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**Area Proxy for IS-IS  
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**Abstract**

Link state routing protocols have hierarchical abstraction already built into them. However, when lower levels are used for transit, they must expose their internal topologies to each other, leading to scale issues.

To avoid this, this document discusses extensions to the IS-IS routing protocol that would allow level 1 areas to provide transit, yet only inject an abstraction of the level 1 topology into level 2. Each level 1 area is represented as a single level 2 node, thereby enabling greater scale.

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## 1. Introduction

The IS-IS routing protocol IS-IS [[IS010589](#)] currently supports a two-level hierarchy of abstraction. The fundamental unit of abstraction is the 'area', which is a (hopefully) connected set of systems running IS-IS at the same level. Level 1, the lowest level, is abstracted by routers that participate in both Level 1 and Level 2, and they inject area information into Level 2. Level 2 systems seeking to access Level 1, use this abstraction to compute the shortest path to the Level 1 area. The full topology database of Level 1 is not injected into Level 2, only a summary of the address space contained within the area, so the scalability of the Level 2 Link State Database (LSDB) is protected.

This works well if the Level 1 area is tangential to the Level 2 area. This also works well if there are several routers in both Level 1 and Level 2 and they are adjacent, so Level 2 traffic will never need to transit Level 1 only routers. Level 1 will not contain any Level 2 topology, and Level 2 will only contain area abstractions for Level 1.

Unfortunately, this scheme does not work so well if the Level 1 only area needs to provide transit for Level 2 traffic. For Level 2 shortest path first (SPF) computations to work correctly, the transit topology must also appear in the Level 2 LSDB. This implies that all routers that could provide transit, plus any links that might also provide Level 2 transit must also become part of the Level 2 topology. If this is a relatively tiny portion of the Level 1 area, this is not overly painful.

However, with today's data center topologies, this is problematic. A common application is to use a Layer 3 Leaf-Spine (L3LS) topology, which is a folded 3-stage Clos [[Clos](#)] fabric. It can also be thought of as a complete bipartite graph. In such a topology, the desire is to use Level 1 to contain the routing dynamics of the entire L3LS topology and then to use Level 2 for the remainder of the network. Leaves in the L3LS topology are appropriate for connection outside of the data center itself, so they would provide connectivity for Level 2. If there are multiple connections to Level 2 for redundancy, or other areas, these too would also be made to the leaves in the topology. This creates a difficulty because there are now multiple Level 2 leaves in the topology, with connectivity between the leaves provided by the spines.

Following the current rules of IS-IS, all spine routers would necessarily be part of the Level 2 topology, plus all links between a Level 2 leaf and the spines. In the limit, where all leaves need to support Level 2, it implies that the entire L3LS topology becomes



part of Level 2. This is seriously problematic as it more than doubles the LSDB held in the L3LS topology and eliminates any benefits of the hierarchy.

This document discusses the handling of IP traffic. Supporting MPLS based traffic is a subject for future work.

### **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 [BCP 14](#) [1] [[RFC2119](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

## **2. Area Proxy**

To address this, we propose to completely abstract away the details of the Level 1 area topology within Level 2, making the entire area look like a single proxy system directly connected to all of the area's Level 2 neighbors. By only providing an abstraction of the topology, Level 2's requirement for connectivity can be satisfied without the full overhead of the area's internal topology. It then becomes the responsibility of the Level 1 area to ensure the forwarding connectivity that's advertised.

For this discussion, we'll consider a single Level 1 IS-IS area to be the Inside Area, and the remainder of the Level 2 area is the Outside Area. All routers within the Inside Area speak Level 1 and Level 2 IS-IS on all of the links within the topology. We propose to implement Area Proxy by having a Level 2 Proxy Link State Protocol Data Unit (PDU, LSP) that represents the entire Inside Area. This is the only LSP from the area that will be flooded into the overall Level 2 LSDB.

There are four classes of routers that we need to be concerned with in this discussion:

**Inside Router** A router within the Inside Area that runs Level 1 and Level 2 IS-IS. A router is recognized as an Inside Router by the existence of its LSP in the Level 1 LSDB.

