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Resilient MPLS Rings
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Abstract

This document describes the use of the MPLS control and data planes on ring topologies. It describes the special nature of rings, and proceeds to show how MPLS can be effectively used in such topologies. It describes how MPLS rings are configured, auto-discovered and signaled, as well as how the data plane works. Companion documents describe the details of discovery and signaling for specific protocols.

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 [RFC2119][RFC8174].

This document is classified as an Experimental RFC. The parameters of this experiment have yet to be defined: how long the experiment runs, what criteria determine that the experiment is over -- does the doc then become Standards Track or Historical, etc. A future update will document these parameters.

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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This Internet-Draft will expire on August 18, 2021.

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1. Introduction

Rings are a very common topology either at infrastructure level (e.g., physical ring fiber deployments in Layer 1 networks) or node interconnection structures (e.g., loops created in bridged interconnected infrastructures [IEEE.802.1D_2004]). A ring is the simplest topology offering link and node resilience. Rings are nearly ubiquitous in access and aggregation networks. As MPLS increases its presence in such networks, and takes on a greater role, it is imperative that MPLS handles rings well; this is not the case today.

This document describes the special nature of rings, and the special needs of MPLS on rings. It then shows how these needs can be met in several ways, some of which involve extensions to protocols such as IS-IS [RFC5305], OSPF[RFC3630], RSVP-TE [RFC3209] and LDP [RFC5036]. RMR LSPs can also be signaled with IGP [RFC8402]; that will be described in a future document.

The intent of this document is to handle rings that "occur naturally". Many access and aggregation networks in metros have their start as a simple ring. They may then grow into more complex topologies, for example, by adding parallel links to the ring, or by adding "express" links. The goal here is to discover these rings (with some guidance), and run MPLS over them efficiently. The intent is not to construct rings in a mesh network with the purpose of using them for protection.

In some other networking situations (e.g., interconnection of bridges), those rings could create loops making the network inoperable, and thus needing from signaling mechanisms (such the Spanning Tree Protocol) for preventing and eliminating such loops [IEEE.802.1D_2004]. Here it is followed a dual approach where the signaling methods are precisely created for automatically identifying and defining rings where efficiently create LSPs adapted to the formed ring topology.

1.1. Definitions

A (directed) graph G = (V, E) consists of a set of vertices (or nodes) V and a set of edges (or links) E. An edge is an ordered pair of nodes (a, b), where a and b are in V. (In this document, the terms node and link will be used instead of vertex and edge.)

A ring is a subgraph of G. A ring consists of a subset of n nodes {R_i, 0 <= i < n} of V. The directed edges {(R_i, R_i+1) and (R_i+1, R_i), 0 <= i < n-1} must be a subset of E (note that index arithmetic is done modulo n). We define the direction from node R_i to R_i+1 as

"clockwise" (CW) and the reverse direction as "anticlockwise" (AC). As there may be several rings in a graph, we number each ring with a distinct ring ID RID.

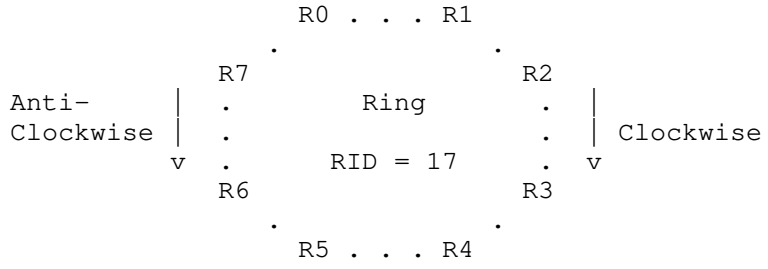


Figure 1: Ring with 8 nodes

The following terminology is used for ring LSPs:

Ring ID (RID): A non-negative number. When the RID identifies a ring, it must be positive and unique in some scope of a Service Provider's network. An RID of zero, when assigned to a node, indicates that the node must behave in "promiscuous mode" (see Section 3.2). A node may belong to multiple rings.

