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

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Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on September 28, 2017.

Abstract

Resource ReserVation Protocol-Traffic Engineering provides support for the communication of exclusion information during labeled switch path setup. This document specifies three new route exclusion types. The new types include exclusions based on LSP, PCE, and network assigned identifiers.

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 for multiple connections is a well-known Service Provider requirement. Diversity constraints ensure that Label-Switched Paths (LSPs) can be established without sharing network resources, thus greatly reducing the probability of simultaneous connection failures.

The source node can compute diverse paths for LSPs when it has full knowledge of the network topology and is permitted to signal an Explicit Route Object. However, there are scenarios where

different nodes perform path computations, and therefore there is a need for relevant diversity constraints to be signaled 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 the core node may perform path computation [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). It facilitates the calculation of diverse paths 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. Employing these mechanisms requires that the source node that initiates signaling knows the relevant properties of the path(s) from which diversity is desired. 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 of the diverse LSP, in which case the addresses of links and SRLGs of the path from which diversity is required are unknown to the source node.

. Exclusion of a path which is known to the source node of the diverse LSP for which the node has incomplete or no path information, e.g. due to operator policy. In this case, the source node is aware of the existence of the reference path but the information required to construct an XRO object to guarantee diversity from the reference path is not fully known. Inter-domain and GMPLS overlay networks can impose such restrictions.

This is exemplified in the Figure 1, where the overlay reference model from [RFC4208] is shown.

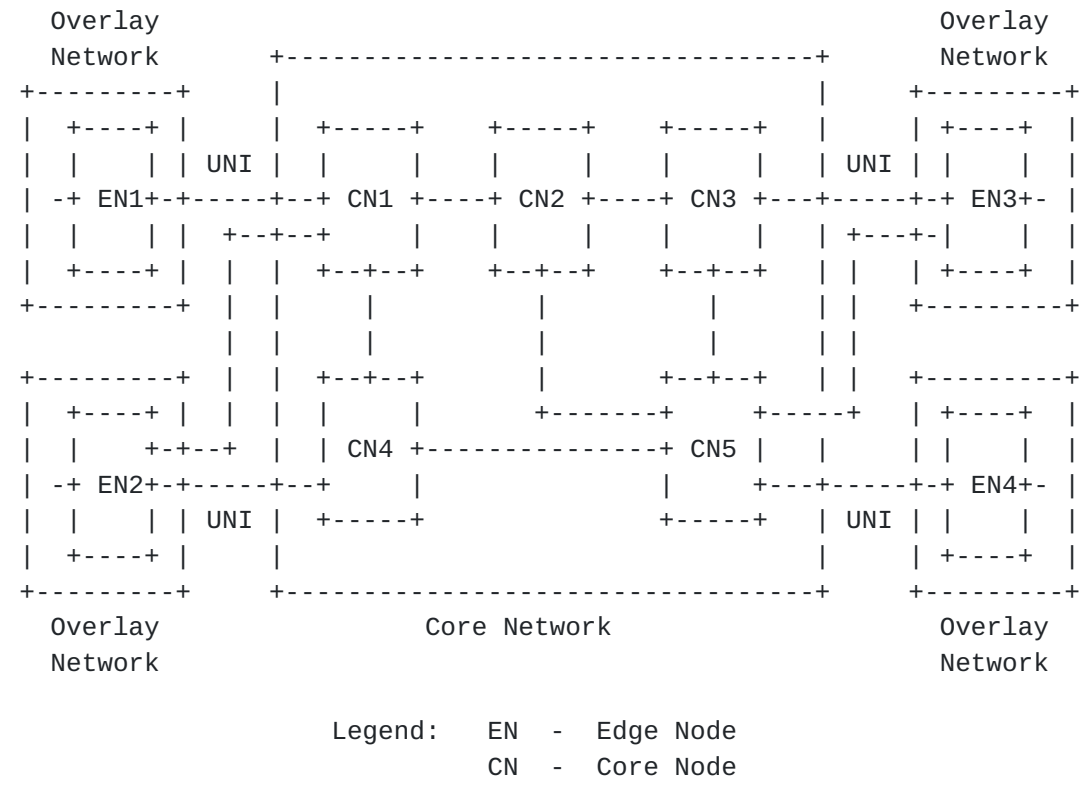


Figure 1: Overlay Reference Model [RFC4208]

Figure 1 depicts two types of UNI connectivity: single-homed and dual-homed ENs (which also applies to higher order multi-homed connectivity.). Single-homed EN devices are connected to a single CN device via a single UNI link. This single UNI link may constitute a single point of failure. UNI connection between EN1 and CN1 is an example of singled-homed UNI connectivity.

