                          IS-IS Multi-Instance

Abstract

   This document describes a mechanism that allows a single router to
   share one or more circuits among multiple Intermediate System to
   Intermediate System (IS-IS) routing protocol instances.

   Multiple instances allow the isolation of resources associated with
   each instance. Routers will form instance-specific adjacencies.
   Each instance can support multiple topologies. Each topology has a
   unique Link State Database (LSDB). Each Protocol Data Unit (PDU)
   will contain a new Type-Length-Value (TLV) identifying the instance
   and the topology (or topologies) to which the PDU belongs.

Status of This Memo

   This is an Internet Standards Track document.

   This document is a product of the Internet Engineering Task Force
   (IETF). It represents the consensus of the IETF community. It has
   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

   An existing limitation of the protocol defined by [ISO10589] is that
   only one instance of the protocol can operate on a given circuit.
   This document defines an extension to IS-IS to remove this
   restriction. The extension is referred to as "Multi-Instance IS-IS"
   (MI-IS-IS).

   Routers that support this extension are referred to as "Multi-
   Instance-capable routers" (MI-RTR).

   The use of multiple instances enhances the ability to isolate the
   resources associated with a given instance both within a router and
   across the network. Instance-specific prioritization for processing
   PDUs and performing routing calculations within a router may be
   specified. Instance-specific flooding parameters may also be defined
   so as to allow different instances to consume network-wide resources
   at different rates.

Another existing protocol limitation is that a given instance
supports a single Update Process operating on a single Link State
Database (LSDB). This document defines an extension to IS-IS to
allow non-zero instances of the protocol to support multiple Update
Processes. Each Update Process is associated with a topology and a
unique topology specific LSDB. Non-zero instances of the protocol
are only supported by MI-RTRs. Legacy routers support the standard
or zero instance of the protocol. The behavior of the standard
instance is not changed in any way by the extensions defined in this
document.

MI-IS-IS might be used to support topology-specific routing. When
used for this purpose, it is an alternative to Multi-Topology IS-IS
[RFC5120].

MI-IS-IS might also be used to support advertisement of information
on behalf of applications [RFC6823]. The advertisement of
information not directly related to the operation of the IS-IS
protocol can therefore be done in a manner that minimizes its impact
on the operation of routing.

The above are examples of how MI-IS-IS might be used. The
specification of uses of MI-IS-IS is outside the scope of this
document.

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 [RFC2119].

2. Elements Of Procedure

An Instance Identifier (IID) is introduced to uniquely identify an
IS-IS instance. The protocol extension includes a new TLV (IID-TLV)
in each IS-IS PDU originated by an MI-RTR except as noted in this
document. The IID-TLV identifies the unique instance as well as the
topology/topologies to which the PDU applies. Each IS-IS PDU is
associated with only one IS-IS instance.

MI-RTRs form instance-specific adjacencies. The IID-TLV included in
IS-IS Hellos (IIH) includes the IID and the set of Instance-Specific
Topology Identifiers (ITIDs) that the sending IS supports. When
multiple instances share the same circuit, each instance will have a
separate set of adjacencies.

MI-RTRs support the exchange of topology-specific Link State PDUs for
the IID/ITID pairs that each neighbor supports. A unique IS-IS

Update Process (see [ISO10589] operates for each IID/ITID pair. This
MAY also imply IID/ITID-specific routing calculations and IID/
ITID-specific routing and forwarding tables. However, this aspect is
outside the scope of this specification.

The mechanisms used to implement support of the separation of IS-IS
instances and topology-specific Update Processes within a router are
outside the scope of this specification.

2.1. Instance Identifier TLV

A new TLV is defined in order to convey the IID and ITIDs supported.
The IID-TLV associates a PDU with an IS-IS instance using a unique
16-bit number. The IID-TLV is carried in all IS-IS PDUs that are
associated with a non-zero instance; this includes IIHs, Sequence
Number PDUs (SNPs), and Link State PDUs (LSPs).

Multiple instances of IS-IS may coexist on the same circuit and on
the same physical router. IIDs MUST be unique within the same
routing domain.

IID #0 is reserved for the standard instance supported by legacy
systems. IS-IS PDUs associated with the standard instance MUST NOT
include an IID-TLV except where noted in this document.

The IID-TLV MAY include one or more ITIDs. An ITID is a 16-bit
identifier where all values (0 - 65535) are valid.

