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                  Usage of The RSVP Association Object

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Abstract

   The RSVP ASSOCIATION object was defined in the context of GMPLS
   (Generalized Multi-Protocol Label Switching) 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 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 (Generalized Multi-Protocol Label Switching) 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-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. Segment recovery usage is defined in [RFC4873] and is covered in Section 2.3. Resource sharing LSP association is also defined in [RFC4873], while strictly speaking such association is beyond the scope of this document, for completeness it is covered in Section 2.4. 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 independent from

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 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 is supported by the ASSOCIATION object, and
downstream correlation is made based on the type.

[RFC4872] defines 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 association with one another. The
[RFC4872] defined fields are:

  o 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.

  o 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 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].

  o 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 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, 11.1. 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, which are 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 3 values:
     - The LSP ID of the LSP being protected.
     - The LSP ID of the LSP protecting an 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. But this is only an option, and is

neither required (i.e., "MUST") nor recommended (i.e., "SHOULD"). It
should be noted that the document does not describe when such a

change should be initiated, or the procedures for 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 how often it will occur. Some believe that
this case is 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 a
[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 3 additional requirements. In general, the narrative
highlights case 3 identified above but does not preclude the other
cases. The 3 additional requirements are, by [RFC4872] Section
number:

   o 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 3 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 more than one LSP to be protected.

   o 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.

   o 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.

   o 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 and furthermore that 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 was 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 which 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 was possible, see [RFC3209].

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

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

     o The Association Type value is set to "Resource Sharing".

     o Association Source is set to the originating node's router
       address.

     o 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 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 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:

  o 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.

o 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. IANA Considerations

There are no new IANA considerations introduced by this document.

6. Acknowledgments

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working group by Nic Neate <nhn@dataconnection.com>. Valuable
comments and input was also received from Dimitri Papadimitriou,
Francois Le Faucheur and Ashok Narayanan.

7. References

7.1. Normative References

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