Configuring Epochs

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This document contains information about and instructions for configuring epochs for Cisco Express Forwarding tables. You can use this functionality to clear and rebuild Cisco Express Forwarding tables for consistency purposes without the loss of table information.

Cisco Express Forwarding is an advanced Layer 3 IP switching technology. It optimizes network performance and scalability for all kinds of networks: those that carry small amounts of traffic and those that carry large amounts of traffic in complex patterns, such as the Internet and networks characterized by intensive web-based applications or interactive sessions.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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.

Prerequisites for Epochs for CEF Tables

Cisco Express Forwarding must be up and running on the router or switch for you to configure epochs for Cisco Express Forwarding Forwarding Information Base (FIB) and adjacency tables.

Information About About Epochs for CEF Tables

Tasks for configuring epochs for Cisco Express Forwarding Forwarding Information Base (FIB) tables were introduced with the Nonstop Forwarding Enhanced FIB Refresh feature in Cisco IOS Release 12.2(8)T.

Before you configure epochs for Cisco Express Forwarding tables, you should understand the following:

(See the Nonstop Forwarding Enhanced FIB Refresh, page 2 for an explanation of the term "epoch.")

Tasks for configuring epochs for Cisco Express Forwarding tables were introduced with the Nonstop Forwarding Enhanced FIB Refresh feature in Cisco IOS Release 12.2(8)T.

For links to information about other Cisco Express Forwarding and distributed Cisco Express Forwarding features you can configure, refer to the Additional References, page 9.

Cisco Platform Support for Central CEF and dCEF

Cisco Express Forwarding is enabled by default on most Cisco platforms running Cisco IOS software Release 12.0 or later. When Cisco Express Forwarding is enabled on a router, the Route Processor (RP) performs the express forwarding.

To find out if Cisco Express Forwarding is enabled on your platform, enter the **show ip cef**command. If Cisco Express Forwarding is enabled, you receive output that looks like this:

```
Router# show ip cef
Prefix              Next Hop            Interface
[...]
10.2.61.8/24        192.168.100.1       FastEthernet1/0/0
                    192.168.101.1       FastEthernet6/1
[...]
```

If Cisco Express Forwarding is not enabled on your platform, the output for the **show ip cef**command looks like this:

```
Router# show ip cef
%CEF not running
```

Distributed Cisco Express Forwarding is enabled by default on the Catalyst 6500 series switch, the Cisco 7500 series router, and the Cisco 12000 Series Internet Router. When Distributed Cisco Express Forwarding is enabled on your platform, the line cards perform the express forwarding.

If Cisco Express Forwarding is not enabled on your platform, use the **ip cef**command to enable (central) Cisco Express Forwarding or the **ip cef distributed** command to enable Distributed Cisco Express Forwarding.

Nonstop Forwarding Enhanced FIB Refresh

Networks must be configured to minimize traffic disruption and offer the most uptime possible. The Nonstop Forwarding (NSF) Enhanced FIB Refresh feature (included with Cisco IOS Release 12.2(8)T)

enables users to continue forwarding IP traffic while Cisco Express Forwarding database tables are being rebuilt. IP forwarding on the router is therefore uninterrupted.

NSF Enhanced FIB Refresh provides for the continuation of Cisco Express Forwarding forwarding by tracking epochs. The term "epoch" refers to a period of time. A new epoch for a Cisco Express Forwarding table begins when a table rebuild is initiated. The time after this instant is in an epoch different from the time before, and the different epochs are numbered between 0 and 255. Through the use of epochs, the software can distinguish between old and new forwarding information in the same database structure and can retain the old Cisco Express Forwarding database table while the software builds a new table. This is called epoch tracking and it allows Cisco Express Forwarding forwarding to continue uninterrupted while new Cisco Express Forwarding tables are being constructed, and it makes possible a seamless switchover when the new table becomes active.

Epoch Numbering for CEF FIB and Adjacency Tables

A new epoch for a Cisco Express Forwarding table begins when a table rebuild is initiated. The time after this instant is in an epoch different from the time before. The first epoch is numbered 0, and it begins when the Cisco Express Forwarding table is created. The epoch number increases by 1 for each new revision of the Cisco Express Forwarding table until the epoch number reaches 255. The next epoch after 255 is 0. A new epoch cannot begin if any table entries remain from the last time the epoch number was used. The epoch number for a given table is the same for each instance of the table (for example, on each RP and on each line card where distributed Cisco Express Forwarding is active).

Each entry added to a FIB table or the adjacency table has a new field that records the current epoch for that table at the time the entry was added. When an entry is modified, the epoch of the entry is updated to record the table's current epoch. A record is kept of how many entries exist from each epoch. The epoch number cannot be incremented if any existing entries have the same epoch number as the next epoch value.

