Proxy LSP Ping
draft-lim-mpls-proxy-lsp-ping-00

Abstract

   This document defines a means of remotely initiating Multiprotocol
   Label Switched Protocol Pings on Label Switched Paths. A proxy ping
   request is sent to any Label Switching Routers along a Label Switched
   Path. The primary motivations for this facility are first to limit
   the number of messages and related processing when using LSP Ping in
   large Point-to-Multipoint LSPs, and second to enable leaf to leaf/
   root tracing.

Status of this Memo

   This Internet-Draft is submitted in full conformance with the
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1. Introduction

It is anticipated that very large Point-to-Multipoint (P2MP) and
Multipoint-to-Multipoint (MP2MP) Label Switched Paths (LSPs) will
exist. Further it is anticipated that many of the applications for
P2MP/MP2MP tunnels will require OAM that is both rigorous and
scalable.

Suppose one wishes to trace a P2MP LSP to localize a fault which is
affecting one egress or a set of egresses. Suppose one follows the
normal procedure for tracing - namely repeatedly pinging from the
root, incrementing the TTL by one after each three or so pings. Such
a procedure has the potential for producing a large amount of
processing at the P2MP-LSP midpoints and egresses. It also could
produce an unwieldy number of replies back to the root.

One alternative would be to begin sending pings from points at or
near the affected egress(es) and working backwards toward the root.
The TTL could be held constant as say two, limiting the number of
responses to the number of next-next-hops of the point where a ping
is initiated.

This document defines protocol extensions to MPLS ping [RFC4379] to
allow a third party to remotely cause an MPLS echo request message to
be sent down a Label Switched Path (LSP) or part of an LSP. The
procedure described in the paragraphs above does require that the
initiator know the previous-hop node to the one which was pinged on
the prior iteration. This information is readily available in
[RFC4875]. This also document provides a means for obtaining this
information for[RFC6388].

While the motivation for this document came from multicast scaling
concerns, its applicability may be wider. However other uses of this
facility are beyond the scope of this document. In particular, the
procedures defined in this document only allow testing of a FEC stack
consisting of a single FEC. It also does not allow the initiator to
specify the label assigned to that FEC, nor does it allow the
initiator to cause any additional labels to be added to the label
stack of the actual MPLS echo request message.

1.1. Requirements Language

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.

The term "Must Be Zero" (MBZ) is used in object descriptions for
reserved fields. These fields MUST be set to zero when sent and

   ignored on receipt.

   Based on context the terms leaf and egress are used interchangeably.
   Egress is used where consistency with[RFC4379] was deemed
   appropriate. Receiver is used in the context of receiving protocol
   messages.

   [Note (to be removed after assignments occur): <tba> = to be assigned
   by IANA]

2. Proxy Ping Overview

   This document defines a protocol interaction between a first node and
   a node which is part of an LSP to allow the first node to request
   that that second node initiate an LSP ping for the LSP on behalf of
   the first node. Two new LSP Ping messages are defined for remote
   pinging, the MPLS proxy ping request and the MPLS proxy ping reply.

   A remote ping operation on a P2MP LSP generally involves at least
   three LSRs; in some scenarios none of these are the ingress (root) or
   an egress (leaf) of the LSP.

   We refer to these nodes with the following terms:

      Initiator - the node which initiates the ping operation by sending
      an MPLS proxy ping request message

      Proxy LSR - the node which is the destination of the MPLS proxy
      request message and potential initiator of the MPLS echo request

      Receiver(s) - the nodes which receive the MPLS echo request
      message

      Responder - A receiver that responds to a MPLS Proxy Ping Request
      or an MPLS Echo Request

   We note that in some scenarios, the initiator could also be the
   responder, in which case the response would be internal to the node.

   The initiator formats an MPLS proxy ping request message and sends it
   to the proxy LSR, a node it believes to be on the path of the LSP.
   This message specifies the MPLS echo request to be sent inband of the
   LSP. It may request the proxy LSR to either Reply with Proxy
   information or the send a MPLS echo request. The initiator requests
   Proxy information so that it can learn additional information it
   needs to use to form a subsequent MPLS Proxy Ping request. For
   example during LSP traceroute an initiator needs the downstream map

   information to form an Echo request. An initiator may also want to
   learn a Proxy LSR's FEC neighbor information so that it can form
   proxy request to various nodes along the LSP.