A single point of failure caused by a single-homed UNI can be avoided when the EN device is connected to two different CN devices, as depicted for EN2 in Figure 1. For the dual-homing case, it is possible to establish two different UNI connections from the same source EN device to the same destination EN device. For example, two connections from EN2 to EN3 may use the two UNI links EN2-CN1 and EN2-CN4. To avoid single points of failure within the provider network, it is necessary to also ensure path (LSP) diversity within the core network.

In a UNI network such as that shown in Figure 1, the CNs typically perform path computation. Information sharing across the UNI boundary is restricted based on the policy rules imposed by the core network. Typically, the core network topology information is not exposed to the ENs. In the network shown in Figure 1, consider a use case where an LSP from EN2 to EN4 needs to be SRLG diverse from an LSP from EN1 to EN3. In this case, EN2 may not know SRLG attributes of the EN1- EN3 LSP and hence cannot construct an XRO to exclude these SRLGs. In this example EN2 cannot use the procedures described in [RFC4874]. Similarly, an LSP from EN2 to EN3 traversing CN1 needs to be diverse from an LSP from EN2 to EN3 going via CN4. Again in this case, exclusions based on [RFC4874] cannot be used.

This document addresses these diversity requirements by introducing the notion of excluding the path taken by particular LSP(s). The reference LSP(s) or route(s) from which diversity is required is/are identified by an "identifier". The type of identifier to use is highly dependent on the networking deployment scenario; it could be client-initiated, allocated by the (core) network or managed by a PCE. This document defines three different types of identifiers corresponding to these three cases: a client initiated identifier, a PCE allocated Identifier and CN ingress node (UNI-N) allocated Identifier.

1.1. Client-Initiated Identifier

There are scenarios in which the ENs have the following requirements for the diversity identifier:

- The identifier is controlled by the client side and is specified as part of the service request.

- Both client and server understand the identifier.

- It is necessary to be able to reference the identifier even if the LSP referenced by it is not yet signaled.

- The identifier is to be stable for a long period of time.

- The identifier is to be stable even when the referenced LSP is rerouted.

These requirements are met by using the LSP identifier. The LSP identifier uniquely identifies an LSP in the network and comprises of the following fields: IPv4/IPv6 tunnel sender address, IPv4/IPv6 tunnel end point address, Tunnel ID, LSP ID,

and Extended Tunnel ID. These fields are defined in [RFC3209], sections 4.6.1.1 and 4.6.2.1.

The usage of the client-initiated identifier is illustrated by Figure 1. Suppose a LSP from EN2 to EN4 needs to be diverse with respect to a LSP from EN1 to EN3. The LSP identifier of the EN1-EN3 LSP is LSP-IDENTIFIER1, where LSP-IDENTIFIER1 is defined by the tuple (tunnel-id = T1, LSP ID = L1, source address = EN1.ROUTE Identifier (RID), destination address = EN3.RID, extended tunnel-id = EN1.RID). Similarly, LSP identifier of the EN2-EN3 LSP is LSP-IDENTIFIER2, where LSP-IDENTIFIER12 is defined by the tuple (tunnel-id = T2, LSP IS = L1, source address = EN2.RID, destination address = EN4.RID, extended tunnel-id = EN2.RID). The EN1-EN3 LSP is signaled with an exclusion requirement from LSP-IDENTIFIER2, and the EN2-EN3 LSP is signaled with an exclusion requirement from LSP-IDENTIFIER1. In order to maintain diversity between these two connections within the core network, it is assumed that the core network implements Crankback Signaling [RFC4920]. Note that crankback signaling is known to lead to slower setup times and sub-optimal paths under some circumstances as described by [RFC4920].

1.2. PCE-allocated Identifier

In scenarios where a PCE is deployed and used to perform path computation, the core edge node (e.g., node CN1 in Figure 1) could consult a PCE to allocate identifiers, which are used to signal path diversity constraints. In other scenarios a PCE is deployed at network node(s) or a PCE is part of a Network Management System (NMS). In all these cases, the Path Key as defined in [RFC5520] can be used in RSVP signaling as the identifier to ensure diversity.

An example of specifying LSP diversity using a Path Key is shown in Figure 2, where a simple network with two domains is shown. It is desired to set up a pair of path-disjoint LSPs from the source in Domain 1 to the destination in Domain 2, but the domains keep strict confidentiality about all path and topology information.

The first LSP is signaled by the source with ERO {A, B, loose Dst} and is set up with the path {Src, A, B, U, V, W, Dst}. However, when sending the RRO out of Domain 2, node U would normally strip the path and replace it with a loose hop to the destination. With this limited information, the source is unable to include enough detail in the ERO of the second LSP to avoid it taking, for example, the path {Src, C, D, X, V, W, Dst} for path-disjointness.