**Area Leader** The Area Leader is an Inside Router that is elected to represent the Level 1 area by injecting the Proxy LSP into the Level 2 LSDB. There may be multiple candidates for Area Leader, but only one is elected at a given time.



**Inside Edge Router** An Inside Edge Router is an Inside Area Router that has at least one Level 2 interface outside of the Inside Area. An interface on an Inside Edge Router that is connected to an Outside Edge Router is an Area Proxy Boundary.

**Outside Edge Router** An Outside Edge Router is a Level 2 router that is outside of the Inside Area that has an adjacency with an Inside Edge Router.

All Inside Edge Routers learn the Area Proxy System Identifier from the Level 1 LSDB and use that as the system identifier in their Level 2 IS-IS Hello PDUs (IIHs) on all Outside interfaces. Outside Edge Routers should then advertise an adjacency to the Area Proxy System Identifier. This allows all Outside Routers to use the Proxy LSP in their SPF computations without seeing the full topology of the Inside Area.

Area Proxy functionality assumes that all circuits on Inside Routers are either Level 1-2 circuits within the Inside Area, or Level 2 circuits between Outside Edge Routers and Inside Edge Routers.

Area Proxy Boundary multi-access circuits (i.e. Ethernets in LAN mode) with multiple Inside Edge Routers and Outside Routers are not recommended. The Inside Edge Routers MUST NOT flood Inside Router LSPs on this link and thus the Boundary LAN does not provide connectivity within the Inside Area. Boundary LANs SHOULD NOT be enabled for Level 1. An Inside Edge Router may be elected the DIS for a Boundary LAN. In this case using the Area Proxy System Id as the basis for the LAN pseudonode identifier could create a collision, so the Insider Edge Router SHOULD compose the pseudonode identifier using its native system identifier.

## **2.1. Segment Routing**

If the Inside Area supports Segment Routing [[RFC8402](#)], then all Inside Nodes MUST advertise an SR Global Block (SRGB). The values of the SRGB advertised by all Inside Nodes MUST be the same.

To support Segment Routing, the Area Leader will take the global SID information found in the L1 LSDB and convey that to L2 through the Proxy LSP. Prefixes with SID assignments will be copied to the Proxy LSP. Adjacency SIDs for Outside Edge Nodes will be copied to the Proxy LSP.

To further extend Segment Routing, it would be helpful to have a SID that refers to the entire Inside Area. This allows a path to refer to an area and have any node within that area accept and forward the packet. In effect, this becomes an anycast SID that is accepted by





all Inside Edge Nodes. The information about this SID is distributed in the Area Proxy Prefix SID Sub-TLV, as part of the Area Leader's L1 LSP. The Inside Edge Nodes MUST establish forwarding based on this SID. The Area Leader SHALL also include the prefix and SID in the Area Proxy LSP so that the remainder of L2 can use it for path construction.

### 3. Inside Router Functions

All Inside Routers run Level 1-2 IS-IS and must be explicitly instructed to enable the Area Proxy functionality. To signal their readiness to participate in Area Proxy functionality, they will advertise the Area Proxy Router Capability as part of its Level 1 Router Capability TLV.

#### 3.1. The Area Proxy Router Capability

The Area Proxy Router Capability is a sub-TLV of the Router Capability TLV [[RFC7981](#)] and has the following format:

```

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

```

TLV Type: YYY

TLV Length: 0

A router advertising this TLV indicates that it is running Level 1-2 and is prepared to perform Area Proxy functions.

#### 3.2. Level 2 SPF Computation

When Outside Routers perform a Level 2 SPF computation, they will use the Area Proxy LSP for computing a path transiting the Inside Area. Because the topology has been abstracted away, the cost for transiting the Inside Area will be zero.

When Inside Routers perform a Level 2 SPF computation, they MUST ignore the Area Proxy LSP. Further, because these systems do see the Inside Area topology, the link metrics internal to the area are visible. This could lead to different and possibly inconsistent SPF results, potentially leading to forwarding loops.