   The proxy LSR either replies with the requested Proxy information or
   it validates that it has a label mapping for the specified FEC and
   that it is authorized to send the specified MPLS echo request on
   behalf of the initiator.

   If the proxy LSR has a label mapping for the FEC and all
   authorization checks have passed, the proxy LSR formats an MPLS echo
   request. If the source address of the IP packet is not the
   initiator, it includes a Reply-to Address object containing the
   initiator's address. It then sends it inband of the LSP.

   The receivers process the MPLS echo request as normal, sending their
   MPLS echo replies back to the initiator.

   If the proxy LSR failed to send a MPLS echo request as normal because
   it encountered and issue while attempting to send, a MPLS proxy ping
   reply message is sent back with a return code indicating that the
   MPLS echo request could not be sent.

3. Proxy MPLS Echo Request / Reply Procedures

3.1. Procedures for the initiator

   The initiator creates an MPLS proxy ping request message.

   The message MUST contain a Target FEC Stack that describes the FEC
   being tested. The topmost FEC in the target FEC stack is used at
   that the Proxy Router to lookup the MPLS label stack that will be
   used to encapsulate the MPLS echo request packet.

   The MPLS Proxy Ping message MUST contain a Proxy Echo Parameters
   object. In that object, the address type is set to either IPv4 or
   IPv6. The Destination IP Address is set to the value to be used in
   the MPLS echo request packet. If the Address Type is IPv4, an
   address from the range 127/8. If the Address Type is IPv6, an
   address from the range ::FFFF:7F00:0/104.

   The Reply mode and Global Flags of the Proxy Echo Parameters object
   are set to the values to be used in the MPLS echo request message
   header. The Source UDP Port is set to the value to be used in the
   MPLS echo request packet. The TTL is set to the value to be used in
   the outgoing MPLS label stack. See Section 5.1 for further details.

If the FEC's Upstream/Downstream Neighbor address information is
required, the initiator sets the "Request for FEC neighbor
information" Proxy Flags in the Proxy Echo Parameters object.

If a Downstream Detailed or Downstream Mapping TLV is required in a
MPLS Proxy Ping Reply, the initiator sets the "Request for Downstream
Detailed Mapping" or "Request for Downstream Mapping" Proxy Flags in
the Proxy Echo Parameters object. Only one of the two flags can be
set.

The Proxy Request reply mode is set with one of the reply modes
defined in [RFC4379] as appropriate.

A list of Next Hop IP Addresses MAY be included to limit the next
hops towards which the MPLS echo request message will be sent. These
are encoded as Next Hop sub-objects and included in the Proxy Echo
Parameters object.

Proxy Echo Parameter object MPLS payload size field may be set to
request that the MPLS echo request (including any IP and UDP header)
be zero padded to the specified size. When the payload size is non
zero, if sending the MPLS Echo Request involves using an IP header,
the DF bit MUST be set to 1.

Any of following objects MAY be included; these objects will be
copied into the MPLS echo request messages:

    Pad

    Vendor Enterprise Number

    Reply TOS Byte

    P2MP Egress Identifier [RFC6425]

    Echo Jitter TLV [RFC6425]

    Vendor Private TLVs

Downstream Detailed Mapping or Downstream Mapping objects MAY be
included. These objects will be matched to the next hop address for
inclusion in those particular MPLS echo request messages.

The message is then encapsulated in a UDP packet. The source UDP
port is chosen by the sender; the destination UDP port is set to
3503. The IP header is set as follows: the source IP address is a
routable address of the sender; the destination IP address is a
routable address of the midpoint. The packet is then sent with the

IP TTL is set to 255.

3.2. Procedures for the proxy LSR

A proxy LSR that receives an MPLS proxy ping request message, parses
the packet to ensure that it is a well-formed packet. It checks that
the TLVs that are not marked "Ignore" are understood. If not, it
sets the Return Code set to "Malformed echo request received" or "TLV
not understood" (as appropriate), and the Subcode set to zero. If
the Reply Mode of the message header is not 1(Do not reply), an MPLS
proxy ping reply message SHOULD be sent as described below. In the
latter case, the misunderstood TLVs (only) are included in an Errored
TLVs object.