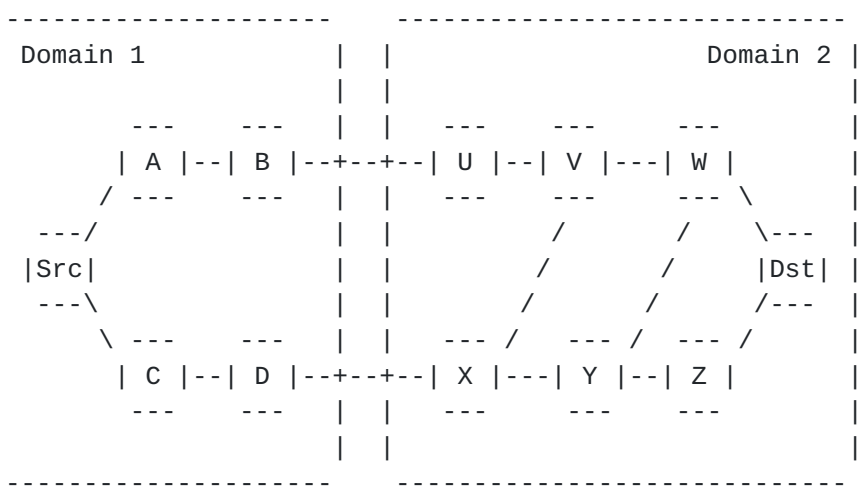


Figure 2: A Simple Multi-Domain Network

In order to improve the situation, node U performs the PCE function and replaces the path segment {U, V, W} in the RRO with a Path Key subobject. The Path Key subobject assigns an "identifier" to the key. The PCE ID in the message indicates that it was node U that made the replacement.

With this additional information, the source is able to signal the subsequent LSPs with the ERO set to {C, D, exclude Path Key(EXRS), loose Dst}. When the signaling message reaches node X, it can consult node U to expand the Path Key and know how to avoid the path of the first LSP. Alternatively, the source could use an ERO of {C, D, loose Dst} and include an XRO containing the Path Key.

This mechanism can work with all the Path-Key resolution mechanisms, as detailed in [RFC5553] section 3.1. A PCE, co-located or not, may be used to resolve the Path-Key, but the node (i.e., a Label Switching Router (LSR)) can also use the Path Key information to index a Path Segment previously supplied to it by the entity that originated the Path-Key, for example the LSR that inserted the Path-Key in the RRO or a management system.

1.3. Network-Assigned Identifier

There are scenarios in which the network provides diversity-related information for a service that allows the client device to include this information in the signaling message. If the Shared Resource Link Group (SRLG) identifier information is both available and shareable (by policy) with the ENs, the procedure

defined in [RFC8001] can be used to collect SRLG identifiers associated with an LSP (LSP1). When a second LSP (LSP2) needs to be diverse with respect to LSP1, the EN constructing the RSVP signaling message for setting up LSP2 can insert the SRLG identifiers associated with LSP1 as diversity constraints into the XRO using the procedure described in [RFC4874]. However, if the core network SRLG identifiers are either not available or not shareable with the ENs based on policies enforced by core network, existing mechanisms cannot be used.

In this draft, a signaling mechanism is defined where information signaled to the CN via the UNI does not require shared knowledge of core network SRLG information. For this purpose, the concept of a Path Affinity Set (PAS) is defined for abstracting SRLG information. The motive behind the introduction of the PAS is to minimize the exchange of diversity information between the core network (CNs) and the client devices (ENs). The PAS contains an abstract SRLG identifier associated with a given path rather than a detailed SRLG list. The PAS is a single identifier that can be used to request diversity and associate diversity. The means by which the processing node determines the path corresponding to the PAS is beyond the scope of this document.

A CN on the core network boundary interprets the specific PAS identifier (e.g. "123") as meaning to exclude the core network SRLG information (or equivalent) that has been allocated by LSPs associated with this PAS identifier value. For example, if a Path exists for the LSP with the identifier "123", the CN would use local knowledge of the core network SRLGs associated with the "123" LSPs and use those SRLGs as constraints for path computation. If a PAS identifier is included for exclusion in the connection request, the CN (UNI-N) in the core network is assumed to be able to determine the existing core network SRLG information and calculate a path that meets the determined diversity constraints.

When a CN satisfies a connection setup for a (SRLG) diverse signaled path, the CN may optionally record the core network SRLG information for that connection in terms of CN based parameters and associates that with the EN addresses in the Path message. Specifically, for Layer-1 Virtual Private Networks (L1VPNs), Port Information Tables (PIT) [RFC5251] can be leveraged to translate between client (EN) addresses and core network addresses.

The means to distribute the PAS information within the core network is beyond the scope of this document. For example, the PAS and the associated SRLG information can be distributed within

the core network by an Interior Gateway Protocol (IGP) or by other means such as configuration. Regardless of means used to distribute the PAS information, the information is kept inside core network and is not shared with the overlay network (see Figure 1).

