RSVP-TE Signaling Extension For The Conversion Between Permanent Connections And Soft Permanent Connections In A GMPLS enabled Transport Network

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Abstract

In a transport network scenario, where Data Plane connections controlled either by GMPLS (Soft Permanent Connections - SPC) or by Management System (Permanent Connections - PC) may independently coexist, the ability of transforming an existing PC into a SPC and vice versa - without actually affecting Data Plane traffic being carried over it - is a valuable option. This applies especially when a GMPLS based Control Plane is first introduced into an existing network and there may be the need, from a Carrier point of view, to pass under GMPLS control existing connections already set up over Data Plane. In other terms, such operation could be seen as a way of transferring the ownership and control of an existing and in-use Data Plane connection between the Management Plane and the Control Plane, leaving its Data Plane state untouched.

This memo provides a minor extension to RSVP-TE signaling protocol, within GMPLS architecture, to enable such connection ownership transfer and describes the proposed procedures.

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 RFC2119 [1].

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1. Introduction

In a typical, traditional transport network scenario, Data Plane connections between two endpoints are controlled basically by means of a Network Management System (NMS) operating within Management Plane (MP). NMS/MP is the owner of such transport connections, being responsible of their set up, tear down and maintenance. The adoption of a GMPLS Control Plane over networks that are already in service – controlled by NMS at Management Plane level – introduces the need for a procedure able to coordinate a control handover of a generic data plane connection from MP to CP. In addition, the control handover in the opposite direction, from CP to MP should be possible as well. The procedures described in this memo have been thought having in mind SDH/SONET LSPs [2] supported by GMPLS but can be applied to any kind of LSPs.

2. Motivation

The main motivation behind this work is the definition of a simple and very low impacting procedure that satisfies the requirements defined in [3]. Such procedure is aimed at giving the transport network operators the chance to convert existing LSP provisioned as PC by NMS to SPC without disrupting user traffic flowing on it. Conversion from PC to SPC (i.e. when existing data plane connection ownership and control is passed from MP to CP) has been proposed as mandatory requirement, while the opposite operation, SPC to SC conversion, has been considered as a nice-to-have feature that can be seen as a back-out option.
For more details on requirements and motivations please refer to [3].

3. Overview Of Proposed RSVP-TE Based Solution
The whole process comprises of the discovery and conversion phases. The discovery phase being described in this document is an OPTIONAL procedure and not mandatory for the conversion phase to proceed. The discovery phase is typically initiated by the operator and is performed hop-by-hop in order to discover the route. The route discovered SHOULD be consistent with the network topology. For example, for a multi-layer network the hops discovered should be contained within the same layer.

Prior to initiating the discovery process it is assumed that the control-plane domains have been established. The operator at the originating node can optionally specify the terminating end-point at the time of initiating the discovery request or it could be automatically discovered. For example, at a network layer boundary the discovery process can be terminated generating a response back to the originator. Another possibility is to terminate the request at the control-plane domain boundary.

For conversion to SC or SPC the conversion phase will create an RSVP-TE session along the discovered or user-specified route and bind with the existing management-plane owned cross-connect resources and at the same time transfer the ownership to the control-plane. For conversion to PC the conversion phase will delete the existing RSVP-TE session without deleting the cross-connect resources and transfer the ownership to the management-plane.

Proposed procedure relies on the utilization of a newly introduced flag, here named Handover flag, in the Administrative Status Object (RFC 3471[4] and RFC 3473 [5]). The point is that standard RSVP-TE signaling flow can be used to inform nodes about the ownership handover request regarding one LSP that is already in place on their data plane, where such flow has to be flagged in order to discriminate it from normal, data plane affecting, LSP setup/release procedure. When a LSP owned by Management Plane (i.e. a PC) has to be handed over to Control Plane (i.e. converted into a SPC), a signaling set-up with HANDOVER flag set has to be sent from ingress node.

For the opposite procedure (when a LSP owned and controlled by Control Plane has to be handed over to Management Plane, i.e. SPC to PC conversion - or back out procedure for previous case) a signaling tear-down with HANDOVER flag set has to be sent from ingress or egress node, following the same procedure of a normal tear-down, from which is recognizable again by reading flag value.

So, basically the HANDOVER flag is introduced and exploited to tell apart a normal set-up (or tear-down) procedure - that has to trigger an action on data plane state at each addressed node along the path.
as usual - from the LSP ownership handover procedure that MUST leave untouched data plane state.