The Proxy LSR checks that the MPLS proxy ping request message did not
arrive via one of its exception processing paths. Packets arriving
via IP TTL expiry, IP destination address set to a Martian address or
label ttl expiry MUST be treated as "Unauthorized" packets. An MPLS
proxy ping reply message MAY be sent with a Return Code of <tba>,
"Remote Ping not authorized".

The header fields Sender's Handle and Sequence Number are not
examined, but are saved to be included in the MPLS proxy ping reply
and MPLS echo request messages.

The proxy LSR validates that it has a label mapping for the specified
FEC, it then determines if it is an ingress, egress, transit or bud
node and sets the Return Code as appropriate. A new return code (FEC
found) has been defined for the case where the Proxy LSR is an
ingress (for example head of the TE tunnel or a transit router)
because the existing RFC4379 return codes don't match the situation.
For example, when a Proxy LSR is a transit router, it's not
appropriate for the return code to describe how the packet would
transit because the Proxy Request doesn't contain information about
what input interface the an MPLS echo request would be switched from
at the Proxy LSR.

The proxy LSR then determines if it is authorized to send the
specified MPLS echo request on behalf of the initiator. A Proxy LSR
MUST be capable of filtering addresses to validate initiators. Other
filters on FECs or MPLS echo request contents MAY be applied. If a
filter has been invoked (i.e. configured) and an address does not
pass the filter, then an MPLS echo request message MUST NOT be sent,
and the event SHOULD be logged. An MPLS proxy ping reply message MAY
be sent with a Return Code of <tba>, "Remote Ping not authorized".

The destination address specified in the Proxy Echo Parameters object
is checked to ensure that it conforms to the address allowed IPv4 or

IPv6 address range. If not, it sets the Return Code set to
"Malformed echo request received" and the Subcode set to zero. If
the Reply Mode of the message header is not 1, an MPLS proxy ping
reply message SHOULD be sent as described below.

If the "Request for FEC Neighbor Address info" flag is set, a
Upstream Neighbor Address Object and/or Downstream Neighbor Address
Object(s) is/are formatted for inclusion in the MPLS proxy ping
reply. If the Upstream or Downstream address is unknown they are not
included in the Proxy Reply.

If there are Next Hop sub-objects in the Proxy Echo Parameters
object, each address is examined to determine if it is a next hop for
this FEC. If any are not, those sub-objects are from the Proxy Echo
Parameters object. The updated object is included in the MPLS proxy
ping reply.

If the "Request for Downstream Detailed Mapping" or "Request for
Downstream Mapping" flag is set the LSR formats (for inclusions in
the MPLS proxy ping reply) a Downstream Detailed/Downstream Mapping
object for each interface over which the MPLS echo request will be
sent.

If the Proxy LSR is the egress of the FEC, a Proxy reply should be
sent to the initiator with the return code set to 3 (Reply router is
Egress for FEC) with return subcode set to 0.

If the Reply Mode of the message header is 1, 2 or 3 and no errors or
modifications have occurred no MPLS proxy ping reply is sent.
Otherwise an MPLS proxy ping reply message SHOULD be sent as
described below.

3.2.1. Downstream Detailed/Downstream Maps in Proxy Reply

When the Proxy LSR is a transit or bud node, downstream maps
corresponding to how the packet is transited can not be supplied
unless an ingress interface for the MPLS echo request is specified,
since this information is not available of useful since all valid
output paths are of interest, the Proxy LSR should include DS/
DDMAP(s) to describe the entire set of paths that the packet can be
replicated to assuming that the packet was sourced from the Proxy
LSR. For mLDP there is a DSMAP/DDMAP per upstream/downstream
neighbor for MP2MP LSPs, or per donwstream neighbor in the P2MP LSP
case.

When the Proxy LSR is a bud node or egress in a MP2MP LSP, the Proxy
Reply should contain DSMAP/DDMAPs assuming that the packet is being
sourced from a leaf. In this case, there will be no DSMAP/DDMAP

   describing the egresses. The Proxy reply return code is either set
   to "Reply router found mapping for the FEC" or "Reply router is
   Egress for the FEC" is returned.

