holddown (PfR)

To configure the Performance Routing (PfR) prefix route dampening timer to set the minimum period of time for which a new exit must be used before an alternate exit can be selected, use the **holddown** command in PfR master controller configuration mode. To return the prefix route dampening timer to the default value, use the **no** form of this command.

holddown *timer*

no holddown

Syntax Description

timer	Specifies the prefix route dampening time period, in seconds. The range for this argument is from 90 to 65535. The default value is 300.

Command Default

PfR uses the default value of 300 seconds for the prefix route dampening time period if this command is not configured or if the **no** form of this command is entered.

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **holddown** command is entered on a master controller. This command is used to configure the prefix route dampening timer to set the minimum period of time for which a new exit must be used before an alternate exit can be selected. The master controller puts a prefix in a holddown state during an exit change to isolate the prefix during the transition period to prevent the prefix from flapping because of rapid state changes. PfR does not implement policy changes while a prefix is in the holddown state. A prefix will remain in a holddown state for the default or configured time period. When the holddown timer expires, PfR will select the best exit based on performance and policy configuration. However, an immediate route change will be triggered if the current exit for a prefix becomes unreachable.

Configuring a new timer value will immediately replace the existing value if the new value is less than the amount of the time remaining. If the new value is greater than the amount of the time remaining, the new timer value will be used when the existing timer is reset.

Examples

The following example sets the prefix route dampening timer to 120 seconds:

```
Router(config)# pfr master
Router(config-pfr-mc)# holddown 120
```

Related Commands

Command	Description
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
set holddown (PfR)	Configures a PfR map to set the prefix route dampening timer to the minimum period of time for which a new exit must be used before an alternate exit can be selected.

host-address (PfR)

To configure information about a host device used by an application interface provider to communicate with a Performance Routing (PfR) master controller, use the **host-address** command in PfR master controller application interface provider configuration mode. To remove a host application interface device, use the **no** form of this command.

host-address *ip-address* **key-chain** *key-chain-name* [**priority** *value*]

no host-address *ip-address*

Syntax Description

ip-address	IP address of the host device.
key-chain	Specifies the key used as a password to authenticate communication for the host device.
key-chain-name	Name of key chain used as a password for the host device.
priority	(Optional) Sets the priority of the host device.
value	(Optional) A number in the range from 1 to 65535. The lower the number, the higher the priority. The default priority is 65535.

Command Default

A host application interface device is not configured.

Command Modes

PfR master controller application interface provider configuration (config-pfr-mc-api-provider)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The PfR application interface defines the mode of communication and messaging between applications and the network for the purpose of optimizing the traffic associated with the applications. A provider is defined as an entity outside the network in which the router configured as a PfR master controller exists, for example, an ISP or a branch office of the same company. The provider has one or more host devices running one or more applications that use the PfR application interface to communicate with a PfR master controller. A provider must be registered with a PfR master controller before an application on a host device can interface with PfR. Use the **api provider** (PfR) command to register the provider, and use the **host-address** command to configure a host device. After registration, a host device in the provider network can initiate a session with a PfR master controller. The PfR application interface provides an automated method for networks to be aware of applications and provides application-aware performance routing.

Use the optional **priority** keyword to specify a priority value for the host device when multiple host devices are configured. The number 1 assigns the highest priority to any requests from the host device. If you assign a priority, each host device must be assigned a different priority number. If you try to assign the same priority number to two different host devices, an error message is displayed on the console.