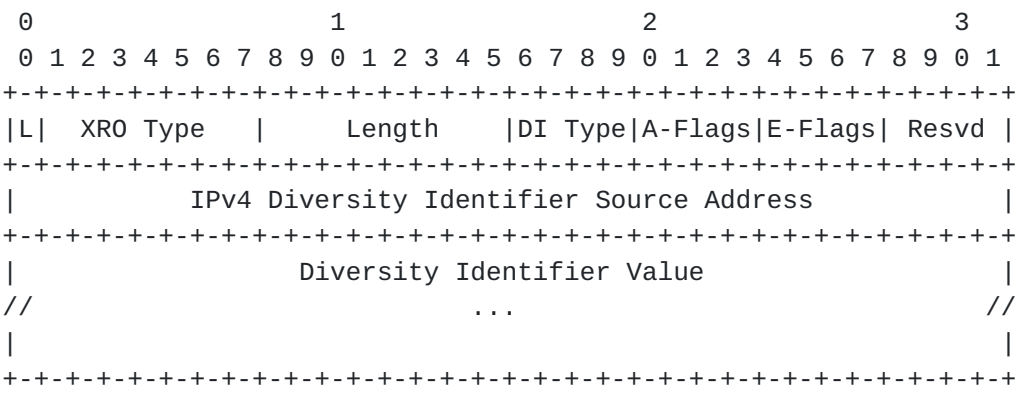
2. RSVP-TE signaling extensions

This section describes the signaling extensions required to address the aforementioned requirements and use cases.

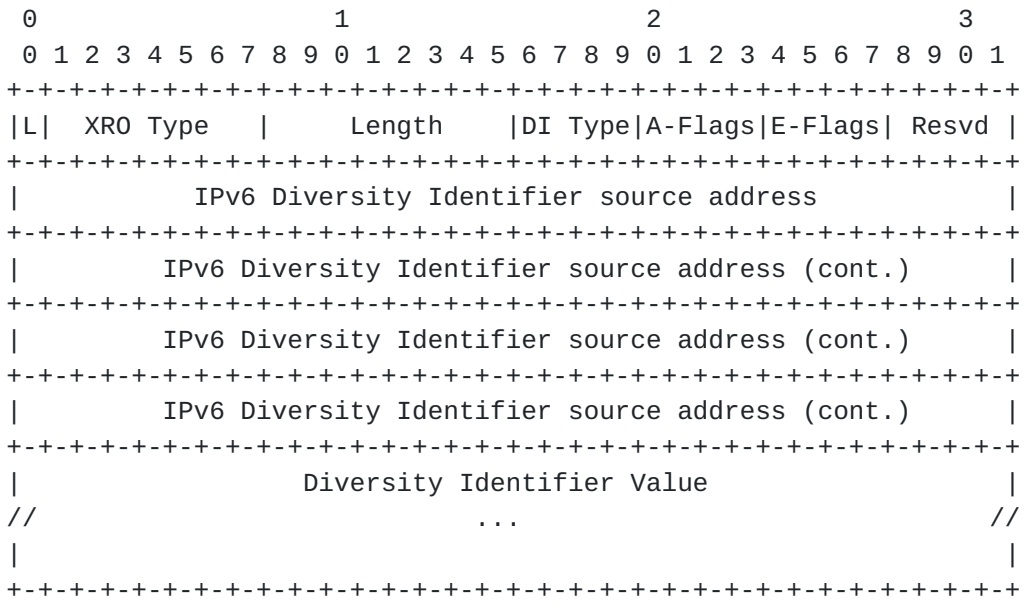
2.1. Diversity XRO Subobject

New Diversity XRO subobjects are defined below for the IPv4 and IPv6 address families. Most of the fields in the IPv4 and IPv6 Diversity XRO subobjects are common and are described following the definition of the two subobjects.

IPv4 Diversity XRO subobject is defined as follows:



Similarly, the IPv6 Diversity XRO subobject is defined as follows:



L:

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

0 indicates that the attribute specified MUST be excluded.

1 indicates that the attribute specified SHOULD be avoided.

XRO Type

The value is set to TBA1 for the IPv4 diversity XRO subobject (value to be assigned by IANA). Similarly, the value is set to TBA2 for the IPv6 diversity XRO subobject (value to be assigned by IANA).

Length

Per [RFC4874], the Length contains the total length of the IPv4/ IPv6 subobject in bytes, including the Type and

Length fields. The Length is variable, depending on the diversity identifier value.