This is in some way similar as an approach to the Restart Procedure, (Section 4.3 RFC 3473 [5]), in the sense that the status of the physical resources at Data Plane has to stay unmodified but the associated information allowing its control has to be transferred. The modification proposed in this document refers only to Administrative Status object, that is, the message flow is left unmodified for both set-up and deletion. Moreover a new Error Value is defined to identify the failure of an Handover procedure.

It is worth stressing that, when the LSP over data plane is adopted either by CP or MP, i.e. at the end of signaling with Handover flag set, normal CP procedures or MP procedures have to take their place as usual when needed. This means that a LSP formerly owned by MP, signalled within CP with Handover flag set (i.e. handed over to CP) can be controlled by usual relevant Control Plane signaling flows (i.e. with Handover flag not set). The same applies when considering the handover of a LSP from CP to MP when, at the end of procedure, the LSP belongs to Management Plane and can be fully controlled by NMS. In other words, after the LSP handover procedures have taken place, the LSP is not different from the other LSP owned by handover destination entity and it has to be treated with usual rules for that entity.

Following paragraphs give detailed description of proposed "MP to CP handover" and "CP to MP handover" procedure, based on Handover flag usage. Handover of a bidirectional LSP is assumed. The case of unidirectional LSP can be easily derived from that.

4. LSP Control Handover Procedure Between Management And Control Planes

   The procedure described below describes how to move the ownership of an LSP from the Management Plane to Control Plane.

4.1 MP to CP handover: LSP Ownership Transfer From Management Plane To Control Plane

   Let’s consider the case of a Data Plane connection created by NMS. The Management Plane has the ownership and control of the LSP and wants to hand it over to Control Plane. At the ingress node NMS initiates the transfer of LSP related information residing within Management Plane to RSVP-TE records within Control Plane. We assume that this happens under operator or management application control and in particular that:
- Control requests are sent to the ingress LSR by the MP
- The MP has some way of knowing when the CP has completed its task or has failed.

Ingress node collects from MP all the LSP related information needed at Control Plane level. The way this operation is done and where such information is collected within MP is outside the scope of this document one possible (optional) way to collect it is explained in Section 5.

A relevant part of such information is represented by the LSP path, which has to be handed over to CP to be used by signalling entity to fill the Explicit Route Object (ERO) during setup.
In order to support the MP to CP handover of LSP, the ERO object in the Path message MUST be filled with all the LSP relevant information down to the Label level. That can be done by means of the object and procedures defined in [5].

The precise filling of the ERO object is needed as we are assuming that the LSP already exists in data plane and that every signalling relevant info about it is available and accessible to MP in terms of required LSP parameters to build a RSVP-TE PATH message. After the collection of all the LSP related information, the ingress node issues a RSVP-TE PATH message including the Administrative Status Object with both HANDOVER and REFLECT flags set. The R flag set assures that also the Resv message will set the H flag.

Upon reception of such RSVP-TE PATH, a node MUST be able to understand that a MP to CP handover procedure is in progress by reading the Handover flag.

Either the ingress node of the LSP (upon request from MP) and intermediate and egress nodes (when receiving a Path message containing an Administrative Status object with the Handover flag set) is informed about the fact that a LSP handover procedure is requested or ongoing. The node assumes that a Data Plane resource related to the info carried in Path Message is already allocated and in place. At the receipt of the Path Message the node SHOULD check the consistence of the actual Data Plane status of such resource:

- If the check goes OK, then a RSVP-TE record for the LSP is created associating it to the corresponding Data Plane state. The node accepts all the LSP information carried in PATH (if the node is not ingress of the LSP, otherwise the information is sent from relevant MP entity) and stores it in Path State Block. After that, the procedure goes on as described below.

- If the check goes NOT OK, that is actual Data Plane state for the indicated resource is different from the one indicated in the Path message, then:
* A PathErr with Path State Removed flag and an error value indicating ‘handover procedure failure’ set must be generated.

* GMPLS Control Plane state information about it is not accepted by the handover destination entity.

In both cases, no operation is done over Data Plane. In case of positive check, no change is required at that level since the connection is already set up and in service. In case of negative check, a mismatch or some other error has occurred and no LSP control handover is possible but no operation MUST be performed at the Data Plane that is the already present cross-connection MUST not be deleted. The procedure rolls back and information transfer process from MP to CP at ingress node of the LSP has to be fixed and reinitiated.

