        MPLS Transport Profile (MPLS-TP) Next-Hop Ethernet Addressing

Abstract

   The MPLS Transport Profile (MPLS-TP) is the set of MPLS protocol
   functions applicable to the construction and operation of packet-
   switched transport networks. This document presents considerations
   for link-layer addressing of Ethernet frames carrying MPLS-TP
   packets.

Status of This Memo

   This is an Internet Standards Track document.

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   received public review and has been approved for publication by the
   Internet Engineering Steering Group (IESG). Further information on
   Internet Standards is available in Section 2 of RFC 5741.

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1. Introduction

   The MPLS Transport Profile (MPLS-TP) [RFC5921] is the set of protocol
   functions that meet the requirements [RFC5654] for the application of
   MPLS to the construction and operation of packet-switched transport
   networks. The MPLS-TP data plane consists of those MPLS-TP functions
   concerned with the encapsulation and forwarding of MPLS-TP packets
   and is described in [RFC5960].

   This document presents considerations for link-layer addressing of
   Ethernet frames carrying MPLS-TP packets. Since MPLS-TP packets are
   MPLS packets, existing procedures ([RFC3032], [RFC5332]) for the
   encapsulation of MPLS packets over Ethernet apply. Because IP
   functionality is optional in an MPLS-TP network, IP-based protocols
   for Media Access Control (MAC) address learning, such as the Address
   Resolution Protocol (ARP) [RFC826] and IPv6 Neighbor Discovery
   [RFC4861], may not be available. This document specifies the options
   for the determination and selection of the next-hop Ethernet MAC
   address when MPLS-TP is used between nodes that do not have an IP
   data plane.

1.1. Terminology

   Term   Definition
   ------- ----------------------------
   ARP   Address Resolution Protocol
   G-ACh   Generic Associated Channel
   LSP   Label Switched Path
   LSR   Label Switching Router
   MAC   Media Access Control
   MPLS-TP MPLS Transport Profile

   Additional definitions and terminology can be found in [RFC5960] and
   [RFC5654].

1.2. 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 [RFC2119].

2. Point-to-Point Link Addressing

   When two MPLS-TP nodes are connected by a point-to-point Ethernet
   link, the question arises as to what destination Ethernet Media
   Access Control (MAC) address should be specified in Ethernet frames
   transmitted to the peer node over the link. The problem of
   determining this address does not arise in IP/MPLS networks because

of the presence of the Ethernet Address Resolution Protocol (commonly
referred to as the Address Resolution Protocol and shortened to ARP)
[RFC826] or IPv6 Neighbor Discovery (ND) protocol [RFC4861], which
allow the unicast MAC address of the peer device to be learned
dynamically.

If existing mechanisms are available in an MPLS-TP network to
determine the destination unicast MAC addresses of peer nodes, for
example, if the network also happens to be an IP/MPLS network, or if
the Link Layer Discovery Protocol (LLDP) [LLDP] is in use, these
methods SHOULD be used. If ARP, ND, and LLDP are not available, and
both peers implement the procedures in Section 4 of this document,
then the GAP mechanism described in this memo SHOULD be used. The
remainder of this section discusses alternative options that might be
employed when none of the preceding mechanisms for learning MAC
addresses are available.

One common approach is for each node to be statically configured with
the MAC address of its peer. However, static MAC address
configuration can present an administrative burden and lead to
operational problems. For example, replacement of an Ethernet
interface to resolve a hardware fault when this approach is used
requires that the peer node be manually reconfigured with the new MAC
address. This is especially problematic if the peer is operated by
another provider.

Another approach that may be considered is to use the Ethernet
broadcast address FF-FF-FF-FF-FF-FF as the destination MAC address in
frames carrying MPLS-TP packets over a link that is known to be
point-to-point. This may, however, lead to excessive frame
distribution and processing at the Ethernet layer. Broadcast traffic
may also be treated specially by some devices, and this may not be
desirable for MPLS-TP data frames.

In view of the above considerations, this document recommends that,
if a non-negotiated address is to be used, both nodes are configured
to use as a destination MAC address an Ethernet multicast address
reserved for MPLS-TP for use over point-to-point links. The address
allocated for this purpose by the Internet Assigned Numbers Authority
(IANA) is 01-00-5E-90-00-00. An MPLS-TP implementation MUST default
to passing to the MPLS sub-system any MPLS packets received from a
point-to-point Ethernet link with this destination MAC address.