Diversity Identifier Type (DI Type)

Diversity Identifier Type (DI Type) indicates the way the reference LSP(s) or route(s) with which diversity is required is identified in the IPv4/ IPv6 Diversity subobjects. The following three DI type values are defined in this document:

DI Type value	Definition
1	Client Initiated Identifier
2	PCE Allocated Identifier
3	Network Assigned Identifier

Attribute Flags (A-Flags):

The Attribute Flags (A-Flags) are used to communicate desirable attributes of the LSP being signaled in the IPv4/ IPv6 Diversity subobjects. The following flags are defined. Each flag acts independently. Any combination of flags is permitted.

0x01 = Destination node exception

Indicates that the exclusion does not apply to the destination node of the LSP being signaled.

0x02 = Processing node exception

Indicates that the exclusion does not apply to the node(s) performing ERO expansion for the LSP being signaled. An ingress UNI-N node is an example of such a node.

0x04 = Penultimate node exception

Indicates that the penultimate node of the LSP being signaled MAY be shared with the excluded path even when this violates the exclusion flags.

0x08 = LSP ID to be ignored

This flag is used to indicate tunnel level exclusion. Specifically, this flag is used to indicate that if diversity identifier contains lsp-id field, the lsp-id is to be ignored and the exclusion applies to any LSP matching the rest of the diversity identifier.

Exclusion Flags (E-Flags):

The Exclusion-Flags are used to communicate the desired type(s) of exclusion requested in the IPv4/ IPv6 diversity subobjects. The following flags are defined. Any combination of these flags is permitted. Please note that the exclusion specified by these flags may be modified by the value of the Attribute-flags. For example, node exclusion flag is ignored for the "Penultimate node" if the "Penultimate node exception" flag of the Attribute-flags is set.

0x01 = SRLG exclusion

Indicates that the path of the LSP being signaled is requested to be SRLG-diverse from the excluded path specified by the IPv4/ IPv6 Diversity XRO subobject.

0x02 = Node exclusion

Indicates that the path of the LSP being signaled is requested to be node-diverse from the excluded path specified by the IPv4/ IPv6 Diversity XRO subobject.

0x04 = Link exclusion

Indicates that the path of the LSP being signaled is requested to be link-diverse from the path specified by the IPv4/ IPv6 Diversity XRO subobject.

Resvd

This field is reserved. It MUST be set to zero on transmission, and MUST be ignored on receipt for both IPv4/ IPv6 Diversity XRO subobjects.

IPv4 / IPv6 Diversity Identifier source address:

This field MUST be set to the IPv4/ IPv6 address of the node that assigns the diversity identifier. Depending on the diversity identifier type, the diversity identifier source may be a client node, PCE entity or network node. Specifically:

- When the diversity identifier type is set to "IPv4/ IPv6 Client Initiated Identifier", the value MUST be set to IPv4/ IPv6 tunnel sender address of the reference LSP against which diversity is desired. IPv4/ IPv6 tunnel sender address is as defined in [RFC3209].

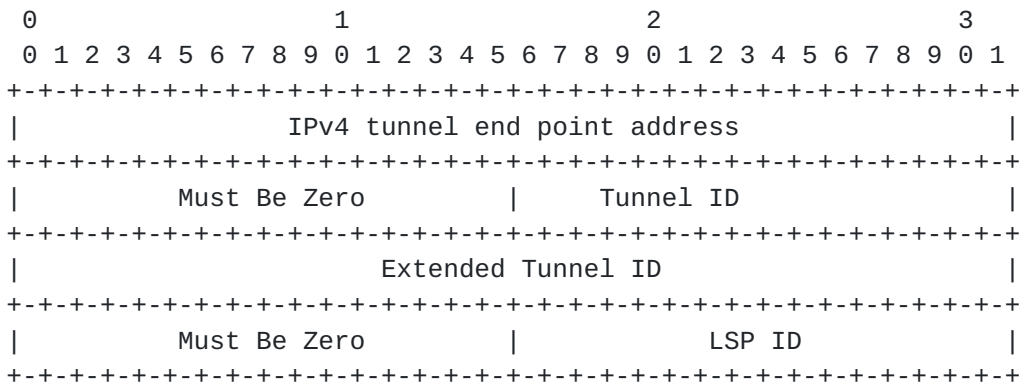
- When the diversity identifier type is set to "IPv4/ IPv6 PCE Allocated Identifier", the value MUST be set to the IPv4/ IPv6 address of the node that assigned the Path Key identifier and that can return an expansion of the Path Key or use the Path Key as exclusion in a path computation. The Path Key is defined in [RFC5553]. The PCE-ID is carried in the Identifier Source Address field of the subobject.

- When the diversity identifier type is set to "IPv4/ IPv6 Network Assigned Identifier", the value MUST be set to the IPv4/ IPv6 address of the node publishing the Path Affinity Set (PAS).