Examples

The following example shows how to configure a host application interface device on a master controller. In this example, more than one provider is registered, and a priority is set for each provider. For the single host device configured for provider 1, no priority is set and the default priority value of 65535 is assigned, giving this host device a lower priority than each of the host devices configured for provider 2.

```
Router(config)# pfr master
Router(config-pfr-mc)# api provider 1
Router(config-pfr-mc-api-provider)# host-address 10.100.2.2 key-chain PFR_HOST
Router(config-pfr-mc-api-provider)# exit
Router(config-pfr-mc)# api provider 2 priority 4000
Router(config-pfr-mc-api-provider)# host-address 10.100.2.2 key-chain PFR_HOST
priority 3000
Router(config-pfr-mc-api-provider)# host-address 10.100.2.2 key-chain PFR_HOST
priority 4000
Router(config-pfr-mc-api-provider)# end
```

Related Commands

Command	Description
api provider (PfR)	Registers an application interface provider with a PfR master controller and enters PfR master controller application interface provider configuration mode.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
show pfr api provider	Displays information about application interface providers registered with PfR.

inside bgp (PfR)

To configure Performance Routing (PfR) to learn the inside prefixes within a network, use the **inside bgp** command in PfR Top Talker and Top Delay learning configuration mode. To disable prefix learning of inside prefixes, use the **no** form of this command.

inside bgp

no inside bgp

Syntax Description

This command has no arguments or keywords.

Command Default

No inside prefixes are learned by PfR.

Command Modes

PfR Top Talker and Top Delay learning configuration (config-pfr-mc-learn)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

This command is used to implement PfR Border Gateway Protocol (BGP) inbound optimization by identifying the prefixes within a network (inside prefixes). PfR BGP inbound optimization supports best entrance selection for traffic that originates from prefixes outside an autonomous system destined for prefixes inside the autonomous system. External BGP (eBGP) advertisements from an autonomous system to another autonomous system (for example, an Internet service provider [ISP]) can influence the entrance path for traffic entering the network. PfR uses eBGP advertisements to manipulate the best entrance selection.

Examples

The following example shows how to configure a PfR master controller to automatically learn the inside prefixes in a network:

```
Router(config)# pfr master
Router(config-pfr-mc)# learn
Router(config-pfr-mc-learn)# inside bgp
```

Related Commands

Command	Description
learn (PfR)	Enters PfR Top Talker and Top Delay learning configuration mode to configure prefixes for PfR to learn.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

interface (PfR)

To configure a border router interface as a Performance Routing (PfR) managed external or internal interface, use the **interface** command in PfR managed border router configuration mode. To remove an interface from PfR control, use the **no** form of this command.

interface *type number* {**external** | **internal**}

no interface *type number* {**external** | **internal**}

Syntax Description

type	Specifies the type of interface.
number	Specifies the interface or subinterface number.
external	Configures an interface as external. External interfaces are used for active monitoring and traffic forwarding. Entering the **external** keyword also enters PfR border exit interface configuration mode.
internal	Configures an interface as internal. Internal interfaces are used for passive monitoring with NetFlow.

Command Default

No border router interfaces are configured as PfR-managed interfaces.

Command Modes

PfR managed border router configuration (config-pfr-mc-br)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **interface** command is entered on a master controller. This command is used to configure external and internal interfaces on border routers to be under PfR control. External interfaces are configured as PfR managed exit links to forward traffic. External interfaces are used by the master controller to actively monitor prefix and link performance. Internal interfaces are used only for passive performance monitoring with NetFlow.

At least one external and one internal interface must be configured on each border router to allow NetFlow to monitor inbound and outbound traffic. At least two external interfaces are required in a PfR-managed network. You can configure a maximum of 20 external interfaces for a single master controller in a PfR-managed network. Loopback interfaces are supported as external or internal interfaces.

Note PfR does not support Ethernet interfaces that are Layer 2 only, for example, Ethernet switched interfaces.

Configuring an interface as external enters PfR border exit configuration mode. Under PfR border exit interface configuration mode, you can configure maximum link utilization on a per-interface basis with the **max-xmit-utilization** (PfR) command.

Note Entering the **interface** command without the **external** or **internal** keyword places the router in global configuration mode and not PfR border exit configuration mode. The **no** form of this command should be applied carefully so that active interfaces are not removed from the router configuration.

