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LSP Modification Using CR-LDP

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1. Abstract

After a CR-LSP is set up, its bandwidth reservation may need to be changed by the network operator, due to the new requirements for the traffic carried on that CR-LSP [2]. This contribution presents an approach to modify the bandwidth and possibly other parameters of an established CR-LSP using CR-LDP [3] without service interruption. The LSP modification feature can be supported by CR-LDP with a minor extension of an _action indicator flag_. This feature has application in dynamic network resources management where traffic of different priorities and service classes is involved.

2. Conventions used in this document

L: LSP (Label Switched Path)
Lid: LSPID (LSP Identifier)
T: Traffic Parameters

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R: LSR (Label Switching Router)
FTN: FEC To NHLFE
FEC: Forwarding Equivalence Class
NHLFE: Next Hop Label Forwarding Entity
TLV: Type Length Value

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](#) [4].

[3.](#) Introduction

Consider an LSP L1 that has been established with its set of traffic parameters T0. A certain amount of bandwidth is reserved along the path of L1. Consider then that some changes are required on L1. For example, the bandwidth of L1 needs to be increased to accommodate the increased traffic on L1. Or the SLA associated with L1 needs to be modified because a different service class is desired. The network operator, in these cases, would like to modify the characteristics of L1, for example, to change its traffic parameter set from T0 to T1, without releasing the LSP L1 to interrupt the service. In some other cases, network operators may want to reroute a CR-LSP to a different path for either improved performance or better network resource utilization. In all these cases, LSP modification is required. In [section 4](#) below, a method to modify an active LSP using CR-LDP is presented. The concept of LSPID in CR-LDP is used to achieve the LSP modification, without releasing the LSP and interrupting the service and, without double booking the bandwidth. Only a minimum extension on CR-LDP, an action indication flag of `_modify_` is needed in order to explicitly specify the behavior, and allow the existing LSPID to support other networking capabilities in the future. [Section 5](#) specifies the action indication flag of `_modify_` for CR-LDP. In the appendix, an example is described to demonstrate an application of the presented method in dynamically managing network bandwidth requirements without interrupting service.

[4.](#) LSP Modification Using CR-LDP

[4.1](#) Basic Procedure

LSP modification can only be allowed when the LSP is already set up and active. That is, modification is not defined nor allowed during the LSP establishment or label release/withdraw phases. Only modification requested by the ingress LSR of the LSP is considered

in this draft for CR-LSP. Ingress LSR cannot modify an LSP before a previous modification procedure is completed.

Assume that CR-LSP L1 is set up with LSPID L-id1, which is unique in the MPLS network. The ingress LSR R1 of L1 has in its FTN (FEC To NHLFE) table FEC1 -> Label A mapping where A is the outgoing label for LSP L1. To modify the characteristics of L1, R1 sends a Label

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Request Message. In the messages, the TLVs will have the new requested values, and the LSPID TLV is included which indicates the value of L-id1. The Traffic Parameters TLV, the ER-TLV, the Resource Class (color) TLV and the Preemption TLV can have values different from those in the original Label Request Message, which has been used to set up L1 earlier. Thus, L1 can be changed in its bandwidth request (traffic parameter TLV), its traffic service class (traffic parameter TLV), the route it traverses (ER TLV) and its setup and holding (Preemption TLV) priorities. The ingress LSR R1 now still has the entry in FTN as FEC1 -> Label A. R1 is waiting to establish another entry for FEC1.

When an LSR Ri along the path of L1 receives the Label Request message, its behavior is the same as that of receiving any Label request message. The only extension is that Ri examines the LSPID carried in the Label Request Message, L-id1 and identifies if it already has L-id1. If Ri does not have L-id1, Ri behaves the same as receiving a new Label Request message. If Ri already has L-id1, Ri takes the newly received Traffic Parameter TLV and computes the new bandwidth required and derives the new service class. Compared with the already reserved bandwidth for L-id1, Ri now reserves only the difference of the bandwidth requirements. This prevents Ri from doing bandwidth double booking. If a new service class is requested, Ri also prepares to receive the traffic on L1 in, perhaps a different type of queue, just the same as handling it for a Label Request Message. Ri assigns a new label for the Label Request Message.

When the Label Mapping message is received, two sets of labels exist for the same LSPID. Then the ingress LSR R1 will have two outgoing labels, A and B, associated with the same FEC, where B is the new outgoing label received for LSP L1. The ingress LSR R1 can now activate the new entry in FTN, FEC1 - > Label B. This means that R1 swaps traffic on L1 to the new label _B_ (_new_ path) for L1. The packets can now be sent with the new label B, with the new set of traffic parameters if any, on a new path, that is, if a new path is requested in the Label Request Message for the modification. All the other LSRs along the path will start to receive the incoming packets with the new label. For the incoming new label, the LSR has already established its mapping to the new outgoing label. Thus, the packets will be sent out with the new outgoing label. The LSRs do not have

to implement new procedures to track the new and old characteristics of the LSP.

The ingress LSR R1 then starts to release the original label A for LSP L1. The Label Release Message is sent by R1 towards the downstream LSRs. The Release message carries the LSPID of L-id1 and the Label TLV to indicate which label is to be released. The Release Message is propagated to the egress LSR to release the original labels previously used for L1. Upon receiving the Label Release Message, LSR R1 examines the LSPID, L-id1 and finds out that the L-id1 has still another set of label (incoming/outgoing) under it.

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Thus, the old label is released without releasing the resource in use. That is, if the bandwidth has been decreased for L1, the delta bandwidth is released. Otherwise, no bandwidth is released. This modification procedure can not only be applied to modify the traffic parameters and/or service class of an active LSP, but also to reroute an existing LSP, and/or change its setup/holding priority if desired. After the release procedure, the modification of the LSP is completed.