Ring node: A member of a ring. Note that a device 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 links: Links that connect ring neighbors.

Express links: Links that connect non-neighboring ring nodes.

Ring direction: A two-bit field in the IGP indicating the direction of a link. The choices are:

UN: 00 undefined link

CW: 01 clockwise ring link

AC: 10 anticlockwise ring link

EX: 11 express link

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

The following notation is used for ring LSPs:

R_k: A ring node with index k. R_k has AC neighbor R_(k-1) and CW neighbor R_(k+1).

RL_k: A (unicast) Ring LSP anchored on node R_k.

CL_jk: A label allocated by R_j for RL_k in the CW direction.

AL_jk: A label allocated by R_j for RL_k in the AC direction.

1.2. Changes from -12 in response to reviews

[Note to RFC Editor: this (sub-)section to be removed prior to publication.]

Reqts Lang: updated (response to Gen-ART review [Gen])

Section 1: updated "transport networks" to "Layer 1 networks" (response to Transport Area review [TAR])

Sec 1: replaced SPRING with IGP (response to OPS directorate [OPS])

Sec 1: rephrased last sentence [TAR]

Sec 2: added para on control plane resilience [TAR]

Sec 3.1: typo fixed [Gen]

Sec 3.2: added figure, caveats for promiscuous mode (response to Security Area Directorate review [SAD])

Sec 3.5: updated reference [OPS]

Sec 3.6: updated text on node protection, TTL [OPS]

Sec 4.1: changed Ring Neighbor TLV/flags to Ring Link TLV/flags; changed SPRING to IGP [OPS]

Sec 4.1: clean up [Gen]

Sec 4.2: updated text on timers T1, T2 [SAD]

Sec 4.3, 4.4: rewrote sections on Mastership, Ring Identification Phases for clarity [OPS]

Sec 4.5: removed "and" [Gen]

Sec 5: updated text on timers [TAR]

New Sec 6.1: added text on traffic transiting a ring [OPS]

Sec Cons: added text on compromised nodes [SAD]

2. Motivation

A ring is the simplest topology that offers resilience. This is perhaps the main reason to lay out fiber in a ring. Thus, effective mechanisms for fast failover on rings are needed. Furthermore, there are large numbers of rings. Thus, configuration of rings needs to be as simple as possible. Finally, bandwidth management on access rings is very important, as bandwidth is generally quite constrained here.

The goals of this document are to present mechanisms for improved MPLS-based resilience in ring networks (using ideas that are reminiscent of Bidirectional Line Switched Rings), for automatic bring-up of LSPs, better bandwidth management and for auto-hierarchy. These goals can be achieved using extensions to existing IGP and MPLS signaling protocols, using central provisioning, or in other ways.

Note that this document addresses data plane resilience. Control plane resilience, and robustness of protocol messaging, is managed by the protocols being used here (IS-IS, OSPF, LDP and RSVP-TE) and not described in this document.

3. Theory of Operation

Say a ring has ring ID RID. The ring is provisioned by choosing one or more ring masters for the ring and assigning them the RID. Other nodes in the ring may also be assigned this RID, or may be configured as "promiscuous". Ring discovery then kicks in. When each ring node knows its CW and AC ring neighbors and its ring links, and all express links have been identified, ring identification is complete.

Once ring identification is complete, each node signals one or more ring LSPs RL_i. RL_i, anchored on node R_i, consists of two counter-rotating unicast LSPs that start and end at R_i. A ring LSP is "multipoint": any node R_j can use RL_i to send traffic to R_i; this can be in either the CW or AC directions, or both (i.e., load

balanced). Both of these counter-rotating LSPs are "active"; the choice of direction to send traffic to R_i is determined by policy at the node where traffic is injected into the ring. The default policy is to send traffic along the shortest path. Bidirectional connectivity between nodes R_i and R_j is achieved by using two different ring LSPs: R_i uses RL_j to reach R_j, and R_j uses RL_i to reach R_i.

