White Paper

Simulate IP Fast Reroute Loop-Free Alternate (LFA)

Learn how to import topology and Interior Gateway Protocol (IGP) metrics using Cisco MATE to improve LFA coverage.

What You Will Learn

Cisco MATE™ software helps you to easily import a current topology and IGP metrics. Using Cisco® MATE simulation tools, you can then evaluate the per-prefix IP fast reroute (IPFRR) loop-free alternate (LFA) coverage. With this analysis, you can use Cisco MATE visualization and optimization tools to model and improve LFA coverage, resulting in improved network resiliency. This paper describes the IPFRR simulation tool, using an example analysis, and offers an example of improving the LFA coverage by redesigning the network.

IP Fast Reroute Overview

IPFRR provides fast reroute capabilities using pure IP (non-MPLS) protocols, such as open shortest path first (OSPF) and Intermediate System-to-Intermediate System (IS-IS). IPFRR can be enabled on one or more routers, after which it calculates one LFA backup path for every prefix. If there is a failure and a router cannot forward packets on the required outbound interface, it can switch quickly, before reconvergence, to an LFA interface. The IPFRR-enabled interface helps to ensure that the packets rejoin the original route downstream from the failure. If the rerouting rejoins the original route at the remote node of the protected interface, the LFA provides circuit protection. If it rejoins further downstream than the remote node, then the LFA provides node failure protection.

The LFAs on the interfaces, as well as the routes over those interfaces, are based on the network topology. The topology could result in LFAs being available to protect all routes over some interfaces, to protect only some routes, or to protect none at all.

Cisco MATE LFA Analysis

The Cisco MATE IPFRR simulation tool enables you to view the LFA topology to determine how extensive and effective the coverage, and thus the protection, is. The simulation tool models the network using demands, and each demand represents an aggregated quantity of traffic routed from a source to a destination in a network. A MATE LFA analysis examines every demand, through every interface, to determine the LFA coverage for that interface. All per-prefix routes aggregated into the same demand have the same LFA behavior for each interface they traverse.

Example LFA Analysis

Figure 1 shows an LFA analysis on a network represented in the MATE plot. The analysis shows that every demand, and so every route, does not have a loop-free alternate. Interfaces are colored according to the results of the LFA analysis. Green indicates the interface has 100 percent LFA coverage. Yellow indicates partial coverage, and red indicates no LFA coverage.

Figure 2 shows the Hamburg site containing two Provider transit core routers and two Provider Edge routers, and a single virtual edge router (representing a larger number of identical edge routers). Some intersite circuits are not protected due to ring topologies. (Sites are denoted by blue, square icons in Figure 1.)