When the routing protocols signal that they have converged, all FIB and adjacency entries that have epoch numbers older than the current epoch number are removed from the FIB and adjacency tables.

When you need a Cisco Express Forwarding table to be rebuilt, the epoch number for that table is incremented, and the table is rebuilt in place. When rebuilding is complete, "stale" entries are removed from the table. You can increment the epoch of a single table or multiple tables at the same time when you enter the **clear ip cef epoch** [**all-vrfs** | **full** | **vrf**[*table*]] command. See the When to Refresh the CEF or Adjacency Tables section for information on when you might need to rebuild a Cisco Express Forwarding table.

When you display information from a Cisco Express Forwarding table (for example, with the **show ip cef epoch**command), the table epoch is shown in the summary table. When detailed information is displayed for each table entry, the epoch number of each entry is shown.

Epoch Synchronization Between the RP and Line Cards

When FIB or adjacency entries are distributed from the central tables on the RP, the updates contain the epoch of the entry, ensuring that the distinction between old and new entries is maintained in distributed systems.

When a table is initialized on a line card, the current epoch of the table on the RP is sent to the line card. When the epoch is incremented on the RP, an event indicating that a new epoch has begun is sent to each line card.

Epoch Numbering for Routers That Support HA

In a router that supports high availability (HA), the epoch numbers for all Cisco Express Forwarding tables are incremented when an RP transitions from standby mode to active. After switchover, the active

secondary RP initially has FIB and adjacency databases that are the same as those of the primary RP. When the epoch number for each table is incremented, all existing entries are considered stale. However, forwarding continues as normal. As the routing protocols start to repopulate the FIB and adjacency databases, existing and new entries receive the new epoch number, indicating that the entries have been refreshed.

When to Refresh the CEF or Adjacency Tables

You refresh or rebuild the Cisco Express Forwarding or adjacency tables when the tables contain inconsistencies.

Cisco 7500 series and Cisco 12000 Series Internet routers support distributed Cisco Express Forwarding, in which line cards make forwarding decisions based on stored copies of the same FIB and adjacency tables that are found on the RP. The tables on the line cards and the RP must remain synchronized.

Inconsistencies occur when forwarding information (a prefix) is missing on a line card, or the next-hop IP address on the line card is not the same as the next-hop IP address on the RP. Because updates to the RP and line card databases are not synchronous, fleeting inconsistencies can result.

Cisco Express Forwarding consistency checkers detect when forwarding information on the line cards and the RP lose synchronization. For more information on consistency checkers, see the Configuring Cisco Express Forwarding Consistency Checkers for Route Processors and Line Cards module.

How to Configure Epochs

This section contains instructions on how to configure epochs for Cisco Express Forwarding tables. Perform the following tasks to begin new epochs and increment the epoch number of the adjacency and Cisco Express Forwarding tables:

Incrementing the Epoch Number of the Adjacency Table

Perform the following task to begin a new epoch and increment the epoch number of the adjacency table.

Use this task when you need to rebuild the adjacency table. A new adjacency table might be required because you need to remove inconsistencies from the table.

SUMMARY STEPS

1. **enable**
2. **show ip cef epoch**
3. **clear adjacency table**
4. **show ip cef epoch**
5. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** Router> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip cef epoch** **Example:** Router# show ip cef epoch	Displays entries in the forwarding information base (FIB) or displays a summary of the FIB. • The **epoch** keyword displays the table epochs of the adjacency table and all FIB tables.
Step 3	**clear adjacency table** **Example:** Router# clear adjacency table	Begins a new epoch and increments the epoch number of the adjacency table.
Step 4	**show ip cef epoch** **Example:** Router# show ip cef epoch	Displays entries in the FIB or displays a summary of the FIB. • The **epoch** keyword displays the table epochs of the adjacency table and all FIB tables.
Step 5	**exit** **Example:** Router# exit	Exits to user EXEC mode.

Incrementing the Epoch Number of One or All CEF Tables

Perform the following task to begin a new epoch and increment the epoch number of one or all of the Cisco Express Forwarding tables.

Use the **clear ip cef epoch** command when you want to rebuild a Cisco Express Forwarding table. This command increments the epoch and flushes entries associated with the old epoch. This command also clears any inconsistencies that might exist between Cisco Express Forwarding tables on the RP and Cisco Express Forwarding tables on the line cards. If everything in the system is working correctly, the command has no effect on the Cisco Express Forwarding forwarding tables, other than changing the current epoch values.