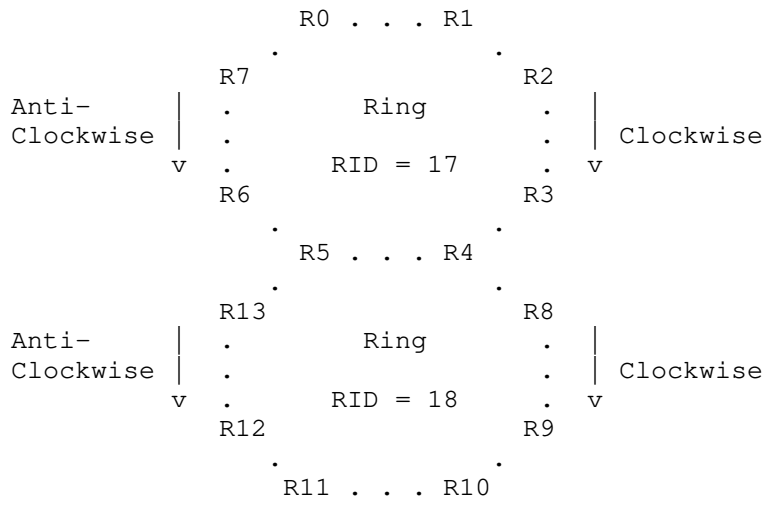
3.1. Provisioning

The goal here is to provision rings with the absolute minimum configuration. The exposition below aims to achieve that using auto-discovery via a link-state IGP (see Section 4). Of course, auto-discovery can be overridden by configuration. For example, a link that would otherwise be classified by auto-discovery as a ring link might be configured not to be used for ring LSPs.

3.2. Ring Nodes

Ring nodes have a loopback address, and run a link-state IGP and an MPLS signaling protocol. To provision a node as a ring node for ring RID, the node is simply assigned that RID. A node may be part of several rings, and thus may be assigned several ring IDs.

To simplify ring provisioning even further, a node N may be made "promiscuous" by being assigned an RID of 0. A promiscuous node listens to RIDs in its IGP neighbors' link-state updates. For every non-zero RID N hears from a neighbor, N joins the corresponding ring by taking on that RID. In many situations, the use of promiscuous mode means that only one or two nodes in a ring needs to be provisioned; everything else is auto-discovered. However, this feature should be used with care. Consider the following:



Two Rings

If R3 and R6 are configured with RID 17, R8 and R13 with RID 18, and all other nodes with RID 0, this will end up as two rings with R4 and R5 in both. However, other permutations of RID configurations could easily end up with all nodes being in both rings 17 and 18, whereupon the maximal ring will consist of R0 to R4, R8 to R13, R5 to R7 (and the link from R4 to R5 will be an express link). In cases such as these, one should eschew promiscuous mode in favor of simply configuring all nodes with the appropriate RIDs.

A ring node indicates in its IGP updates the ring LSP signaling protocols it supports. This can be LDP and/or RSVP-TE. Ideally, each node should support both.

3.3. Ring Links and Directions

Ring links must be MPLS-capable. They are by default unnumbered, point-to-point (from the IGP point of view) and "auto-bundled". The "auto-bundled" attribute means that parallel links between ring neighbors are considered as a single link, without the need for explicit configuration for bundling (such as a Link Aggregation Group). Note that each component may be advertised separately in the IGP; however, signaling messages and labels across one component link apply to all components. Parallel links between a pair of ring nodes is often the result of having multiple lambdas or fibers between those nodes. RMR is primarily intended for operation at the packet layer; however, parallel links at the lambda or fiber layer may result in parallel links at the packet layer.

A ring link is not provisioned as belonging to the ring; it is discovered to belong to ring RID if both its adjacent nodes belong to RID. A ring link's direction (CW or AC) is also discovered; this process is initiated by the ring's ring master. Note that the above two attributes can be overridden by provisioning if needed; it is then up to the provisioning system to maintain consistency across the ring.

3.3.1. Express Links

Express links are discovered once ring nodes, ring links and directions have been established. As defined earlier, express links are links joining non-neighboring ring nodes; often, this may be the result of optically bypassing ring nodes.