Figure 1. MATE LFA Analysis

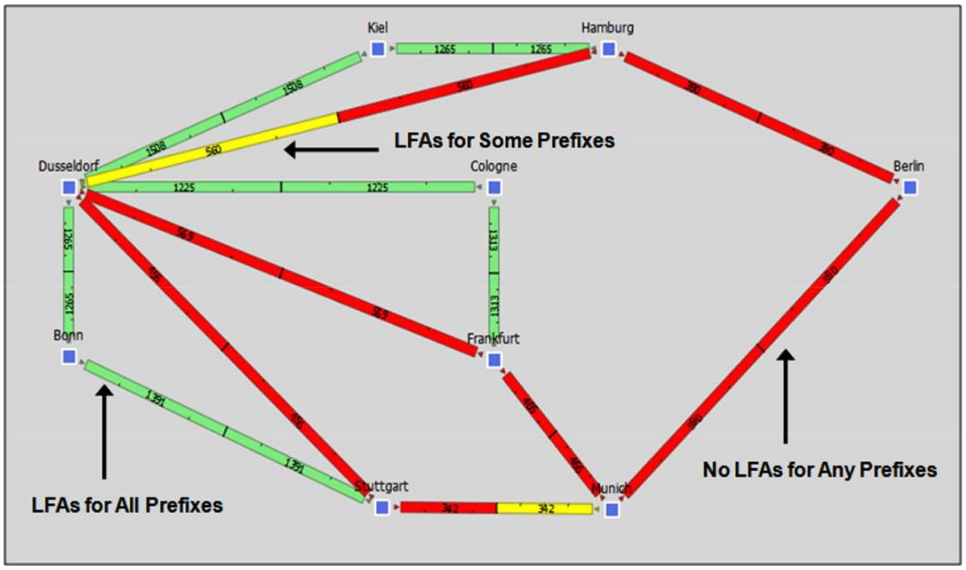
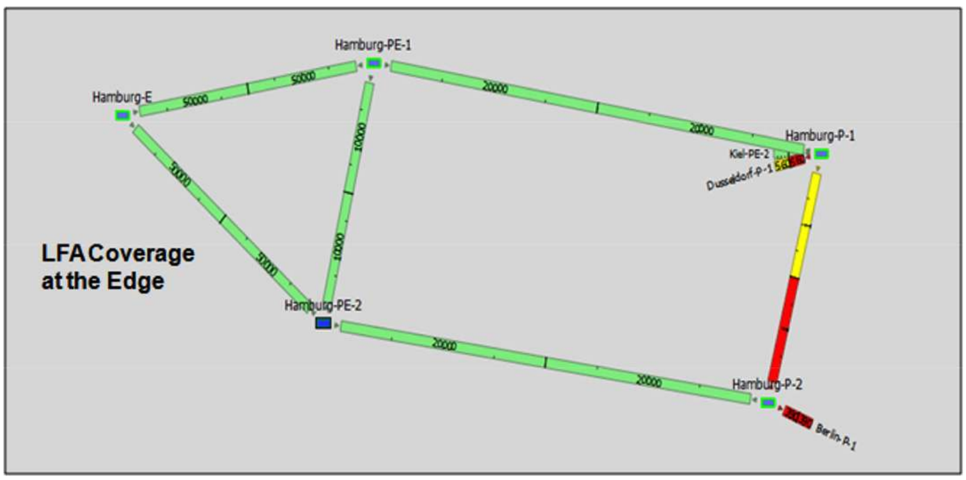


Figure 2. MATE Site LFA Analysis



A MATE report, such as in Figure 3, identifies that in this network 74 percent of the traffic is circuit-protected using IPFRR, and 57 percent is node protected. Figure 3 also shows the percentage of LFA coverage per interface. The report excerpt in Figure 4 shows more detailed LFA information that can be used when looking for ways to improve the coverage.

Figure 3. IPFRR LFA Report Excerpts Showing LFA Coverage per Interface

IPFRR LFA Summary

Interface traffic covered by IPFRR: **74.5%** (107705.65 Mbps out of 144578.41 Mbps)

57.3% of the traffic is also node diverse

	Node	Interface	IPFRR LFA Coverage
19	Munich-P-2	{to_Frankfurt-P-2}	0.00
20	Dusseldorf-P-2	{to_Dusseldorf-P-1}	4.59
21	Hamburg-P-1	{to_Hamburg-P-2}	5.22
22	Dusseldorf-P-1	{to_Hamburg-P-1}	24.72
23	Munich-P-2	{to_Stuttgart-P-2}	28.23
24	Dusseldorf-P-1	{to_Dusseldorf-P-2}	69.46
25	Frankfurt-P-1	{to_Frankfurt-P-2}	100.00
26	Frankfurt-P-2	{to_Frankfurt-P-1}	100.00
27	Hamburg-E	{to_Hamburg-PE-1}	100.00
28	Hamburg-PE-1	{to_Hamburg-E}	100.00
29	Hamburg-E	{to_Hamburg-PE-2}	100.00
30	Hamburg-PE-2	{to_Hamburg-E}	100.00