To prevent this, the Inside Routers MUST consider the metrics of links outside of the Inside Area (inter-area metrics) separately from



the metrics of the Inside Area links (intra-area metrics). Intra-area metrics MUST be treated as less than any inter-area metric. Thus, if two paths have different total inter-area metrics, the path with the lower inter-area metric would be preferred, regardless of any intra-area metrics involved. However, if two paths have equal inter-area metrics, then the intra-area metrics would be used to compare the paths.

Point-to-Point links between two Inside Routers are considered to be Inside Area links. LAN links which have a pseudonode LSP in the Level 1 LSDB are considered to be Inside Area links.

#### **4. Area Leader Functions**

The Area Leader has several responsibilities. First, it MUST inject the Area Proxy System Identifier into the Level 1 LSDB. Second, the Area Leader MUST generate the Proxy LSP for the Inside Area.

##### **4.1. Area Leader Election**

The Area Leader is selected using the election mechanisms and TLVs described in Dynamic Flooding for IS-IS [[I-D.ietf-lsr-dynamic-flooding](#)].

##### **4.2. Redundancy**

If the Area Leader fails, another candidate may become Area Leader and MUST regenerate the Area Proxy LSP. The failure of the Area Leader is not visible outside of the area and appears to simply be an update of the Area Proxy LSP.

For consistency, all Area Leader candidates SHOULD be configured with the same Proxy System Id, Proxy Hostname, and any other information that may be inserted into the Proxy LSP.

##### **4.3. The Area Proxy TLV**

The Area Proxy TLV is a container for sub-TLVs with Area Proxy Information. This TLV is injected into the Area Leader's Level 1 LSP.

The format of the Area Proxy 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    | Sub-TLVs ...
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

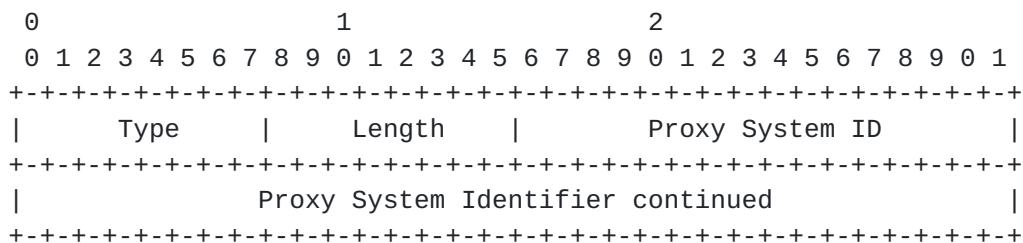


TLV Type: XXX

TLV Length: length of the sub-TLVs

#### **4.3.1. The Area Proxy System Id Sub-TLV**

The Area Proxy System Id Sub-TLV MUST be used by the Area Leader to distribute the Area Proxy System Id. This is an additional system identifier that is used by Inside Nodes. The format of this sub-TLV is:



Type: AAA

Length: length of a system ID (6)

Proxy System Identifier: the Area Proxy System Identifier.

The Area Leader SHOULD advertise the Area Proxy System Identifier Sub-TLV when it observes that all Inside Routers are advertising the Area Proxy Router Capability. Their advertisements indicate that they are individually ready to perform Area Proxy functionality. The Area Leader then advertises the Area Proxy System Identifier TLV to indicate that the Inside Area SHOULD enable Area Proxy functionality.

Other candidates for Area Leader MAY also advertise the Area Proxy System Identifier when they observe that all Inside Routers are advertising the Area Proxy Router Capability. All candidates advertising the Area Proxy System Identifier TLV MUST be advertising the same system identifier. Multiple proxy system identifiers in a single area is a misconfiguration and each unique occurrence SHOULD be logged.

The Area Leader and other candidates for Area Leader MAY withdraw the Area Proxy System Identifier when one or more Inside Routers are not advertising the Area Proxy Router Capability. This will disable Area Proxy functionality. However, before withdrawing the Area Proxy System Identifier, an implementation SHOULD protect against unnecessary churn from transients by delaying the withdrawal. The amount of delay is implementation-dependent.



