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Usage of the RSVP ASSOCIATION Object

Abstract

The Resource Reservation Protocol (RSVP) ASSOCIATION object is defined in the context of GMPLS-controlled label switched paths (LSPs). In this context, the object is used to associate recovery LSPs with the LSP they are protecting. This document reviews how the association is to be provided in the context of GMPLS recovery. No new procedures or mechanisms are defined by this document, and it is strictly informative in nature.

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1. Introduction

End-to-end and segment recovery are defined for GMPLS-controlled label switched paths (LSPs) in [RFC4872] and [RFC4873], respectively. Both definitions use the ASSOCIATION object to associate recovery LSPs with the LSP they are protecting. This document provides additional narrative on how such associations are to be identified. This document does not define any new procedures or mechanisms and is strictly informative in nature.

It may not be immediately obvious to the informed reader why this document is necessary; however, questions were repeatedly raised in the Common Control and Measurement Plane (CCAMP) working group on the proper interpretation of the ASSOCIATION object in the context of end-to-end and segment recovery, and the working group agreed that this document should be produced in order to close the matter. This document formalizes the explanation provided in an e-mail to the working group authored by Adrian Farrel, see [AF-EMAIL]. This document in no way modifies the normative definitions of end-to-end and segment recovery, see [RFC4872] or [RFC4873].

2. Background

This section reviews the definition of LSP association in the contexts of end-to-end and segment recovery as defined in [RFC4872] and [RFC4873]. This section merely reiterates what has been defined; if differences exist between this text and [RFC4872] or [RFC4873], the earlier RFCs provide the authoritative text.

2.1. LSP Association

[RFC4872] introduces the concept and mechanisms to support the association of one LSP to another LSP across different RSVP - Traffic Engineering (RSVP-TE) sessions. Such association is enabled via the introduction of the ASSOCIATION object. The ASSOCIATION object is defined in Section 16 of [RFC4872]. It is explicitly defined as having both general application and specific use within the context of recovery. End-to-end recovery usage is defined in [RFC4872] and is covered in Section 2.2 of this document. Segment recovery usage is defined in [RFC4873] and is covered in Section 2.3 of this document. Resource sharing type LSP association is also defined in [RFC4873]. While strictly speaking, such association is beyond the scope of this document, it is covered in Section 2.4 of this document for completeness. The remainder of this section covers generic usage of the ASSOCIATION object.

In general, LSP association using the ASSOCIATION object can take place based on the values carried in the ASSOCIATION object. This means that association between LSPs can take place independently of and across different sessions. This is a significant enhancement from the association of LSPs that is possible in base MPLS [RFC3209] and GMPLS [RFC3473].

When using the ASSOCIATION object, LSP association is always initiated by an upstream node that inserts appropriate ASSOCIATION objects in the Path message of LSPs that are to be associated. Downstream nodes then correlate LSPs based on received ASSOCIATION objects. Multiple types of LSP association are supported by the ASSOCIATION object, and downstream correlation is made based on the type.

[RFC4872] defines Class Types (C-Types) 1 and 2 of the ASSOCIATION object. Both objects have essentially the same semantics, only differing in the type of address carried (IPv4 and IPv6). The defined objects carry multiple fields. The fields, taken together, enable the identification of which LSPs are in association with one another. The [RFC4872]-defined fields are:

- Association Type:
  This field identifies the usage, or application, of the ASSOCIATION object. The currently defined values are "Recovery" [RFC4872] and "Resource Sharing" [RFC4873]. This field also scopes the interpretation of the object. In other words, the type field is included when matching LSPs (i.e., the type fields must match), and the way associations are identified may be type dependent.

- Association Source:
  This field is used to provide global scope (within the address space) to the identified association. There are no specific rules in the general case for which an address should be used by a node creating an ASSOCIATION object beyond that the address is "associated to the node that originated the association", see [RFC4872].

- Association ID:
  This field provides an "identifier" that further scopes an association. Again, this field is combined with the other ASSOCIATION object fields to support identification of associated LSPs. The generic definition does not provide any specific rules on how matching is to be done, so such rules are governed by the Association Type. Note that the definition permits the association of an arbitrary number of LSPs.

As defined, the ASSOCIATION object may only be carried in a Path message, so LSP association takes place based on the Path state. The definition permits one or more objects to be present. The support for multiple objects enables an LSP to be associated with other LSPs in more than one way at a time. For example, an LSP may carry one ASSOCIATION object to associate the LSP with another LSP for end-to-end recovery, and at the same time carry a second ASSOCIATION object to associate the LSP with another LSP for segment recovery, and at the same time carry a third ASSOCIATION object to associate the LSP with yet another LSP for resource sharing.

2.2. End-to-End Recovery LSP Association

The association of LSPs in support of end-to-end LSP recovery is defined in Section 16.2 of [RFC4872]. There are also several additional related conformance statements (i.e., use of [RFC2119] defined key words) in Sections 7.3, 8.3, 9.3, and 11.1 of [RFC4872]. When analyzing the definition, as with any Standards Track RFC, it is critical to note and differentiate which statements are made using [RFC2119] defined key words, which relate to conformance, and which statements are made without such key words, and are thereby only informative in nature.