The method described above follows the normal behavior of Label Request / Mapping / Notification / Release /Withdraw procedure of a CR-LDP operated LSR with a specific action taken on LSPID. If Label Withdraw Message is used to withdraw a label associated with an LSPID, the Label TLV should be included to specify which label to withdraw. Since the LSPID can also be used for other feature support, an action indication flag of `_modify_` assigned to the LSPID would explicitly explain the action/semantics that should be associated with the messaging procedure. The details of this flag are addressed in [Section 3](#) below.

[4.2](#) Priority Handling

When sending a Label Request Message for an active LSP L1 to request changes, the setup priority used in the label Request Message can be different from the one used in the previous Label Request Message, effectively indicating the priority of this `_modification_` request. Network operators can use this feature to decide what priority is to be assigned to a modification request, based on their policies/algorithms and other traffic situations in the network. For example, the priority for modification can be determined by the priority of the customer/LSP. If a customer has exceeded the reserved bandwidth of its VPN LSP tunnel by too much, the modification request's priority may be given higher.

The Label Request message for the modification of an active LSP can also be sent with a holding priority different from its previous one. This effectively changes the holding priority of the LSP. Upon receiving a Label Request Message that requests a new holding

priority, the LSR assigns the new holding priority to the bandwidth. That is, the new holding priority is assigned to both the existing incoming / outgoing labels and the new labels to be established for the LSPID in question. In this way self-bumping is prevented.

[4.3](#) Modification Failure Case Handling

A modification attempt may fail due to insufficient resource or other situations. A Notification message is sent back to the ingress LSR R1 to indicate the failure of Label Request Message that intended to modify the LSP. Retry may be attempted if desired by the network operator.

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If the LSP on the original path failed when a modification attempt is in progress, the attempt should be aborted by using the Label Abort Request message as specified in LDP draft [5].

[5](#). Proposed Extensions to CR-LDP for CR-LSP Modification

[5.1](#) _Action indicator Flag_ in LSPID TLV

As LSPID can be used for other purpose as well, for example, for LSP merge or stacking, etc. which are not intended to be covered here, an _action indicator flag_ is proposed to be carried in the LSPID TLV. This _action indicator flag_ shows explicitly the action that should be taken if the LSP already exists on the LSR receiving the message. The indicator flag can take 4 bits (right most 4 bits) out of the two reserved bytes in the LSPID TLV. A set of indicator code points is proposed as follows:

0001: modify

The procedure for code point _modify_ is defined as in the above [section 2.1](#). The procedures for others are for future work.

[5.2](#) New Status Code

Status code	Type
Modify request not supported	0x04000008

This error code can be used to indicate that for some reason, the modification attempt on the given LSPID is not allowed by the LSR. For example, this can be an attempt that is sent out too soon after last modification, before the LSR has completed the procedures in the last modification attempt.

6. Intellectual Property Consideration

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7. Security Considerations

No security issues are addressed in this draft.

8. References

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- 1 Bradner, S., "The Internet Standards Process -- Revision 3", [BCP 9](#), [RFC 2026](#), October 1996.
- 2 Ash, J., et. al., QoS Resource Management in MPLS-Based Networks, [draft-ash-qos-routing-00.txt](#), (work in progress).
- 3 Jamoussi, B., et. al., Constraint-Based LSP Setup using LDP, [draft-ietf-mpls-cr-ldp-01.txt](#), February 1999,(work in progress).
- 4 Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- 5 Andersson, L., et. al., LDP Specification, [draft-ietf-mpls-ldp-05.txt](#) (work in progress)

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[Appendix](#)

[Application of LSP Bandwidth Modification in Dynamic Resource Management](#)

In this section, we gave an example of dynamic network resource management using the LSP bandwidth modification capability. The details of this example can be found in a previous Internet draft presented in the last meeting. Assume that customers are assigned with their CR-LSPs. These customers' are assigned with one of the priorities as key, normal or best effort. The network operator doesn't want to bump any LSPs during an LSP setup, so after these CR-LSPs are set up, their holding priority are all assigned as the highest.

The network operator wants to control the resource on the links of LSRs, so all LSRs keep the usage status of its links and based on the usage history, each link is assigned a current threshold priority P_i . Which means that the link has no bandwidth available for Label Request with a setup priority lower than P_i . When a LSP's bandwidth needs to be modified, the operator uses policy based algorithm to assign a priority for its modification request, say M_p for LSP L2. Then the ingress LSR sends Label Request message with (Setup Priority = M_p). The rule is then only if there is enough bandwidth on the link and, the Setup priority in the Label Request

Message is higher in priority (M_p numerically smaller) than P_i of the link, the Label Request Message will be accepted by the LSR. Otherwise, the Label Request message will be rejected with a Notification message indicates that there isn't enough resources. It should also be note that when OSPF (or IS-IS) floods the link available bandwidth information, the available bandwidth associated with priority lower than P_i (numerical value bigger) should be indicated as $_0_$. This procedure based on a priority threshold P_i is implementation specific and value added. It offers networks flexibility to prioritize and control its resources.

The calculation of M_p is network dependent, based on operator's own algorithm. For example, the operator may assign a higher M_p to L2 if L2 belongs to a customer with $_Key_$ priority. The operator may also collect the actual usage of each LSP and assign a high M_p to L2 if in the past week, L2 has exceeding its reserved bandwidth by 2 times on the average, and the customer of L2 agrees to increase its bandwidth for a better guaranteed service. Some operator may try to increase the bandwidth of L2 on its existing path unsuccessfully as there isn't enough bandwidth there. Then the operator is willing to change the path of L2 in order to increase its bandwidth, but with a lower priority M_p this time as L2 now is routed on its secondary path, which should yield priority to the LSPs that are on its primary paths here.

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