#### 4.3.2. The Area Proxy Prefix SID Sub-TLV

The Area Proxy Prefix SID Sub-TLV allows the Area Leader to advertise a SID that represents the entirety of the Inside Area to all of the nodes in the area. This prefix and SID SHOULD also be advertised in the Proxy Node LSP using a normal Prefix-SID sub-TLV within an appropriate reachability TLV. The Area Proxy Prefix SID Sub-TLV has the format:

```

      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 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|   Type   |   Length   |   Topology   |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|   Flags   |  Reserved  |   Range   |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Prefix Length |   Prefix (variable)   //
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                                     Sub-Sub-TLVs (variable) |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

where:

Type: BBB

Length: variable (7 + Prefix Length + sub-TLV length)

Topology: 2 octets, see below.

Flags: 1 octet, see below.

Reserved: Reserved bits. MUST be zero on transmission, ignored on reception.

Range: 2 octets. This field is not used and MUST be set to 1 for compatibility with [\[RFC8667\]](#).

Prefix Length: 1 octet, the length of the prefix in bits. Only the most significant octets of the prefix are encoded.

Prefix: The prefix being advertised. If the Prefix Length is not a multiple of 8, then any trailing bits are set to zero.

Sub-Sub-TLVs: variable length, see below.





#### 4.3.2.1. Topology

Topology is defined as:

```

      0                               1
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
+-+--+--+--+--+--+--+--+--+--+--+
| Resvd |           MT ID           |
+-+--+--+--+--+--+--+--+--+--+--+

```

where:

Resvd: Reserved bits. MUST be zero on transmission and ignored on reception.

MT ID: MT ID is a 12-bit field containing the ID of the topology being announced. [[RFC5120](#)]

#### 4.3.2.2. Flags

The Flags octet is defined as follows:

```

      0 1 2 3 4 5 6 7
+-+--+--+--+--+--+--+
| F|M|S|D|A|      |
+-+--+--+--+--+--+--+

```

where:

F: Address-Family Flag. If unset, then the prefix carries an IPv4 prefix. If set, then the prefix carries an IPv6 prefix.

M: Not used. MUST be zero when originated and ignored when received. Retained for compatibility with [[RFC8667](#)].

S: Not used. MUST be zero when originated and ignored when received. Retained for compatibility with [[RFC8667](#)].

D: Not used. MUST be zero when originated and ignored when received. Retained for compatibility with [[RFC8667](#)].

A: Not used. MUST be zero when originated and ignored when received. Retained for compatibility with [[RFC8667](#)].

Other bits: MUST be zero when originated and ignored when received.



#### **4.3.2.3. The SID/Label Sub-Sub-TLV**

The SID/Label Sub-Sub-TLV is defined in [Section 2.3 of \[RFC8667\]](#).

#### **4.4. Area Proxy LSP Generation**

Each Inside Router generates a Level 2 LSP, and the Level 2 LSPs for the Inside Edge Routers will include adjacencies to Outside Edge Routers. Unlike normal Level 2 operations, these LSPs are not advertised outside of the Inside Area and MUST be filtered by all Inside Edge Routers to not be flooded to Outside Routers. Only the Area Proxy LSP is injected into the overall Level 2 LSDB.

The Area Leader uses the Level 2 LSPs generated by the Inside Edge Routers to generate the Area Proxy LSP. This LSP is originated using the Area Proxy System Identifier. The Area Leader MAY also insert the following additional TLVs into the Area Proxy LSP for additional information for the Outside Area.

##### **4.4.1. The Protocols Supported TLV**

The Area Leader SHOULD insert a Protocols Supported TLV (129) [\[RFC1195\]](#) into the Area Proxy LSP. The values included in the TLV SHOULD be the protocols supported by the Inside Area.

##### **4.4.2. The Area Address TLV**

The Area Leader SHOULD insert an Area Addresses TLV (1) [\[ISO10589\]](#) into the Area Proxy LSP.

##### **4.4.3. The Dynamic Hostname TLV**

It is RECOMMENDED that the Area Leader insert the Dynamic Hostname TLV (137) [\[RFC5301\]](#) into the Area Proxy LSP. The contents of the hostname may be specified by configuration. The presence of the hostname helps to simplify debugging the network.

##### **4.4.4. The IS Neighbors TLV**

The Area Leader MAY insert the IS Neighbors TLV (2) [\[ISO10589\]](#) into the Area Proxy LSP once for each Outside Edge Router. The Area Leader learns of the Outside Edge Routers by examining the LSPs generated by the Inside Edge Routers and using the lowest metric for each Outside Edge Router. Since the Outside Edge Routers also advertise an adjacency to the Area Proxy System Identifier, this will result in a bi-directional adjacency.



An entry for a neighbor in both the IS Neighbors TLV and the Extended IS Neighbors would be functionally redundant, so the Area Leader SHOULD NOT do this.

#### **4.4.5. The Extended IS Neighbors TLV**

The Area Leader MAY insert the Extended IS Reachability TLV (22) [[RFC3784](#)] into the Area Proxy LSP. The Area Leader SHOULD copy the lowest metric advertisement of each Outside Edge Router in an Extended IS Reachability TLV into the Proxy LSP.

If the Inside Area supports Segment Routing and Segment Routing selects a SID where the L-Flag is unset, then the Area Lead SHOULD include an Adjacency Segment Identifier sub-TLV (31) [[RFC8667](#)] using the selected SID.

#### **4.4.6. The MT Intermediate Systems TLV**

If the Inside Area supports Multi-Topology, then the Area Leader SHOULD copy each Outside Edge Router advertisement that is advertised by an Inside Edge Router in a MT Intermediate Systems TLV into the Proxy LSP.

#### **4.4.7. Reachability TLVs**

The Area Leader SHOULD insert additional TLVs describing any routing prefixes that should be advertised on behalf of the area. These prefixes may be learned from the Level 1 LSDB, Level 2 LSDB, or redistributed from another routing protocol. This applies to all of various types of TLVs used for prefix advertisement:

IP Internal Reachability Information TLV (128) [[RFC1195](#)]

IP External Reachability Information TLV (130) [[RFC1195](#)]

Extended IP Reachability TLV (135) [[RFC5305](#)]

IPv6 Reachability TLV (236) [[RFC5308](#)]

Multi-Topology Reachable IPv4 Prefixes TLV (235) [[RFC5120](#)]

Multi-Topology Reachable IPv6 Prefixes TLV (237) [[RFC5120](#)]

For TLVs in the Level 1 LSDB, for a given TLV type and prefix, the Area Leader SHOULD select the TLV with the lowest metric and copy that TLV into the Area Proxy LSP.



When examining the Level 2 LSDB for this function, the Area Leader SHOULD only consider TLVs advertised by Inside Routers. Further, for prefixes that represent Boundary links, the Area Leader SHOULD copy all TLVs that have unique sub-TLV contents.

If the Inside Area supports Segment Routing and the selected TLV includes a Prefix Segment Identifier sub-TLV (3) [[RFC8667](#)], then the sub-TLV SHOULD be copied as well. The P-Flag SHOULD be set in the copy of the sub-TLV to indicate that penultimate hop popping SHOULD not be performed for this prefix.