A node participating in a MP to CP handover procedure MUST in fact keep track of the special ‘handover’ condition of the LSP involved, by retaining information that an handover procedure is ongoing.

This is important because during handover procedure no other Data Plane, Control Plane or Management Plane action has to be taken on the LSP outside the control of the procedure itself. Such special state regarding the involved LSP has to be retained until the procedure itself has correctly ended.

After propagating handover Path, a node MUST wait for a Resv message including Administrative Status Object with Handover flag set. After receiving it, the actual migration of LSP information is complete, the LSP is left completely under control of RSVP-TE within Control Plane. This means that any memory about the former MP ownership of the LSP is lost. If a Confirmation message was requested that it is generated. The handover procedure does not modify the Confirmation procedure.

In case of failures during the processing of the Resv message the node that generates the failure sends:

- A PathErr with Path State Removed flag and an error value indicating ‘handover procedure failure’ set should be towards Ingress node. This case is similar to a failure during the Path processing.

- A ResvErr message, with the indication (a special Flag) that an error occurred during the Resv processing, towards Egress Node. Nodes processing this ResvErr with special flag and Error Value will delete the Control Plane information associated with the
cross-connection and move its ownership under the Management Plane domain.

Let’s consider a LSP over the network, connecting an Ingress node say I with an Egress node say E. Let’s call timeslot A and B the Data Plane resources referred by control information involved in Handover in a given node traversed by the LSP. This means that Handover flagged signaling refers to A-B cross-connection over Data Plane. The ingress node initiates the procedure upon request from Management Plane. The way LSP related information is passed from MP to ingress node is outside the scope of this procedure description. Intermediates nodes and egress node receive the request for LSP adoption and the information needed for the operation from Handover flagged RSVP-TE signaling. The symbol <----> in table below indicates that the two Timeslots involved in Data Plane cross-connection are actually cross-connected over Data Plane, hence Data Plane state corresponds to the indication provided by LSP data held by MP and in the process of being handed over to CP.

<table>
<thead>
<tr>
<th>Case</th>
<th>Timeslot</th>
<th>Data Plane State</th>
<th>MP Expectation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>A&lt;----&gt;B</td>
<td>No info yet</td>
<td>MP expects A-B</td>
<td>OK to MP to CP (LSP handover)</td>
</tr>
<tr>
<td>Case 2</td>
<td>A&lt;----&gt;C</td>
<td>No info yet</td>
<td>MP expects A-B</td>
<td>NOT OK for MP to CP LSP handover</td>
</tr>
<tr>
<td>Case 3</td>
<td>No state</td>
<td>No info yet</td>
<td>MP expects A-B</td>
<td>Depends on locally configured policy</td>
</tr>
</tbody>
</table>

Case 1:
- LSP info from MP to be used for LSP control handover to RSVP-TE matches Data Plane state in terms of involved resources
- LSP data record is not owned yet by Control Plane, hence LSP control is still up to MP
- Checks are OK, so RSVP-TE state (related to involved LSP) is associated to Data Plane state after Handover flagged signaling flow (Path/Resv with Handover flag set) has ended.
- At the end of signaling the LSP is completely under CP control.
- No actions are taken in the Data Plane.

Case 2:
- LSP info from MP to be used for LSP control handover to RSVP-TE doesn’t match Data Plane state in terms of involved resources.
- Control Plane does not own LSP data record yet; hence LSP control is still up to MP.
- Checks are NOT OK. A-B connection is not actually present over Data Plane and indicated resources are used within other context (A is x-connected to C).
- RSVP-TE state (related to involved LSP) is not associated to the cross connection after Handover flagged Path message.
- A PathErr with Path State Removed flag set MUST be sent Upstream.
- LSP ownership remains completely under MP control. Handover has failed.
- No actions are taken in the Data Plane.

Case 3:
- LSP info from MP to be used for LSP control handover to RSVP-TE does not exist in the Data Plane in terms of involved resources.
- LSP data record is not owned yet by Control Plane, hence LSP control is still up to MP
- decision about if the procedure is OK or KO is a local policy.

