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M-ISIS: Multi Topology (MT) Routing in IS-IS
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Abstract

This document describes an optional mechanism within ISIS used today by many ISPs for IGP routing within their clouds. This document describes how to run within a single ISIS domain a set of independent IP topologies that we call Multi-Topologies (MTs). This MT extension can be used for variety of purposes such as an in-band management network ``on top'' of the original IGP topology,

maintain separate IGP routing domains for isolated multicast or IPv6 islands within the backbone, or force a subset of an address space to follow a different topology.

Internet Draft

M-ISIS

November 2007

[1.](#) Introduction

Maintaining multiple MTs for ISIS [[ISO10589](#)] [[RFC1195](#)] in a backwards-compatible manner necessitates several extensions to the packet encoding and additional SPF procedures. The problem can be partitioned into forming of adjacencies, and advertising of prefixes and reachable intermediate systems within each topology. Having put all the necessary additional information in place, it must be properly used by MT capable SPF computation. The following sections describe each of the problems separately. To simplify the text, "standard" ISIS topology is defined to be MT ID #0 (zero).

[1.1](#) Conventions Used in This Document

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](#)].

[1.2](#) Definitions of Terms Used in This Document

CSNP Complete Sequence Number Packet. Used to describe all the contents of a link state database of IS-IS.

DIS Designated Intermediate System. The intermediate system elected to advertise the pseudonode for a broadcast network.

IIH IS-IS Hello. Packets that are used to discover adjacent intermediate systems.

LSP Link State Packet. Packet generated by an intermediate system and lists adjacent systems, prefixes and other information.

PSNP Partial Sequence Number Packet. Used to request information from an adjacent intermediate system's link state database.

SPF Shortest Path First. An algorithm that takes a database

of nodes within a domain and builds a tree of connectivity along the shortest paths through the entire network.

[2.](#) Maintaining MT Adjacencies

Each adjacency formed MUST be classified as belonging to a set of MTs on the interface. This is achieved by adding a new TLV into IIH packets that advertises which topologies the interface belongs to. If MT #0 is the only MT on the interface, it is optional to advertise it in the new TLV. Thus not including such a TLV in the IIH implies MT ID #0 capability only. Through this exchange of MT

capabilities, a router is able to advertise the IS TLVs in LSPs with common MT set over those adjacencies.

In the case of adjacency contains multiple MTs on an interface, and if there exists overlapping IP address space among the topologies, additional mechanism MUST be used to resolve the topology identity of the incoming IP packets on the interface. See more discussion in [section 8.2.2](#) of this document.

[2.1.](#) Forming Adjacencies on Point-to-Point Interfaces

Adjacencies on point-to-point interfaces are formed as usual with ISIS routers not implementing MT extensions. If local router does not participate in certain MTs, it will not advertise those MTIDs in its IIHs and thus will not include that neighbor within its LSPs. On the other hand, if a MTID is not detected in remote side's IIHs, the local router MUST NOT include that neighbor within its LSPs. The local router SHOULD NOT form an adjacency if they don't have at least one common MT over the interface.

[2.2.](#) Forming Adjacencies on Broadcast Interfaces

On a LAN, all the routers on the LAN which implement the MT extension MAY advertise their MT capability TLV in their IIHs. If there is at least one adjacency on the LAN interface which belongs to this MT, the MT capable router MUST include the corresponding MT IS Reachable TLV in its LSP, otherwise it MAY include this MT IS Reachable TLV in its LSP if the LAN interface participates in this MT set.

Two Routers on a LAN SHALL always establish adjacency regardless whether they have common MT or not. This is to ensure all the routers on the LAN can correctly elect the same DIS. The IS SHOULD NOT include the MT IS TLV in its LSP if none of the adjacencies on the LAN contains this MT.

The DIS, CSNP and PSNP functions are not changed by MT extension.

[3.](#) Advertising MT Reachable Intermediate Systems in LSPs

A router MUST include within its LSPs in the Reachable Intermediate Systems TLVs only adjacent nodes that are participating in the corresponding topology and advertise such TLVs only if it participates itself in the corresponding topology. Standard Reachable Intermediate Systems TLV is acting here as MT ID #0 equivalent of the newly introduced MT Reachable Intermediate Systems TLV. A router MUST announce the MT IS TLV when there is at least one adjacency on the interface that belongs to this MT, otherwise it MAY announce the MT IS TLV of an adjacency for a given MT if this interface participates in the LAN.