3.4. Ring LSPs

Ring LSPs are not provisioned. Once a ring node R_i knows its RID, its ring links and directions, it kicks off ring LSP signaling automatically. R_i allocates CW and AC labels for each ring LSP RL_k. R_i also initiates the creation of RL_i. As the signaling propagates around the ring, CW and AC labels are exchanged. When R_i receives CW and AC labels for RL_k from its ring neighbors, primary and fast reroute (FRR) paths for RL_k are installed at R_i.

For RSVP-TE LSPs, bandwidths may be signaled in both directions. However, these are not provisioned either; rather, one does "reverse call admission control". When a service needs to use an LSP, the ring node where the traffic enters the ring attempts to increase the bandwidth on the LSP to the egress. If successful, the service is admitted to the ring.

3.5. Installing Primary LFIB Entries

In setting up RL_k, a node R_j sends out two labels: CL_jk to R_j-1 and AL_jk to R_j+1. R_j also receives two labels: CL_j+1,k from R_j+1, and AL_j-1,k from R_j-1. R_j can now set up the forwarding entries for RL_k. In the CW direction, R_j swaps incoming label CL_jk with CL_j+1,k with next hop R_j+1; these allow R_j to act as LSR for RL_k. R_j also installs an LFIB entry to push CL_j+1,k with next hop R_j+1 to act as ingress for RL_k. Similarly, in the AC direction, R_j swaps incoming label AL_jk with AL_j-1,k with next hop R_j-1 (as LSR), and an entry to push AL_j-1,k with next hop R_j-1 (as ingress).

Clearly, R_k does not act as ingress for its own LSPs. However, R_k can send OAM messages, for example, an MPLS ping or traceroute ([RFC8029]), using labels CL_k,k+1 and AL_k-1,k, to test the entire

ring LSP anchored at R_k in both directions. Furthermore, if these LSPs use Ultimate Hop Popping, then R_k installs LFIB entries to pop CL_k,k for packets received from R_k-1 and to pop AL_k,k for packets received from R_k+1.

3.6. Protection

In this scheme, there are no protection LSPs as such -- no node or link bypass LSPs, no standby LSPs, no detours, and no LFA-type protection. Protection is via the "other" direction around the ring, which is why ring LSPs are in counter-rotating pairs. Protection works in the same way for link, node and ring LSP failures.

If a node R_j detects a failure from R_j+1 -- either all links to R_j+1 fail, or R_j+1 itself fails, R_j switches traffic on all CW ring LSPs to the AC direction using the FRR LFIB entries. If the failure is specific to a single ring LSP, R_j switches traffic just for that LSP. In either case, this switchover can be very fast, as the FRR LFIB entries can be preprogrammed. Fast detection and fast switchover lead to minimal traffic loss.

R_j then sends an indication to R_j-1 that the CW direction is not working, so that R_j-1 can similarly switch traffic to the AC direction. For RSVP-TE, this indication can be a PathErr or a Notify; other signaling protocols have similar indications. These indications propagate AC until each traffic source on the ring AC of the failure uses the AC direction. Thus, within a short period, traffic will be flowing in the optimal path, given that there is a failure on the ring. This contrasts with (say) bypass protection, where until the ingress recomputes a new path, traffic will be suboptimal.

Note that the failure of a node or a link will not necessarily affect all ring LSPs. Thus, it is important to identify the affected LSPs (and switch them), but to leave the rest alone.

One point to note is that when a ring node, say R_j, fails, RL_j is clearly unusable. However, the above protection scheme will cause a traffic loop: R_j-1 detects a failure CW, and protects by sending CW traffic on RL_j back all the way to R_j+1, which in turn sends traffic to R_j-1, etc. There are three proposals to avoid this:

1. Each ring node acting as ingress sends traffic with a TTL of at most 2*n, where n is the number of nodes in the ring.

2. A ring node sends protected traffic (i.e., traffic switched from CW to AC or vice versa) with TTL just large enough to reach the egress.