The following format is used for the IID-TLV:

```
   Type:   7
   Length: 2 - 254
   Value:
                                              No. of octets
                    +--------------------------+
                    | IID (0 - 65535)          |      2
                    +--------------------------+
                    | Supported ITID           |      2
                    +--------------------------+
                    :                          :
                    +--------------------------+
                    | Supported ITID           |      2
                    +--------------------------+
```

When the IID = 0, the list of supported ITIDs MUST NOT be present.

An IID-TLV with IID = 0 MUST NOT appear in an SNP or LSP. When the
TLV appears (with a non-zero IID) in an SNP or LSP, exactly one ITID

MUST be present indicating the topology with which the PDU is
associated. If no ITIDs or multiple ITIDs are present or the IID is
zero, then the PDU MUST be ignored.

When the IID is non-zero and the TLV appears in an IIH, the set of
ITIDs supported on the circuit over which the IIH is sent is
included. There MUST be at least one ITID present.

Multiple IID-TLVs MAY appear in IIHs. If multiple IID-TLVs are
present and the IID value in all IID-TLVs is not the same, then the
PDU MUST be ignored.

A single IID-TLV will support advertisement of up to 126 ITIDs. If
multiple IID-TLVs are present in an IIH PDU, the supported set of
ITIDs is the union of all ITIDs present in all IID-TLVs.

When an LSP purge is initiated, the IID-TLV MUST be retained, but the
remainder of the body of the LSP SHOULD be removed. The purge
procedure is described in [RFC6233] and [RFC6232].

A PDU without an IID-TLV belongs to the standard instance.

2.2. Instance Membership

Each MI-RTR is configured to be participating in one or more
instances of IS-IS. For each non-zero instance in which it
participates, an MI-RTR marks IS-IS PDUs (IIHs, LSPs, or SNPs)
generated that pertain to that instance by including the IID-TLV with
the appropriate instance identifier.

2.3. Use of Authentication

When authentication is in use, the IID, if present, is first used to
select the authentication configuration that is applicable. The
authentication check is then performed as normal. When multiple
ITIDs are supported, ITID-specific authentication MAY be used in SNPs
and LSPs.

2.4. Adjacency Establishment

In order to establish adjacencies, IS-IS routers exchange IIH PDUs.
Two types of adjacencies exist in IS-IS: point-to-point and
broadcast. The following subsections describe the additional rules
an MI-RTR MUST follow when establishing adjacencies.

2.4.1. Point-to-Point Adjacencies

   MI-RTRs include the IID-TLV in the point-to-point Hello PDUs they
   originate. Upon reception of an IIH, an MI-RTR inspects the received
   IID-TLV and if the IID matches any of the IIDs that the router
   supports on that circuit, normal adjacency establishment procedures
   are used to establish an instance-specific adjacency. Note that the
   absence of the IID TLV implies IID #0. For instances other than IID
   #0, an adjacency SHOULD NOT be established unless there is at least
   one ITID in common.

   This extension allows an MI-RTR to establish multiple adjacencies to
   the same physical neighbor over a point-to-point circuit. However,
   as the instances are logically independent, the normal expectation of
   at most one neighbor on a given point-to-point circuit still applies.

2.4.2. Multi-Access Adjacencies

   Multi-Access (broadcast) circuits behave differently than point-to-
   point in that PDUs sent by one router are visible to all routers and
   all routers must agree on the election of a Designated Intermediate
   System (DIS) independent of the set of ITIDs supported.

   MI-RTRs will establish adjacencies and elect a DIS per IS-IS
   instance. Each MI-RTR will form adjacencies only with routers that
   advertise support for the instances that the local router has been
   configured to support on that circuit. Since an MI-RTR is not
   required to support all possible instances on a LAN, it's possible to
   elect a different DIS for different instances.

2.5. Update Process Operation

   For non-zero instances, a unique Update Process exists for each
   supported ITID.

2.5.1. Update Process Operation on Point-to-Point Circuits

   On Point-to-Point circuits -- including Point-to-Point Operation over
   LAN [RFC5309] -- the ITID-specific Update Process only operates on
   that circuit for those ITIDs that are supported by both ISs operating
   on the circuit.

2.5.2. Update Process Operation on Broadcast Circuits

   On broadcast circuits, a single DIS is elected for each supported IID
   independent of the set of ITIDs advertised in LAN IIHs. This
   requires that the DIS generate pseudo-node LSPs for all supported
   ITIDs and that the Update Process for all supported ITIDs operate on

the broadcast circuit. Among MI-RTRs operating on a broadcast
circuit, if the set of supported ITIDs for a given non-zero IID is
inconsistent, connectivity for the topology (or topologies)
associated with the ITIDs not supported by some MI-RTRs can be
compromised.