Since it is not possible to prevent a router that does not understand MT extensions from being responsible for generation of the according pseudo-node, it is not possible either to introduce special TLVs in the pseudo-node LSPs nor run distinct DIS elections per MT. Therefore, a generated pseudo-node LSP by DIS MUST contain in its IS Reachable TLV all nodes on the LAN as usual regardless of their MT capabilities. In other words, there is no change to the pseudo-node LSP construction.

[4.](#) MTs and Overload, Partition and Attached Bits

A router could for each of the MTs become potentially partitioned, overloaded and attached independently. To prevent unnecessary complexity, MT extensions does not support MT based partition repair. The overload, partition and attached bits in LSP header only reflect the status of the default topology.

Attached bit and overload bit are part of the MT TLV being distributed within a node's LSP fragment zero. Since each adjacency can belong to different MTs, it is possible that some MTs are L2

attached, and others are not on the same router. The overload bit in the MT TLV can be used to signal the topology being overloaded. A MT based system is considered being overloaded if the overload bit in the MT is set.

Route leaking between the levels SHOULD only be performed within the same MT.

5. Advertising MT Specific IP Prefixes

Each of the MTs commands its own address space so a new TLV is necessary for prefixes stored in MTs other than MT ID #0. To make the encoding less confusing when same prefixes are present in multiple MTs and accelerate SPF per MT, rather than adding a sub-TLV in TE extensions, a new TLV is introduced for that purpose that closely follows TE encoding [[LS01](#)].

6. MT SPF Computation

Each MT MUST run its own instance of the decision process. The pseudo-node LSPs are used by all topologies during computation. Each non-default topology MAY have it's attached bit and overload bit set in the MT TLV. Reverse connectivity check within SPF MUST follow the according MT to assure the bi-directional reachability within the same MT.

The results of each computation SHOULD be stored in a separate RIB in normal cases, otherwise overlapping addresses in different

topologies could lead to undesirable routing behavior such as forwarding loops. The forwarding logic and configuration need to ensure the same MT is traversed from the source to the destination for packets. The nexthops derived from the MT SPF MUST belong to the adjacencies conforming to the same MT for correct forwarding. It is recommended for the administrators to ensure consistent configuration of all routers in the domain to prevent undesirable forwarding behavior.

No attempt is made in this document to allow one topology to calculate routes using the routing information from another topology inside SPF. Even though it is possible to redistribute

and leak routes from another IS-IS topology or from external sources, and the exact mechanism is beyond the scope of this document.

7. Packet Encoding

Three new TLVs are added to support MT extensions. One of them is common for the LSPs and IIHs. Encoding of Intermediate System TLV and IPv4 Reachable Prefixes is tied to traffic engineering extensions [[LS01](#)] to simplify the implementation effort. The main reasons we choose using new TLVs instead of using sub-TLVs inside existing TLV type-22 and type-135 are: In many cases, multi-topologies are non-congruent, using sub-TLV approach will not save LSP space; Many sub-TLVs are already being used in TLV type-22, and many more are being proposed while there is a maximum limit on the TLV size, from the existing TLVs; If traffic engineering or some other applications are being applied per topology level later, the new TLVs can automatically inherit the same attributes already defined for the "standard" IPv4 topology without going through long standard process to redefine them per topology.

7.1. Multi-Topology TLV

TLV number of this TLV is 229. It contains one or more MTs the router is participating in the following structure:

- x CODE - 229
- x LENGTH - total length of the value field, it SHOULD be 2 times the number of MT components.
- x VALUE - one or more 2-byte MT components, structured as follows:

		No. of Octets
+-----+		
0 A R R	MT ID	2
+-----+		

Bit 0 represents the OVERLOAD bit for the MT (only valid

in LSP fragment zero for MTs other than ID #0, otherwise SHOULD be set to 0 on transmission and ignored on receipt.)

Bit A represents the ATTACH bit for the MT (only valid in LSP fragment zero for MTs other than ID #0, otherwise SHOULD be set to 0 on transmission and ignored on receipt.)

Bits R are reserved, SHOULD be set to 0 on transmission and ignored on receipt.

MT ID is a 12-bit field containing the ID of the topology being announced.

This MT TLV can advertise up to 127 MTs and it can occur multiple times if needed within IIHs and LSP fragment zero. The result MT set SHOULD be the union of all the MT TLV occurrence in the packet. Any other ISIS PDU occurrence of this TLV MUST be ignored. Lack

of MT TLV in hellos and fragment zero LSP MUST be interpreted as participation of the advertising interface or router in MT ID #0 only. If a router advertises MT TLV, it has to advertise all the MTs it participates in, specifically including topology ID #0 also.