As defined in Section 16.2, end-to-end recovery-related LSP association may take place in two distinct forms:

a. Between multiple (one or more) working LSPs and a single shared (associated) recovery LSP. This form essentially matches the shared 1:N (N >= 1) recovery type described in the other sections of [RFC4872].

b. Between a single working LSP and multiple (one or more) recovery LSPs. This form essentially matches all other recovery types described in [RFC4872].

Both forms share the same Association Type (Recovery) and the same Association Source (the working LSP's tunnel sender address). They also share the same definition of the Association ID, which is (quoting [RFC4872]):

> The Association ID MUST be set to the LSP ID of the LSP being protected by this LSP or the LSP protecting this LSP. If unknown, this value is set to its own signaled LSP_ID value (default). Also, the value of the Association ID MAY change during the lifetime of the LSP.

The interpretation of the above is fairly straightforward. The Association ID carries one of three values:

- The LSP ID of the LSP being protected.
- The LSP ID of the protection LSP.
- In the case where the matching LSP is not yet known (i.e., initiated), the LSP ID value of the LSP itself.

The text also explicitly allows for changing the Association ID during the lifetime of an LSP. However, this is only an option, and is neither required (i.e., "MUST") nor recommended (i.e., "SHOULD"). It should be noted that [RFC4872] does not describe when such a change should be initiated or the procedures for executing such a change. Clearly, care needs to be taken when changing the Association ID to ensure that the old association is not lost during the transition to a new association.

The text does not preclude, and it is therefore assumed, that one or more ASSOCIATION objects may also be added to an LSP that was originated without any ASSOCIATION objects. Again, this is a case that is not explicitly discussed in [RFC4872].

From the above, this means that the following combinations may occur:

Case 1. When the ASSOCIATION object of the LSP being protected is initialized before the ASSOCIATION objects of any recovery LSPs are initialized, the Association ID in the LSP being protected and any recovery LSPs will carry the same value, and this value will be the LSP ID value of the LSP being protected.

Case 2. When the ASSOCIATION object of a recovery LSP is initialized before the ASSOCIATION object of any protected LSP is initialized, the Association ID in the recovery LSP and any LSPs being protected by that LSP will carry the same value, and this value will be the LSP ID value of the recovery LSP.

Case 3. When the ASSOCIATION objects of both the LSP being protected and the recovery LSP are concurrently initialized, the value of the Association ID carried in the LSP being protected is the LSP ID value of the recovery LSP, and the value of the Association ID carried in the recovery LSP is the LSP ID value of the LSP being protected. As this case can only be applied to LSPs with matching tunnel sender addresses, the scope of this case is limited to end-to-end recovery. Note that this is implicit in [RFC4872], as its scope is limited to end-to-end recovery.

In practical terms, Case 2 will only occur when using the shared 1:N (N >= 1) end-to-end recovery type, and Case 1 will occur with all other end-to-end recovery types. Case 3 is allowed, and it is subject to interpretation as to how often it will occur. Some believe that this will be the common case and, furthermore, that working and recovery LSPs will often first be initiated without any ASSOCIATION objects, and then Case 3 objects will be added once the LSPs are established. Others believe that Case 3 will rarely, if ever occur. Such perspectives have little impact on interoperability, as an [RFC4872]-compliant implementation needs to properly handle (identify associations for) all three cases.

It is important to note that Section 16.2 of [RFC4872] provides no further requirements on how or when the Association ID value is to be selected. The other sections of the document do provide further narrative and three additional requirements. In general, the narrative highlights Case 3 identified above but does not preclude the other cases. The three additional requirements are, by [RFC4872] section number:

- Section 7.3 -- "The Association ID MUST be set by default to the LSP ID of the protected LSP corresponding to N = 1."

  When considering this statement together with the three cases enumerated above, it can be seen that this statement clarifies which LSP ID value should be used when a single shared protection LSP is established simultaneously with Case 3, or after Case 2, and with more than one LSP to be protected.

- Section 8.3 -- "Secondary protecting LSPs are signaled by setting in the new PROTECTION object the S bit and the P bit to 1, and in the ASSOCIATION object, the Association ID to the associated primary working LSP_ID, which MUST be known before signaling of the secondary LSP."

  This requirement clarifies that when using the "Rerouting without Extra-Traffic" type of recovery, it is required to follow either Case 1 or 3, but not 2, as enumerated above.

- Section 9.3 -- "Secondary protecting LSPs are signaled by setting in the new PROTECTION object the S bit and the P bit to 1, and in the ASSOCIATION object, the Association ID to the associated primary working LSP_ID, which MUST be known before signaling of the secondary LSP."

  This requirement clarifies that when using the "Shared-Mesh Restoration" type of recovery, it is required to follow either Case 1 or 3, but not 2, as enumerated above.

- Section 11.1 -- "In both cases, the Association ID of the ASSOCIATION object MUST be set to the LSP ID value of the signaled LSP."

  This requirement clarifies that when using the "LSP Rerouting" type of recovery, it is required to follow either Case 1 or 3, but not 2, as enumerated above.

