Configuring EIGRP Loop-Free Alternate IP Fast Reroute

The Enhanced Interior Gateway Routing Protocol Loop-Free Alternate IP Fast Reroute feature allows the EIGRP to reduce the routing transition time to less than 50 ms by precomputing repair paths or backup routes and installing these paths or routes in the routing information base (RIB). Fast Reroute (FRR) is the mechanism that enables traffic that traverses a failed link to be rerouted around the failure. In EIGRP networks, precomputed backup routes or repair paths are known as feasible successors or LFAs. This module describes how to configure the EIGRP Loop-Free Alternate Fast Reroute feature and enable load-sharing and tie-breaking configurations for the feasible successors or Loop-Free Alternates (LFAs) that are identified by EIGRP.

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Restrictions for EIGRP Loop-Free Alternate IP Fast Reroute

- IPv6 LFA IP FRR is not supported.
- LFA IP FRR is not supported with primary path or backup path as Multiprotocol Label Switching (MPLS).
- LFA IP FRR is not supported with primary path or backup path as Equal-Cost Multipath (ECMP).
- LFA IP FRR is only available in network-advantage license level.
- Generic Routing Encapsulation (GRE) tunnel as primary path is not supported.
- The convergence time may be higher in cases of high CPU utilization.
- The convergence time is dependent on the primary link status detection. Therefore, if the physical link goes down, in cases of logical interfaces such as Switched Virtual interface (SVI) and port channels, the convergence time is expected to be higher.

Information About EIGRP Loop-Free Alternate IP Fast Reroute

The following sections provide detailed information about EIGRP Loop-Free Alternate IP Fast Reroute.

Repair Paths Overview

When a link or a device fails, distributed routing algorithms compute new routes or repair paths. The time taken for this computation is called routing transition. Until the transition is complete and all the devices are converged on a common view of the network, the connectivity between the source and destination pairs of devices is interrupted. Repair paths forward traffic during a routing transition.

When a link or a device fails, initially, only the neighboring devices are aware of the failure. All the other devices in the network are unaware of the nature and location of this failure until information about this failure is propagated through the routing protocol. The propagation of this information may take several hundred milliseconds. Meanwhile, packets affected by the network failure need to be steered to their destinations. A device adjacent to the failed link employs a set of repair paths for packets that would have used the failed link. These repair paths are used from the time the router detects the failure until the routing transition is complete. By the time the routing transition is complete, all the devices in the network revise their forwarding data, and the failed link is eliminated from the routing computation. Routing protocols precompute repair paths in anticipation of failures so that the repair paths can be activated the moment a failure is detected. In EIGRP networks, precomputed repair paths or backup routes are known as feasible successors or LFAs.

LFA Computation

An LFA is a precomputed next-hop route that delivers a packet to its destination without looping back. Traffic is redirected to an LFA after a network failure, and the LFA makes the forwarding decision without any knowledge of the failure.

Interior Gateway Protocols (IGPs) compute LFAs in the following ways:

- Per-link (link-based) computation: In link-based LFAs, all the prefixes (networks) that are reachable through the primary (protected) link share the same backup information. This means that the whole set of prefixes sharing the primary link also share the repair or the Fast Reroute (FRR) ability. The per-link approach protects only the next-hop address. It need not necessarily protect the destination node. Therefore, the per-link approach is suboptimal and not the best approach for capacity planning because all traffic from the primary link is redirected to the next hop instead of being spread over multiple paths. Redirecting all traffic to the next hop may lead to congestion on the link to the next hop.
- Per-prefix (prefix-based) computation: Prefix-based LFAs allow computing backup information per prefix (network) and protect the destination address. The per-prefix approach is preferred over the per-link approach because of its greater applicability and better bandwidth utilization. Per-prefix computations provide better load sharing and better protection coverage than per-link computations because per-prefix computations evaluate all possible LFAs and use tie-breakers to select the best LFA from among the available LFAs.

Note The repair or backup information computed for a primary path by using prefix-based LFAs may be different from that computed by using link-based LFAs.

EIGRP always computes prefix-based LFAs. EIGRP uses the Diffusing Update Algorithm (DUAL) to calculate the successor and feasible successors. EIGRP uses the successor as the primary path and feasible successors as repair paths or LFAs.

LFA Tie-Breaking Rules

When there are multiple candidate LFAs for a given primary path, EIGRP uses a tie-breaking rule to select one LFA per primary path per prefix. A tie-breaking rule considers LFAs that satisfy certain conditions or have certain attributes. EIGRP uses the following four attributes to implement tie-breaking rules:

- Interface-disjoint: Eliminates LFAs that share the outgoing interface with the protected path.
- Linecard-disjoint: Eliminates LFAs that share the line card with the protected path.
- Lowest-repair-path-metric: Eliminates LFAs whose metric to the protected prefix is high. Multiple LFAs with the same lowest path metric may remain in the routing table after this tie-breaker is applied.
- Shared Risk Link Group-disjoint: Eliminates LFAs that belong to any of the protected path Shared Risk Link Groups (SRLGs). SRLGs refer to situations where links in a network share a common fiber (or a common physical attribute). If one link fails, other links in the group may also fail. Therefore, links in a group share risks.

