



Configure Topology-Independent Loop-Free Alternate (TI-LFA)

Topology-Independent Loop-Free Alternate (TI-LFA) uses segment routing to provide link protection in topologies where other fast reroute techniques cannot provide protection.

- Classic Loop-Free Alternate (LFA) is topology dependent, and therefore cannot protect all destinations in all networks. A limitation of LFA is that, even if one or more LFAs exist, the optimal LFA may not always be provided.
- Remote LFA (RLFA) extends the coverage to 90-95% of the destinations, but it also does not always provide the most desired repair path. RLFA also adds more operational complexity by requiring a targeted LDP session to the RLFAs to protect LDP traffic.

TI-LFA provides a solution to these limitations while maintaining the simplicity of the IPFRR solution.

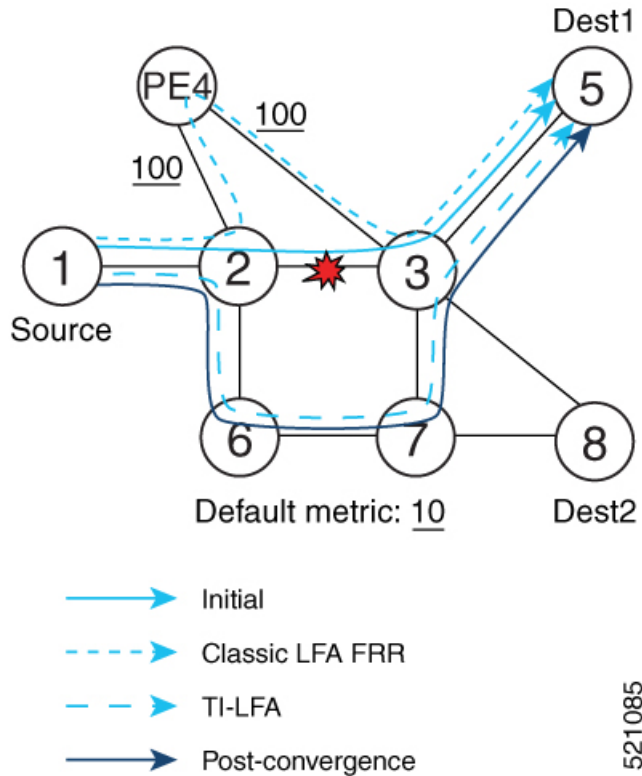
The goal of TI-LFA is to reduce the packet loss that results while routers converge after a topology change due to a link failure. Rapid failure repair (< 50 msec) is achieved through the use of pre-calculated backup paths that are loop-free and safe to use until the distributed network convergence process is completed.

The optimal repair path is the path that the traffic will eventually follow after the IGP has converged. This is called the post-convergence path. This path is preferred for the following reasons:

- Optimal for capacity planning — During the capacity-planning phase of the network, the capacity of a link is provisioned while taking into consideration that such link will be used when other links fail.
- Simple to operate — There is no need to perform a case-by-case adjustment to select the best LFA among multiple candidate LFAs.
- Fewer traffic transitions — Since the repair path is equal to the post-convergence path, the traffic switches paths only once.

The following topology illustrates the optimal and automatic selection of the TI-LFA repair path.

Figure 1: TI-LFA Repair Path



Node 2 protects traffic to destination Node 5.

With classic LFA, traffic would be steered to Node 4 after a failure of the protected link. This path is not optimal, since traffic is routed over edge node Node 4 that is connected to lower capacity links.

TI-LFA calculates a post-convergence path and derives the segment list required to steer packets along the post-convergence path without looping back.

In this example, if the protected link fails, the shortest path from Node2 to Node5 would be:

Node2 → Node6 → Node7 → Node3 → Node5

Node7 is the PQ-node for destination Node5. TI-LFA encodes a single segment (prefix SID of Node7) in the header of the packets on the repair path.

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Usage Guidelines and Limitations

The TI-LFA guidelines and limitations are listed below:

| TI-LFA Functionality | IS-IS ¹ | OSPFv2 |
|--------------------------------|--------------------|--------|
| <i>Protected Traffic Types</i> | | |

| TI-LFA Functionality | IS-IS ¹ | OSPFv2 |
|--|---------------------|-------------|
| Protection for SR labeled traffic | Supported | Supported |
| Protection of IPv4 unlabeled traffic | Supported (IS-ISv4) | Supported |
| Protection of IPv6 unlabeled traffic | Unsupported | N/A |
| <i>Protection Types</i> | | |
| Link Protection | Supported | Supported |
| Node Protection | Supported | Supported |
| Local SRLG Protection | Supported | Supported |
| Weighted Remote SRLG Protection | | |
| Line Card Disjoint Protection | Supported | Unsupported |
| <i>Interface Types</i> | | |
| Ethernet Interfaces | Supported | Supported |
| Ethernet Bundle Interfaces | Supported | Supported |
| TI-LFA over GRE Tunnel as Protecting Interface | | |
| <i>Additional Functionality</i> | | |
| BFD-triggered | Supported | Supported |
| BFDv6-triggered | Supported | N/A |
| Prefer backup path with lowest total metric | Supported | Supported |
| Prefer backup path from ECMP set | Supported | Supported |
| Prefer backup path from non-ECMP set | Supported | Supported |
| Load share prefixes across multiple backups paths | Supported | Supported |
| Limit backup computation up to the prefix priority | Supported | Supported |