The use of broadcast or multicast addressing for the purpose
described in this section, i.e., as a placeholder for the unknown
unicast MAC address of the destination, is applicable only when the
attached Ethernet link is known to be point-to-point. If a link is
not known to be point-to-point, these forms of broadcast or multicast

addressing MUST NOT be used. Thus, the implementation MUST provide a
means for the operator to declare that a link is point-to-point if it
supports these addressing modes. Moreover, the operator is cautioned
that it is not always clear whether a given link is, or will remain,
strictly point-to-point, particularly when the link is supplied by an
external provider; point-to-point declarations therefore need to be
used with care. Because of these caveats, it is RECOMMENDED that
implementations support the procedures in Section 4 so that unicast
addressing can be used.

3. Multipoint Link Addressing

   When a multipoint Ethernet link serves as a section [RFC5960] for a
   point-to-multipoint MPLS-TP LSP, and multicast destination MAC
   addressing at the Ethernet layer is used for the LSP, the addressing
   and encapsulation procedures specified in [RFC5332] SHALL be used.

   When a multipoint Ethernet link (that is, a link that is not known to
   be point-to-point) serves as a section for a point-to-point MPLS-TP
   LSP, unicast destination MAC addresses MUST be used for Ethernet
   frames carrying packets of the LSP. According to the discussion in
   the previous section, this implies the use of either static MAC
   address configuration or a protocol that enables peer MAC address
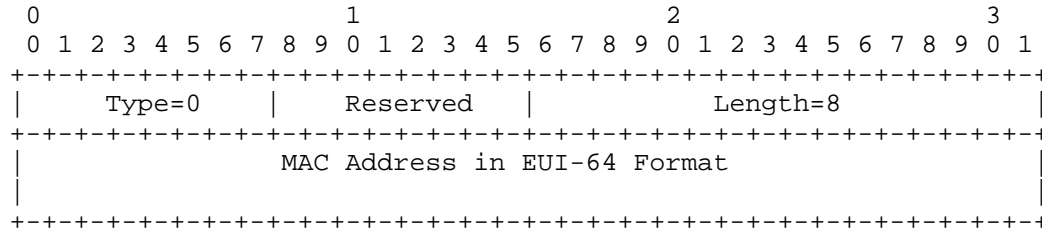   discovery.

4. MAC Address Discovery via the G-ACh Advertisement Protocol

   The G-ACh Advertisement Protocol (GAP) [RFC7212] provides a simple
   means of informing listeners on a link of the sender's capabilities
   and configuration. When used for this purpose on an Ethernet link,
   GAP messages are multicast to the address 01-00-5e-80-00-0d (see
   Section 7 of [RFC7212]). If these messages contain the unicast MAC
   address of the sender, then listeners can learn this address and use
   it in the future when transmitting frames containing MPLS-TP packets.
   Since the GAP does not rely on IP, this provides a means of unicast
   MAC discovery for MPLS-TP nodes without IP support.

   This document defines a new GAP application "Ethernet Interface
   Parameters" (0x0001) to support the advertisement of Ethernet-
   specific parameters associated with the sending interface. The
   following Type-Length-Value (TLV) objects are defined for this
   application; the TLV format is as defined in [RFC7212]:

      Source MAC Address (type = 0, length = 8): The Value of this
      object is an EUI-64 [EUI-64] unicast MAC address assigned to one
      of the interfaces of the sender that is connected to this data
      link. The IEEE-defined mapping from 48-bit MAC addresses to
      EUI-64 form is used.

Maximum Frame Size (MFS) (type = 1, length = 4): The Value of this
object is a 32-bit unsigned integer encoded in network byte order
that specifies the maximum frame size in octets of an Ethernet
Frame that can be sent over the sending interface. Where MAC
address learning occurs by some other means, this TLV group MAY be
used to advertise only the MFS. If multiple advertisements are
made for the same parameter, use of these advertisements is
undefined.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Type=0     |    Reserved   |          Length=8             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             MAC Address in EUI-64 Format                      |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                   Source MAC Address Object 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Type=1     |    Reserved   |          Length=4             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Maximum Frame Size (MFS)                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
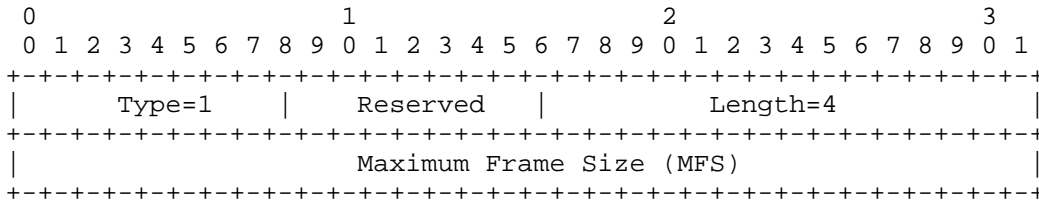
                         MFS Object Format

Per [RFC7212], MAC address discovery information needs to be
periodically retransmitted and is to be retained by a receiver based
on the period of time indicated by the associated Lifetime field. To
expedite the initialization of a link, it is RECOMMENDED that a node
that has been reconfigured, rebooted, or is aware that it has been
disconnected from its peer send a GAP Ethernet Interface Parameters
message, and that it issue a GAP Request message for the Ethernet
Interface Parameters of its peers, at the earliest opportunity.