3.2.2. Sending an MPLS proxy ping reply

   The Reply mode, Sender's Handle and Sequence Number fields are copied
   from the proxy ping request message. The objects specified above are
   included. The message is encapsulated in a UDP packet. The source
   IP address is a routable address of the proxy LSR; the source port is
   the well-known UDP port for LSP ping. The destination IP address and
   UDP port are copied from the source IP address and UDP port of the
   echo request. The IP TTL is set to 255.

3.2.3. Sending the MPLS echo requests

   A base MPLS echo request is formed as described in the next section.
   The section below that describes how the base MPLS echo request is
   sent on each interface.

3.2.3.1. Forming the base MPLS echo request

   A Next_Hop_List is created as follows. If Next Hop sub-objects were
   included in the received Proxy Parameters object, the Next_Hop_List
   created from the address in those sub-objects as adjusted above.
   Otherwise, the list is set to all the next hops to which the FEC
   would be forwarded.

   The proxy LSR then formats an MPLS echo request message. The Global
   Flags and Reply Mode are copied from the Proxy Echo Parameters
   object. The Return Code and Return Subcode are set to zero.

   The Sender's Handle and Sequence Number are copied from the remote
   echo request message.

   The TimeStamp Sent is set to the time-of-day (in seconds and
   microseconds) that the echo request is sent. The TimeStamp Received
   is set to zero.

   A Reply-to Address object containing the initiator's address is
   included.

   The following objects are copied from the MPLS proxy ping request
   message. Note that of these, only the Target FEC Stack is REQUIRED
   to appear in the MPLS proxy ping request message.

      Target FEC Stack

     Pad

     Vendor Enterprise Number

     Reply TOS Byte

     P2MP Egress Identifier [RFC6425]

     Echo Jitter TLV [RFC6425]

     Vendor Private TLVs

   The message is then encapsulated in a UDP packet. The source UDP
   port is copied from the Proxy Echo Parameters object. The
   destination port copied from the proxy ping request message.

   The source IP address is set to a routable address of the proxy LSR.
   Per usual the TTL of the IP packet is set to 1.

   If the Explicit DSCP flag is set, the Requested DSCP byte is
   examined. If the setting is permitted then the DSCP byte of the IP
   header of the MPLS Echo Request message is set to that value.
   Otherwise the DSCP byte is set to a default value. In this case the
   MPLS Proxy Echo Parameters with the Explicit DSCP flag cleared MUST
   be included in any MPLS proxy ping reply message. The return code
   MUST be set to <tba>, "Proxy ping parameters modified". The DSCP
   field of the MPLS Proxy Echo Parameters SHOULD be set to the actual
   value used.

3.2.3.2. Per interface sending procedures

   The proxy LSR now iterates through the Next_Hop_List modifying the
   base MPLS echo request to form the MPLS echo request packet which is
   then sent on that particular interface.

   For each next hop address, the outgoing label stack is determined.
   The TTL for the label corresponding to the FEC specified in the FEC
   stack is set such that the TTL on the wire will be one less than the
   TTL specified in the Proxy Echo Parameters. If any additional labels
   are pushed onto the stack, their TTLs are set to 255.

   If the MPLS proxy ping request message contained Downstream Mapping/
   Enhanced Downstream Mapping objects, they are examined. If the
   Downstream IP Address matches the next hop address that Downstream
   Mapping object is included in the MPLS echo request.

   The packet is then transmitted on this interface.

4. Proxy Ping Request / Reply Messages

   This document defines two new LSP Ping messages, the MPLS proxy ping
   request and the MPLS proxy ping reply.

4.1. Proxy Ping Request / Reply Message formats

   Except where noted, the definitions of all fields in the messages are
   identical to those found in [RFC4379]. The messages have the
   following format:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |       Version Number          |         MUST Be Zero          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Message Type |   Reply mode   |  Return Code  | Return Subcode|
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                       Sender's Handle                         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                       Sequence Number                         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                         TLVs ...                              |
   .                                                               .
   .                                                               .
   .                                                               .
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Version Number

      The Version Number is currently 1. (Note: the Version Number
      is to be incremented whenever a change is made that affects the
      ability of an implementation to correctly parse or process an
      MPLS echo request/reply. These changes include any syntactic
      or semantic changes made to any of the fixed fields, or to any
      TLV or sub-TLV assignment or format that is defined at a
      certain version number. The Version Number may not need to be
      changed if an optional TLV or sub-TLV is added.)

