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IS-IS Multi Topology Deployment Considerations
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Abstract

This document analyzes IS-IS Multi Topology (MT) applicability in various IS-IS deployments. This document explores the nuances around the terminology and usage of various IS-IS address families, topologies with different considerations, for choosing the right combination for a specific deployment scenario.

This document also discusses various ways one can deploy IPv6 only IS-IS topology.

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 [RFC2119], RFC8174 [RFC8174] when, and only when they appear in all capitals, as shown here.

Status of This Memo

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1. Introduction

IS-IS originally developed for OSI [ISO.10589.1992] and extensions have been made available to support IPv4 [RFC1195]. A method for exchanging IPv6 routing information using the IS-IS routing protocol is specified in [RFC5308]. How to run a set of independent IP topologies with topology specific adjacencies, within a single IS-IS domain has been defined in IS-IS MT [RFC5120].

There are number of networks, including mobile backhaul networks seeking to use IPv6 only solutions. It is possible to conceive, various parts of the backhaul networks use IPv4 and appropriate migration strategy needed before eventually moving towards IPv6 only

network. While any IGP can be used in these networks, this document covers only IS-IS protocol aspects.

Various layer-3 DC fabric routing options (refs: openfabric, spine-leaf, controller-based) by changing or optimizing some aspects w.r.t adjacency formation, flooding optimizations, or/and mechanisms to automatically compute the location of the node in the fat tree topology are proposed recently and this document brings some of the multi topology deployment aspects relevant to these networks. Please note, part of the discussion around IS-IS MT is not specific to DC or CLOS fabrics and generally applicable to any IS-IS deployment but discussed here because of multiple proposals to use various forms of IS-IS in this context.

2. Need for MT in IS-IS networks

For mobile transport backhaul networks seeking only IPv6 network or transitioning from parts of the network with only IPv4, IS-IS MT is needed. For layer-3 DC fabric underlay, which provide reachability, only one address family (either IPv4 or IPv6) SHOULD be sufficient. However if either only IPv6 address family is needed in the underlay or deploying both IPv4 and IPv6 address families are desired discussion in Section 4 is relevant.

It is an unlikely requirement, where DC fabric to be partitioned logically to have different topologies in the underlay but this can happen in various scenarios as listed in Section 4.1. If one does the same to meet a particular requirement, it introduces a manageability complexity of these logical topologies. IS-IS MT [RFC5120] also designed to address the above need and discussion in Section 4.2 is relevant. It is worth noting, majority of the IS-IS deployments use MT primarily to have a separate logical topology for IPv6 address family.

3. Acronyms

IIH : IS-IS Hello Protocol Data Unit

LSP : Link State PDU

MT : Multi Topology

SPF : Shortest Path First

4. Topologies and Address Families

Terminology around IS-IS topologies and address families is somewhat confusing at best. Just to give an example, MT ID #2 defined in [RFC5120] says, it is "Reserved for IPv6 routing topology". While multiple MT ID's can be deployed in a network with IPv6 topologies, MT ID #2, perhaps referring to a first such topology with IPv6 only address family. This section details various topology and address family options possible with currently available IS-IS specifications with respective defined TLVs.

4.1. Single Topology Mode and Multiple Address Families

IS-IS with IPv4 address family and with wide-metrics [RFC5305] is widely deployed, with TLV 22 defined for IS Reachability and TLV 135 for IP (IPv4) reachability information . This is essentially a single topology for the entire IS-IS area/domain with a single address family (IPv4 unicast).

IS-IS can also be enabled with IPv6 unicast address family in a single topology mode along with IPv4 unicast address family. Here IPv6 uses the same underlying topology that is used for IPv4 and this can be done as specified in IS-IS IPv6 [RFC5308] which introduces TLV 236, an IPv6 reachability TLV. It is important to note same IS-IS adjacency is used for both address families and with a single SPF (decision process) both IPv4 and IPv6 reachability would be computed.

However, for the above to work effectively, both IPv4 and IPv6 address families MUST share a common network topology. That is to use IS-IS for IPv4 and IPv6 routing, any interface configured for IPv4 IS-IS MUST also be configured for IPv6 IS-IS, and vice versa. All routers within an IS-IS area (Level 1 routing) or domain (Level 2 routing) MUST also support the same set of address families: IPv4 only, IPv6 only, or both IPv4 and IPv6. Any discrepancy in the configuration w.r.t above can cause routing black holes and one such scenario is discussed below.

```
                        | /         \|
                    ...Rx          Ry...
                        | \          /
                        |   \      / |
                        |     \  /   |
                        |      /\    |
                        |    /    \  |
                        |  /        \|
                    ... R1          R2...
                        | \        / |
```

Figure 1: IS-IS with multiple address families

As shown, in the above diagram all routers in the network enabled with both IPv4 and IPv6 unicast address families at the IS level and single topology would be built. However, at a link level all but except one link, say if IPv6 is not configured on the link between the routers Rx and R2; due to a single IS-IS topology, the shortest path between Rx and R2 is the direct link and since IPv6 is not enabled on that link, Rx and R2 cannot exchange IPv6 data traffic even though there's an alternate path between them in the topology through Rx, R1, Ry and R2.