3. A ring node sends protected traffic with a special purpose label below the ring LSP label. A protecting node first checks for the presence of this label; if present, it means that the traffic is looping and MUST be dropped.

Approaches 1 and 2 work for traffic that remains on the ring or terminates on a ring node (see Section 6.1); for traffic transiting the ring, playing with TTL may affect forwarding beyond the ring. Approach 3 is the most general and is the one we advocate; however, this will require the allocation and definition of a new special purpose label.

3.7. Installing FRR LFIB Entries

At the same time that R_j sets up its primary CW and AC LFIB entries, it can also set up the protection forwarding entries for RL_k. In the CW direction, R_j sets up an FRR LFIB entry to swap incoming label CL_jk with AL_j-1,k with next hop R_j-1. In the AC direction, R_j sets up an FRR LFIB entry to swap incoming label AL_jk with CL_j+1,k with next hop R_j+1. Again, R_k does not install FRR LFIB entries in this manner.

Say R1 receives label L42 from R2 to reach R4 in the clockwise direction, and receives label L40 from R0 to reach R4 in the anti-clockwise direction. Say R1 also receives label L52 from R2 to reach R5 in the clockwise direction, and receives label L50 from R0 to reach R5 in the anti-clockwise direction. R1 makes the following LFIB entries:

Dest	CW/NH	CW FRR/NH	AC/NH	AC FRR/NH
...				
R4	L42/R2	L40/R0	L40/R0	L42/R2
R5	L52/R2	L50/R0	L50/R0	L52/R2
...				

R1's LFIB

4. Autodiscovery

4.1. Overview

Auto-discovery proceeds in three phases. The first phase is the announcement phase. The second phase is the mastership phase. The third phase is the ring identification phase.

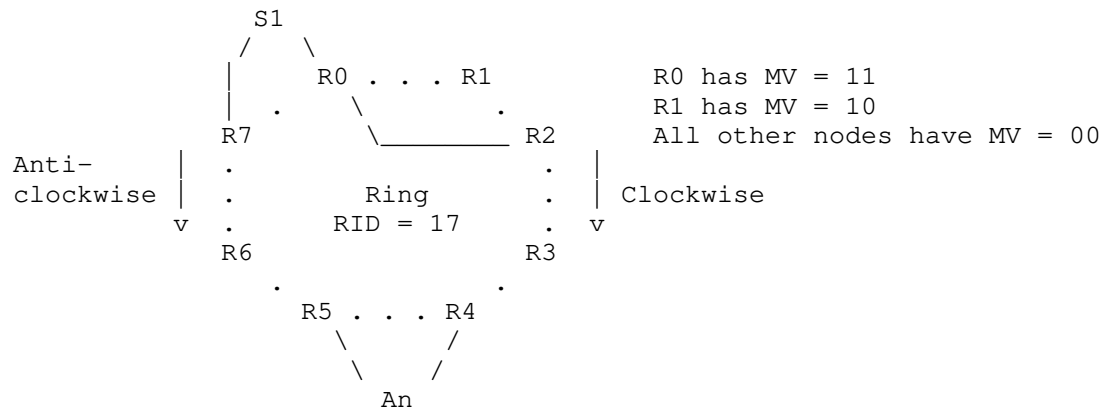


Figure 2: Ring with non-ring nodes and links

We use three concepts below:

ring nodes: all nodes that announce ring node TLVs with a given RID.

IGP neighbors: all nodes which are IGP neighbors of a given node.

ring neighbors: ring nodes that are IGP neighbors of a given node. Exactly one is the CW neighbor and one is the AC neighbor; all other ring neighbors are express neighbors.

In Figure 2, R0 through R7 are ring nodes belonging to ring 17. R0 has IGP neighbors R1, R2, R7 and S1. R0 has ring neighbors R1 (CW), R2 (express) and R7 (AC). Autodiscovery aims to identify ring nodes of a given ring, ring neighbors of each ring node, and the CW and AC node for each ring node.