   Message Type

      Type   Message
      ----   -------
        5   MPLS proxy ping request
               (Pending IANA assignment)
        6   MPLS proxy ping reply
               (Pending IANA assignment)

4.2. Proxy Ping Request Message contents

The MPLS proxy ping request message MAY contain the following
objects:

```
    Type    Object
    ----    -----------
       1    Target FEC Stack
       2    Downstream Mapping
       3    Pad
       5    Vendor Enterprise Number
      10    Reply TOS Byte

      11    P2MP Egress Identifier [RFC6425]
      12    Echo Jitter TLV [RFC6425]
      20    Downstream Detailed Mapping
      30    Proxy Echo Parameters (Pending IANA assignment)
            Vendor Private TLVs
```

4.3. Proxy Ping Reply Message Contents

The MPLS proxy ping reply message MAY contain the following objects:

```
    Type    Object
    ----    -----------
       1    Target FEC Stack
       2    Downstream Mapping
       5    Vendor Enterprise Number
       9    Errored TLVs
      20    Downstream Detailed Mapping
      30    Proxy Echo Parameters
            (Pending IANA assignment)
      31    Upstream Neighbor Address
      32    Downstream Neighbor Address (0 or more)
            Vendor Private objects
```

5. Object formats

5.1. Proxy Echo Parameters Object

The Proxy Echo Parameters object is a TLV that MUST be included in an
MPLS Proxy Echo Request message. The length of the TLV is 12 + K +
S, where K is the length of the Destination IP Address field and S is
the total length of the sub-objects. The Proxy Echo Parameters
object can be used to either to 1) control attributes used in
Composing and Sending an MPLS echo request or 2) query the Proxy LSR
for information about the topmost FEC in the target FEC stack but not

both. In the case where the Proxy LSR is being queried (ie
information needs to be returned in a Proxy Reply), no MPLS echo
request will be sent from the Proxy LSR. The MPLS Proxy Echo request
echo header's Reply Mode should be set to "Reply with Proxy Info".

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Address Type |   Reply mode  |          Proxy Flags          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     TTL      |  Rqst'd DSCP  |         Source UDP Port       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         Global Flags         |        MPLS Payload size       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   :                   Destination IP Address                     :
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   :                                                               :
   :                        Sub-Objects                           :
   :                                                               :
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Address Type

   The type and length of the address found in the in the
   Destination IP Address and Next Hop IP Addresses fields.
   The type codes appear in the table below:

      Address Family   Type   Length

         IPv4   1   4
         IPv6   3   16

Reply mode

   The reply mode to be sent in the MPLS Echo Request message; the
   values are as specified in [RFC4379].

Proxy Flags

   Request for FEC Neighbor Address info   0x01

      When set this requests that the proxy LSR supply the
      Upstream and Downstream neighbor address information in the
      MPLS proxy ping reply message. This flag is only applicable

      for the topmost FEC in the FEC stack if the FEC types
      corresponds with a P2MP or MP2MP LSPs. The Proxy LSR MUST
      respond as spplicable with a Upstream Neighbor Address
      Object and Downstream Neighbor Address Object(s) in the MPLS
      Proxy ping reply message. Upstream Neighbor Address Object
      needs be included only if there is an upstream neighbor.
      Similarly, one Downstream Neighbor Address Object needs to
      be included for each Downstream Neighbor for which the LSR
      learned bindings from.

      Setting this flag will cause the proxy LSR to cancel
      sending an Echo request as the information being requested
      needs to be returned for use in a subsequent Proxy Request.

   Request for Downstream Mapping   0x02

      When set this requests that the proxy LSR supply a
      Downstream Mapping object see [RFC4379] in the MPLS
      proxy ping reply message. It's not valid
      to have Request for Enhanced Downstream Mapping flag set
      when this flag is set.