How to Configure EIGRP Loop-Free Alternate IP Fast Reroute

The following sections provide information about the various tasks that comprise the configuration of EIGRP loop-free alternate IP fast reroute.

Configuring LFA IP FRRs Per Prefix

Perform this task to configure LFA IP FRRs per prefix in an EIGRP network. You can enable LFAs for all the available prefixes in the EIGRP topology, or for prefixes specified by route maps.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router eigrp** *virtual-name*
4. **address-family ipv4 autonomous-system** *autonomous-system-number*
5. **topology base**
6. **fast-reroute per-prefix {all | route-map** *route-map-name***}**
7. **end**
8. **show ip eigrp topology frr**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**router eigrp** *virtual-name* **Example:** `Device(config)# router eigrp name`	Configures an EIGRP routing process and enters router configuration mode.
Step 4	**address-family ipv4 autonomous-system** *autonomous-system-number* **Example:** `Device(config-router)# address-family ipv4 autonomous-system 1`	Enters IPv4 VRF address family configuration mode and configures an EIGRP routing instance.
Step 5	**topology base** **Example:** `Device(config-router-af)# topology base`	Configures a base EIGRP topology and enters router address family topology configuration mode.
Step 6	**fast-reroute per-prefix {all | route-map** *route-map-name*} **Example:** `Device(config-router-af-topology)# fast-reroute per-prefix all`	Enables IP FRR for all the prefixes in the topology. Enter the **route-map** keyword to enable IP FRR on prefixes specified by a route map.
Step 7	**end** **Example:** `Device(config-router-af-topology)# end`	Exits router address family topology configuration mode and returns to privileged EXEC mode.
Step 8	**show ip eigrp topology frr** **Example:** `Device# show ip eigrp topology frr`	Displays the list of configured LFAs in the EIGRP topology table.

Disabling Load Sharing Among Prefixes

When the primary path is an Equal Cost Multipath (ECMP) path with multiple LFAs, prefixes (networks) are distributed equally among the LFAs because the default behavior for ECMP paths is load sharing. However,

you can control the selection of LFAs by enabling tie-breaking configurations. Perform this task to disable load sharing among prefixes.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router eigrp** *virtual-name*
4. **address-family ipv4 autonomous-system** *autonomous-system-number*
5. **topology base**
6. **fast-reroute load-sharing disable**
7. **end**
8. **show ip eigrp topology frr**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**router eigrp** *virtual-name* **Example:** `Device(config)# router eigrp name`	Configures an EIGRP routing process and enters router configuration mode.
Step 4	**address-family ipv4 autonomous-system** *autonomous-system-number* **Example:** `Device(config-router)# address-family ipv4 autonomous-system 1`	Enters IPv4 VRF address family configuration mode and configures an EIGRP routing instance.
Step 5	**topology base** **Example:** `Device(config-router-af)# topology base`	Configures a base EIGRP topology and enters router address family topology configuration mode.
Step 6	**fast-reroute load-sharing disable** **Example:** `Device(config-router-af-topology)# fast-reroute load-sharing disable`	Disables load sharing among prefixes.

	Command or Action	Purpose
Step 7	**end** **Example:** `Device(config-router-af-topology)# end`	Exits router address family topology configuration mode and returns to privileged EXEC mode.
Step 8	**show ip eigrp topology frr** **Example:** `Device# show ip eigrp topology frr`	Displays the list of configured feasible successors or LFAs in the EIGRP topology table.