Diversity Identifier Value:

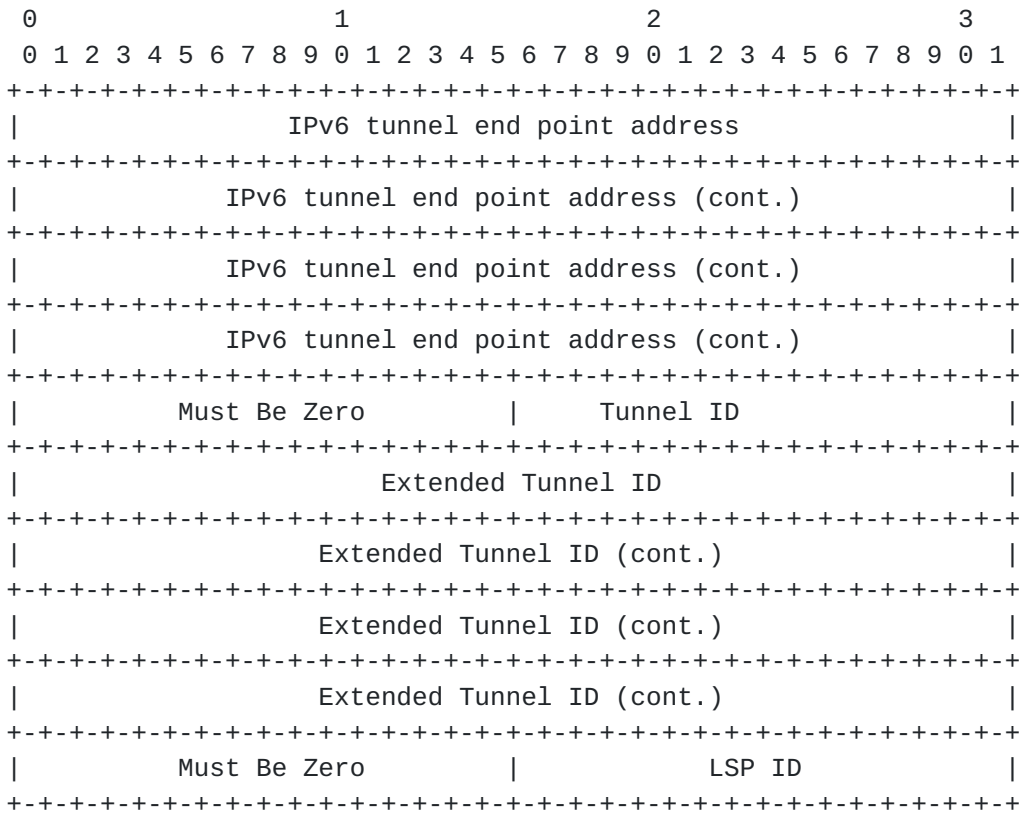
Encoding for this field depends on the diversity identifier type, as defined in the following.

When the diversity identifier type is set to "Client Initiated Identifier" in IPv4 Diversity XRO subobject, the diversity identifier value MUST be encoded as follows:



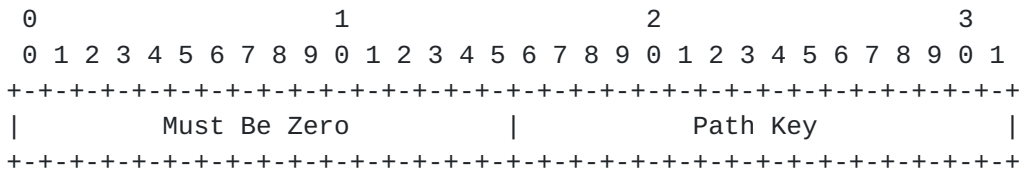
The IPv4 tunnel end point address, Tunnel ID, Extended Tunnel ID and LSP ID are as defined in [RFC3209].

When the diversity identifier type is set to "IPv6 Client Initiated Identifier" in IPv6 Diversity XRO subobject, the diversity identifier value MUST be encoded as follows:



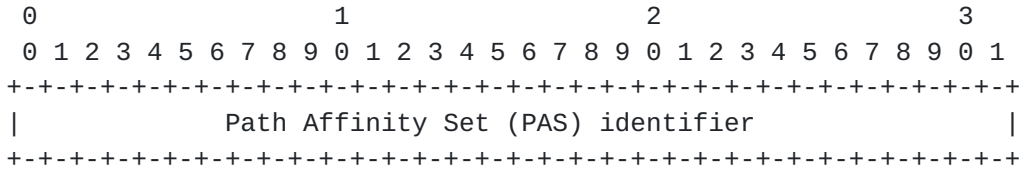
The IPv6 tunnel end point address, Tunnel ID, IPv6 Extended Tunnel ID and LSP ID are as defined in [RFC3209].

When the diversity identifier type is set to "PCE Allocated Identifier" in IPv4 or IPv6 Diversity XRO subobject, the diversity identifier value MUST be encoded as follows:



The Path Key is defined in [RFC5553].

