                           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.

   This document obsoletes RFC 6822.

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 7841.

   Information about the current status of this document, any errata,
   and how to provide feedback on it may be obtained at
   http://www.rfc-editor.org/info/rfc8202.

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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. Two
   methods of supporting such a use are defined in this document: one
   supports the use of [RFC5120] within a reserved instance-specific
   topology and the other is an alternative to [RFC5120] that supports
   topology-specific flooding of link state information.

   MI-IS-IS might also be used to support the 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.

2. Requirements Language

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
   "OPTIONAL" in this document are to be interpreted as described in
   BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all
   capitals, as shown here.

3. 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
   instance-specific 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 (IIHs) 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.

3.1. 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 instance-specific
      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.

      ITID #0 is reserved for a specific use case as described later in
      this document. ITID #0 MUST NOT be supported in combination with
      any non-zero ITID. If multiple ITIDs are advertised in an IIH and
      one of the ITIDs is #0, then the PDU MUST be ignored.

      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].

It is recommended that (when present) the IID-TLV(s) be the first
TLV(s) in the PDU. This allows determination of the association of a
PDU with a particular instance more quickly.

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

3.2. 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.

3.3. 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.

3.4. 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 for non-zero
instances.

3.4.1. Point-to-Point Adjacencies

MI-RTRs include the IID-TLV in the point-to-point Hello PDUs
associated with non-zero instances that 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.

3.4.2. 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.

3.5. Update Process Operation

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

3.5.1. 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.

3.5.2. 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.

3.6. Interoperability Considerations

[ISO10589] requires that any TLV that is not understood be 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.

3.6.1. 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; therefore, no disruption is caused.

When sending SNPs, LSPs, and LAN IIHs for the standard instance (IID
#0), an MI-RTR will use either the AllL1IS or the AllL2IS MAC-layer
addresses (as defined in [ISO10589]) as the destination address.
When sending SNPs, LSPs, and LAN IIHs for any non-zero IID, an MI-RTR
MUST use one of two new dedicated Layer 2 multicast addresses
(AllL1MI-ISs or AllL2MI-ISs) as the destination address. These
addresses are specified in Section 7.

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

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

o The destination multicast address is AllL1MI-ISs or AllL2MI-ISs
   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, AllL2IS, and/or AllIS 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.

3.6.1.1. Special Considerations when Operating in Point-to-Point Mode

When operating in point-to-point mode on a broadcast circuit
[RFC5309], an MI-RTR will use AllL1IS, AllL2IS, or AllIS MAC-layer
addresses when sending SNPs, LSPs, and point-to-point IIHs associated
with the standard instance. When sending SNPs, LSPs, and point-to-
point IIHs for a non-zero IID, an MI-RTR MUST use one of the two new

multicast addresses (AllL1MI-ISs or AllL2MI-IS) as the destination
address. When sending point-to-point IIHs for a non-zero IID, either
address is permitted.

3.6.2. 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.

4. 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.

4.1. 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].

4.2. 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.

   When multiple ITIDs are supported by an instance, ITID #0 MUST NOT be
   supported.

4.3. 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.

5. 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 MTIDs defined in [RFC5120] and the ITIDs defined in this
   document.

   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 and
   single IS-IS Update Process are used in support of all topologies.
   In such cases, if an MI-RTR uses the extensions in support of the
   BFD-Enabled TLV [RFC6213], the ITID MUST be used in place of the
   MTID; in which case, all 16 bits of the identifier field are useable.

   An MI-RTR MAY support [RFC5120] multi-topology within a non-zero
   instance when ITID #0 is supported. When ITID #0 is supported it
   MUST be the only ITID supported by that instance. In such cases, if
   an MI-RTR uses the extensions in support of the BFD Enabled TLV
   [RFC6213] the [RFC5120] MTID MUST be used as specified in [RFC6213].

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

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

6. 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.

7. IANA Considerations

   IANA has registered an IS-IS TLV, reflected in the "IS-IS TLV
   Codepoints Registry":

Value	Name	IIH	LSP	SNP	Purge
7	Instance Identifier	y	y	y	y

   Per [RFC6822], IANA has registered two EUI-48 multicast addresses
   from the IANA-managed EUI address space as specified in [RFC7042].
   The addresses are as follows:

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

   All references to [RFC6822] in the "IS-IS TLV Codepoints Registry"
   and the "IANA Multicast 48-bit MAC Addresses" registry have been
   replaced by references to this document.

8. Security Considerations

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

9. References

9.1. Normative References

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Appendix A. Changes to RFC 6822

   RFC 6822 prohibited the use of Multi-Topology (MT) support as
   described in RFC 5120 in a non-zero instance. However, deployment
   experience since the writing of RFC 6822 has revealed a desire to be
   able to support the style of MT in RFC 5120 using multiple non-zero
   instances as an alternative means of controlling leaking of
   information between L1 areas while also supporting incongruent
   topologies for different address families. The rules have therefore
   been relaxed to allow use of MT per RFC 5120 in a non-zero instance
   so long as ITID #0 is the only instance topology (ITID) supported by
   the instance. Note that this change is not backwards compatible with
   implementations strictly following RFC 6822. As of this writing, all
   known implementations are compatible with this change.

   A suggestion has been added to place the IID-TLV as the first TLV in
   a PDU to speed recognition of the correct instance when parsing a
   received PDU.

   Clarification that when operating in point-to-point mode on a
   broadcast circuit the IID-TLV is only included in point-to-point IIHs
   associated with non-zero instances has been added. This addresses
   Errata ID 4519 [Err4519].

   Clarification of the appropriate MAC multicast addresses to use when
   sending PDUs on a broadcast interface for both standard instance and
   non-zero instances has been provided. This addresses Errata ID 4520
   [Err4520].

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Authors' Addresses

   Les Ginsberg
   Cisco Systems
   821 Alder Drive
   Milpitas, CA 95035
   United States of America

   Email: ginsberg@cisco.com

   Stefano Previdi
   Cisco Systems
   Via Del Serafico 200
   Rome 0144
   Italy

   Email: sprevidi@cisco.com

   Wim Henderickx
   Nokia
   Belgium

   Email: wim.henderickx@nokia.com