Examples

The following example configures one internal interface and two external interfaces on a border router:

```
Router(config)# pfr master
Router(config-pfr-mc)# border 10.4.9.6 key-chain BR-KEY
Router(config-pfr-mc-br)# interface FastEthernet0/1 internal
Router(config-pfr-mc-br)# interface FastEthernet0/0 external
Router(config-pfr-mc-br)# interface Serial 1/0 external
```

Related Commands

Command	Description
border (PfR)	Enters PfR-managed border router configuration mode to establish communication with a PfR border router.
local (PfR)	Identifies a local interface on a PfR border router as the source for communication with a PfR master controller.
max-xmit-utilization (PfR)	Configures maximum utilization on a single PfR-managed exit link.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

jitter (PfR)

To specify the threshold jitter value that Performance Routing (PfR) will permit for an exit link, use the **jitter** command in PfR master controller configuration mode. To reset the maximum jitter value to its default value, use the **no** form of this command.

jitter threshold *maximum*

no jitter threshold

Syntax Description

threshold	Specifies a maximum absolute threshold value for jitter. Jitter is a measure of voice quality.
maximum	Number (in milliseconds) in the range from 1 to 1000, where 1 represents the highest voice quality, and 1000 represents the lowest voice quality. The default value is 30.

Command Default

No jitter values are specified.

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **jitter** command is used to specify the maximum tolerable jitter value permitted on an exit link. Jitter is a measure of voice quality where the lower the jitter value, the better the voice quality. If the jitter value is greater than the user-defined or the default value, PfR determines that the exit link is out-of-policy and searches for an alternate exit link.

Another measure of voice quality is the estimated Mean Opinion Score (MOS). Use the **mos** command and the **jitter** command in a PfR policy to define voice quality.

Examples

The following example shows how to configure the master controller to search for a new exit link if the jitter threshold value exceeds 20 milliseconds:

```
Router(config)# pfr master
Router(config-pfr-map)# jitter threshold 20
```

Related Commands

Command	Description
mos (PfR)	Specifies the threshold and percentage MOS values that PfR will permit for an exit link.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
set jitter (PfR)	Configures a PfR map to set the threshold jitter value that PfR will permit for an exit link.

keepalive (PfR)

To configure the length of time that a Performance Routing (PfR) master controller will maintain connectivity with a PfR border router after no keepalive packets have been received, use the **keepalive** command in PfR master controller configuration mode. To return the keepalive timer to the default time interval, use the **no** form of this command.

keepalive [*timer*]

no keepalive

Syntax Description

timer	(Optional) Sets the keepalive time interval, in seconds. The configurable range for this argument is from 0 to 1000. The default time interval is 5.

Command Default

PfR sets the keepalive time interval to 5 seconds if this command is not configured or if the **no** form of this command is entered.

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **keepalive** command is entered on a master controller. The PfR master controller sends keepalive packets to border routers to maintain connectivity between the master controller and the border router. If the master controller does not receive keepalive packets from a border router before the keepalive timer expires and this situation happens three times in a row, then the master controller will not maintain the connection.

Examples

The following example sets the keepalive time interval to 10 seconds:

```
Router(config)# pfr master
Router(config-pfr-mc)# keepalive 10
```

Related Commands

Command	Description
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

learn (PfR)

To enter PfR Top Talker and Top Delay learning configuration mode to configure Performance Routing (PfR) to learn prefixes, use the **learn** command in PfR master controller configuration mode. To disable prefix learning, use the **no** form of this command.

learn

no learn

Syntax Description

This command has no arguments or keywords.

Command Default

PfR Top Talker and Top Delay learning configuration mode is not entered.

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **learn** command is entered on a master controller and is used to enter PfR Top Talker and Top Delay learning configuration mode to configure a master controller to learn and optimize prefixes based on the highest throughput or the highest delay. Under the Top Talker and Top Delay learning configuration mode, you can configure prefix learning based on delay and throughput statistics. You can configure the length of the prefix learning period, the interval between prefix learning periods, the number of prefixes to learn, and the prefix learning based on protocol.

