INTERNET DRAFT
Network Working Group

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MPLS Label Stack Encapsulation in IP

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Abstract

Several useful applications of MPLS tunnels based on LSPs with second level labels between non adjacent LSRs have been identified: IP-VPNs and VoIP over MPLS are just two examples. This tunnelling technique can easily be extended to non-MPLS core networks.

This Internet-Draft explains the motivation for encapsulating MPLS messages in IP and provides the protocol specification of the encapsulation.

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1. Motivation

MPLS provides not only for the label based forwarding of datagrams by label switching routers (LSRs) but also, through the use of a second or higher level labels, for the labelled forwarding of messages between non-adjacent LSRs [1]. This capability may be used for general purpose tunnelling between non-adjacent LSRs. Using extended MPLS signalling (e.g. [3] or [4]) and the label stacking technique, a pair LSRs may establish tunnels on demand without disturbing the intervening LSRs. Figure 1 illustrates the "labelled tunnelling" technique.

```
+-----+                                                    +-----+
|L2=a|                                                     |L2=a|
+-----+            +----+----+           +----+----+       +-----+
|L1=x|--------|L1=x|L1=y|--------|L1=y|L1=z|--------|L1=z|
+-----+            +----+----+           +----+----+       +-----+
 LSR-1               LSR-2                 LSR-3            LSR-4
```

Figure 1 - Labelled tunnelling over an MPLS network
using a label stack

In this example, an LSP exists between LSR-1 and LSR-4 that is label switched through LSRs-2 and -3. This LSP has labels x, y and z on the respective data-links between the LSRs, as shown. Additionally, LSRs-1 and -4 are directly connected via an LSP with the label a. (The label having been distributed via an extended MPLS signalling session, such as LDP or BGP-4, between LSRs-1 and -4.) This LSP may be used as a "labelled tunnel."

Examples of the utility of this kind of MPLS tunnelling include:

Signalled multi-protocol tunnelling
By adding FEC types to MPLS signalling, MPLS can be used to

tunnel arbitrary protocols. Alternatively, consistent configuration of LSRs may be used to associate specific label spaces with specific protocols. For the tunnelling of vendor specific protocols the opaque FEC type together with LDP's vendor specific TLVs may be used to indicate the encapsulated protocol type.

Tunnelling of multiple protocol sessions.

Extended MPLS signalling allows the efficient establishment and tear-down of tunnels between a pair of LSRs. This facility has value in the support of certain protocol stacking techniques that require the multiplexing of multiple parallel protocol sessions, e.g. remote access, IP Virtual Private Networks with potentially overlapping addresses, or multi-hop voice-over-IP headers compression.

The MPLS-in-IP encapsulation specified in Section 2 allows the use of labelled tunnelling in those situations in which the intervening network nodes are not MPLS LSRs. Figure 2 contrasts this technique with the label stacking technique shown in Figure 1. The inherent protocol layering hides the differences between labelled tunnelling over MPLS (Figure 1) and labelled tunnelling over IP (Figure 2) from the tunnelled protocol layer and layers above, and from the extended MPLS signalling session between LSR-1 and LSR-2.

```
+-----+                                                 +-----+
|L1=a|                                                  |L1=a|
+-----+                                                 +-----+
|MiIP|                                                  |MiIP|
+-----+       +----------+       +----------+           +-----+
| IP |--------|    IP    |--------|    IP    |--------| IP |
+-----+       +----------+       +----------+           +-----+
 LSR-1           Router             Router               LSR-2
```

Figure 2 - Labelled tunnelling over an IP network using MPLS-in-IP (MiIP) encapsulation

Thus an MPLS-in-IP encapsulation extends the applicability of extended MPLS signalling and labelled tunnelling to use over non-MPLS clouds.

2. MPLS-in-IP protocol specification

MPLS-in-IP messages have the following format:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                     |
|              IP Header              |
|                                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                     |
|          MPLS Label Stack           |
|                                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                     |
|            Message Body             |
|                                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IP Header
: This field contains an IPv4 or an IPv6 datagram header as defined in [5] and [6] respectively. The source and destination addresses are set to addresses of the encapsulating and decapsulating LSRs respectively.

MPLS Label Stack
: This field contains an MPLS Label Stack as defined in [2].

Message Body
: This field contains one MPLS message body.

The Protocol Number field in an IPv4 header and the Next Header field in an IPv6 are set as follows:

X   indicates an MPLS unicast message,

Y   indicates an MPLS multicast message.

Allocation of an IP Protocol Number for MPLS unicast messages is

required by MPLS-in-IP encapsulation.

For the time being there appears to be no need to allocate an IP Protocol Number for MPLS multicast messages.

3. Usage considerations

MPLS-in-IP is useful when an MPLS tunnel is useful but where an MPLS network between the tunnel end-points is not available. It should be noted, however, that certain capabilities often connoted with MPLS are not available with MPLS-in-IP. Firstly, RSVP and CR-LDP cannot provide resource allocation (e.g. bandwidth allocation) for the tunnels since the signalling does not interact with the network between the tunnel endpoints. Other techniques applicable at the IP level, such as Diff-Serv or RSVP/Int-Serv, may be used in conjunction with MPLS-in-IP. Secondly, in MPLS-in-IP, RSVP and CR-LDP signalling cannot provide control of a source route for the tunnels.

LDP and BGP directly support sessions between non-adjacent nodes. If, however, RSVP is to be used for control of MPLS-in-IP tunnels, RSVP packets requiring router alert should be encapsulated using IP-in-IP and addressed to the remote tunnel end-point.

The source and destination addresses in the IP Header of MPLS-in-IP messages may be any of the respective encapsulating and decapsulating LSRs' addresses. Usually the LSR Ids will be suitable.

MPLS-in-IP encapsulation is not normally appropriate if an MPLS messages needs to be forwarded over a GRE tunnel [7]. In this case GRE encapsulation with the Protocol Type set to the corresponding ethertype (MPLS Unicast = 0x8847 and MPLS Multicast = 8848) is preferable.

4. Security Considerations

Particular security precautions applicable to MPLS LSRs and LERs are applicable also when MPLS-in-IP encapsulation is used.

References

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