SUMMARY STEPS

1. **enable**
2. **show ip cef epoch**
3. **clear ip cef epoch** [**all-vrfs** | **full** | **vrf** [*table*]]
4. **show ip cef epoch**
5. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip cef epoch** **Example:** `Router# show ip cef epoch`	Displays entries in the FIB or displays a summary of the FIB. • The **epoch** keyword displays the table epochs of the adjacency table and all FIB tables.
Step 3	**clear ip cef epoch** [**all-vrfs**	**full**	**vrf** [*table*]] **Example:** `Router# clear ip cef epoch full`	Begins a new epoch and increments the epoch number of one or all Cisco Express Forwarding tables. • The **all-vrfs** keyword begins a new epoch for all FIB tables. • The **full** keyword begins a new epoch for all tables, including adjacency tables. • The **vrf** keyword begins a new epoch for the specified FIB table. • The *table* argument is the name of a specific Virtual Private Network (VPN) routing and forwarding instance (VRF).
Step 4	**show ip cef epoch** **Example:** `Router# show ip cef epoch`	Displays entries in the FIB or displays a summary of the FIB. • The **epoch** keyword displays the epochs of the adjacency table and all FIB tables.
Step 5	**exit** **Example:** `Router# exit`	Exits to user EXEC mode.

Verifying Epoch Information

Perform the following task to verify epoch information for Cisco Express Forwarding and adjacency tables.

SUMMARY STEPS

1. **enable**
2. **show adjacency summary detail**
3. **show adjacency summary**
4. **show ip cef epoch**
5. **exit**

DETAILED STEPS

Step 1 **enable**

Use this command to enable privileged EXEC mode. For example:

Example:

```
Router> enable
```

Enter your password if prompted.

Step 2 **show adjacency summary detail**

Use this command to verify that the epoch number is displayed for each entry in the adjacency table as you expect. For example:

Example:

```
Router# show adjacency detail
Protocol Interface              Address
IP       Serial5/0/0/1:1        point2point(7)
                                0 packets, 0 bytes
                                0F000800
                                CEF   expires: 00:02:09
                                      refresh: 00:00:09
                                Epoch: 14
IP       Serial5/0/1/1:1        point2point(7)
                                0 packets, 0 bytes
                                0F000800
                                CEF   expires: 00:02:09
                                      refresh: 00:00:09
                                Epoch: 14
```

The epoch number is displayed for each entry in the adjacency table. In this example, the epoch number of each entry is 14.

Step 3 **show adjacency summary**

Use this command to verify that the epoch number for each adjacency in the adjacency table is as you expect. For example:

Example:

```
Router# show adjacency summary
Adjacency Table has 2 adjacencies
  Table epoch: 14 (2 entries at this epoch)

  Interface                 Adjacency Count
Serial5/0/0/1:1             1
Serial5/0/1/1:1             1
```

Use the epoch information in the summary section to verify that the epoch number for each adjacency in the adjacency table is as expected. The epoch number is 14 in this example, the same as the epoch number displayed in the **show adjacency detail** command in the previous step.

Step 4   **show ip cef epoch**

Use this command to verify that Cisco Express Forwarding information in all FIB tables, including the adjacency table, is as you expect.

In the following example, Cisco Express Forwarding epoch information is verified for all FIB tables, including the adjacency table:

Example:

```
Router# show ip cef epoch
CEF epoch information:

Table: Default-table
  Table epoch: 77 (19 entries at this epoch)

Adjacency table
  Table epoch: 16 (2 entries at this epoch)
```

Step 5   **exit**

Use this command to exit to user EXEC mode. For example:

Example:

```
Router# exit
Router>
```

Configuration Examples for Epochs

Example Incrementing the Epoch Number of the Adjacency Table

The following example shows how to begin a new epoch and increment the epoch number of the adjacency table:

```
Router# show ip cef epoch
CEF epoch information:
Table: Default-table
     Table epoch: 2 (43 entries at this epoch)
Adjacency table
     Table epoch: 2 (5 entries at this epoch)
Router# clear adjacency table
```

After clearing:

```
Router# show ip cef epoch
CEF epoch information:
```

```
Table: Default-table
      Table epoch: 3 (43 entries at this epoch)
Adjacency table
      Table epoch: 3 (5 entries at this epoch)
```

Example Incrementing the Epoch Number of One or All CEF Tables

The following example shows how to begin a new epoch and increment the epoch number of all Cisco Express Forwarding tables:

```
Router# clear ip cef epoch full
```

The following example shows the output before and after you clear the epoch table and increment the epoch number. Before clearing:

```
router# show ip cef epoch
CEF epoch information:
Table: Default-table
      Table epoch: 3 (43 entries at this epoch)
Adjacency table
      Table epoch: 3 (5 entries at this epoch)
```