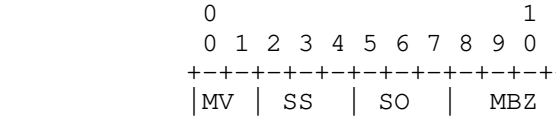
The format of an RMR Node Type-Length-Value (TLV) is given below. It consists of information pertaining to the node and optionally, sub-TLVs. A Neighbor sub-TLV contains information pertaining to the node's neighbors. Other sub-TLVs may be defined in the future. Details of the format specific to IS-IS and OSPF will be given in the corresponding IGP documents.

[RMR Node Type][RMR Node Length][RID][Node Flags][sub-TLVs]

Ring Node TLV Format

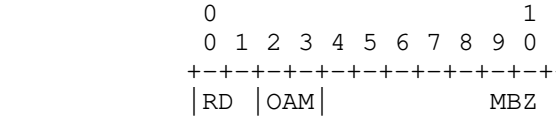
[My Intf Inx][Rem Intf Inx][RID 1][Flags for RID 1]
[RID 2][Flags for RID 2]...

Ring Link Sub-TLV Format



MV: Mastership Value
SS: Supported Signaling Protocols
(100 = RSVP-TE; 010 = LDP; 001 = IGP)
MBZ: Must be zero
SO: Supported OAM Protocols (100 = BFD; 010 = CFM; 001 = EFM)
SU: Signaling Protocol to Use (00: none; 01: LDP; 10: RSVP-TE;
11: IGP)
M : Elected Master (0 = no, 1 = yes)

Flags for a Ring Node TLV



RD: Ring Direction (00 = none; 01 = CW; 10 = AC; 11 = express)
OAM: OAM Protocol to use (00 = none; 01 = BFD; 10 = CFM; 11 = EFM)
MBZ: Must be zero

Flags for a Ring Link TLV

4.2. Ring Announcement Phase

Each node participating in an MPLS ring is assigned an RID; in the example, RID = 17. A node is also provisioned with a mastership value. Each node advertises a ring node TLV for each ring it is participating in, along with the associated flags. It then starts timer T1; this timer is to allow each node time to hear from all other nodes in the ring. [The settings for timers T1 and T2 (below) are particular to the specific IGP used for signaling; they will be discussed in the IGP document that defines the ring node/link TLVs.] The settings for timers T1 and T2 (below) will be discussed in the IGP document that defines the ring node/link TLVs.]

A node in promiscuous mode doesn’t advertise any ring node TLVs. However, when it hears a ring node TLV from an IGP neighbor, it joins that ring, and sends its own ring node TLV with that RID.

The announcement phase allows a ring node to discover other ring nodes in the same ring so that a ring master can be elected.

4.3. Mastership Phase

When timer T1 fires, a node enters the mastership phase. In this phase, each ring node N starts timer T2 and checks if it is master as follows. N examines the MV value of all ring nodes and selects those with the highest MV vale. Among these nodes, N finds the node with the lowest loopback address. If that node is N, N declares itself master to the entire ring by readvertising its ring node TLV with the M bit set.

When timer T2 fires, each node examines the ring node TLVs from all other nodes in the ring to identify the ring master. There should be exactly one; if not, each node restarts timer T2 and tries again.

Barring software bugs or malicious code, the principal reason for multiple nodes for setting their M bit is late-arriving ring announcements. Say nodes N1 and N2 have the highest mastership values, and N1 has the lowest loopback address, while N2 has the second lowest loopback address. If N1 makes its ring announcement just as N2's T1 timer fires, both N1 and N2 will think they are the master (since N2 will not have heard N1's announcement in time). However, in the next round, N2 will realize that N1 is indeed the master. In the worst case, the mastership phase will occur as many times as there are nodes in the ring.