2.3. Segment Recovery LSP Association

GMPLS segment recovery is defined in [RFC4873]. Segment recovery reuses the LSP association mechanisms, including the Association Type field value, defined in [RFC4872]. The primary text to this effect in [RFC4873] is:

> 3.2.1. Recovery Type Processing
>
> Recovery type processing procedures are the same as those defined in [RFC4872], but processing and identification occur with respect to segment recovery LSPs. Note that this means that multiple ASSOCIATION objects of type recovery may be present on an LSP.

This statement means that Case 2, as enumerated above, is to be followed; furthermore, the Association Source is set to the tunnel sender address of the segment recovery LSPs. The explicit exclusion of Case 3 is not listed, as its non-applicability is considered

obvious to the informed reader. (Perhaps having this exclusion explicitly identified would have obviated the need for this document.)

2.4. Resource Sharing LSP Association

Section 3.2.2 of [RFC4873] defines an additional type of LSP association that is used for "Resource Sharing". Resource sharing enables the sharing of resources across LSPs with different SESSION objects. Without this object, only sharing across LSPs with a shared SESSION object is possible, see [RFC3209].

Resource sharing is indicated using a new Association Type value. As the Association Type field value is not the same as what is used in recovery type LSP association, the semantics used for the association of LSPs using an ASSOCIATION object containing the new type differs from recovery type LSP association.

Section 3.2.2 of [RFC4873] states the following rules for the construction of an ASSOCIATION object in support of resource sharing type LSP association:

- The Association Type value is set to "Resource Sharing".
- Association Source is set to the originating node’s router address.
- The Association ID is set to a value that uniquely identifies the set of LSPs to be associated.

  The setting of the Association ID value to the working LSP’s LSP ID value is mentioned, but using the "MAY" key word. Per [RFC2119], this translates to the use of the LSP ID value as being completely optional and that the choice of Association ID is truly up to the originating node.

Additionally, the identical ASSOCIATION object is used for all LSPs that should be associated using Resource Sharing. This differs from recovery type LSP association where it is possible for the LSPs to carry different Association ID fields and still be associated (see Case 3 in Section 2.2).

3. Association of GMPLS Recovery LSPs

The previous section reviews the construction of an ASSOCIATION object, including the selection of the value used in the Association ID field, as defined in [RFC4872] and [RFC4873]. This section reviews how a downstream receiver identifies that one LSP is

associated within another LSP based on ASSOCIATION objects. Note that this section in no way modifies the normative definitions of end-to-end and segment recovery, see [RFC4872] or [RFC4873].

As the ASSOCIATION object is only carried in Path messages, such identification only takes place based on Path state. In order to support the identification of the recovery type association between LSPs, a downstream receiver needs to be able to handle all three cases identified in Section 2.2. Cases 1 and 2 are simple, as the associated LSPs will carry the identical ASSOCIATION object. This is also always true for resource sharing type LSP association, see Section 2.4. Case 3 is more complicated, as it is possible for the LSPs to carry different Association ID fields and still be associated. The receiver also needs to allow for changes in the set of ASSOCIATION objects included in an LSP.

Based on the [RFC4872] and [RFC4873] definitions related to the ASSOCIATION object, the following behavior can be followed to ensure that a receiver always properly identifies the association between LSPs:

- Covering Cases 1 and 2 and resource sharing type LSP association:

  For ASSOCIATION objects with the Association Type field values of "Recovery" (1) and "Resource Sharing" (2), the association between LSPs is identified by comparing all fields of each of the ASSOCIATION objects carried in the Path messages associated with each LSP. An association is deemed to exist when the same values are carried in all fields of an ASSOCIATION object carried in each LSP's Path message. As more than one association may exist (e.g., in support of different association types or end-to-end and segment recovery), all carried ASSOCIATION objects need to be examined.

- Covering Case 3:

  Any ASSOCIATION object with the Association Type field value of "Recovery" (1) that does not yield an association in the prior comparison needs to be checked to see if a Case 3 association is indicated. As this case only applies to end-to-end recovery, the first step is to locate any other LSPs with the identical SESSION object fields and the identical tunnel sender address fields as the LSP carrying the ASSOCIATION object. If such LSPs exist, a case 3 association is identified by comparing the value of the Association ID field with the LSP ID field of the other LSP. If the values are identical, then an end-to-end recovery association exists. As this behavior only applies to

end-to-end recovery, this check need only be performed at the egress.

No additional behavior is needed in order to support changes in the set of ASSOCIATION objects included in an LSP, as long as the change represents either a new association or a change in identifiers made as described in Section 2.2.

4. Security Considerations

This document reviews procedures defined in [RFC4872] and [RFC4873] and does not define any new procedures. As such, no new security considerations are introduced in this document.

5. Acknowledgments

This document formalizes the explanation provided in an e-mail to the working group authored by Adrian Farrel, see [AF-EMAIL]. This document was written in response to questions raised in the CCAMP working group by Nic Neate <nhn@dataconnection.com>. Valuable comments and input were also received from Dimitri Papadimitriou, Francois Le Faucheur, and Ashok Narayanan.

6. References

6.1. Normative References

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6.2. Informative References

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