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IS-IS Route Preference for Extended IP and IPv6 Reachability
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Abstract

Existing specifications as regards route preference are not explicit when applied to IP/IPv6 Extended Reachability TLVs. There are also inconsistencies in the definition of how the up/down bit applies to route preference when the prefix advertisement appears in Level 2 LSPs. This document addresses these issues.

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].

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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Table of Contents

1. Introduction

[RFC5302] defines the route preferences rules as they apply to Type/Length/Value(TLV)s 128 and 130. [RFC5305] introduced the IP Extended Reachability TLV 135 but did not explicitly adapt the route preference rules defined in [RFC5302] for the new TLV. [RFC5308] defines the IPv6 Reachability TLV 236 and does include an explicit

statement as regards route preference - but the statement introduces use of the up/down bit in advertisements which appear in Level 2 Link State Protocol Data Units(LSPs) which is inconsistent with statements made in [RFC5302] and [RFC5305]. This document defines explicit route preference rules for TLV 135, revises the route preferences rules for TLV 236, and clarifies the usage of the up/down bit when it appears in TLVs in Level 2 LSPs. This document is viewed as a clarification (NOT correction) of [RFC5302] and [RFC5305] and a correction of the route preference rules defined in [RFC5308] to be consistent with the rules for IPv4. It also makes explicit that the same rules apply for the Multi-Topology(MT) equivalent TLVs 235 and 237.

2. Use of the up/down Bit in Level 2 LSPs

The up/down bit was introduced in support of leaking prefixes downwards in the IS-IS level hierarchy. Routes which are leaked downwards have the bit set to 1. Such prefixes MUST NOT be leaked upwards in the hierarchy. So long as we confine ourselves to a single IS-IS instance and the current number of supported levels (two) it is impossible to have a prefix advertised in a Level 2 LSP and have the up/down bit set to 1. However, because [RFC5302] anticipated a future extension to IS-IS which might support additional levels it allowed for the possibility that the up/down bit might be set in a Level-2 LSP and in support of easier migration in the event such an extension was introduced Section 3.3 stated:

"...it is RECOMMENDED that implementations ignore the up/down bit in L2 LSPs, and accept the prefixes in L2 LSPs regardless of whether the up/down bit is set."

[RFC5305] addressed an additional case wherein an implementation included support for multiple virtual routers running IS-IS in different areas. In such a case it is possible to redistribute prefixes between two IS-IS instances in the same manner that prefixes are redistributed from other protocols into IS-IS. This introduced the possibility that a prefix could be redistributed from Level 1 to Level 1 (as well as between Level 2 and Level 2) and in the event the redistributed route was leaked from Level 1 to Level 2 two different routers in different areas would be advertising the same prefix into the Level 2 sub-domain. To prevent this [RFC5305] specified in Section 4.1:

"If a prefix is advertised from one area to another at the same level, then the up/down bit SHALL be set to 1."

However, the statement in [RFC5302] that the up/down bit is ignored in Level 2 LSPs is not altered by [RFC5305].

The conclusion then is that there is no "L2 inter-area route" - and indeed no such route type is defined by [RFC5302]. However, [RFC5308] ignored this fact and introduced such a route type in Section 5 when it specified a preference for " Level 2 down prefix". This is an error which this document corrects.

3. Types of Routes in IS-IS Supported by Extended Reachability TLVs

[RFC5302] is the authoritative reference for the types of routes supported by TLVs 128 and 130. However, a number of attributes supported by those TLVs are NOT supported by TLVs 135, 235, 236, 237. Distinction between internal/external metrics is not supported. In the case of IPv4 TLVs (135 and 235) the distinction between internal and external route types is not supported. It is therefore useful to explicitly state the supported route types for these TLVs.

3.1. Types of Routes Supported by TLVs 135 and 235

This section defines the types of route supported for IPv4 when using TLV 135 [RFC5305] and/or TLV 235 [RFC5120]. The text follows as closely as possible the original text from [RFC5302].

L1 intra-area routes: These are advertised in L1 LSPs, in TLV 135 or TLV 235. The up/down bit is set to zero. These IP prefixes are directly connected to the advertising router. These routes are indistinguishable from L1 external routes.

L1 external routes: These are advertised in L1 LSPs, in TLV 135 or TLV 235. The up/down bit is set to zero. These IP prefixes are learned from other protocols and are usually not directly connected to the advertising router. These routes are indistinguishable from L1 intra-area routes.