2.6. Interoperability Considerations

[ISO10589] requires that any TLV that is not understood is silently
ignored without compromising the processing of the whole IS-IS PDU
(IIH, LSP, SNP).

To a router not implementing this extension, all IS-IS PDUs received
will appear to be associated with the standard instance regardless of
whether an IID TLV is present in those PDUs. This can cause
interoperability issues unless the mechanisms and procedures
discussed below are followed.

2.6.1. Interoperability Issues on Broadcast Circuits

In order for routers to correctly interoperate with routers not
implementing this extension and in order not to cause disruption, a
specific and dedicated Media Access Control (MAC) address is used for
multicasting IS-IS PDUs with any non-zero IID. Each level will use a
specific layer 2 multicast address. Such an address allows MI-RTRs
to exchange IS-IS PDUs with non-zero IIDs without these PDUs being
processed by legacy routers, and therefore no disruption is caused.

An MI-RTR will use the AllL1IS or AllL2IS ISIS MAC-layer address (as
defined in [ISO10589]) as the destination address when sending an
IS-IS PDU for the standard instance. An MI-RTR will use one of two
new dedicated layer 2 multicast addresses (AllL1MI-ISs or AllL2MI-
ISs) as the destination address when sending an IS-IS PDU for any
non-zero IID. These addresses are specified in Section 6. If
operating in point-to-point mode on a broadcast circuit [RFC5309], an
MI-RTR MUST use one of the two new multicast addresses as the
destination address when sending point-to-point IIHs associated with
a non-zero instance. (Either address will do.)

MI-RTRs MUST discard IS-IS PDUs received if either of the following
is true:

o The destination multicast address is AllL1IS or AllL2IS and the
   PDU contains an IID-TLV.

o The destination multicast address is one of the two new addresses,
   and the PDU contains an IID-TLV with a zero value for the IID or
   has no IID-TLV.

NOTE: If the multicast addresses AllL1IS and/or AllL2IS are
improperly used to send IS-IS PDUs for non-zero IIDs, legacy systems
will interpret these PDUs as being associated with IID #0. This will
cause inconsistencies in the LSDB in those routers, may incorrectly
maintain adjacencies, and may lead to inconsistent DIS election.

2.6.2. Interoperability Using Point-to-Point Circuits

In order for an MI-RTR to interoperate over a point-to-point circuit
with a router that does NOT support this extension, the MI-RTR MUST
NOT send IS-IS PDUs for instances other than IID #0 over the point-
to-point circuit as these PDUs may affect the state of IID #0 in the
neighbor.

The presence or absence of the IID-TLV in an IIH indicates that the
neighbor does or does not support this extension, respectively.
Therefore, all IIHs sent on a point-to-point circuit by an MI-RTR
MUST include an IID-TLV. This includes IIHs associated with IID #0.
Once it is determined that the neighbor does not support this
extension, an MI-RTR MUST NOT send PDUs (including IIHs) for
instances other than IID #0.

Until an IIH is received from a neighbor, an MI-RTR MAY send IIHs for
a non-zero instance. However, once an IIH with no IID TLV has been
received -- indicating that the neighbor is not an MI-RTR -- the
MI-RTR MUST NOT send IIHs for a non-zero instance. The temporary
relaxation of the restriction on sending IIHs for non-zero instances
allows a non-zero instance adjacency to be established on an
interface on which an MI-RTR does NOT support the standard instance.

Point-to-point adjacency setup MUST be done through the use of the
three-way handshaking procedure as defined in [RFC5303] in order to
prevent a non-MI capable neighbor from bringing up an adjacency
prematurely based on reception of an IIH with an IID-TLV for a non-
zero instance.

3. Usage Guidelines

As discussed above, MI-IS-IS extends IS-IS to support multiple
instances on a given circuit. Each instance is uniquely identified
by the IID and forms instance-specific adjacencies. Each instance
supports one or more topologies as represented by the ITIDs. All
topologies associated with a given instance share the instance-
specific adjacencies. The set of topologies supported by a given IID
MAY differ from circuit to circuit. Each topology has its own set of
LSPs and runs a topology-specific Update Process. Flooding of
topology-specific LSPs is only performed on circuits on which both
the local router and the neighbor(s) support a given topology (i.e.,

advertise the same ITID in the set of supported ITIDs sent in the
IID-TLV included in IIHs).

The following subsections provide some guidelines for usage of
instances and topologies within each instance. While this represents
examples based on the intent of the authors, implementors are not
constrained by the examples.

