     Intermediate System to Intermediate System (IS-IS) Extensions
      in Support of Generalized Multi-Protocol Label Switching (GMPLS)

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Abstract

   This document specifies encoding of extensions to the IS-IS routing
   protocol in support of Generalized Multi-Protocol Label Switching
   (GMPLS).

1. Introduction

   This document specifies extensions to the IS-IS routing protocol in
   support of carrying link state information for Generalized Multi-
   Protocol Label Switching (GMPLS). The set of required enhancements
   to IS-IS are outlined in [GMPLS-ROUTING]. Support for unnumbered
   interfaces assumes support for the "Point-to-Point Three-Way
   Adjacency" IS-IS Option type [ISIS-3way].

   In this section we define the enhancements to the Traffic Engineering
   (TE) properties of GMPLS TE links that can be announced in IS-IS Link
   State Protocol Data Units.

   In this document, we enhance the sub-TLVs for the extended IS
   reachability TLV (see [ISIS-TE]) in support of GMPLS. Specifically,
   we add the following sub-TLVs:

Sub-TLV Type	Length	Name
4	8	Link Local/Remote Identifiers
20	2	Link Protection Type
21	variable	Interface Switching Capability Descriptor

   We further add one new TLV to the TE TLVs:

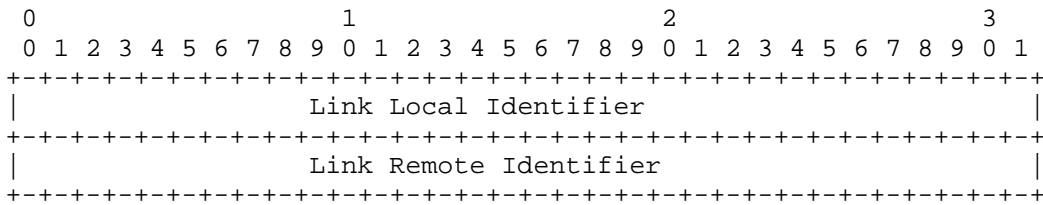   TLV Type   Length   Name
              138   variable   Shared Risk Link Group

   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 [RFC2119].

1.1. Link Local/Remote Identifiers

   A Link Local Interface Identifiers is a sub-TLV of the extended IS
   reachability TLV. The type of this sub-TLV is 4, and length is eight
   octets. The value field of this sub-TLV contains four octets of Link
   Local Identifier followed by four octets of Link Remote Identifier
   (see Section "Support for unnumbered links" of [GMPLS-ROUTING]). If
   the Link Remote Identifier is unknown, it is set to 0.

   The following illustrates encoding of the Value field of the Link
   Local/Remote Identifiers sub-TLV.

        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
       +-+
       | Link Local Identifier |
       +-+
       | Link Remote Identifier |
       +-+
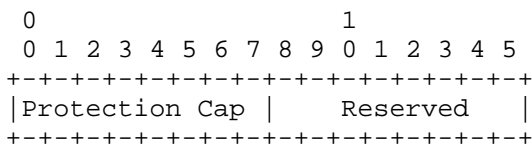
   The Link Local/Remote Identifiers sub-TLV MUST NOT occur more than
   once within the extended IS reachability TLV. If the Link
   Local/Remote Identifiers sub-TLV occurs more than once within the
   extended IS reachability TLV, the receiver SHOULD ignore all these
   sub-TLVs.

1.2. Link Protection Type

   The Link Protection Type is a sub-TLV (of type 20) of the extended IS
   reachability TLV, with length two octets.

   The following illustrates encoding of the Value field of the Link
   Protection Type sub-TLV.

        0   1
        0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |Protection Cap | Reserved |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