Examples

The following example enters PfR Top Talker and Top Delay learning configuration mode:

```
Router(config)# pfr master
Router(config-pfr-mc)# learn
Router(config-pfr-mc-learn)#
```

Related Commands

Command	Description
match pfr learn	Creates a match clause entry in a PfR map to match PfR-learned prefixes.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

link-group (PfR)

To configure a Performance Routing (PfR) border router exit interface as a member of a link group, use the **link-group** command in PfR border exit interface configuration mode. To remove an interface from a link group from the, use the **no** form of this command.

link-group *link-group-name* [*link-group-name* [*link-group-name*]]

no link-group *link-group-name* [*link-group-name* [*link-group-name*]]

Syntax Description

link-group-name	Name of a link group.

Command Default

No link groups are configured for a PfR border router exit interface.

Command Modes

PfR border exit interface configuration (config-pfr-mc-br-if)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

Link groups are used to define a group of exit links as a preferred set of links or as a fallback set of links for PfR to use when optimizing a specified traffic class. Up to three link groups can be specified for each interface. Configure this command on a master controller to define the link group for an interface, and use the **set link-group** (PfR) command to define the primary link group and a fallback link group for a specified traffic class in a PfR map.

Use the **show pfr master link-group** command to view information about configured PfR link groups.

Examples

The following example configures one external interface on a border router as a member of the link group named VIDEO and another external interface as a member of two link groups named VOICE and DATA:

```
Router(config)# pfr master
Router(config-pfr-mc)# border 10.4.9.6 key-chain BR-KEY
Router(config-pfr-mc-br)# interface Serial 1/0 external
Router(config-pfr-mc-br-if)# link-group VIDEO
Router(config-pfr-mc-br-if)# exit
Router(config-pfr-mc-br)# interface Serial 2/0 external
Router(config-pfr-mc-br-if)# link-group VOICE DATA
Router(config-pfr-mc-br-if)# exit
Router(config-pfr-mc-br)# interface FastEthernet0/1 internal
Router(config-pfr-mc-br)# end
```

Related Commands

Command	Description
border (PfR)	Enters PfR managed border router configuration mode to establish communication with a PfR border router.
interface (PfR)	Configures a border router interface as a PfR managed external or internal interface.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
set link-group (PfR)	Specifies a link group for traffic classes defined in a PfR policy.
show pfr master link-group	Displays information about PfR link groups.

list (PfR)

To create a Performance Routing (PfR) learn list to specify criteria for learning traffic classes and to enter learn list configuration mode, use the **list** command in PfR Top Talker and Top Delay learning configuration mode. To remove the learn list, use the **no** form of this command.

list seq *number* **refname** *ref-name*

no list seq *number* **refname** *ref-name*

Syntax Description

seq	Applies a sequence number to a learn list.
number	Number representing a sequence that is used to determine the order in which learn list criteria are applied. The range of sequence numbers that can be entered is from 1 to 65535.
refname	Specifies a reference name for the PfR learn list.
ref-name	Reference name for the learn list. The name must be unique within all the configured PfR learn lists.

Command Default

No PfR learn lists are created.

Command Modes

PfR Top Talker and Top Delay learning configuration (config-pfr-mc-learn)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

Learn lists are a way to categorize learned traffic classes. In each learn list, different criteria for learning traffic classes including prefixes, application definitions, filters, and aggregation parameters can be configured. A traffic class is automatically learned by PfR based on each learn list criteria, and each learn list is configured with a sequence number. The sequence number determines the order in which learn list criteria are applied. Learn lists allow different PfR policies to be applied to each learn list; in previous releases the traffic classes could not be divided, and a PfR policy was applied to all the traffic classes profiled during one learning session.

New **traffic-class** commands were introduced under learn list configuration mode to simplify the learning of traffic classes. Three types of traffic classes—to be automatically learned—can be profiled:

- Traffic classes based on destination prefixes.
- Traffic classes representing custom application definitions using access lists.
- Traffic classes based on a static application mapping name with an optional prefix list filtering to define destination prefixes.