4.4. Ring Identification Phase

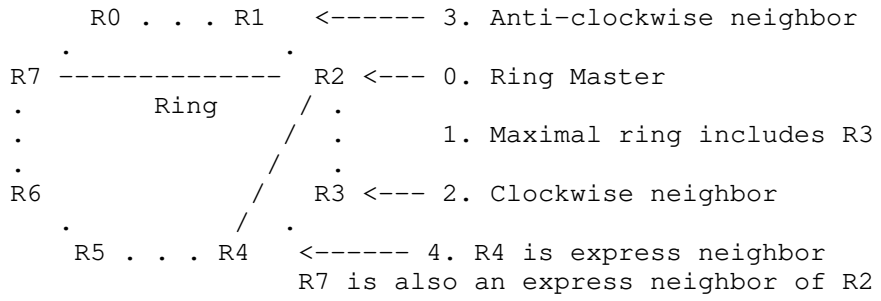


Figure 3: Ring Identification

When there is exactly one ring master M (here, R2), M enters the Ring Identification Phase. M indicates that it has successfully completed this phase by advertising ring link TLVs. This is the trigger for

M's CW neighbor to enter the Ring Identification Phase. This phase passes CW until all ring nodes have completed ring identification.

The Ring Identification Phase proceeds as follows:

1. M identifies all ring nodes for ring RID, i.e., those that have announced ring node TLVs with the ring ID = RID.

2. M computes a maximal ring among these nodes.

3. Based on that, M picks a CW neighbor and an AC neighbor.

4. M then inserts ring link TLVs with ring direction CW for each link to its CW neighbor; M also inserts a ring link TLV with direction AC for each link to its AC neighbor. (Note that there may be multiple links from M to each of its neighbors.)

5. Finally, M determines its express links. These are links to IGP neighbors that are ring nodes but neither the CW or AC neighbor. M advertises ring link TLVs for express links by setting the link direction to "express link".

This process passes on to the CW neighbor X as follows:

1. Each node Y listens for ring link TLVs. The set of nodes S consists of those that have announced ring link TLVs.

2. If a node Z announces a ring link TLV with Y as the CW neighbor, then Y is next.

X follows the same procedure as M with two small changes:

1. when X computes a maximal ring, it MUST include all nodes in S.

2. X knows its AC neighbor (Z above), and doesn't have to pick it.

Here, R2 (the master) knows R0 through R7 are ring nodes (Step 1). R1, R3, R4 and R7 are its ring neighbors. R2 computes a maximal ring (Step 2). It then picks R3 as its CW neighbor and R1 as its AC neighbor (Step 3). Finally, it declares the links to R4 and R7 as express links (Step 5).

4.5. Ring Changes

The main changes to a ring are:

ring link addition;

ring link deletion;

ring node addition;

ring node deletion.

The main goal of handling ring changes is (as much as possible) not to perturb existing ring operation. Thus, if the ring master hasn't changed, all of the above changes should be local to the point of change. Link adds just update the IGP; signaling should take advantage of the new capacity as soon as it learns. Link deletions in the case of parallel links also show up as a change in capacity (until the last link in the bundle is removed.)

The removal of the last ring link between two nodes, or the removal of a ring node is an event that triggers protection switching. In a simple ring, the result is a broken ring. However, if a ring has express links, then it may be able to converge to a smaller ring with protection.

The addition of a new ring node can also be handled incrementally.

5. Ring OAM

Each ring node should advertise in its ring node TLV the OAM protocols it supports. Each ring node is expected to run a link-level OAM over each ring link. This should be an OAM protocol that both neighbors agree on. The default hello time is that of the protocol chosen.

Each ring node also sends OAM messages over each direction of its ring LSP. This is a multi-hop OAM to check LSP liveness; typically, BFD would be used for this. Each node chooses the hello interval, the choice of which should be based on the size of the ring (as each node would have to send out twice that many hello messages every interval) and the desired failure detection time.

6. Advanced Topics

6.1. Beyond the Ring

The discourse above discusses traffic that originates and terminates on a ring. However, in many cases, traffic may come originate on a ring node and terminate at a non-ring node; other traffic may originate on a non-ring node and terminate on a ring node; and in yet other cases, traffic may transit a ring, i.e., originate on a non-ring node, arrive at a ring node, traverse the ring, and leave for a

non-ring destination. This section discusses these cases, and how traffic traversing a ring can profit from ring protection.