When the MAC address in the received Source MAC Address TLV changes,
the new MAC address MUST be used (see Section 5.2 of [RFC7212]).

If a minimum MFS is configured for a link and the MFS advertised by
the peer is lower than that minimum, the operator MUST be notified of
the MFS mismatch. Under these circumstances, the operator may choose
to configure the LSR to shut down the link, thereby triggering a

fault and causing the end-to-end path to be repaired. Alternatively,
the operator may choose to configure the LSR to leave the link up so
that an OAM message can be used to verify the actual MFS.

A peer node could cease transmission of G-ACh advertisements, or
cease to include a Source MAC Address TLV in advertisements, or cease
to be connected, any of which will cause the TLV lifetime to expire.
After the Source MAC Address TLV lifetime has expired, this MAC
Address MUST NOT be used as the peer MAC address. The node MUST
return to selecting MAC addresses as though no advertisements were
received, using the method configured for this eventuality.

5. Manageability Considerations

   The values sent and received by this protocol MUST be made accessible
   for inspection by network operators, and where local configuration is
   updated by received information, it MUST be clear why the configured
   value has been changed. If the received values change, the new
   values MUST be used and the change made visible to the network
   operators.

   The Ethernet address and associated parameters advertised for an
   interface SHOULD be persistent across restarts. In the event of a
   system restart, any data that has been retained as a consequence of
   prior Ethernet Interface Parameters advertisements from GAP peers
   MUST be discarded; this prevents incorrect operation on the basis of
   stale data.

   Where the link changes to a new type, i.e., from point-to-point to
   point-to-multipoint, the network operator SHOULD be informed. If the
   new link type is incompatible with the Ethernet addressing method in
   use, the system MUST take the action that is configured under those
   circumstances.

6. Security Considerations

   The use of broadcast or multicast Ethernet destination MAC addresses
   for frames carrying MPLS-TP data packets can potentially result in
   such frames being distributed to devices other than the intended
   destination node or nodes when the Ethernet link is not point-to-
   point. The operator should take care to ensure that MPLS-TP nodes
   are aware of the Ethernet link type (point-to-point or multipoint).
   In the case of multipoint links, the operator should either ensure
   that no devices are attached to the link that are not authorized to
   receive the frames or take steps to mitigate the possibility of
   excessive frame distribution (for example, by configuring the
   Ethernet switch to appropriately restrict the delivery of multicast
   frames to authorized ports).

An attacker could disrupt communications by modifying the Source MAC
Address or the MFS values; however, this is mitigated by the use of
cryptographic authentication as described in [RFC7212], which also
describes other considerations applicable to the GAP protocol.
Visibility into the contents of either of the TLVs could provide
information that is useful for an attacker. This is best addressed
by physical security of the links.

7. IANA Considerations

7.1. Ethernet Multicast Address Allocation

   IANA has allocated an Ethernet multicast address from the "IANA
   Multicast 48-bit MAC Addresses" address block in the "Ethernet
   Numbers" registry for use by MPLS-TP LSRs over point-to-point links
   as described in Section 2. The allocated address is
   01-00-5E-90-00-00. IANA has updated the reference to point to the
   RFC number assigned to this document.

7.2. G-ACh Advertisement Protocol Allocation

   IANA has allocated a new Application ID in the "G-ACh Advertisement
   Protocol Application Registry", as follows:

   Application ID Description   Reference
   -------------- ----------------------------- ----------
   0x0001   Ethernet Interface Parameters This RFC

7.3. Creation of Ethernet Interface Parameters Registry

   IANA has created a new registry, "G-ACh Advertisement Protocol:
   Ethernet Interface Parameters" within the "Generic Associated Channel
   (G-ACh) Parameters" registry with fields and initial allocations as
   follows:

   Type Name   Type ID Reference
   ------------------ ------- ---------
   Source MAC Address 0   This RFC
   Maximum Frame Size 1   This RFC

   The range of the Type ID field is 0 - 255.

   The allocation policy for this registry is IETF Review or IESG
   Approval.

8. Acknowledgements

   We thank Adrian Farrel for his valuable review comments on this
   document.

9. References

9.1. Normative References

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9.2. Informative References

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