Only one type of **traffic-class** command can be specified per learn list, and the **throughput** (PfR) and **delay** (PfR) commands are also mutually exclusive within a learn list.

Examples

The following example shows how to configure a master controller to learn top prefixes based on the highest throughput for a learn list named LEARN_REMOTE_LOGIN_TC that learns Telnet and Secure Shell (SSH) application traffic class entries:

```
Router(config)# pfr master
Router(config-pfr-mc)# learn
Router(config-pfr-mc-learn)# list seq 10 refname LEARN_REMOTE_LOGIN_TC
Router(config-pfr-mc-learn-list)# traffic-class application telnet ssh
Router(config-pfr-mc-learn-list)# aggregation-type prefix-length 24
Router(config-pfr-mc-learn-list)# throughput
```

Related Commands

Command	Description
learn (PfR)	Enters PfR Top Talker and Top Delay learning configuration mode to configure PfR to automatically learn traffic classes.
pfr	Enables a PfR process and configure a router as a PfR border router or as a PfR master controller.

local (PfR)

To identify a local interface on a Performance Routing (PfR) border router as the source for communication with a PfR master controller, use the **local** command in PfR border router configuration mode. To remove the interface from the PfR border router configuration and disable communication between the border router and the master controller, use the **no** form of this command.

local *interface-type interface-number*

no local *interface-type interface-number*

Syntax Description

interface-type	Specifies the interface type.
interface-number	Specifies the interface number.

Command Default

No local interface is configured.

Command Modes

PfR border router configuration (config-pfr-br)

Command History

Release	Modification
15.1(2)T	This command was introduced.
Cisco IOS XE Release 3.1S	This command was integrated into Cisco IOS XE Release 3.1S.

Usage Guidelines

The **local** command is configured on a PfR border router. This command is used to specify the source interface IP address that will be used for communication between a border router and a master controller.

The IP address that is configured for the local interface must also be configured on the master controller using the **border** (PfR) command and the **interface** (PfR) command.

The **no** form of this command cannot be entered while the border router process is active. The border router process must first be stopped with the **shutdown** (PfR) command. If you stop the border router process to deconfigure the local interface with the **no** form of this command, you must configure another local interface before the border router process will reestablish communication with the master controller.

Examples

The following example configures Fast Ethernet interface 0/0 as a local interface:

```
Router(config)# pfr border
Router(config-pfr-br)# local FastEthernet0/0
```

Related Commands

Command	Description
border (PfR)	Enters PfR-managed border router configuration mode to establish communication with a PfR border router.
interface (PfR)	Configures a border router interface as a PfR-managed external or internal interface.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

logging (PfR)

To enable syslog event logging for a Performance Routing (PfR) master controller or a PfR border router process, use the **logging** command in PfR master controller or PfR border router configuration mode. To disable PfR event logging, use the **no** form of this command.

logging

no logging

Syntax Description

This command has no keywords or arguments.

Command Default

Syslog event logging is not enabled for a PfR master controller or border router process.

Command Modes

PfR border router configuration (config-pfr-br)
PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.
Cisco IOS XE Release 3.1S	This command was integrated into Cisco IOS XE Release 3.1S.

Usage Guidelines

The **logging** command is entered on a master controller or border router. System logging is enabled and configured in Cisco IOS software under global configuration mode. The **logging** command in PfR master controller or PfR border router configuration mode is used only to enable or disable system logging under PfR. PfR system logging supports the following message types:

- *Error Messages*—These messages indicate PfR operational failures and communication problems that can impact normal PfR operation.
- *Debug Messages*—These messages are used to monitor detailed PfR operations to diagnose operational or software problems.
- *Notification Messages*—These messages indicate that PfR is performing a normal operation.
- *Warning Messages*—These messages indicate that PfR is functioning properly, but an event outside of PfR may be impacting normal PfR operation.

