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Hierarchical IS-IS  
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Abstract

The IS-IS routing protocol was originally defined with a two level hierarchical structure. This was adequate for the networks at the time. As we continue to expand the scale of our networks, it is apparent that additional hierarchy would be a welcome degree of flexibility in network design.

This document defines IS-IS Levels 3 through 8.

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## 1. Introduction

The IS-IS routing protocol IS-IS [ISO10589] 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.

Practical considerations, such as the size of an area's link state database, cause network designers to restrict the number of routers in any given area. Concurrently, the dominance of scale-out architectures based around small routers has created a situation where the scalability limits of the protocol are going to become critical in the foreseeable future.

The goal of this document is to enable additional hierarchy within IS-IS by creating additional hierarchy. Each additional level of hierarchy has a multiplicative effect on scale, so the addition of six levels should be a significant improvement. While all six levels may not be needed in the short term, it is apparent that the original designers of IS-IS reserved enough space for these levels, and defining six additional levels is only slightly harder than adding a

single level, so it makes some sense to expand the design for the future.

The modifications described herein are designed to be fully backward compatible.

Section references in this document are references to sections of IS-IS [ISO10589].

### 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. PDU changes

In this section, we enumerate all of the redefinitions of protocol header fields necessary to add additional levels.

### 2.1. Circuit Type

In the fixed header of some IS-IS PDUs, a field is named 'Reserved/Circuit Type' (Section 9.5). The high order six bits are reserved, with the low order two bits indicating Level 1 (bit 1) and Level 2 (bit 2).

This field is renamed to be 'Circuit Type'. The bits are redefined as follows:

1. Level 1
2. Level 2
3. Level 3
4. Level 4
5. Level 5
6. Level 6
7. Level 7
8. Level 8

The value of zero (no bits set) is reserved. PDUs with a Circuit Type of zero SHALL be ignored.

The set bits of the Circuit Type MUST be contiguous. If bit n and bit m are set in the Circuit Type, then all bits in the interval [n:m] must be set.

## 2.2. PDU Type

The fixed header of IS-IS PDUs contains an octet with three reserved bits and the 'PDU Type' field. The three reserved bits are transmitted as zero and ignored on receipt. (Section 9.5)

To allow for additional PDU space, this entire octet is renamed the 'PDU Type' field.

## 3. Additional PDUs

### 3.1. LAN IS to IS hello PDU (LAN-HELLO-PDU)

The 'LAN IS to IS hello PDU' (LAN-HELLO-PDU) is identical in format to the 'Level 2 LAN IS to IS hello PDU' (Section 9.6), except that the PDU Type has value AAA. The LAN-HELLO-PDU MUST be used instead of the 'Level 1 LAN IS to IS hello PDU' (Section 9.5) or the 'Level 2 LAN IS to IS hello PDU' on any circuit that has one or more of Level 3 through Level 8 enabled.

### 3.2. Point-to-point IS to IS hello PDU (P2P-HELLO-PDU)

The 'Point-to-point IS to IS hello PDU' can be used on circuits of any Level without modification.

### 3.3. Level n Link State PDU (Ln-LSP-PDU)

The 'Level n Link State PDU' (Ln-LSP-PDU) has the same format as the 'Level 2 Link State PDU' (Section 9.9), except for the PDU Type. The PDU Types for Levels 3 through 8 are defined as follows:

Level 3 (L3-LSP-PDU): BBB

Level 4 (L4-LSP-PDU): CCC

Level 5 (L5-LSP-PDU): DDD

Level 6 (L6-LSP-PDU): EEE

Level 7 (L7-LSP-PDU): FFF

Level 8 (L8-LSP-PDU): GGG

#### 3.4. Level n complete sequence numbers PDU (Ln-CSNP-PDU)

The 'Level n complete sequence numbers PDU' (Ln-CSNP-PDU) has the same format as the 'Level 2 complete sequence numbers PDU' (Section 9.11), except for the PDU Type. The PDU Types for Levels 3 through 8 are defined as follows:

Level 3 (L3-CSNP-PDU): HHH

Level 4 (L4-CSNP-PDU): III

Level 5 (L5-CSNP-PDU): JJJ

Level 6 (L6-CSNP-PDU): KKK

Level 7 (L7-CSNP-PDU): LLL

Level 8 (L8-CSNP-PDU): MMM

#### 3.5. Level n partial sequence numbers PDU (Ln-PSNP-PDU)

The 'Level 2 partial sequence numbers PDU' (Ln-PSNP-PDU) has the same format as the 'Level 2 partial sequence numbers PDU' (Section 9.13), except for the PDU Type. The PDU Types for Levels 3 through 8 are defined as follows:

Level 3 (L3-PSNP-PDU): NNN

Level 4 (L4-PSNP-PDU): OOO

Level 5 (L5-PSNP-PDU): PPP

Level 6 (L6-PSNP-PDU): QQQ

Level 7 (L7-PSNP-PDU): RRR

Level 8 (L8-PSNP-PDU): SSS

#### 4. Inheritance of TLVs

All existing Level 2 TLVs may be used in the corresponding Level 3 through Level 8 PDUs. When used in a Level 3 through Level 8 PDU, the semantics of these TLVs will be applied to the Level of the containing PDU. If the original semantics of the PDU was carrying a reference to Level 1 in a Level 2 TLV, then the semantics of the TLV at level N will be a reference to level N-1. The intent is to retain the original semantics of the TLV at the higher level.

## 5. Acknowledgements

The author would like to thank Dinesh Dutt for inspiring this document.

## 6. IANA Considerations

This document makes many requests to IANA, as follows:

### 6.1. PDU Type

The existing IS-IS PDU registry currently supports values 0-31. This should be expanded to support the values 0-255. The existing value assignments should be retained. Value 255 should be reserved.

### 6.2. New PDUs

IANA is requested to allocate values from the IS-IS PDU registry for the following:

LAN-HELLO-PDU: AAA

L3-LSP-PDU: BBB

L4-LSP-PDU: CCC

L5-LSP-PDU: DDD

L6-LSP-PDU: EEE

L7-LSP-PDU: FFF

L8-LSP-PDU: GGG

L3-CSNP-PDU: HHH

L4-CSNP-PDU: III

L5-CSNP-PDU: JJJ

L6-CSNP-PDU: KKK

L7-CSNP-PDU: LLL

L8-CSNP-PDU: MMM

L3-PSNP-PDU: NNN

L4-PSNP-PDU: OOO

L5-PSNP-PDU: PPP

L6-PSNP-PDU: QQQ

L7-PSNP-PDU: RRR

L8-PSNP-PDU: SSS

To allow for PDU types to be defined independent of this document, the above values should be allocated from the range 32-254.

## 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. 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,  
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