4.2 CP to MP handover - LSP Ownership Transfer From Control Plane To Management Plane

Let’s now consider the case of LSP Ownership Transfer From Control Plane To Management Plane. The scenario is still a Data Plane connection between two nodes acting as ingress and egress for a LSP. But let’s assume in this case that Control Plane has the ownership and control of the LSP and that we want to hand it over to Management Plane. This means that at the end of such procedure, the Data Plane state related to that connection is still untouched, but the LSP related information record is no more owned by RSVP-TE over Control Plane.

In other words, after LSP ownership transfer from CP to MP, the LSP is no more under control of RSVP-TE, which is no more able to "see" the LSP itself. This Section covers the procedure needed to manage this procedure as a dual, opposite procedure respect to the one described in previous section.

The procedure is performed at a signaling level as described in Section 7.2.1 of the RFC 3473 [5].

At LSP ingress node, relevant MP entity requests the ownership of the LSP, How this is done is outside the scope of memo. Ingress node and MP exchange the relevant information for this task and then propagates it over Control Plane by means of RSVP-TE tear down signaling flow as detailed below.

Ingress node MUST send out a Path message, with Handover and Reflect bits in Admin Status set. No action is taken over Data Plane and Control Plane keeps track of special handover state the LSP is in. Transit and Egress nodes, upon reception of such handover Path, propagate it without any Data Plane action, retaining the handover
state information associated to the LSP. After that, every node waits until the Handover bit is received back in the Resv. Then a PathTear is issued and the whole LSP information record is cleared from RSVP-TE data structures. In other words, a normal LSP tear down signaling is exchanged between nodes traversed by the LSP, but handover flag set in Path message indicates that no Data Plane action has to correspond to Control Plane signaling. At the end of handover tear down signaling flow, the LSP is released from Control Plane point of view, but its Data Plane state is still unmodified and it is now owned and controllable by MP.

4.3 CP to MP Handover Procedure Failure Handling

Failures during CP to MP handover procedure MUST be managed at signaling level as in normal LSP tear down procedure. The only difference is the handover flag set in Administrative Status Object inside Path message which MUST be read by receiving node and imposes that no action has to be made over Data Plane resource whose corresponding Control Plane record is involved in handover procedure.

5. Discovery Phase

The discovery process starts by the originating end-point transmitting a discovery request Notify message out a link as specified by the cross-connection identified to be part of the converted LSP in the originating node. The Notify message is forwarded hop-by-hop by tracing the cross-connect information and identifying the next-hop. The assumption being made here is that information regarding individual neighbors is already available.

In case the destination address is not known the RSVP-TE session destination address MAY not be specified (i.e. set to 0.0.0.0) in the discovery request Notify message.

Any node that decides to terminate the discovery process will not forward the Notify message and generate a discovery response Notify message.

In case of any errors detected which prevent the discovery process to complete the ERROR_SPEC object in the response Notify message will be filled in with a failure code else it MUST be set to the success code. The discovery response message SHOULD be sent hop-by-hop back to the requestor.

In case the destination address in the request message is 0.0.0.0 then it MUST be filled in by the terminating entity in the response message SESSION object.
The format of the Notify Message is as follows:

\[
<\text{Notify message}> ::= <\text{Common Header}> \[ <\text{INTEGRITY}> \]
\[ [ <\text{MESSAGE_ID_ACK}> | <\text{MESSAGE_ID_NACK}>]...\]
\[ <\text{MESSAGE_ID}> \]
<\text{ERROR_SPEC}>
<\text{discovery info}>
\]

\[
<\text{discovery info}> ::= <\text{SESSION}> <\text{RSVP_HOP}> <\text{RECOVERY_LABEL}>
\[ [ <\text{ADMIN_STATUS}> ]\]
\[ [ <\text{POLICY_DATA}> ]\]
\[ [ <\text{SESSION_ATTRIBUTES}>]\]
\[ [ <\text{UPSTREAM_LABEL}> ]\]
\[ [ <\text{RECORD_ROUTE}> ]\]
\]

6. Alternative Way Of Retrieving Information Needed For MP To CP Handover

An alternative way of getting the LSP related information required for the MP to CP handover is also proposed in this draft. The rationale behind this way is that only a minimal set of information is handed over from MP to CP at LSPs Ingress node. Instead of collecting within MP all the LSP relevant information down to the label level, formatting it to an ERO and passing it to CP, as in previously described solution, it is possible to start with a minimum amount of information. At the ingress node, the information needed to specify the LSP is the outgoing interface ID, upstream label and downstream label of this interface and the incoming interface ID of egress node. The remaining information about an existing LSP can then be collected hop by hop, as the signalling is going on, by looking up the cross-connection table in data plane at each node along the LSP path.