To modify system, terminal, destination, and other system global logging parameters, use the **logging** commands in global configuration mode. For more information about system logging commands, see the *Cisco IOS Configuration Fundamentals Command Reference*.

Cisco IOS XE Release 3.1S

This command is supported only in PfR border router configuration mode.

Examples

The following example enables PfR system logging on a master controller:

```
Router(config)# pfr master
Router(config-pfr-mc)# logging
```

The following example enables PfR system logging on a border router:

```
Router(config)# pfr border
Router(config-pfr-br)# logging
```

Related Commands

Command	Description
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

loss (PfR)

To set the relative or maximum packet loss limit that Performance Routing (PfR) will permit for an exit link, use the **loss** command in PfR master controller configuration mode. To return the packet loss limit to the default value, use the **no** form of this command.

loss {**relative** *average* | **threshold** *maximum*}

no loss

Syntax Description

relative *average*	Sets a relative percentage of packet loss based on a comparison of short-term and long-term packet loss percentages. The range of values that can be configured for this argument is a number from 1 to 1000. Each increment represents one tenth of a percent.
threshold *maximum*	Sets absolute packet loss based on packets per million (PPM). The range of values that can be configured for this argument is from 1 to 1000000.

Command Default

PfR uses the following default value if this command is not configured or if the **no** form of this command is entered:

relative *average*: 100 (10 percent packet loss)

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **loss** command is used to specify the relative percentage or maximum number of packets that PfR will permit to be lost during transmission on an exit link. If packet loss is greater than the user-defined or default value, PfR determines that the exit link is out-of-policy and searches for an alternate exit link.

The **relative** keyword is used to configure the relative packet loss percentage. The relative packet loss percentage is based on a comparison of short-term and long-term packet loss. The short-term measurement reflects the percentage of packet loss within a 5-minute period. The long-term measurement reflects the percentage of packet loss within a 60-minute period. The following formula is used to calculate this value:

Relative packet loss = ((short-term loss – long-term loss) / long-term loss) * 100

The master controller measures the difference between these two values as a percentage. If the percentage exceeds the user-defined or default value, the exit link is determined to be out-of-policy. For example, if long-term packet loss is 200 PPM and short-term packet loss is 300 PPM, the relative loss percentage is 50 percent.

The **threshold** keyword is used to configure the absolute maximum packet loss. The maximum value is based on the actual number of PPM that have been lost.

Examples

The following example configures the master controller to search for a new exit link if the difference between long- and short-term measurements (relative packet loss) is greater than 20 percent:

```
Router(config)# pfr master
Router(config-pfr-mc)# loss relative 200
```

The following example configures PfR to search for a new exit link when 20,000 packets have been lost:

```
Router(config)# pfr master
Router(config-pfr-mc)# loss threshold 20000
```

Related Commands

Command	Description
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
set loss (PfR)	Configures a PfR map to set the relative or maximum packet loss limit that PfR will permit for an exit link.

master (PfR)

To establish communication with a Performance Routing (PfR) master controller, use the **master** command in PfR border router configuration mode. To disable communication with the specified master controller, use the **no** form of this command.

master *ip-address* **key-chain** *key-name*

no master

Syntax Description

ip-address	IP address of the master controller.
key-chain *key-name*	Specifies the key chain to authenticate with the master controller.

Command Default

No communication is established between a border router and a master controller.

Command Modes

PfR border router configuration (config-pfr-br)

Command History

Release	Modification
15.1(2)T	This command was introduced.
Cisco IOS XE Release 3.1S	This command was integrated into Cisco IOS XE Release 3.1S.

Usage Guidelines

The **master** command is entered on a border router. This command is used to establish communication between a PfR border router and a master controller. Communication is established between the border router process and the master controller process to allow the master controller to monitor and control PfR exit links. PfR communication must also be established on the master controller with the **border** PfR master controller configuration command. At least one border router must be configured to enable PfR. A maximum of ten border routers can be configured to communicate with a single master controller. The IP address that is used to specify the border router must be assigned to a local interface on the border router and must be reachable by the master controller.