¹ Unless specified, IS-IS support is IS-ISv4 and IS-ISv6

Configuring TI-LFA for IS-IS

This task describes how to enable per-prefix Topology Independent Loop-Free Alternate (TI-LFA) computation to converge traffic flows around link failures.

Before you begin

Ensure that the following topology requirements are met:

- Router interfaces are configured as per the topology.
- Routers are configured with IS-IS.

- Segment routing for IS-IS is configured. See [Enabling Segment Routing for IS-IS Protocol](#).

SUMMARY STEPS

1. **configure**
2. **router isis** *instance-id*
3. **interface** *type interface-path-id*
4. **address-family ipv4** [**unicast**]
5. **fast-reroute per-prefix**
6. **fast-reroute per-prefix ti-lfa**

DETAILED STEPS

| | Command or Action | Purpose |
|---------------|---|---|
| Step 1 | configure Example: RP/0/RP0/CPU0:router# configure | Enters XR Config mode. |
| Step 2 | router isis <i>instance-id</i> Example: RP/0/RP0/CPU0:router(config)# router isis 1 | Enables IS-IS routing for the specified routing instance, and places the router in router configuration mode. Note You can change the level of routing to be performed by a particular routing instance by using the is-type router configuration command. |
| Step 3 | interface <i>type interface-path-id</i> Example: RP/0/RP0/CPU0:router(config-isis)# interface GigabitEthernet0/0/2/1 | Enters interface configuration mode. |
| Step 4 | address-family ipv4 [unicast] Example: RP/0/RP0/CPU0:router(config-isis-if)# address-family ipv4 unicast | Specifies the IPv4 address family, and enters router address family configuration mode. |
| Step 5 | fast-reroute per-prefix Example: RP/0/RP0/CPU0:router(config-isis-if-af)# fast-reroute per-prefix | Enables per-prefix fast reroute. |
| Step 6 | fast-reroute per-prefix ti-lfa Example: | Enables per-prefix TI-LFA fast reroute link protection. |

| | Command or Action | Purpose |
|--|--|---------|
| | <pre>RP/0/RP0/CPU0:router(config-isis-if-af)# fast-reroute per-prefix ti-lfa</pre> | |

TI-LFA has been successfully configured for segment routing.

Configuring TI-LFA for OSPF

This task describes how to enable per-prefix Topology Independent Loop-Free Alternate (TI-LFA) computation to converge traffic flows around link failures.



Note TI-LFA can be configured on the instance, area, or interface. When configured on the instance or area, all interfaces in the instance or area inherit the configuration.

Before you begin

Ensure that the following topology requirements are met:

- Router interfaces are configured as per the topology.
- Routers are configured with OSPF.
- Segment routing for OSPF is configured. See [Enabling Segment Routing for OSPF Protocol](#).

SUMMARY STEPS

1. **configure**
2. **router ospf** *process-name*
3. **area** *area-id*
4. **interface** *type interface-path-id*
5. **fast-reroute per-prefix**
6. **fast-reroute per-prefix ti-lfa**

DETAILED STEPS

| | Command or Action | Purpose |
|---------------|---|---|
| Step 1 | configure Example: <pre>RP/0/RP0/CPU0:router# configure</pre> | Enters XR Config mode. |
| Step 2 | router ospf <i>process-name</i> Example: | Enables OSPF routing for the specified routing process, and places the router in router configuration mode. |

| | Command or Action | Purpose |
|---------------|--|---|
| | RP/0/RP0/CPU0:router(config)# router ospf 1 | |
| Step 3 | area <i>area-id</i> Example: RP/0/RP0/CPU0:router(config-ospf)# area 1 | Enters area configuration mode. |
| Step 4 | interface <i>type interface-path-id</i> Example: RP/0/RP0/CPU0:router(config-ospf-ar)# interface GigabitEthernet0/0/2/1 | Enters interface configuration mode. |
| Step 5 | fast-reroute per-prefix Example: RP/0/RP0/CPU0:router(config-ospf-ar-if)# fast-reroute per-prefix | Enables per-prefix fast reroute. |
| Step 6 | fast-reroute per-prefix ti-lfa Example: RP/0/RP0/CPU0:router(config-ospf-ar-if)# fast-reroute per-prefix ti-lfa | Enables per-prefix TI-LFA fast reroute link protection. |

TI-LFA has been successfully configured for segment routing.