Starting from the information available at ingress TNE about the outgoing interface ID of that ingress node, the incoming interface ID of next hop can be found by looking up the link resource table/database in TNE itself. Following the similarity existing between the MP to CP handover procedure and the Restart Procedure, the Recovery Label Object MUST be used to carry the downstream label and the Upstream Label Object MUST be used to carry the upstream label to the next node.

The Path message is hence built with the Recovery Label Object (RFC 3473[5]) and the Upstream Label Object (RFC 3473[5]), where the upstream label and downstream label of ingress outgoing interface of the LSP are included in these two objects. In addition to above mentioned objects, the Path message MUST include the Administrative Status Object with HANDOVER flag set, as already defined in previous chapter for the detailed ERO based way of proceeding. Such handover Path is sent to the incoming interface of next hop. When this Path
message reaches the second node along the LSP path, the information about incoming interface ID and the upstream and downstream labels of this interface is extracted from it and it is used to find next hop outgoing interface ID and the upstream/ downstream labels by looking up the data plane cross-connection table. After having determined in this way the parameters describing the LSPs next hop, the outgoing Path message to be sent is built replacing the Recovery Label Object and Upstream Label Object content with the looked-up values of upstream and downstream labels. Re-iterating this procedure for each transit node along the LSP path, it is possible to make the handover Path message reach the egress node, exactly following the LSP that is in place over data plane. The ERO MAY in this case be included in the Path message as an optional object, and MAY be filled with the LSP relevant information down to either the port level with interface ID or the Label level with upstream and downstream labels. The ERO can be used to check the consistence of resource in data plane down to the port level or label level at each intermediate node along the LSP path.

7. RSVP Message Formats

This memo does not introduce any modification in RSVP messages object composition.

8. Objects Modification

8.1 Administrative Status Object

This memo introduces a new flag into the Administrative Status object.
The Admin_Status Object is defined in RFC 3473 [5].
This document uses the H-bit of the Admin_Status object. The bit is bit number (TBD by IANA).

The format of the Admin_Status Object is:

```
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Length             | Class-Num(196) |   C-Type (1)  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|R|                        Reserved               |H|L|I|C|T|A|D|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Handover signaling (H): 1 bit
When set, indicates that a Handover procedure for the transfer of LSP ownership between Management and Control Planes is ongoing.

The H bit must be used in conjunction with the R flag when is set in the Path message. This will assure that the Resv message will maintain the H flag set.

8.2 Error Spec Object

This memo introduces and a new flag and new Error Code/Value into Error_Spec Object that is defined in RFC 2205 [6].

ERRORSPEC class = 6.

- IPv4 ERROR_SPEC object: Class = 6, C-Type = 1

<table>
<thead>
<tr>
<th>Flags</th>
<th>Error Code</th>
<th>Error Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x01</td>
<td>InPlace</td>
<td></td>
</tr>
<tr>
<td>0x02</td>
<td>NotGuilty</td>
<td></td>
</tr>
<tr>
<td>(TBD)</td>
<td>HandOverFailure</td>
<td></td>
</tr>
</tbody>
</table>

The new flag is ‘handover procedure failure’ the actual value is (TBD by IANA). When this flag is set the receiver must delete the control plane status associated with the LPS and move the ownership of the cross-connections to the Management Plane.

9. Security Considerations

The procedures described in this document rely completely on RSVP-TE messages and mechanism. The use of Handover Flag set in Admin Status Object basically informs the receiving entity that no operations are to be done over Data Plane as consequence of such special signaling flow. Using specially flagged signaling messages we want to limit the function of setup and tear down messages to Control Plane, making them not effective over related Data Plane resource usage. So, no additional or special issues are arisen by adopting this procedure, that aren’t already brought up by the use of the same messages, without handover flag setting, for LSP control. For RSVP-TE Security please refer to [5].
10. IANA Consideration

IANA has been asked to manage the bit allocations for the Administrative Status object [5]. This document requires the allocation of the Handover bit: the H-bit. IANA is requested to allocate a bit for this purpose.

11. References


12. Acknowledgments

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