Internet Engineering Task Force
Internet-Draft
Intended status: Informational
Expires: September 19, 2018

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March 18, 2018

Dynamic Flooding for IS-IS
draft-li-dynamic-flooding-isis-01

Abstract

Routing with link state protocols in dense network topologies can result in sub-optimal convergence times due to the overhead associated with flooding. This can be addressed by decreasing the flooding topology so that it is less dense.

This document discusses extensions to the IS-IS routing protocol to support a solution to flooding in dense subgraphs.

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

In recent years, there has been increased focused on how to address the dynamic routing of networks that have a bipartite (a.k.a. spine-leaf), Clos [Clos], or Fat Tree [Leiserson] topology. Conventional Interior Gateway Protocols (IGPs, i.e. IS-IS [ISO10589], OSPF [RFC5340]) under-perform, redundantly flooding information throughout the dense topology, leading to overloaded control plane inputs and thereby creating operational issues. For practical considerations, network architects have resorted to applying unconventional techniques to address the problem, applying BGP in the data center [RFC7938], however it is very clear that using an Exterior Gateway Protocol as an IGP is sub-optimal, if only due to the configuration overhead.

This problem is discussed in more detail in [Architecture], along with an architectural solution for the problem. The remainder of this document is focused on describing extensions to the IS-IS protocol to implement that architecture. Three additions appear to be necessary.

1. A TLV that an IS may inject into its LSP to indicate its preference for becoming Area Leader.

2. A TLV to carry the list of system IDs that compromise the flooding topology for the area.

3. A TLV to carry the adjacency matrix for the flooding topology for the area.

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. Area Leader TLV

The Area Leader TLV allows a system to indicate its eligibility and priority for becoming Area Leader. Intermediate Systems (routers) not advertising this TLV are not eligible to become Area Leader.

The Area Leader is the router with the numerically highest Area Leader priority in the area. In the event of ties, the router with the numerically highest system ID is the Area Leader. Due to transients during database flooding, different routers may not agree on the Area Leader.

The format of the Area Leader TLV is:

```
 0                   1                   2
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| TLV Type      | TLV Length    | Priority      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

TLV Type: XXX

TLV Length: 1

Priority: 0-255, unsigned integer

3. Area System IDs TLV

The Area System IDs TLV is used by the Area Leader to enumerate the system IDs that it has used in computing the flooding topology. Conceptually, the Area Leader creates a list of system IDs for all routers in the area, assigning indices to each system, starting with index 0.

Because the space in a single TLV is small, it may require more than one TLV to encode all of the system IDs in the area. This TLV may recur in multiple LSP segments so that all system IDs can be advertised.

The format of the Area System IDs TLV is:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| TLV Type      | TLV Length    | Starting Index                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Ending Index                  |L| Reserved    | System IDs ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 System IDs continued ....
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

TLV Type: YYY

TLV Length: 9 + (ID length * N)

Starting index: The index of the first system ID that appears in this TLV.

Ending index: The index of the last system ID that appears in this TLV.

L (Last): This bit is set if the ending index of this TLV is the last index in the full list of system IDs for the area.

System IDs: A concatenated list of system IDs for the area.

4. Flooding Path TLV

The Flooding Path TLV is used to denote a path in the flooding topology. The goal is an efficient encoding of the links of the topology. A single link is a simple case of a path that only covers two nodes. A connected path may be described as a sequence of indices: (I1, I2, I3, ...), denoting a link from the system with index 1 to the system with index 2, a link from the system with index 2 to the system with index 3, and so on.

If a path exceeds the size that can be stored in a single TLV, then the path may be distributed across multiple TLVs by the replication of a single system index.

Complex topologies that are not a single path can be described using multiple TLVs.

The Flooding Path TLV contains a list of system indices relative to the systems advertised through the Area System IDs TLV. At least 2 indices must be included in the TLV. Due to the lenth restriction of TLVs, this TLV can contain at most 126 system indices.

The Flooding Path TLV has the format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| TLV Type      | TLV Length    | Starting Index                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Index 2                       | Additional indices ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

TLV Type: ZZZ

TLV Length: 9 + Length of Matrix octet contents

Starting index: The index of the first system in the path.

Index 2: The index of the next system in the path.

Additional indices: A sequence of additional indices to systems along the path.

Matrix: The concatenated rows of the upper right triangular portion of the adjacency matrix for the flooding topology, padded with 0 bits to an octet boundary.

5. Acknowledgements

The author would like to thank Adam Sweeney for his diligent review.

6. IANA Considerations

This memo requests that IANA allocate and assign three code points from the IS-IS TLV Codepoints registry. One for each of the following TLVs:

1. Area Leader TLV

2. Area System IDs TLV

3. Flooding Path TLV

7. Security Considerations

This document introduces no new security issues. Security of routing within a domain is already addressed as part of the routing protocols themselves. This document proposes no changes to those security architectures.

8. References

8.1. Normative References

[ISO10589]
International Organization for Standardization, "Intermediate System to Intermediate System Intra-Domain Routing Exchange Protocol for use in Conjunction with the Protocol for Providing the Connectionless-mode Network Service (ISO 8473)", ISO/IEC 10589:2002, Nov. 2002.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

8.2. Informative References

[Architecture]
Li, T., "An Architecture for Dynamic Flooding on Dense Graphs", Internet draft draft-li-dynamic-flooding, Jan. 2018.

[Clos] Clos, C., "A Study of Non-Blocking Switching Networks", The Bell System Technical Journal Vol. 32(2), DOI 10.1002/j.1538-7305.1953.tb01433.x, March 1953, <http://dx.doi.org/10.1002/j.1538-7305.1953.tb01433.x>.

[Leiserson]
Leiserson, C., "Fat-Trees: Universal Networks for Hardware-Efficient Supercomputing", IEEE Transactions on Computers 34(10):892-901, 1985.

[RFC5340] Coltun, R., Ferguson, D., Moy, J., and A. Lindem, "OSPF for IPv6", RFC 5340, DOI 10.17487/RFC5340, July 2008, <https://www.rfc-editor.org/info/rfc5340>.

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