By default, passive monitoring in PfR observe mode is enabled when communication is established between a master controller and a border router. Communication between the master controller and the border router is protected by key-chain authentication. The authentication key must be configured on both the master controller and the border router before communication can be established. The key-chain configuration is defined in global configuration mode on both the master controller and the border router before key-chain authentication is enabled for communication between a master controller and a border router. For more information about key management in Cisco IOS software, see the "Managing Authentication Keys" section in the "Configuring IP Protocol-Independent Features" chapter of the *Cisco IOS IP Routing: Protocol-Independent Configuration Guide*.

Examples

The following example defines a key chain named MASTER in global configuration mode and then configures a PfR border router to communicate with the PfR master controller at 10.4.9.7. The master controller authenticates the border router based on the defined key CISCO.

```
Router(config)# key chain MASTER
Router(config-keychain)# key 1
Router(config-keychain-key)# key-string CISCO
Router(config-keychain-key)# exit
Router(config-keychain)# exit
Router(config)# pfr border
Router(config-pfr-br)# master 10.4.9.7 key-chain MASTER
Router(config-pfr-br)# end
```

Related Commands

Command	Description
border (PfR)	Enters PfR managed border router configuration mode to establish communication with a PfR border router.
key	Identifies an authentication key on a key chain.
key chain (IP)	Enables authentication for routing protocols.
key-string (authentication)	Specifies the authentication string for a key.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

match ip address (PfR)

To reference an extended IP access list or an IP prefix as match criteria in a Performance Routing (PfR) map, use the **match ip address** command in PfR map configuration mode. To delete the match clause entry, use the **no** form of this command.

match ip address {**access-list** *name* | **prefix-list** *name* [**inside**]}

no match ip address

Syntax Description

access-list *name*	Specifies a named extended access list (created with the **ip access-list** command) as the match criterion in a PfR map.
prefix-list *name*	Specifies a prefix list (created with the **ip prefix-list** command) as the match criterion in a PfR map.
inside	(Optional) Specifies an inside prefix.

Command Default

No match is performed.

Command Modes

PfR map configuration (config-pfr-map)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **match ip address** (PfR) command defines a policy, within a PfR map, for a list of prefixes. The **match ip address** (PfR) command is entered on a master controller in PfR map configuration mode. This command is used to configure a named extended access list or IP prefix list as a match criteria in a PfR map. Only one match clause can be configured for each PfR map sequence. The access list is created with the **ip access-list** command. Only named extended IP access lists are supported. The IP prefix list is created with the **ip prefix-list** command. A prefix can be any IP network number combined with a prefix mask that specifies the prefix length.

The **inside** keyword is used to support PfR BGP inbound optimization which in turn supports best entrance selection for traffic that originates from prefixes outside an autonomous system destined for prefixes inside the autonomous system. External BGP (eBGP) advertisements from an autonomous system to an Internet service provider (ISP) can influence the entrance path for traffic entering the network. PfR uses eBGP advertisements to manipulate the best entrance selection.

Examples

The following example creates a prefix list named CUSTOMER. The prefix list creates a filter for the 10.4.9.0/24 network. The **match ip address** (PfR) command configures the prefix list as match criterion in a PfR map.

```
Router(config)# ip prefix-list CUSTOMER permit 10.4.9.0/24
Router(config)# pfr-map SELECT_EXIT 10
Router(config-pfr-map)# match ip address prefix-list CUSTOMER
Router(config-pfr-map)# set mode select-exit good
```

The following example creates an extended access list named FTP. The named extended access list creates a filter for FTP traffic that is sourced from the 10.1.1.0/24 network. The **match ip address** (PfR) command configures the access list as the match criterion in a PfR map. FTP traffic is policy-routed to the first in-policy exit.

```
Router(config)# ip access-list extended FTP
Router(config-ext-nacl)# permit tcp 10.1.1.0 0.0.0.255 any eq ftp
Router(config-ext-nacl)# exit
Router(config)# pfr-map SELECT_EXIT 10
Router(config-pfr-map)# match ip address access-list FTP
Router(config-pfr-map)# set mode select-exit good
```