Figure 4. Report Excerpt Showing Further Details of LFA Coverage

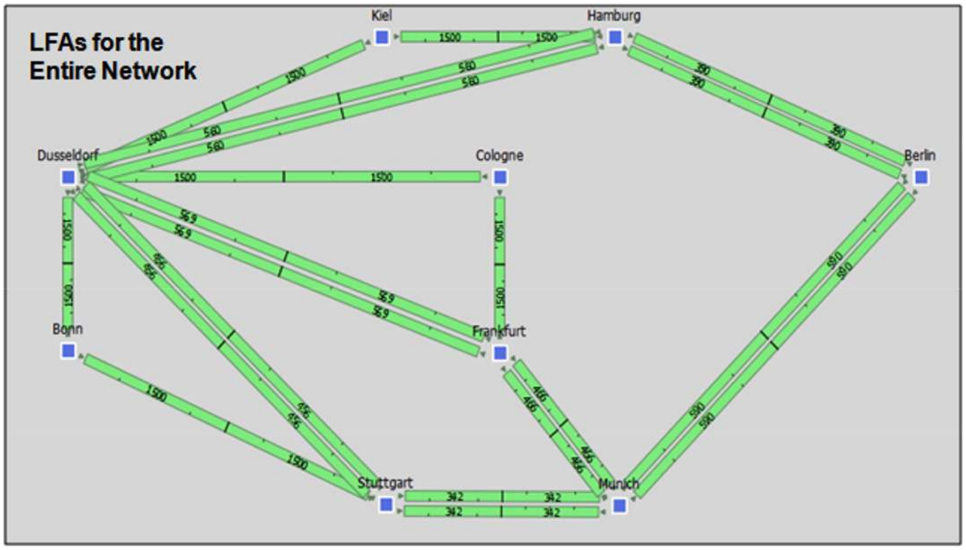
```
(1) Processing routing table
  (2) Processing interface Munich-P-1 ({to_Berlin-P-2}) to Berlin-P-2
    (d) Neighbor: Munich-PE-1
    (d) Neighbor: Munich-P-2
    (d) Munich-E|Berlin-E: no LFA, traffic: 276.72 Mbps
    (d) Frankfurt-E|Berlin-E: no LFA, traffic: 379.01 Mbps
    (d) Stuttgart-E|Berlin-E: no LFA, traffic: 315.84 Mbps
    (d) Munich-E|Hamburg-E: no LFA, traffic: 415.08 Mbps
    (d) Munich-E|Kiel-E: no LFA, traffic: 166.03 Mbps
  (2) NO IPFRR for Munich-P-1:{to_Berlin-P-2}
  (2) Processing interface Munich-P-2 ({to_Frankfurt-P-2}) to Frankfurt-P-2
    (d) Neighbor: Stuttgart-P-2
    (d) Neighbor: Munich-PE-2
    (d) Neighbor: Munich-P-1
    (d) Munich-E|Frankfurt-E: no LFA, traffic: 691.79 Mbps
    (d) Berlin-E|Frankfurt-E: no LFA, traffic: 236.88 Mbps
    (d) Stuttgart-E|Frankfurt-E: no LFA, traffic: 789.61 Mbps
  (2) IPFRR INTERFACE (LFA coverage: 0.0%, 0 out of 3 routes)
  (2) Processing interface Kiel-PE-2 ({to_Kiel-PE-1}) to Kiel-PE-1
    (d) Neighbor: Hamburg-P-1
    (d) Neighbor: Kiel-E
  (2) NO IPFRR for Kiel-PE-2:{to_Kiel-PE-1}
```

Example Solution

After analyzing this LFA result, you could then use MATE visualization and simulation tools to create a dual-plane topology that provides 100 percent circuit and node protection throughout the entire network, as shown in Figure 5. In this solution, pairs of Provider transit routers in each core site are connected to pairs of Provider transit routers in neighboring core sites using dual circuits with matching metrics (displayed on each interface).

Note that in addition to resolving LFA coverage issues by making topology changes, you can also run the MATE Metric Optimization tool to balance traffic utilization over all routes, which can result in increased LFA coverage.

Figure 5. Dual-Plane Topology Provides 100 Percent LFA Protection



IPFRR Add-On

A Cisco MATE add-on is a tightly integrated user-defined application that is called from the GUI. This capability helps you to quickly prototype and extends MATE functionality to adapt to your specific needs.

Given IPFRR is a new protocol whose various implementations are in flux, the IPFRR simulation tool is provided as a MATE add-on. We will incorporate this simulation function into the core MATE product when router vendor implementations stabilize.

Conclusion

Using Cisco MATE simulation tools, you can analyze the LFA coverage based on demand meshes (for example, edge to edge), as well as based on real or projected traffic. With the analysis, you can further use MATE tools to determine the best solutions for improving network reliability through LFA coverage.

For More Information

To learn more about Cisco MATE products visit http://www.cisco.com.

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