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Resilient MPLS Rings using SPRING  
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Abstract

This document describes the use of SPRING to setup LSP(s) for resilient MPLS ring networks. It specifies how clockwise and anti-clockwise ring SIDs are allocated and signaled using IGP protocol extensions, and how such ring SIDs achieve ring protection.

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## 1. Introduction

Ring topologies are very common in transport networks, and are ubiquitous in access and aggregation networks.

This draft introduces extensions to IGP protocols to establish SPRING Label Switched Paths (LSPs) for Resilient MPLS Rings (RMR). An RMR LSP is a multipoint to point (MP2P) LSP with simple protection.

SPRING [RFC8402] defines the notion of node SIDs which guide packets along the IGP shortest path to the advertising node. Node SIDs are typically advertised by an IGP. This draft uses a similar notion to guide packets along a "clockwise" (CW) or "anti-clockwise" (AC) path to the advertising node. The concept of CW and AC are well-defined in RMR rings.

Rings are auto-discovered using the mechanisms described in the [I-D.ietf-mpls-rmr]. Signaling extensions for IS-IS and OSPF are introduced in [I-D.kompella-isis-ospf-rmr] to enable the auto-discovery of ring topologies. After the ring topology is discovered, each node in the ring determines its CW and AC ring neighbors and associated ring links.

[I-D.ietf-teas-rsvp-rmr-extension] describes RSVP-TE [RFC3209] extensions to set up Resilient MPLS Ring (RMR) LSPs. [I-D.ietf-mpls-ldp-rmr-extensions] describes LDP [RFC5036] extensions to set up LDP RMR LSPs. This document does the same for SPRING RMR LSPs and the associated protection LSPs.

The first revisions of this document will focus on the simple most common ring topologies in access networks that do not include any "express links". Future revisions of this document will expand on express link(s) for the more general rings.

## 2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

### 2.1. Ring Terminology

A ring consists of a subset of  $n$  nodes  $\{R_i, 0 \leq i < n\}$ . The direction from node  $R_i$  to  $R_{i+1}$  is defined as as "clockwise" (CW) and the reverse direction is defined as "anti-clockwise" (AC). As there may be several rings in a graph, each ring is numbered with a distinct Ring ID (RID).

The following terminology is used for rings:

**Ring ID (RID):** A non-zero number that identifies a ring; this is unique in some scope of a Service Provider's network. A node may belong to multiple rings, each identified by its unique RID

**Ring Node:** A member of a ring. Note that a node may belong to several rings.

**Node Index:** A logical numbering of nodes in a ring, from zero up to one less than the ring size. Used purely for exposition in this document.

**Ring Master:** The ring master initiates the ring identification process. Mastership is indicated in the IGP by a two-bit field.

**Ring Neighbors:** Nodes whose indices differ by one (modulo ring size).

**Ring Size:** The ring size for a given instantiation is  $N$ . This can change as nodes are added or removed, or go up or down.

**Ring Links:** Links that connect ring neighbors.

**Express Links:** Links that connect non-neighbor ring nodes.

Ring LSP: Each LSP in the ring is a multipoint to point LSP such that LSP can have multiple ingress nodes and one egress node.

Ring Identification: The process of discovering ring nodes, ring links, link directions, and express links.

Ring SID: Each ring node W advertises a pair of unique Ring Segment Identifiers (Ring SIDs): a CW ring SID CW-W, to send traffic clockwise to W, and an AC ring SID AC-W to send traffic anti-clockwise to W.

### 3. Protocol extensions

A node participating in an RMR ring that is capable of SPRING can choose to advertise this by setting the SPRING bit in the "Supported Signaling Protocols" (SS), as specified in [I-D.ietf-mppls-rmr]. If so, the node advertises a Ring SID sub-TLV as a sub-TLV of the RMR Node TLV, as follows:

[RMR-SID Type] [Length = 8] [CW Ring SID Index] [AC Ring SID Index]

This sub-TLV has the following format in IS-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
Type (TBD)								Length (8)								CW Ring SID ...															
... CW Ring SID																AC Ring SID ...															
... AC Ring SID																															

where:

Type: is the type of the RMR SID sub-TLV (TBD)

Length: 8

Value: The CW SID followed by the AC SID.

In OSPF, the sub-TLV has the same format, except that the Type is two octets and the Length is two octets.

#### 4. Ring SPRING LSPs

The semantics of Ring SIDs is very straightforward: a CW Ring SID advertised by node W (CW-W) simply says: to get to W, take the CW path. Similarly, the AC Ring SID AC-W to W says, take the AC path to W.

Protection involves switching directions and labels.

##### 4.1. Ring SID Assignment

CW and AC Ring SIDs MUST be unique for each (RID, node) combination. This uniqueness can be guaranteed by configuration, or by the use of DHCP, as described next.

###### 4.1.1. Ring SID Assignment Using DHCP

The Dynamic Host Configuration Protocol is uniquely well-suited for handling node and ring SID assignments. When ring directions have been established for all links in the ring, each node can request, as a DHCP client, a pair of ring SIDs. The DHCP server responds with two unique values from the SID block(s) for Ring SIDs with which it has been configured. The DHCP server SHOULD be configured with very long leases for such assignments, as well as "sticky" assignments; that is, should a lease expire, the pair of values assigned should not be offered to another client unless the server has run out of ring SID values; also, should the same client re-request ring SIDs, the server SHOULD return the same SIDs if at all possible.

Further details are provided in [I-D.kompella-spring-dhcp].

##### 4.2. Ring SPRING LSP Set Up

When ring identification of ring R is complete, each node W that is SPRING capable advertises a pair of CW and AC Ring SIDs, CW-W and AC-W. Each node Y that is a member of ring R then installs a FIB entry as follows:

1. Let X be Y's AC neighbor, and Z be Y's CW neighbor.
2. For each received CW Ring SID CW-W, Y installs an LFIB entry to forward the packet to Z.
3. For each received CW Ring SID AC-W, Y installs an LFIB entry to forward the packet to X.

Note that Y must deal with the SRGB mapping corresponding to X and Z.

#### 4.3. Protection and Fastreroute

At the same time that Y installs LFIB entries for CW-W and AC-W, it also installs backup LFIB entries as follows:

1. Let X be Y's AC neighbor, and Z be Y's CW neighbor.
2. For each received CW Ring SID CW-W, Y installs a backup LFIB entry to swap CW-W with AC-W and forward the packet to X (swap label and ring direction). If all nodes AC of Y until W are NFFRR capable, the NFFRR SPL [I-D.kompella-mpls-nffrr] SHOULD be pushed below AC-W.
3. For each received AC Ring SID AC-W, Y installs a backup LFIB entry to swap AC-W with CW-W and forward the packet to Z (swap label and ring direction). If all nodes CW of Y until W are NFFRR capable, the NFFRR SPL SHOULD be pushed below CW-W.

Again, Y must deal with the corresponding SRGB mappings.

#### 5. IANA Considerations

Need to allocate Ring SID sub-TLV Types for IS-IS and OSPF.

#### 6. Security Considerations

It is not anticipated the extensions to IGP SR protocols described in this document may introduce additional security risk(s). Future revisions of this document will update this section with details about those risks.

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