Enabling Tie-Breaking Rules for EIGRP LFAs

Perform this task to enable tie-breaking rules to select a single LFA when there are multiple LFAs for a given primary path. The EIGRP allows you to use four attributes to configure tie-breaking rules. Each of the following keywords of the **fast-reroute tie-break** command allows you to configure a tie-breaking rule based on a specific attribute—**interface-disjoint**, **linecard-disjoint**, **lowest-backup-path-metric**, and **srlg-disjoint**. You can assign a priority value for each attribute. Tie-breaking rules are applied on the basis of the priority assigned to each attribute. The lower the assigned priority value, the higher the priority of the tie-breaking attribute.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router eigrp** *virtual-name*
4. **address-family ipv4 autonomous-system** *autonomous-system-number*
5. **topology base**
6. **fast-reroute tie-break {interface-disjoint | linecard-disjoint | lowest-backup-path-metric | srlg-disjoint}** *priority-number*
7. **end**
8. **show ip eigrp topology frr**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**router eigrp** *virtual-name* **Example:** `Device(config)# router eigrp name`	Configures an EIGRP routing process and enters router configuration mode.
Step 4	**address-family ipv4 autonomous-system** *autonomous-system-number* **Example:** `Device(config-router)# address-family ipv4 autonomous-system 1`	Enters IPv4 VRF address family configuration mode and configures an EIGRP routing instance.
Step 5	**topology base** **Example:** `Device(config-router-af)# topology base`	Configures a base EIGRP topology and enters router address family topology configuration mode.
Step 6	**fast-reroute tie-break {interface-disjoint | linecard-disjoint | lowest-backup-path-metric | srlg-disjoint}** *priority-number* **Example:** `Device(config-router-af-topology)# fast-reroute tie-break lowest-backup-path-metric 2`	Enables EIGRP to select an LFA by configuring a tie-breaking attribute and assigning a priority to that attribute. **Note** You cannot configure an attribute more than once in an address family.
Step 7	**end** **Example:** `Device(config-router-af-topology)# end`	Exits router address family topology configuration mode and returns to privileged EXEC mode.
Step 8	**show ip eigrp topology frr** **Example:** `Device# show ip eigrp topology frr`	Displays the list of configured feasible successors or LFAs in the EIGRP topology table.

Configuration Examples for EIGRP Loop-Free Alternate IP Fast Reroute

The following sections provide various examples of the EIGRP loop-free alternate IP fast reroute configuration.

Example: Configuring LFA IP FRRs Per Prefix

The following example shows how to configure EIGRP LFA IP FRRs for prefixes specified by the route map named map1:

```
Device> enable
Device# configure terminal
Device(config)# router eigrp name
Device(config-router)# address-family ipv4 autonomous-system 1
```

```
Device(config-router-af)# topology base
Device(config-router-af-topology)# fast-reroute per-prefix route-map map1
Device(config-router-af-topology)# end
```

Example: Disabling Load Sharing Among Prefixes

The following example shows how disable load sharing among prefixes:

```
Device> enable
Device# configure terminal
Device(config)# router eigrp name
Device(config-router)# address-family ipv4 autonomous-system 1
Device(config-router-af)# topology base
Device(config-router-af-topology)# fast-reroute load-sharing disable
Device(config-router-af-topology)# end
```

Example: Enabling Tie-Breaking Rules

The following examples show how to enable tie-breaking configurations to allow the EIGRP to select an LFA when there are multiple candidate LFAs for a given primary path.

The following example shows how to enable the tie-breaking rule that eliminates LFAs that share the outgoing interface with the primary path:

```
Device> enable
Device# configure terminal
Device(config)# router eigrp name
Device(config-router)# address-family ipv4 autonomous-system 1
Device(config-router-af)# topology base
Device(config-router-af-topology)# fast-reroute tie-break interface-disjoint 2
Device(config-router-af-topology)# end
```

The following example shows how to enable the tie-breaking rule that eliminates LFAs that share the linecard with the primary path:

```
Device> enable
Device# configure terminal
Device(config)# router eigrp name
Device(config-router)# address-family ipv4 autonomous-system 1
Device(config-router-af)# topology base
Device(config-router-af-topology)# fast-reroute tie-break linecard-disjoint 3
Device(config-router-af-topology)# end
```

The following example shows how to enable the tie-breaking rule that selects the LFA with the lowest metric:

```
Device> enable
Device# configure terminal
Device(config)# router eigrp name
Device(config-router)# address-family ipv4 autonomous-system 1
Device(config-router-af)# topology base
Device(config-router-af-topology)# fast-reroute tie-break lowest-backup-path-metric 4
Device(config-router-af-topology)# end
```

The following example shows how to enable the tie-breaking rule that eliminates LFAs that share SRLGs with the primary path:

```
Device> enable
Device# configure terminal
Device(config)# router eigrp name
Device(config-router)# address-family ipv4 autonomous-system 1
Device(config-router-af)# topology base
Device(config-router-af-topology)# fast-reroute tie-break srlg-disjoint 1
Device(config-router-af-topology)# end
```

Feature Information for EIGRP Loop-Free Alternate IP Fast Reroute

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for EIGRP Loop-Free Alternate IP Fast Reroute

Feature Name	Releases	Feature Information
EIGRP Loop-Free Alternate IP Fast Reroute	Cisco IOS XE Amsterdam 17.3.1	The EIGRP Loop-Free Alternate IP Fast Reroute feature allows the EIGRP to reduce the routing transition time to less than 50 ms by precomputing repair paths or backup routes and installing these paths or routes in the RIB. In EIGRP networks, the precomputed backup routes are known as feasible successors or LFAs. Support for this feature was introduced on the C9500-32C, C9500-32QC, C9500-48Y4C, and C9500-24Y4C models of the Cisco Catalyst 9500 Series Switches.