7.2. MT Intermediate Systems TLV

TLV number of this TLV is 222. It is aligned with extended IS reachability TLV type 22 beside an additional two bytes in front at the beginning of the TLV.

- x CODE - 222
- x LENGTH - total length of the value field
- x VALUE - 2-byte MT membership plus the format of extended IS reachability TLV, structured as follows:

	No. of Octets
<pre> +-----+ R R R R MT ID +-----+ </pre>	2
<pre> extended IS TLV format +-----+ </pre>	11 - 253
<pre> . . +-----+ </pre>	
<pre> extended IS TLV format +-----+ </pre>	11 - 253

Bits R are reserved, SHOULD be set to 0 on transmission and ignored on receipt.

MT ID is a 12-bit field containing the non-zero MT ID of the

After the 2-byte MT membership format, the MT IS content is in the same format as extended IS TLV, type 22 [[LS01](#)]. It can contain up to 23 neighbors of the same MT if no sub-TLVs are used.

7.3. Multi-Topology Reachable IPv4 Prefixes TLV

```
x  CODE - 235
x  LENGTH - total length of the value field
x  VALUE - 2-byte MT membership plus the format of extended
           extended IP reachability TLV, structured as follows:
```

	No. of Octets
+-----+ R R R R MT ID +-----+	2
+-----+ extended IP TLV format +-----+	5 - 253
· · +-----+	· ·
+-----+ extended IP TLV format +-----+	5 - 253

MT ID is a 12-bit field containing the non-zero ID of the topology being announced. The TLV **MUST** be ignored if the ID is zero. This is to ensure the consistent view of the standard unicast topology.

This TLV can occur multiple times.

[7.4.](#) Multi-Topology Reachable IPv6 Prefixes TLV

TLV number of this TLV is 237. It is aligned with IPv6 Reachability

TLV type 236 beside an additional two bytes in front.

- x CODE - 237
- x LENGTH - total length of the value field
- x VALUE - 2-byte MT membership plus the format of IPv6 Reachability TLV, structured as follows:

		No. of Octets
+-----+		
R R R R	MT ID	2
+-----+		
IPv6 Reachability format		6 - 253
+-----+		
.		.
+-----+		
IPv6 Reachability format		6 - 253
+-----+		

Bits R are reserved, SHOULD be set to 0 on transmission and ignored on receipt.

MT ID is a 12-bit field containing the ID of the topology being announced. The TLV MUST be ignored if the ID is zero.

After the 2-byte MT membership format, the MT IPv6 context is in the same format as IPv6 Reachability TLV, type 236 [[H01](#)].

This TLV can occur multiple times.

[7.5.](#) Reserved MT ID Values

Certain MT topologies are assigned to serve pre-determined purposes:

- MT ID #0: Equivalent to the "standard" topology.

- MT ID #1: Reserved for IPv4 in-band management purposes.
- MT ID #2: Reserved for IPv6 routing topology.
- MT ID #3: Reserved for IPv4 multicast routing topology.
- MT ID #4: Reserved for IPv6 multicast routing topology.
- MT ID #5: Reserved for IPv6 in-band management purposes.
- MT ID #6-#3995: Reserved for IETF consensus.
- MT ID #3996-#4095: Reserved for development, experimental and proprietary features [[RFC3692](#)].

[8.](#) MT IP Forwarding Considerations

Using MT extension for ISIS routing can result in multiple RIBs on the system. In this section we list some of the known considerations for IP forwarding in various MT scenario. Certain deployment scenarios presented here imply different trade-offs in terms of deployment difficulties and advantages obtained.

[8.1.](#) Each MT belong to a distinct address family

In this case, each MT related routes are installed into a separate RIB. Multiple topologies can share the same ISIS interface on detecting the incoming packet address family. As an example, IPv4 and IPv6 can share the same interface without any further considerations under MT ISIS.

[8.2.](#) Some MTs belong to the same address family

[8.2.1.](#) Each interface belongs to one and only one MT

In this case, MTs can be used to forward packets from the same address family, even with overlapping addresses. Since the MTs have their dedicated interfaces, and those interfaces can be associated with certain MT RIBs and FIBs.

[8.2.2.](#) Multiple MTs share an interface with overlapping addresses

Some additional mechanism is needed to select the correct RIBs for the incoming IP packets to determine the correct RIB to make

a forwarding decision. For example, if the topologies are QoS partitioned, then the DSCP bits in the IP packet header can be utilized to make the decision. Some IP header or even packet data information MAY be checked to make the forwarding table selection, such as source IP address in the header can be used to determine the desired forwarding behavior.