3.1. One-to-One Mapping between Topologies and Instances

When the set of information to be flooded in LSPs is intended to be
flooded to all MI-RTRs supporting a given IID, a single topology MAY
be used. The information contained in the single LSDB MAY still
contain information associated with multiple applications as the
GENINFO TLV for each application has an application-specific ID that
identifies the application to which the TLV applies [RFC6823].

3.2. Many-to-One Mapping between Topologies and Instances

When the set of information to be flooded in LSPs includes subsets
that are of interest to a subset of the MI-RTRs supporting a given
IID, support of multiple ITIDs allows each subset to be flooded only
to those MI-RTRs that are interested in that subset. In the simplest
case, a one-to-one mapping between a given application and an ITID
allows the information associated with that application to be flooded
only to MI-RTRs that support that application -- but a many-to-one
mapping between applications and a given ITID is also possible. When
the set of application-specific information is large, the use of
multiple ITIDs provides significantly greater efficiencies, as
MI-RTRs only need to maintain the LSDB for applications of interest
and that information only needs to be flooded over a topology defined
by the MI-RTRs who support a given ITID.

The use of multiple ITIDs also allows the dedication of a full LSP
set (256 LSPs at each level) for the use of a given (set of)
applications, thereby minimizing the possibility of exceeding the
carrying capacity of an LSP set. Such a possibility might arise if
information for all applications were to be included in a single LSP
set.

Note that the topology associated with each ITID MUST be fully
connected in order for ITID-specific LSPs to be successfully flooded
to all MI-RTRs that support that ITID.

3.3. Considerations for the Number of Instances

   The support of multiple topologies within the context of a single
   instance provides better scalability in support of multiple
   applications both in terms of the number of adjacencies that are
   required and in the flooding of topology-specific LSDB. In many
   cases, the use of a single non-zero instance would be sufficient and
   optimal. However, in cases where the set of topologies desired in
   support of a set of applications is largely disjoint from the set of
   topologies desired in support of a second set of applications, it
   could make sense to use multiple instances.

4. Relationship to M-ISIS

   [RFC5120] defines support for multi-topology routing. In that
   document, 12-bit Multi-Topology Identifiers (MTIDs) are defined to
   identify the topologies that an IS-IS instance (a "standard instance"
   as defined by this document) supports. There is no relationship
   between the Multi-topology IDs defined in [RFC5120] and the ITIDs
   defined in this document.

   If an MI-RTR uses the extensions in support of the BFD-Enabled TLV
   [RFC6213], the ITID SHOULD be used in place of the MTID, in which
   case all 16 bits of the identifier field are usable.

   An MI-RTR MAY use the extensions defined in this document to support
   multiple topologies in the context of an instance with a non-zero
   IID. Each MI topology is associated with a unique LSDB identified by
   an ITID. An ITID-specific IS-IS Update Process operates on each
   topology. This differs from [RFC5120] where a single LSDB or single
   IS-IS Update Process is used in support of all topologies.

   An MI-RTR MUST NOT support [RFC5120] multi-topology within a non-zero
   instance. The following TLVs MUST NOT be sent in an LSP associated
   with a non-zero instance and MUST be ignored when received:

     TLV 222 - MT IS Neighbors
     TLV 235 - MT IP Reachability
     TLV 237 - MT IPv6 Reachability

5. Graceful Restart Interactions

   [RFC5306] defines protocol extensions in support of graceful restart
   of a routing instance. The extensions defined there apply to MI-RTRs
   with the notable addition that as there are topology-specific LSP
   databases all of the topology-specific LSP databases must be
   synchronized following restart in order for database synchronization

to be complete. This involves the use of additional T2 timers. See
[RFC5306] for further details.

6. IANA Considerations

Per this document, IANA has registered a new IS-IS TLV, which is
reflected in the "IS-IS TLV Codepoints" registry:

Type	Description	IIH	LSP	SNP	Purge
7	Instance Identifier	y	y	y	y

Per this document, IANA has registered two EUI-48 multicast addresses
from the IANA-managed EUI address space as specified in [RFC5342].
The addresses are as follows:

```
01-00-5E-90-00-02  AllL1MI-ISs
01-00-5E-90-00-03  AllL2MI-ISs
```

7. Security Considerations

Security concerns for IS-IS are addressed in [ISO10589], [RFC5304],
and [RFC5310].

8. Acknowledgements

The authors would like to acknowledge contributions made by Dino
Farinacci and Tony Li.

9. References

9.1. Normative References

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