      Setting this flag will cause the proxy LSR to cancel
      sending an Echo request as the information being requested
      needs to be returned for use in a subsequent Proxy Request.

   Request for Enhanced Downstream Mapping 0x04

      When set this requests that the proxy LSR supply a
      Enhanced Downstream Mapping object see [RFC6424] in the
      MPLS proxy ping reply message. It's not valid
      to have Request for Downstream Mapping flag set
      when this flag is set.

      Setting this flag will cause the proxy LSR to cancel
      sending an Echo request as the information being requested
      needs to be returned for use in a subsequent Proxy Request.

   Explicit DSCP Request   0x08

      When set this requests that the proxy LSR use
      the supplied "Rqst'd DSCP" byte in the echo request message

   TTL

      The TTL to be used in the label stack entry corresponding to
      the topmost FEC in the in the MPLS Echo Request packet

Requested DSCP

   This field is valid only if the Explicit DSCP flag is set. If
   not set, the field MUST be zero on transmission and ignored on
   receipt. When the flag is set this field contains the DSCP
   value to be used in the MPLS echo request packet IP header.

Source UDP Port

   The source UDP port to be sent in the MPLS Echo Request packet

Global Flags

   The Global Flags to be sent in the MPLS Echo Request message

MPLS Payload Size

   Used to request that the MPLS payload (IP header + UDP header
   + MPLS echo request) be padded using a zero filled Pad TLV
   so that the IP header, UDP header nad MPLS echo request total
   the specified size. Field set to zero means no
   size request is being made. If the requested size is less
   than the minimum size required to form the MPLS echo request,
   the request will be treated as a best effort request with
   the Proxy LSR building the smallest possible packet (ie
   not using a Pad TLV).   The IP header DF bit should be set
   when this field is non zero.

Destination IP Address

   If the Address Type is IPv4, an address from the range 127/8;
   If the Address Type is IPv6, an address from the range
   ::FFFF:7F00:0/104

Sub-Objects

   A TLV encoded list of sub-objects. Currently one is defined.

   Sub-Type   Length   Value Field
   --------   ------   -----------
        1   8+   Next Hop

5.1.1. Next Hop sub-Object

This sub-object is used to describe a particular next hop towards
which the Echo Request packet should be sent. If the topmost FEC in
the FEC-stack is a multipoint LSP, this sub-object may appear
multiple times.

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Addr Type   |                 MUST be Zero                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |             Next Hop IP Address (4 or 16 octets)             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |             Next Hop Interface  (0, 4 or 16 octets)          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
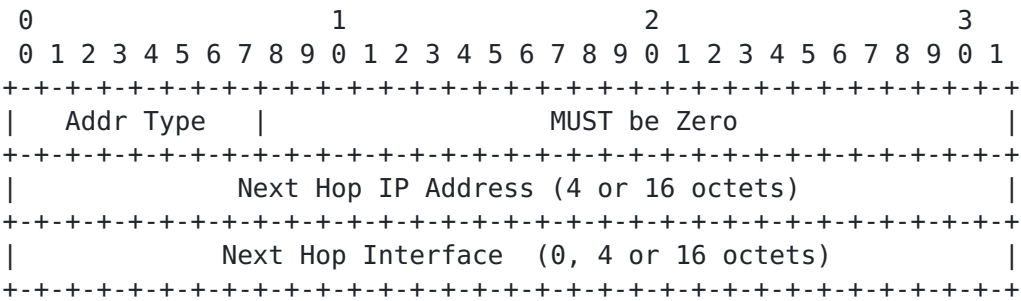
Address Type

Type	Type of Next Hop	Addr Length	IF Length
1	IPv4 Numbered	4	4
2	IPv4 Unnumbered	4	4
3	IPv6 Numbered	16	16
4	IPv6 Unnumbered	16	4
5	IPv4 Protocol Adj	4	0
6	IPv6 Protocol Adj	16	0

Note: Types 1-4 correspond to the types in the DS Mapping
       object. They are expected to populated with information
       obtained through a previously returned DS Mapping object.
       Types 5 and 6 are intended to be populated from the local
       address information obtained from a previously returned
       Previous Hop Address Object.