When the diversity identifier type is set to "Network Assigned Identifier" in IPv4 or IPv6 Diversity XRO subobject, the diversity identifier value MUST be encoded as follows:



The Path Affinity Set (PAS) identifier field is a 32-bit value that is scoped by, i.e., is only meaningful when used in combination with, the Diversity Identifier source address field. There are no restrictions on how a node selects a PAS identifier value. Section 1.3 defines the PAS term and provides context on how values may be selected.

2.2. Diversity 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 Diversity subobject as specified in this document. The same type values TBA1 and TBA2 SHALL be used.

2.3. Processing rules for the Diversity XRO and EXRS subobjects

The procedure defined in [RFC4874] for processing the XRO and EXRS is not changed by this document. The processing rules for the Diversity XRO and EXRS subobjects are similar unless the differences are explicitly described. Similarly, IPv4 and IPv6 Diversity XRO subobjects and IPv4 and IPv6 Diversity EXRS subobjects follow the same processing rules.

If the processing node cannot recognize the Diversity XRO/ EXRS subobject, the node is expected to follow the procedure defined in [RFC4874].

An XRO/ EXRS object MAY contain multiple Diversity subobjects of the same DI Type. E.g., in order to exclude multiple Path Keys, a node MAY include multiple Diversity XRO subobjects each with a different Path Key. Similarly, in order to exclude the routes taken by multiple LSPs, a node MAY include multiple Diversity XRO/ EXRS subobjects each with a different LSP identifier. Likewise, to exclude multiple PAS identifiers, a node MAY include multiple Diversity XRO/ EXRS subobjects each with a different PAS identifier. However, all Diversity subobjects in an XRO/ EXRS MUST contain the same Diversity Identifier Type. If a Path message contains an XRO/ EXRS with multiple Diversity subobjects of different DI Types, the processing node MUST return a PathErr with the error code "Routing Problem" (24) and error sub-code "XRO/ EXRS Too Complex" (68/ 69).

If the processing node recognize the Diversity XRO/ EXRS subobject but does not support the DI type, it MUST return a PathErr with the error code TBA3 "Routing Problem" and error value of "Unsupported Diversity Identifier Type".

The nodes in the domain that perform path computation SHOULD process the diversity information signaled in the XRO/ EXRS Diversity subobjects. The transit nodes in a domain and the domain egress node SHOULD NOT process the signaled diversity information. While processing EXRS object, 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 attribute-flags affect the processing of the Diversity XRO/ EXRS subobject as follows:

- o When the "processing node exception" flag is set, the exclusion MUST be ignored for the node processing the XRO or EXRS subobject.

- o When the "destination node exception" flag is set, the exclusion MUST be ignored for the destination node in processing the XRO subobject. The destination node exception for the EXRS subobject applies to the explicit node identified by the ERO subobject that identifies the next abstract node. When the "destination node exception" flag is set in the EXRS subobject, exclusion MUST be ignored for the said node (i.e., the next abstract node).

- o When the "penultimate node exception" flag is set in the XRO subobject, the exclusion MUST be ignored for the penultimate node on the path of the LSP being established. 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. When the "penultimate node exception" flag is set in the EXRS subobject, the exclusion MUST be ignored for the said node (i.e., the node before the next abstract node).

If the L-flag of the diversity XRO subobject or diversity EXRS subobject is not set, the processing node proceeds as follows.

- If the Diversity Identifier Type is set to "IPv4/IPv6 Client Initiated Identifiers", the processing node MUST ensure that the path calculated/ expended for the signaled LSP is diverse from the route taken by the LSP identified in the Diversity Identifier Value field.

- If the Diversity Identifier Type is set to "IPv4/IPv6 PCE Allocated Identifiers", the processing node MUST ensure that any path calculated for the signaled LSP is diverse from the route identified by the Path-Key. The processing node MAY use the PCE identified by the IPv4/IPv6 Diversity Identifier Source Address in the subobject for route computation. The processing node MAY use the Path-Key resolution mechanisms described in [RFC5553].

- If the Diversity Identifier Type is set to "IPv4/IPv6 Network Assigned Identifiers", the processing node MUST ensure that the path calculated for the signaled LSP is diverse with respect to

the values associated with the PAS identifier and Diversity Identifier source address fields.

- Regardless of whether the path computation is performed locally or at a remote node (e.g., PCE), the processing node MUST ensure that any path calculated for the signaled LSP is diverse from the requested Exclusion Flags.

- If the excluded path referenced in the XRO subobject is unknown to the processing node, the processing node SHOULD ignore the diversity XRO subobject and SHOULD proceed with the signaling request. After sending the Resv for the signaled LSP, the processing node MUST return a PathErr with the error code "Notify Error" (25) and error sub-code TBA4 "Route of XRO LSP identifier unknown" (value to be assigned by IANA) for the signaled LSP.

