and Multi-Region Networks (MLN/MRN)", RFC 6001, October 2010.

[PCE-DOMAIN] Dhody, D., Palle, U., and R. Casellas, "Standard Representation Of Domain Sequence. (draft-ietf-pce-pcep-domain-sequence-01)", July 2012.

[ISO 10589] ISO, "Intermediate system to Intermediate system routeing information exchange protocol for use in conjunction with the Protocol for providing the Connectionless-mode Network Service (ISO 8473)", ISO/IEC 10589:2002.

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