Next Hop IP Address

   A next hop address that the echo request message is to
   be sent towards

Next Hop Interface

   Identifier of the interface through which the echo request
   message is to be sent

5.2. Reply-to Address Object

Used to specify the MPLS echo request IP source address. This
address must be IP reachable via the Proxy LSR otherwise it will be
rejected.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Address Type |               MUST be Zero                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
:                      Reply-to Address                         :
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Address Type

    A type code as specified in the table below:

        Type   Type of Address

          1   IPv4
          3   IPv6

[5.3](#). **Upstream Neighbor Address Object**
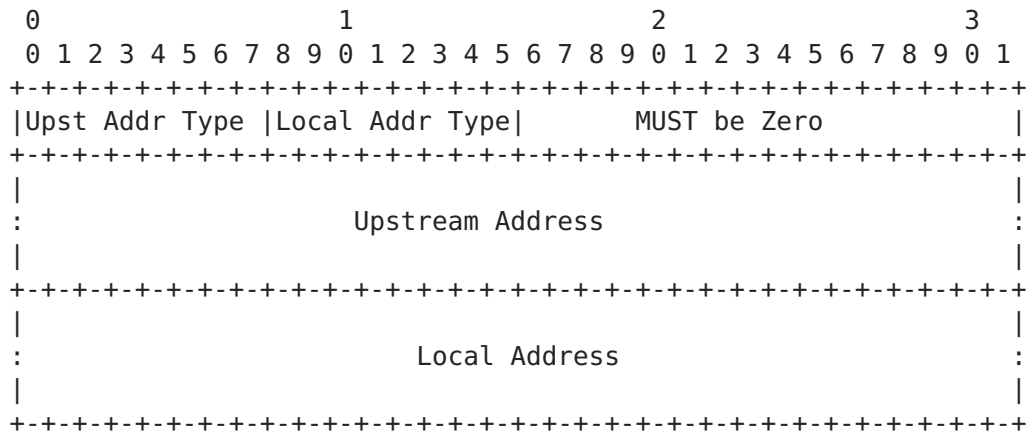
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Upst Addr Type |Local Addr Type|         MUST be Zero          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
:                      Upstream Address                         :
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
:                       Local Address                           :
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Upst Addr Type; Local Addr Type

   These two fields determine the type and length of the
   respective addresses. The codes are specified in the table
   below:

      Type   Type of Address   Length

       0   No Address Supplied   0
       1   IPv4   4
       3   IPv6   16

Upstream Address

   The address of the immediate upstream neighbor for the topmost
   FEC in the FEC stack. If protocol adjacency exists by which
   the label for this FEC was exchanged, this address MUST be the
   address used in that protocol exchange.

Local Address

   The local address used in the protocol adjacency exists by
   which the label for this FEC was exchanged.

5.4. Downstream Neighbor Address Object

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |Dnst Addr Type |Local Addr Type|       MUST be Zero            |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
    :                    Downstream Address                         :
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
    :                      Local Address                            :
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Upst Addr Type; Local Addr Type

      These two fields determine the type and length of the
      respective addresses. The codes are specified in the table
      below:

         Type   Type of Address   Length

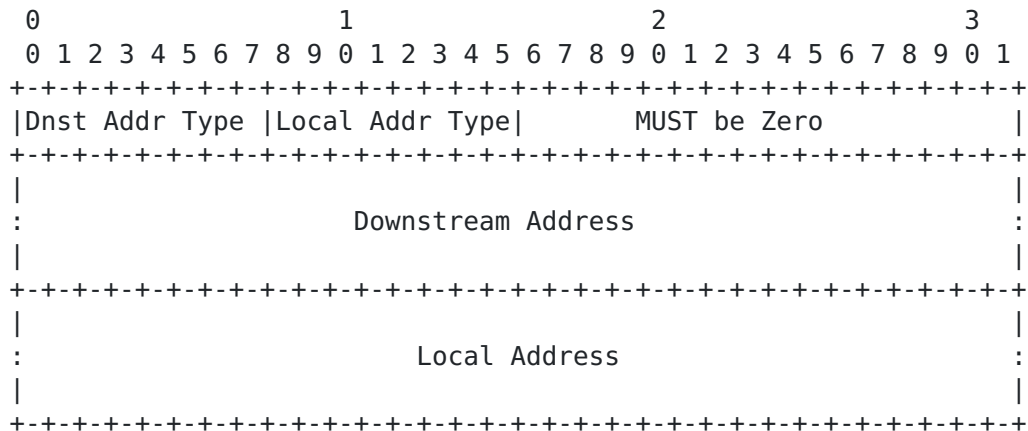   0   No Address Supplied   0
          1   IPv4   4
          3   IPv6   16