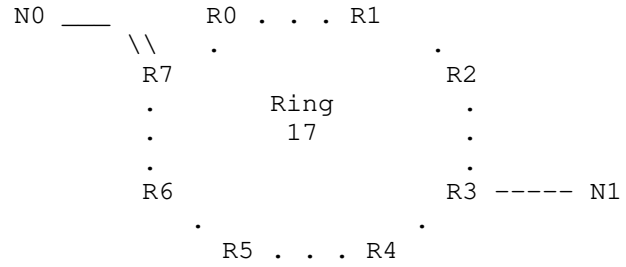


Figure 4: Beyond the Ring

In all these cases, the "end-to-end" path needs to be either stitched with, or overlaid on, the ring path. The latter approach is recommended, using hierarchy in both the control and data planes. In the figure above, traffic from N0 to N1 (both non-ring nodes) traverses Ring 17. If nodes outside Ring 17 use LDP to signal LSPs, here's one way to accomplish this: R7 and R3 have targeted LDP sessions to exchange labels. The following LDP label exchanges occur (among others):

1. N1 sends an "egress label" L0 for its loopback N1 to R3 and inserts a "pop L0 and forward" entry in its LFIB.

2. R3 sends a label L1 for N1 to R7 over the targeted LDP session and inserts a "swap L1 with L0" in its LFIB.

3. R7 sends label L2 for N1 to N0 and inserts a "swap L2 with L1" entry in its LFIB.

4. N0 inserts a "push L2" entry in its LFIB for traffic destined to N1.

In parallel, nodes in Ring 17 exchange labels for traffic within the ring.

To send a packet to N1, N0 pushes label L2. When this reaches R7, R7 swaps L2 with L1 and additionally pushes a ring label to reach R3. Ring forwarding occurs between R7 and R3. R3 pops the ring label, swaps L2 with L1 and forwards the packet to N1. If a failure occurs on the ring, ring protection kicks in. A failure of R7, R3 or any non-ring node will be dealt with by the non-ring label distribution protocol (in this case, LDP).

6.2. Half-rings

In some cases, a ring H may be incomplete, either because H is permanently missing a link (not just because of a failure), or because the link required to complete H is in a different IGP area. Either way, the ring discovery algorithm will fail. We call such a ring a "half-ring". Half-rings are sufficiently common that finding a way to deal with them effectively is a useful problem to solve. This topic will not be addressed in this document; that task is left for a future document.

6.3. Hub Node Resilience

Let's call the node(s) that connect a ring to the rest of the network "hub node(s)" (usually, there are a pair of hub nodes.) Suppose a ring has two hub nodes H1 and H2. Suppose further that a non-hub ring node X wants to send traffic to some node Z outside the ring. This could be done, say, by having targeted LDP (T-LDP) sessions from H1 and H2 to X advertising LDP reachability to Z via H1 (H2); there would be a two-label stack from X to reach Z. Say that to reach Z, X prefers H1; thus, traffic from X to Z will first go to H1 via a ring LSP, then to Z via LDP.

If H1 fails, traffic from X to Z will drop until the T-LDP session from H1 to Z fails, the IGP reconverges, and H2's label to Z is chosen. Thereafter, traffic will go from X to H2 via a ring LSP, then to Z via LDP. However, this convergence could take a long time. Since this is a very common and important situation, it is again a useful problem to solve. However, this topic too will not be addressed in this document; that task is left for a future document.

7. Security Considerations

This document proposes extensions to IS-IS, OSPF, LDP and RSVP-TE, all of which have mechanisms to secure them. The extensions proposed do not represent per se a compromise to network security when the control plane is secured, since any manipulation of the content of the messages or even the control plane misinterpretation of the semantics are avoided.

A compromised or otherwise misbehaving node can foil the autodiscovery process Section 4, leading to a ring never transitioning to a usable state.

8. Acknowledgments

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9. IANA Considerations

There are no requests as yet to IANA for this document.

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