Hence to summarize the restrictions: all routers in the topology MUST support only IPv4, only IPv6 or both IPv4 and IPv6 address families on all links and node. In other words, network MUST be congruent. While this model is to simpler to operate, might not be flexible enough for some IS-IS deployments. Some examples where congruency is not possible as follows:

a. When IPv6 is getting introduced in the network legacy nodes that are IPv6 incapable.

b. Implementation issues causing IPv6 to be disabled on some nodes.

c. Hardware scale limitations causing IPv6 to be disabled on some low-end nodes.

4.2. Multiple Topology Mode and Multiple Address Families

Multi-topology IS-IS uses multiple SPFs to compute routes and removes the restriction that all interfaces MUST support all configured address families and that all routers in an IS-IS area or domain MUST support the same set of address families. This introduces the concept of topology specific adjacency with MT IS Reachability TLV 222 and MT capable IPv4 Reachability with TLV 235 and MT capable IPv6 Reachability with TLV 237.

When MT IS-IS is enabled with IPv4 and IPv6 address families, the routers build two topologies, one for each address family (IPv4 and IPv6) and can find the optimum path for each address family even when some links in the network support only one of them. IS-IS MT [RFC5120] defines MT ID #0 for backward compatibility, as the "standard" topology and this essentially operate as IS-IS single topology mode as specified in Section 4.1 and supports both IPv4 and IPv6 address families. MT ID #2 [RFC5120] is defined for IPv6 address family in MT mode.

4.2.1. Transition Mode

Most of the vendors supported MT transition feature (though some vendors disabled to avoid confusion around this) in the IS-IS networks to facilitate MT deployments without disrupting the single topology mode. The MT transition mode allows a network operating in single topology IS-IS IPv6 [RFC5308] to continue to work while upgrading routers to include MT IS-IS IPv6 support i.e., MT ID #2 with [RFC5120] . While in transition mode, both types of TLVs (single-topology with TLVs 22/236 and MT with TLVs 222/237) are sent in LSPs for all configured IPv6 addresses, nodes can continue to process these and operate in single topology mode though being in MT mode ("standard" IS-IS topology with MT ID #0). After all routers in the area or domain have been upgraded to support MT IPv6 transition mode can be removed from the configuration. Once all routers in the area or domain are operating in MT IPv6 mode, the topological restrictions of single-topology mode can be made no longer in effect.

When transition mode is enabled, the router advertises both MT TLVs and the old style IS-IS IPv6 TLVs but the topological restrictions of the single topology mode discussed above are in effect. However, there were instances while this mode is enabled and expectations for different result in the actual deployments.

4.3. IPv6 Only Topology

Though it is theoretically possible to build IPv6 only underlay (with TLV 236 for IPv6 reachability prefixes) in single topology mode as discussed in Section 4.1, lot of legacy implementations require IPv4 address families too be configured in single topology mode (ingrained code structures for IPv4 address family). IPv6 only DC underlay network can be built with multi topology adjacencies (TLV 222) and reachability prefixes (TLV 237) with MT ID #2 as discussed above in Section 4.2. With this, any other address family can be introduced including "standard" topology MT ID #0 (Single topology mode with both address families) and there are no restrictions on which address family has to enable on which link as specified in Section 4.1.

5. IS-IS MT and LFA

IP Fast Reroute (FRR) or Loop Free Alternative (LFA) computation in MT mode are described in detail in Section 5.2 of [RFC5120].

6. Acknowledgements

Thanks to Acee Lindem, Chris Hopps, Michael Abramson and Les Ginsberg for various inputs on this work.

7. IANA Considerations

This document has no actions for IANA.

8. Security Considerations

Security concerns for IS-IS are addressed in [RFC5304] and [RFC5310]. Further security analysis for IS-IS protocol is done in [RFC7645].

This document does not introduce any change in any of the IS-IS protocol or IS-IS protocol extensions. This document also does not introduce any new security issues other than as noted in the referenced IS-IS protocol extensions.

9. References

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