L2 intra-area routes: These are advertised in L2 LSPs, in TLV 135 or TLV 235. The up/down bit is set to zero. These IP prefixes are directly connected to the advertising router. These prefixes cannot be distinguished from L1->L2 inter-area routes and/or L2 external routes.

L1->L2 inter-area routes: These are advertised in L2 LSPs, in TLV 135 or TLV 235. The up/down bit is set to zero. These IP prefixes are learned via L1 routing and were derived during the L1 Shortest Path First (SPF) computation from prefixes advertised in L1 LSPs in TLV 135 or TLV 235. These prefixes cannot be distinguished from L2 intra-area routes and/or L2 external routes.

L2 external routes: These are advertised in L2 LSPs, in TLV 135 or TLV 235. The up/down bit is set to zero. These IP prefixes are

learned from other protocols and are usually not directly connected to the advertising router. These routes are indistinguishable from L2 intra-area routes and/or L1->l2 inter-area routes.

L2->L1 inter-area routes: These are advertised in L1 LSPs, in TLV 135 or TLV 235. The up/down bit is set to one. These IP prefixes are learned via L2 routing and were derived during the L2 SPF computation from prefixes advertised in TLV 135 or TLV 235. These routes are indistinguishable from L1->L1 inter-area routes.

L1->L1 inter-area routes: These are advertised in L1 LSPs, in TLV 135 or TLV 235. The up/down bit is set to one. These IP prefixes are learned from another IS-IS instance operating in another area. These routes are indistinguishable from L2->L1 inter-area routes.

L2->L2 inter-area routes: These are advertised in L2 LSPs, in TLV 135 or TLV 235. The up/down bit is set to one but is ignored and treated as if it were set to 0. These IP prefixes are learned from another IS-IS instance operating in another area.

3.2. Types of Routes Supported by TLVs 236 and 237

This section defines the types of route supported for IPv6 when using TLV 236 [RFC5308] and/or TLV 237 [RFC5120].

L1 intra-area routes: These are advertised in L1 LSPs, in TLV 236 or TLV 237. The up/down bit is set to zero. The eXternal bit is set to 0. These IPv6 prefixes are directly connected to the advertising router.

L1 external routes: These are advertised in L1 LSPs, in TLV 236 or TLV 237. The up/down bit is set to zero. The eXternal bit is set to 1. These IPv6 prefixes are learned from other protocols and are usually not directly connected to the advertising router.

L2 intra-area routes: These are advertised in L2 LSPs, in TLV 236 or TLV 237. The up/down bit is set to zero. The eXternal bit is set to 0. These IPv6 prefixes are directly connected to the advertising router. These prefixes cannot be distinguished from L1->L2 inter-area routes.

L1->L2 inter-area routes: These are advertised in L2 LSPs, in TLV 236 or TLV 237. The up/down bit is set to zero. The eXternal bit is set to 0. These IPv6 prefixes are learned via L1 routing and were derived during the L1 Shortest Path First (SPF) computation from prefixes advertised in L1 LSPs in TLV 236 or TLV 237. These prefixes cannot be distinguished from L2 intra-area routes.

L2 external routes: These are advertised in L2 LSPs, in TLV 236 or TLV 237. The up/down bit is set to zero. the eXternal bit is set to 1. These IPv6 prefixes are learned from other protocols and are usually not directly connected to the advertising router.

L1->L2 external routes: These are advertised in L2 LSPs, in TLV 236 or TLV 237. The up/down bit is set to zero. The eXternal bit is set to 1. These IPv6 prefixes are learned via L1 routing and were derived during the L1 Shortest Path First (SPF) computation from L1 external routes advertised in L1 LSPs in TLV 236 or TLV 237. These prefixes cannot be distinguished from L2 external routes.

L2->L1 inter-area routes: These are advertised in L1 LSPs, in TLV 236 or TLV 237. The up/down bit is set to one. The eXternal bit is set to 0. These IPv6 prefixes are learned via L2 routing and were derived during the L2 SPF computation from prefixes advertised in TLV 236 or TLV 237. These routes are indistinguishable from L1->L1 inter-area routes.

