             Intermediate System to Intermediate System (IS-IS)
                        Transient Blackhole Avoidance

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Abstract

   This document describes a simple, interoperable mechanism that can be
   employed in Intermediate System to Intermediate System (IS-IS)
   networks in order to decrease the data loss associated with
   deterministic blackholing of packets during transient network
   conditions. The mechanism proposed here requires no IS-IS protocol
   changes and is completely interoperable with the existing IS-IS
   specification.

1. Introduction

   When an IS-IS router that was previously a transit router becomes
   unavailable as a result of some transient condition such as a reboot,
   other routers within the routing domain must select an alternative
   path to reach destinations which have previously transited the failed
   router. Presumably, the newly selected router(s) comprising the path
   have been available for some time and, as a result, have complete
   forwarding information bases (FIBs) which contain a full set of
   reachability information for both internal and external (e.g., BGP)
   destination networks.

   When the previously failed router becomes available again, it is only
   seconds before the paths that had previously transited the router are
   again selected as the optimal path by the IGP. As a result,
   forwarding tables are updated and packets are once again forwarded
   along the path. Unfortunately, external destination reachability
   information (e.g., learned via BGP) is not yet available to the
   router, and as a result, packets bound for destinations not learned
   via the IGP are unnecessarily discarded.

A simple interoperable mechanism to alleviate the offshoot associated
with this deterministic behavior is discussed below.

2. Discussion

This document describes a simple, interoperable mechanism that can be
employed in IS-IS [1, 2] networks in order to avoid transition to a
newly available path until other associated routing protocols such as
BGP have had sufficient time to converge.

The benefits of such a mechanism can be realized when considering the
following scenario depicted in Figure 1.

```
                            D.1
                             |
                        +--------+
                        | RtrD   |
                        +--------+
                         /      \
                        /        \
              +--------+          +--------+
              | RtrB   |          | RtrC   |
              +--------+          +--------+
                   \                  /
                    \                /
                        +--------+
                        | RtrA   |
                        +--------+
                             |
                            S.1
```
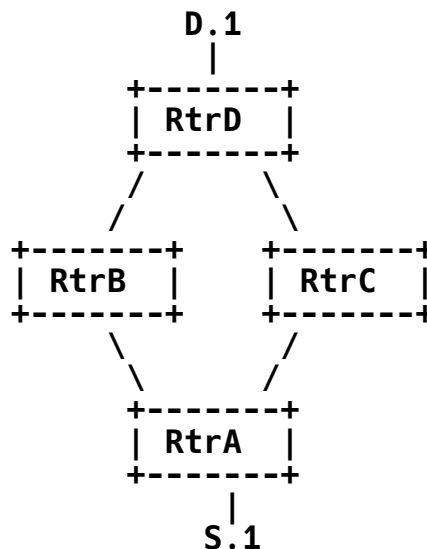
Figure 1: Example Network Topology

Host S.1 is transmitting data to destination D.1 via a primary path
of RtrA->RtrB->RtrD. Routers A, B and C learn of reachability to
destination D.1 via BGP from RtrD. RtrA's primary path to D.1 is
selected because when calculating the path to BGP NEXT_HOP of RtrD,
the sum of the IS-IS link metrics on the RtrA-RtrB-RtrD path is less
than the sum of the metrics of the RtrA-RtrC-RtrD path.

Assume RtrB becomes unavailable and as a result the RtrC path to RtrD
is used. Once RtrA's FIB is updated and it begins forwarding packets
to RtrC, everything should behave properly as RtrC has existing
forwarding information regarding destination D.1's availability via
BGP NEXT_HOP RtrD.

Assume now that RtrB comes back online. In only a few seconds, IS-IS
neighbor state has been established with RtrA and RtrD and database
synchronization has occurred. RtrA now realizes that the best path
to destination D.1 is via RtrB, and therefore updates it FIB
appropriately. RtrA begins to forward packets destined to D.1 to
RtrB. Though, because RtrB has yet to establish and synchronize its
BGP neighbor relationship and routing information with RtrD, RtrB has
no knowledge regarding reachability of destination D.1, and therefore
discards the packets received from RtrA destined to D.1.