#### **4.4.8. The Router Capability TLV**

The Area Leader MAY insert the Router Capability TLV (242) [[RFC7981](#)] into the Area Proxy LSP. If Segment Routing is supported by the inside area, as indicated by the presence of an SRGB being advertised by all Inside Nodes, then the Area Leader SHOULD advertise an SR-Capabilities sub-TLV (2) [[RFC8667](#)] with an SRGB identical to that advertised by all Inside Routers.

#### **4.4.9. The Multi-Topology TLV**

If the Inside Area supports multi-topology, then the Area Leader SHOULD insert the Multi-Topology TLV (229) [[RFC5120](#)], including the topologies supported by the Inside Area.

#### **4.4.10. The SID/Label Binding and The Multi-Topology SID/Label Binding SID TLV**

If an Inside Node advertises the SID/Label Binding or Multi-Topology SID/Label Binding SID TLV [[RFC8667](#)], then the Area Leader MAY copy the TLV to the Area Proxy LSP.

### **5. Inside Edge Router Functions**

The Inside Edge Router has two additional and important functions. First, it MUST generate IIHs that appear to have come from the Area Proxy System Identifier. Second, it MUST filter the L2 LSPs, Partial Sequence Number PDUs (PSNPs), and Complete Sequence Number PDUs (CSNPs) that are being advertised to Outside Routers.

#### **5.1. Generating L2 IIHs to Outside Routers**

The Inside Edge Router has one or more Level 2 interfaces to Outside Routers. These may be identified by explicit configuration or by the fact that they are not also Level 1 circuits. On these Level 2 interfaces, the Inside Edge Router MUST NOT send an IIH until it has learned the Area Proxy System Id from the Area Leader. Then, once it





has learned the Area Proxy System Id, it MUST generate its IIHs on the circuit using the Proxy System Id as the source of the IIH.

Using the Proxy System Id causes the Outside Router to advertise an adjacency to the Proxy System Id, not to the Inside Edge Router, which supports the proxy function. The normal system id of the Inside Edge Router MUST NOT be used as it will cause unnecessary adjacencies to form and subsequently flap.

## **5.2. Filtering LSP information**

For the proxy abstraction to be effective the L2 LSPs generated by the Inside Routers MUST be restricted to the Inside Area. The Inside Routers know which system ids are members of the Inside Area based on the Level 1 LSDB. To prevent unwanted LSP information from escaping the Inside Area, the Inside Edge Router MUST perform filtering of LSP flooding, CSNPs, and PSNPs. Specifically:

A Level 2 LSP with a source system identifier that is found in the Level 1 LSDB MUST never be flooded to an Outside Router.

A Level 2 CSNP sent to an Outside Router MUST NOT contain any information about an LSP with a system identifier found in the Level 1 LSDB. If an Inside Edge Router filters a CSNP and there is no remaining content, then the CSNP MUST NOT be sent. The source address of the CSNP MUST be the Area Proxy System Id.

A Level 2 PSNP sent to an Outside Router MUST NOT contain any information about an LSP with a system identifier found in the Level 1 LSDB. If an Inside Edge Router filters a PSNP and there is no remaining content, then the PSNP MUST NOT be sent. The source address of the PSNP MUST be the Area Proxy System Id.

## **6. Acknowledgments**

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## **7. IANA Considerations**

This memo requests that IANA allocate and assign one code point from the IS-IS TLV Codepoints registry for the Area Proxy TLV (XXX). In association with this, this memo requests that IANA create a registry for code points for the sub-TLVs of the Area Proxy TLV.

Name of the registry: Sub-TLVs for TLV XXX (Area Proxy TLV)



Required information for registrations: Temporary registrations may be made under the Early IANA Allocation of Standards Track Code Points policy. [RFC7120] Permanent registrations require the publication of an RFC describing the usage of the code point.

Applicable registration policy: RFC Required and Expert Review. We propose the initial experts be Chris Hopps, Tony Li, and Sarah Chen.

Size, format, and syntax of registry entries: Value (0-255), Name, and Reference

Initial assignments and reservations: IANA is requested to assign the following code points:

+-----+	-----	+-----+
Value	Name	Reference
+-----+	-----	+-----+
AAA	Area Proxy System Identifier	This document
BBB	Area Proxy Prefix SID	This document
+-----+	-----	+-----+

IANA is also requested to allocate and assign one code point from the IS-IS Router Capability TLV sub-TLV registry for the Area Proxy Capability (YYY).

## 8. 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.

## 9. References

### 9.1. Normative References

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## **9.3. URIs**

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