   Upstream Address

      The address of a immediate downstream neighbor for the topmost
      FEC in the FEC stack. If protocol adjacency exists by which
      the label for this FEC was exchanged, this address MUST be the
      address used in that protocol exchange.

   Local Address

      The local address used in the protocol adjacency exists by
      which the label for this FEC was exchanged.

[6]. Security Considerations

   The mechanisms described in this document are intended to be used
   within a Service Provider network and to be initiated only under the
   authority of that administration.

   If such a network also carries internet traffic, or permits IP access
   from other administrations, MPLS proxy ping message SHOULD be

discarded at those points. This can be accomplished by filtering on
source address or by filtering all MPLS ping messages on UDP port.

Any node which acts as a proxy node SHOULD validate requests against
a set of valid source addresses. An implementation MUST provide such
filtering capabilities.

MPLS proxy ping request messages are IP addressed directly to the
Proxy node. If a node which receives an MPLS proxy ping message via
IP or Label TTL expiration, it MUST NOT be acted upon.

MPLS proxy ping request messages are IP addressed directly to the
Proxy node. If a MPLS Proxy ping request IP destination address is a
Martian Address, it MUST NOT be acted upon.

if a MPLS Proxy ping request IP source address is not IP reachable,
it MUST NOT be acted upon.

MPLS proxy ping requests are limited to making their request via the
specification of a FEC. This ensures that only valid MPLS echo
request messages can be created. No label spoofing attacks are
possible.

[7](#). IANA Considerations

This document makes the following assignments (pending IANA action)

LSP Ping Message Types

```
     Type        Value Field
     ----        -----------
       03(tba)  MPLS proxy ping request message
       04(tba)  MPLS proxy ping reply
```

Objects and Sub-Objects

```
     Type       Sub-Type        Value Field
     ----       --------        -----------
       22(tba)                  Proxy Echo Parameters
                     1          Next Hop
       23(tba)                  Reply-to Address
       24(tba)                  Upstream Neighbor Address
       25(tba)                  Downstream Neighbor Address
```

Return Code [pending IANA assignment]

```
     Value      Meaning
     -----      -------
       16(tba)  Proxy ping not authorized.
       17(tba)  Proxy ping parameters need to be modified.
       18(tba)  MPLS Echo Request Could not be sent.
       18(tba)  Replying router has FEC mapping for topmost FEC.
```


8. References

8.1. Normative References

   [RFC4379] Kompella, K. and G. Swallow, "Detecting Multi-Protocol
              Label Switched (MPLS) Data Plane Failures", RFC 4379,
              February 2006.

   [RFC6424] Bahadur, N., Kompella, K., and G. Swallow, "Mechanism for
              Performing Label Switched Path Ping (LSP Ping) over MPLS
              Tunnels", RFC 6424, November 2011.

   [RFC6425] Saxena, S., Swallow, G., Ali, Z., Farrel, A., Yasukawa,
              S., and T. Nadeau, "Detecting Data-Plane Failures in
              Point-to-Multipoint MPLS - Extensions to LSP Ping",
              RFC 6425, November 2011.

8.2. Informative References

   [RFC4875] Aggarwal, R., Papadimitriou, D., and S. Yasukawa,
              "Extensions to Resource Reservation Protocol - Traffic
              Engineering (RSVP-TE) for Point-to-Multipoint TE Label
              Switched Paths (LSPs)", RFC 4875, May 2007.

   [RFC6388] Wijnands, IJ., Minei, I., Kompella, K., and B. Thomas,
              "Label Distribution Protocol Extensions for Point-to-
              Multipoint and Multipoint-to-Multipoint Label Switched
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