After clearing:

```
router# clear ip cef epoch full
router# show ip cef epoch
CEF epoch information:
Table: Default-table
      Table epoch: 4 (43 entries at this epoch)
Adjacency table
      Table epoch: 4 (5 entries at this epoch)
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IP switching commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples.	*Cisco IOS IP Switching Command Reference*
Overview of the Cisco Express Forwarding feature	Cisco Express Forwarding Overview
Tasks for verifying basic Cisco Express Forwarding and distributed Cisco Express Forwarding operation	Configuring Basic Cisco Express Forwarding for Improved Performance, Scalability, and Resiliency in Dynamic Networks
Tasks for enabling or disabling Cisco Express Forwarding or distributed Cisco Express Forwarding	Enabling or Disabling Cisco Express Forwarding or Distributed Cisco Express Forwarding to Customize Switching and Forwarding for Dynamic Networks

Related Topic	Document Title
Tasks for configuring a load-balancing scheme for Cisco Express Forwarding	Configuring a Load-Balancing Scheme for Cisco Express Forwarding Traffic
Tasks for configuring Cisco Express Forwarding consistency checkers	Configuring Cisco Express Forwarding Consistency Checkers for Route Processors and Line Cards
Tasks for configuring and verifying Cisco Express Forwarding network accounting	Configuring Cisco Express Forwarding Network Accounting
Tasks for customizing the display of recorded Cisco Express Forwarding events	Customizing the Display of Recorded Cisco Express Forwarding Events
Troubleshooting tips for incomplete adjacencies	http://www.cisco.com/en/US/tech/tk827/tk831/technologies_tech_note09186a0080094303.shtml Troubleshooting Incomplete Adjacencies with CEF
Description and use of the Cisco Express Forwarding consistency checkers available for the Cisco 7500 and 12000 series routers	Troubleshooting Prefix Inconsistencies with Cisco Express Forwarding
Explanation of and troubleshooting information for the Cisco IOS software implementation of Layer 3 load balancing across multiple parallel links when Cisco Express Forwarding is used	Troubleshooting Load Balancing Over Parallel Links Using Cisco Express Forwarding
Causes of common Cisco Express Forwarding-related error messages on platforms running distributed Cisco Express Forwarding switching (Cisco 7500 series routers and Cisco 12000 Series Internet routers) and how to troubleshoot them	Troubleshooting Cisco Express Forwarding-Related Error Messages

Standard

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIB

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFC

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Configuring Epochs

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 Configuring Epochs to Clear and Rebuild Cisco Express Forwarding and Adjacency Tables*

Feature Name	Releases	Feature Configuration Information
Nonstop Forwarding Enhanced FIB Refresh	12.2(8)T	This feature allows you to clear the forwarding table on demand and to continue forwarding through the use of the old entries in the table while the new forwarding table is being built.

Glossary

adjacency --A relationship formed between selected neighboring routers and end nodes for the purpose of exchanging routing information. Adjacency is based upon the use of a common media segment by the routers and nodes involved.

Cisco Express Forwarding --A Layer 3 switching technology. Cisco Express Forwarding can also refer to central Cisco Express Forwarding mode, one of two modes of Cisco Express Forwarding operation. Cisco Express Forwarding enables a Route Processor to perform express forwarding. Distributed Cisco Express Forwarding is the other mode of Cisco Express Forwarding operation.

distributed Cisco Express Forwarding --A mode of Cisco Express Forwarding operation in which line cards (such as Versatile Interface Processor (VIP) line cards) maintain identical copies of the forwarding information base (FIB) and adjacency tables. The line cards perform the express forwarding between port adapters; this relieves the Route Switch Processor of involvement in the switching operation.

FIB --forwarding information base. A component of Cisco Express Forwarding that is conceptually similar to a routing table or information base. The router uses the FIB lookup table to make destination-based switching decisions during Cisco Express Forwarding operation. The router maintains a mirror image of the forwarding information in an IP routing table.

LIB --label information base. A database used by a label switch router (LSR) to store labels learned from other LSRs, as well as labels assigned by the local LSR.

line card --A general term for an interface processor that can be used in various Cisco products. For example, a Versatile Interface Processor (VIP) is a line card for the Cisco 7500 series router.

prefix --The network address portion of an IP address. A prefix is specified by a network and mask and is generally represented in the format network/mask. The mask indicates which bits are the network bits. For example, 1.0.0.0/16 means that the first 16 bits of the IP address are masked, making them the network bits. The remaining bits are the host bits. In this example, the network number is 10.0.

RIB --Routing Information Base. A central repository of routes that contains Layer 3 reachability information and destination IP addresses or prefixes. The RIB is also known as the routing table.

RP --Route Processor. The processor module in the Cisco 7000 series routers that contains the CPU, system software, and most of the memory components that are used in the router. It is sometimes called a supervisory processor.

RSP --Route Switch Processor. The processor module used in the Cisco 7500 series routers that integrates the functions of the Route Processor (RP) and the Switch Processor (SP).

SP --Switch Processor. Cisco 7000-series processor module that acts as the administrator for all CxBus activities. Sometimes called CiscoBus controller.