The first octet is a bit vector describing the protection
capabilities of the link (see Section "Link Protection Type" of
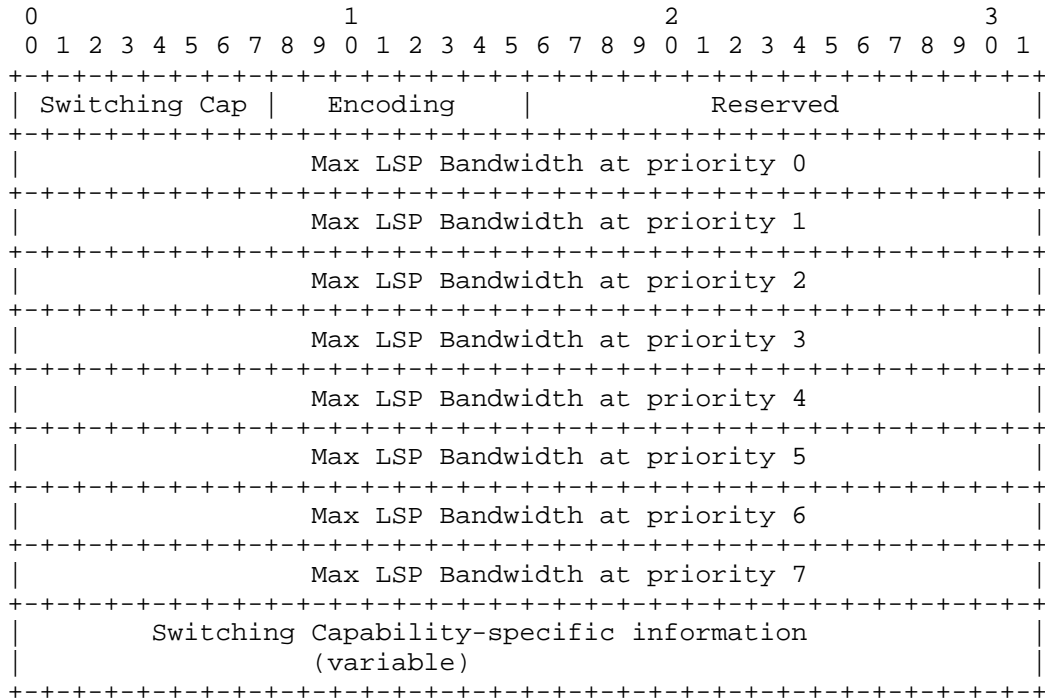[GMPLS-ROUTING]). They are:

     0x01 Extra Traffic

     0x02 Unprotected

     0x04 Shared

     0x08 Dedicated 1:1

     0x10 Dedicated 1+1

     0x20 Enhanced

     0x40 Reserved

     0x80 Reserved

The second octet SHOULD be set to zero by the sender, and SHOULD be
ignored by the receiver.

The Link Protection Type sub-TLV MUST NOT occur more than once within
the extended IS reachability TLV. If the Link Protection Type sub-
TLV occurs more than once within the extended IS reachability TLV,
the receiver SHOULD ignore all these sub-TLVs.

1.3. Interface Switching Capability Descriptor

The Interface Switching Capability Descriptor is a sub-TLV (of type
21) of the extended IS reachability TLV. The length is the length of
value field in octets. The following illustrates encoding of the
Value field of the Interface Switching Capability Descriptor sub-TLV.

```
          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
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         | Switching Cap |   Encoding    |             Reserved          |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |                 Max LSP Bandwidth at priority 0               |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |                 Max LSP Bandwidth at priority 1               |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |                 Max LSP Bandwidth at priority 2               |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |                 Max LSP Bandwidth at priority 3               |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |                 Max LSP Bandwidth at priority 4               |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |                 Max LSP Bandwidth at priority 5               |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |                 Max LSP Bandwidth at priority 6               |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |                 Max LSP Bandwidth at priority 7               |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |          Switching Capability-specific information           |
         |                         (variable)                           |
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   The Switching Capability (Switching Cap) field contains one of the
   following values:

```
        1       Packet-Switch Capable-1 (PSC-1)
        2       Packet-Switch Capable-2 (PSC-2)
        3       Packet-Switch Capable-3 (PSC-3)
        4       Packet-Switch Capable-4 (PSC-4)
        51      Layer-2 Switch Capable  (L2SC)
        100     Time-Division-Multiplex Capable (TDM)
        150     Lambda-Switch Capable   (LSC)
        200     Fiber-Switch Capable    (FSC)
```
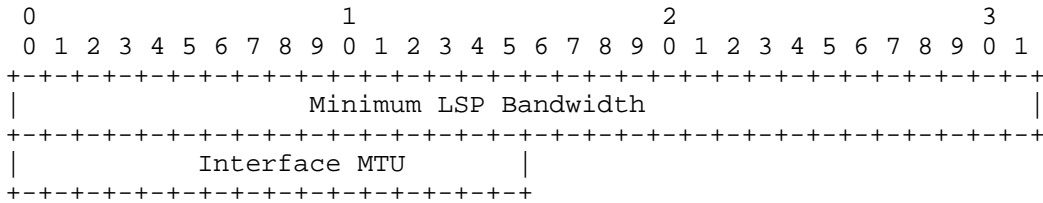
   The Encoding field contains one of the values specified in Section
   3.1.1 of [GMPLS-SIG].

   Maximum LSP Bandwidth is encoded as a list of eight 4 octet fields in
   the IEEE floating point format [IEEE], with priority 0 first and
   priority 7 last. The units are bytes (not bits!) per second.

   The content of the Switching Capability specific information field
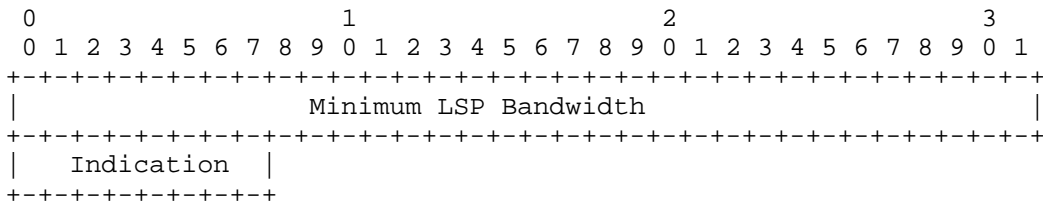   depends on the value of the Switching Capability field.

When the Switching Capability field is PSC-1, PSC-2, PSC-3, or PSC-4,
the Switching Capability specific information field includes Minimum
LSP Bandwidth and Interface MTU.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     Minimum LSP Bandwidth                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         Interface MTU         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The Minimum LSP Bandwidth is encoded in a 4 octets field in the IEEE
floating point format. The units are bytes (not bits!) per second.
The Interface MTU is encoded as a 2 octets integer, and carries the
MTU value in the units of bytes.

When the Switching Capability field is L2SC, there is no Switching
Capability specific information field present.

When the Switching Capability field is TDM, the Switching Capability
specific information field includes Minimum LSP Bandwidth and an
indication whether the interface supports Standard or Arbitrary
SONET/SDH.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     Minimum LSP Bandwidth                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Indication  |
   +-+-+-+-+-+-+-+-+
```

The Minimum LSP Bandwidth is encoded in a 4 octets field in the IEEE
floating point format. The units are bytes (not bits!) per second.
The indication whether the interface supports Standard or Arbitrary
SONET/SDH is encoded as 1 octet. The value of this octet is 0 if the
interface supports Standard SONET/SDH, and 1 if the interface
supports Arbitrary SONET/SDH.

When the Switching Capability field is LSC, there is no Switching
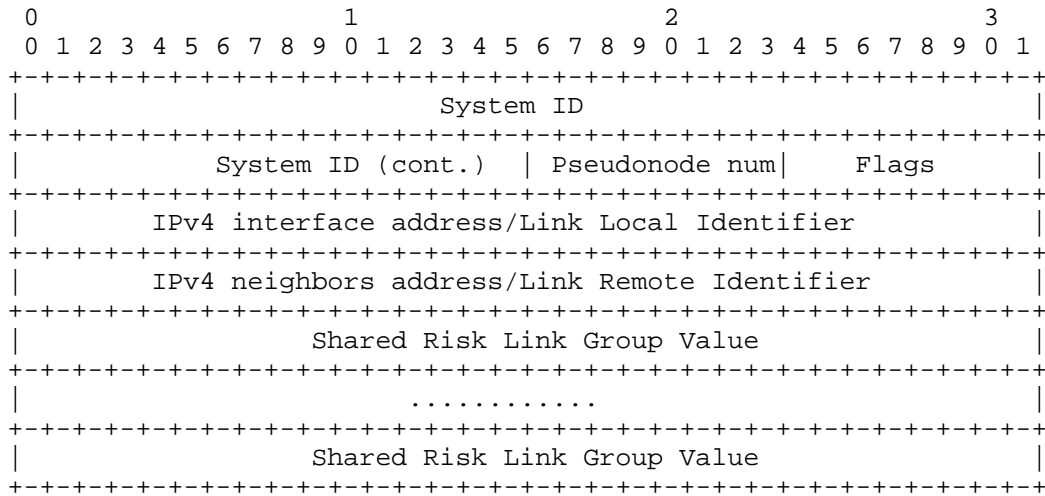Capability specific information field present.