If RtrB were to temporarily set its LSP Overload bit while
synchronizing BGP tables with its neighbors, RtrA would continue to
use the working RtrA->RtrC->RtrD path, and the LSP should only be
used to obtain reachability to locally connected networks (rather
than for calculating transit paths through the router, as defined in
[1]).

However, it should be noted that when RtrB goes away, its LSP is
still present in the IS-IS databases of all other routers in the
routing domain. When RtrB comes back it establishes adjacencies. As
soon as its neighbors have an adjacency with RtrB, they will
advertise their new adjacency in their new LSP. The result is that
all the other routers will receive new LSPs from RtrA and RtrD
containing the RtrB adjacency, even though RtrB is still completing
its synchronization and therefore has not yet sent its new LSP.

At this time SPF is computed and everyone will include RtrB in their
tree since they will use the old version of RtrB LSP (the new one has
not yet arrived). Once RtrB has finished establishing all its
adjacencies, it will then regenerate its LSP and flood it. Then all
other routers within the domain will finally compute SPF with the
correct information. Only at that time will the Overload bit be
taken into account.

As such, it is recommended that each time a router establishes an
adjacency, it will update its LSP and flood it immediately, even
before beginning database synchronization. This will allow for the
Overload bit setting to propagate immediately, and remove the
potential for an older version of the reloaded routers LSP to be
used.

After synchronization of BGP tables with neighboring routers (or
expiry of some other timer or trigger), RtrB would generate a new
LSP, clearing the Overload bit, and RtrA could again begin using the
optimal path via RtrB.

Typically, in service provider networks IBGP connections are done via peerings with 'loopback' addresses. As such, the newly available router must advertise its own loopback (or similar) IP address, as well as associated adjacencies, in order to make the loopbacks accessible to other routers within the routing domain. It is because of this that simply flooding an empty LSP is not sufficient.

3. Deployment Considerations

Such a mechanism increases overall network availability and allows network operators to alleviate the deterministic blackholing behavior introduced in this scenario. Similar mechanisms [3] have been defined for OSPF, though only after realizing the usefulness obtained from that of the IS-IS Overload bit technique.

This mechanism has been deployed in several large IS-IS networks for a number of years.

Triggers for setting the Overload bit as described are left to the implementer. Some potential triggers could perhaps include "N seconds after booting", or "N number of BGP prefixes in the BGP Loc-RIB".

Unlike similar mechanisms employed in [3], if the Overload bit is set in a router's LSP, NO transit paths are calculated through the router. As such, if no alternative paths are available to the destination network, employing such a mechanism may actually have a negative impact on convergence (i.e., the router maintains the only available path to reach downstream routers, but the Overload bit disallows other nodes in the network from calculating paths via the router, and as such, no feasible path exists to the routers).

Finally, if all systems within an IS-IS routing domain haven't implemented the Overload bit correctly, forwarding loops may occur.

4. Potential Alternatives

Alternatively, it may be considered more appealing to employ something more akin to [3] for this purpose. With this model, during transient conditions a node advertises excessively high link metrics to serve as an indication, to other nodes in the network that paths transiting the router are "less desirable" than existing paths.

The advantage of a metric-based mechanism over the Overload bit mechanism model proposed here is that transit paths may still be calculated through the router. Another advantage is that a metric-based mechanism does not require that all nodes in the IS-IS domain correctly implement the Overload bit.

However, as currently deployed, IS-IS provides for only 6 bits of
space for link metric allocation, and 10 bits aggregate path metric.
Though extensions proposed in [4] remove this limitation, they have
not yet been widely deployed. As such, there's currently little
flexibility when using link metrics for this purpose. Of course,
both methods proposed in this document are backwards-compatible.

5. Security Considerations

The mechanisms specified in this memo introduces no new security
issues to IS-IS.

6. Acknowledgements

The author of this document makes no claim to the originality of the
idea. Thanks to Stefano Previdi for valuable feedback on the
mechanism discussed in this document.

7. References

[1] ISO, "Intermediate system to Intermediate system routing
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[4] Li, T. and H. Smit, "IS-IS extensions for Traffic Engineering",
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8. Author's Address

Danny McPherson
TCB
Phone: 303.470.9257
EMail: danny@tcb.net

9. Full Copyright Statement

Acknowledgement