L2->L1 external routes: These are advertised in L1 LSPs, in TLV 236 or TLV 237. The up/down bit is set to one. The eXternal bit is set to 1. These IPv6 prefixes are learned via L2 routing and were derived during the L2 SPF computation from prefixes advertised in TLV 236 or TLV 237.

L1->L1 inter-area routes. These are advertised in L1 LSPs, in TLV 236 or TLV 237. The up/down bit is set to one. The eXternal bit is set to 0. These IP prefixes are learned from another IS-IS instance operating in another area. These routes are indistinguishable from L2->L1 inter-area routes.

L2->L2 inter-area routes. These are advertised in L2 LSPs, in TLV 236 or TLV 237. The up/down bit is set to one but is ignored and treated as if it were set to 0. The eXternal bit is set to 0. These IP prefixes are learned from another IS-IS instance operating in another area.

3.3. Order of Preference for all types of routes supported by TLVs 135 and 235

This document defines the following route preferences for IPv4 routes advertised in TLVs 135 or 235.

1. L1 intra-area routes; L1 external routes

2. L2 intra-area routes; L2 external routes; L1->L2 inter-area routes; L2-L2 inter-area routes

3. L2->L1 inter-area routes; L1->L1 inter-area routes

3.4. Order of Preference for all types of routes supported by TLVs 236 and 237

This document defines the following route preferences for IPv6 routes advertised in TLVs 236 or 237.

1. L1 intra-area routes; L1 external routes

2. L2 intra-area routes; L2 external routes; L1->L2 inter-area routes; L1-L2 external routes;L2-L2 inter-area routes

3. L2->L1 inter-area routes; L2->L1 external routes;L1->L1 inter-area routes

4. IANA Considerations

No IANA actions required.

5. Security Considerations

None.

6. Acknowledgements

TBD

7. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC5120] Przygienda, T., Shen, N., and N. Sheth, "M-ISIS: Multi Topology (MT) Routing in Intermediate System to Intermediate Systems (IS-ISs)", RFC 5120, February 2008.

[RFC5302] Li, T., Smit, H., and T. Przygienda, "Domain-Wide Prefix Distribution with Two-Level IS-IS", RFC 5302, October 2008.

[RFC5305] Li, T. and H. Smit, "IS-IS Extensions for Traffic Engineering", RFC 5305, October 2008.

[RFC5308] Hopps, C., "Routing IPv6 with IS-IS", RFC 5308, October 2008.

Appendix A. Example Interoperability Issue

This documents a real world interoperability issue which occurs because implementations from different vendors have interpreted the use of the up/down bit in Level 2 LSPs inconsistently.

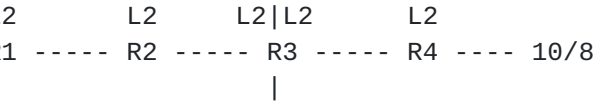

Figure 1

Considering Figure 1, both R0 and R4 are advertising the prefix 10/8. Two ISIS Level 2 instances are running on R3 to separate the network into two areas. R3 is performing route-leaking and advertises prefixes from R4 to the other Level 2 process. The network is using extended metrics (TLV135 defined in [RFC5305]). R0 is advertising 10/8 with metric 2000 and R3 advertises 10/8 with metric 100. All links have a metric of 1. When advertising 10/8 in its Level 2 LSP, R3 sets the down bit as specified in [RFC5305].

R1, R2 and R3 are from three different vendors (R1->Vendor1, R2->Vendor2, R3->Vendor3). During interoperability testing, routing loops are observed in this scenario.

- R2 has two possible paths to reach 10/8, Level 2 route with metric 2002, up/down bit is 0 (from R0) and Level 2 route with metric 101, up/down bit is 1 (from R3). R2 selects R1 as nexthop to 10/8 because it prefers the route which does NOT have up/down bit set.

- R3 has two possible paths to reach 10/8, Level 2 route with metric 2003, up/down bit is 0 (from R0) and Level 2 route with metric 101, up/down bit is 0 (from R4). R3 selects R4 as nexthop due to lowest metric.

- R1 has two possible paths to reach 10/8, Level 2 route with metric 2001, up/down bit is 0 (from R0) and Level 2 metric 102, up/down bit is 1 (from R3). R1 selects R2 as nexthop due to lowest metric.

When R1 or R2 try to send traffic to 10/8, packets are looping due to inconsistent routing decision between R1 and R2.

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