To support interfaces that have more than one Interface Switching
Capability Descriptor (see Section "Interface Switching Capability
Descriptor" of [GMPLS-ROUTING]) the Interface Switching Capability
Descriptor sub-TLV MAY occur more than once within the extended IS
reachability TLV.

1.4. Shared Risk Link Group TLV

   The SRLG TLV (of type 138) contains a data structure consisting of:

        6 octets of System ID
        1 octet of Pseudonode Number
        1 octet Flag
        4 octets of IPv4 interface address or 4 octets of a Link Local
          Identifier
        4 octets of IPv4 neighbor address or 4 octets of a Link Remote
          Identifier
        (variable) list of SRLG values, where each element in the list
          has 4 octets.

   The following illustrates encoding of the Value field of the SRLG
   TLV.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                         System ID                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |         System ID (cont.)     | Pseudonode num|    Flags      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        IPv4 interface address/Link Local Identifier          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        IPv4 neighbors address/Link Remote Identifier         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                 Shared Risk Link Group Value                 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        ...........                           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                 Shared Risk Link Group Value                 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   The neighbor is identified by its System Id (6-octets), plus one
   octet to indicate the pseudonode number if the neighbor is on a LAN
   interface.

   The Least Significant Bit of the Flag octet indicates whether the
   interface is numbered (set to 1), or unnumbered (set to 0). All
   other bits are reserved and should be set to 0.

   The length of this TLV is 16 + 4 * (number of SRLG values).

   This TLV carries the Shared Risk Link Group information (see Section
   "Shared Risk Link Group Information" of [GMPLS-ROUTING]).

The SRLG TLV MAY occur more than once within the IS-IS Link State
Protocol Data Units.

1.5. Link Identifier for Unnumbered Interfaces

Link Identifiers are exchanged in the Extended Local Circuit ID field
of the "Point-to-Point Three-Way Adjacency" IS-IS Option type
[ISIS-3way].

2. Implications on Graceful Restart

The restarting node SHOULD follow the ISIS restart procedures
[ISIS-RESTART], and the RSVP-TE restart procedures [GMPLS-RSVP].

When the restarting node is going to originate its IS-IS Link State
Protocol data units for TE links, these Link State Protocol data
units SHOULD be originated with 0 unreserved bandwidth, Traffic
Engineering Default metric set to 0xffffff, and if the link has LSC
or FSC as its Switching Capability then also with 0 as Max LSP
Bandwidth, until the node is able to determine the amount of
unreserved resources taking into account the resources reserved by
the already established LSPs that have been preserved across the
restart. Once the restarting node determines the amount of
unreserved resources, taking into account the resources reserved by
the already established LSPs that have been preserved across the
restart, the node SHOULD advertise these resources in its Link State
Protocol data units.

In addition, in the case of a planned restart prior to restarting,
the restarting node SHOULD originate the IS-IS Link State Protocol
data units for TE links with 0 as unreserved bandwidth, and if the
link has LSC or FSC as its Switching Capability then also with 0 as
Max LSP Bandwidth. This would discourage new LSP establishment
through the restarting router.

Neighbors of the restarting node SHOULD continue to advertise the
actual unreserved bandwidth on the TE links from the neighbors to
that node.

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5. Security Considerations

   This document specifies the contents of GMPLS TE TLVs in ISIS. As
   these TLVs are not used for SPF computation or normal routing, the
   extensions specified here have no direct effect on IP routing.
   Tampering with GMPLS TE TLVs may have an effect on the underlying
   transport (optical and/or SONET-SDH) network. Mechanisms to secure
   ISIS Link State PDUs and/or the TE TLVs [ISIS-HMAC] can be used to
   secure the GMPLS TE TLVs as well.

6. IANA Considerations

   This document defines the following new ISIS TLV type that needs to
   be reflected in the ISIS TLV code-point registry:

Type	Description	IIH	LSP	SNP
138	Shared Risk Link Group	n	y	n

   This document also defines the following new sub-TLV types of top-
   level TLV 22 that need to be reflected in the ISIS sub-TLV registry
   for TLV 22:

Type	Description	Length
4	Link Local/Remote Identifiers	8
20	Link Protection Type	2
21	Interface Switching Capability Descriptor	variable

References

Normative References

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