- If the processing node fails to find a path 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 L-flag of the XRO diversity subobject or EXRS diversity subobject is set, the processing node proceeds as follows:

- If the Diversity Identifier Type is set to "IPv4/IPv6 Client Initiated Identifiers", the processing node SHOULD ensure that the path calculated/ expended for the signaled LSP is diverse from the route taken by the LSP identified in the Diversity Identifier Value field.

- If the Diversity Identifier Type is set to "IPv4/IPv6 PCE Allocated Identifiers", the processing node SHOULD ensure that the path calculated for the signaled LSP is diverse from the route identified by the Path-Key.

- If the Diversity Identifier Type is set to "IPv4/IPv6 Network Assigned Identifiers", the processing node SHOULD ensure that the path calculated for the signaled LSP is diverse with respect to the values associated with the PAS identifier and Diversity Identifier source address fields.

- If the processing node fails to find a path that meets the requested constraint, it SHOULD proceed with signaling using a suitable path that meets the constraint as far as possible. After sending the Resv for the signaled LSP, it MUST return a PathErr message with error code "Notify Error" (25) and error

sub-code TBA5 "Failed to satisfy Exclude Route" (value: to be assigned by IANA) to the source node.

If, subsequent to the initial signaling of a diverse LSP, an excluded path referenced in the XRO subobject becomes known to the processing node, or a change in the excluded path becomes known to the processing node, the processing node MUST re-evaluate the exclusion and diversity constraints requested by the diverse LSP to determine whether they are still satisfied.

If, subsequent to the initial signaling of a diverse LSP, the requested exclusion constraints for the diverse LSP are no longer satisfied and an alternative path for the diverse LSP that can satisfy those constraints exists, then:

- 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 Path_State_Removed flag (PSR) [RFC3473] MUST NOT be set. A source node receiving a PathErr message with this error code and sub-code combination SHOULD take appropriate actions to migrate to a compliant path.

- If the L-flag was set in the original exclusion, the processing node MUST send a PathErr message for the diverse LSP with the error code "Notify Error" (25) and a new error sub-code TBA6 "Compliant path exists" (value: to be assigned by IANA). The PSR flag MUST NOT be set. A source node receiving a PathErr message with this error code and sub-code combination MAY signal a new LSP to migrate the compliant path.

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

- 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 MUST be set.

- If the L-flag was set in the original exclusion, the processing node MUST send a PathErr message for the diverse LSP with the error code error code "Notify Error" (25) and error sub-code TBA5 "Failed to satisfy Exclude Route" (value: to be assigned by IANA). The PSR flag MUST NOT be set. The source

node MAY take no action and keep the LSP along the non-compliant path.

3. Security Considerations

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

The diversity mechanism defined in this document, relies on the new diversity subobject that is carried in the XRO or EXRS, respectively. In section 7 of [RFC4874], it is stated that the XRO could be considered for removal from the Path message due to security concerns for example at administrative boundaries. In this case, the diversity subobject would also be removed. Hence, the diversity subobject must be kept while other subobjects may be removed.

4. IANA Considerations

IANA is requested to administer the assignment of new values defined in this document and summarized in this section.

4.1. New XRO subobject types

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

This document defines two new subobjects for the EXCLUDE_ROUTE object [RFC4874], C-Type 1. (see: http://www.iana.org/assignments/rsvp-parameters/rsvp-parameters.xhtml#rsvp-parameters-94)

Subobject Description	Subobject Type
IPv4 Diversity subobject	TBA1
IPv6 Diversity subobject	TBA2

4.2. New EXRS subobject types

The diversity XRO subobjects are also defined as new EXRS subobjects. (EXPLICIT_ROUTE see: http://www.iana.org/assignments/rsvp-parameters/rsvp-parameters.xhtml#rsvp-parameters-24). The same numeric subobject type values TBA1 and TBA2 are being requested for the two 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 "Routing Problem" (24) (see [RFC3209]) the following sub-codes are defined. (see: http://www.iana.org/assignments/rsvp-parameters/rsvp-parameters.xhtml#rsvp-parameters-105)

Error Value Sub-codes	Description	Reference
TBA3	Unsupported Diversity Identifier Type	This document

For Error Code "Notify Error" (25) (see [RFC3209]) the following sub-codes are defined. (see: http://www.iana.org/assignments/rsvp-parameters/rsvp-parameters.xhtml#rsvp-parameters-105)

Error Value Sub-codes	Description	Reference
TBA4	Route of XRO LSP identifier unknown	This document
TBA5	Failed to satisfy Exclude Route	This document
TBA6	Compliant path exists	This document

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6. References

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