This topic is not unique to IS-IS or even to Multi-topology, it is a local policy and configuration decision to make sure the inbound traffic uses the correct forwarding tables. For example, preferred customer packets are sent through a L2TP towards the high-bandwidth upstream provider, and other packets are sent through a different L2TP to a normal-bandwidth provider. Those mechanism are not part of the L2TP protocol specifications.

The generic approach of packet to multiple MT RIB mapping over the same inbound interface is outside the scope of this document.

[8.2.3](#). Multiple MTs share an interface with non-overlapping addresses

When there is no overlap in the address space among all the MTs, strictly speaking the destination address space classifies the topology a packet belongs to. It is possible to install routes

from different MTs into a shared RIB. As an example of such a deployment, a special ISIS topology can be setup for certain EBGp nexthop addresses.

[8.3](#) Some MTs are not used for forwarding purpose

MT in ISIS MAY be used even if the resulting RIB is not used for forwarding purposes. As an example, multicast RPF check can be performed on a different RIB than the standard unicast RIB albeit an entirely different RIB is used for the multicast forwarding. However, an incoming packet MUST be still clearly identified as belonging to a unique topology.

[9](#). MT Network Management Considerations

When multiple ISIS topologies exist within a domain, some of the routers can be configured to participate in a subset of the MTs in the network. This section discusses some of the options we

have to enable operations on the network management stations to access those routers.

[9.1.](#) Create dedicated management topology to include all the nodes

This approach is to setup a dedicated management topology or 'in-band' management topology. This 'mgmt' topology will include all the routers need to be managed. The computed routes in the topology will be installed into the 'mgmt' RIB. In the condition of the 'mgmt' topology uses a set of non-overlapping address space with the default topology, those 'mgmt' routes can also be optionally installed into the default RIB.

The advantages of duplicate 'mgmt' routes in both RIBs include: the network management utilities on the system does not have to be modified to use specific RIB other than the default RIB; the 'mgmt' topology can share the same link with the default topology if so designed.

[9.2.](#) Extend the default topology to all the nodes

Even in the case default topology is not used on some of the nodes in the IP forwarding, we MAY want to extend the default topology to those nodes for the purpose of network management. Operators SHOULD set high cost on the links which belong to the extended portion of the default topology. This way the IP data traffic will not be forwarded through those nodes during network topology changes.

[10.](#) Acknowledgments

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[11.](#) Security Consideration

ISIS security applies to the work presented. No specific security issues with the proposed solutions are known. The authentication

procedure for ISIS PDUs is the same regardless of MT information inside the ISIS PDUs.

Note that an authentication mechanism, such as the one defined in [RFC3567] SHOULD be applied if there is high risk resulting from modification of multi-topology information.

As described in [section 8.2.2](#), multiple topologies share an interface in the same address space, some mechanism beyond IS-IS need to be used to select the right forwarding table for an inbound packet. A misconfiguration on the system or a packet with spoofed source address for example can lead to packet loss or unauthorized use of premium network resource.

[12.](#) IANA Considerations

This document defines the following new IS-IS TLV types, which have already been reflected in the IANA IS-IS TLV code-point registry:

Name	Value
MT-ISN	222
M-Topologies	229
MT IP. Reach	235
MT IPv6 IP. Reach	237

IANA is requested to create a new registry, "IS-IS multi-topology ID values" with the assignment listed in [Section 7.5](#) of this document and registration policies [RFC2434] for future assignments. The MT ID values range 6-3095 are allocated through Expert Review; values in the range of 3096-4095 are reserved for Private Use. In all cases, assigned values are to be registered with IANA.

[13.](#) References

[13.1.](#) Normative References

[ISO10589] ISO. Intermediate System to Intermediate System Routing Exchange Protocol for Use in Conjunction with the

Service. ISO 10589, 1992.

- [RFC1195] R. Callon. Use of OSI ISIS for Routing in TCP/IP and Dual Environments. [RFC 1195](#), December 1990.
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[13.2](#). Informative References

- [RFC3567] Li, T. and R. Atkinson, "Intermediate System to Intermediate System (IS-IS) Cryptographic Authentication", [RFC 3567](#), July 2003.
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- [H01] C. Hopps. Routing IPv6 with IS-IS. [draft-ietf-isis-ipv6-07.txt](#), October 2007.
(work in progress)

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