The following example creates a prefix list named INSIDE1. The prefix list creates a filter for the 10.2.2.0/24 network. The **match ip address** (PfR) command configures the prefix list as the match criterion in a PfR map.

```
Router(config)# ip prefix-list INSIDE1 seq 5 permit 10.2.2.0/24
Router(config)# pfr-map INSIDE_PREFIXES 10
Router(config-pfr-map)# match ip address prefix-list INSIDE1 inside
Router(config-pfr-map)# set as-path prepend 45000
```

Related Commands

Command	Description
ip access-list	Defines an IP access list.
ip prefix-list	Creates an entry in a prefix list.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.

match pfr learn

To create a match clause entry in a Performance Routing (PfR) map to match PfR-learned prefixes, use the **match pfr learn** command in PfR map configuration mode. To delete the match clause entry, use the **no** form of this command.

match pfr learn {**delay** | **inside** | **list** *refname* | **throughput**}

no match pfr learn {**delay** | **inside** | **list** |**throughput**}

Syntax Description

delay	Specifies prefixes learned based on highest delay.
inside	Specifies prefixes learned based on prefixes that are inside the network.
list	Specifies prefixes learned based on a PfR learn list.
refname	Reference name for a learn list. The name is defined using the **list** (PfR) command and must be unique within all the configured PfR learn lists.
throughput	Specifies prefixes learned based on highest throughput.

Command Default

No match is performed.

Command Modes

PfR map configuration (config-pfr-map)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **match pfr learn** command is entered on a master controller in PfR map configuration mode. PfR can be configured to learn prefixes based on delay, inside prefix, criteria specified in a learn list, or throughput. This command is used to configure PfR learned prefixes as match criteria in a PfR map. Only one match clause can be configured for each PfR map sequence.

Examples

The following example creates a PfR map named DELAY that matches traffic learned based on delay. The set clause applies a route control policy that configures PfR to actively control this traffic.

```
Router(config)# pfr-map DELAY 20
Router(config-pfr-map)# match pfr learn delay
Router(config-pfr-map)# set mode route control
```

The following example creates a PfR map named INSIDE that matches traffic learned based on inside prefixes. The set clause applies a route control policy that configures PfR to actively control this traffic.

```
Router(config)# pfr-map INSIDE 40
Router(config-pfr-map)# match pfr learn inside
Router(config-pfr-map)# set mode route control
```

The following example creates a PfR map named LIST that matches traffic learned based on criteria defined in the PfR learn list named LEARN_LIST_TC. prefixes. The learn list policy map is activated using the **policy-rules** (PfR) command.

```
Router(config)# pfr-map LIST 40
Router(config-pfr-map)# match pfr learn LEARN_LIST_TC
Router(config-pfr-map)# exit
Router(config)# pfr master
Router(config-pfr-mc)# policy-rules LIST
```

The following example creates a PfR map named THROUGHPUT that matches traffic learned based on throughput. The set clause applies a route control policy that configures PfR to actively control this traffic.

```
Router(config)# pfr-map THROUGHPUT 30
Router(config-pfr-map)# match pfr learn throughput
Router(config-pfr-map)# set mode route control
```

Related Commands

Command	Description
learn (PfR)	Enters PfR Top Talker and Top Delay learning configuration mode to configure PfR to learn prefixes.
list (PfR)	Creates a PfR learn list to specify criteria for learning traffic classes and enters learn list configuration mode.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.
policy-rules (PfR)	Applies a configuration from a PfR map to a master controller configuration.

match traffic-class access-list (PfR)

To define a match clause using an access list in a Performance Routing (PfR) map to create a traffic class, use the **match traffic-class access-list** command in PfR map configuration mode. To remove the match clause, use the **no** form of this command.

match traffic-class access-list *access-list-name*

no match traffic-class access-list

Syntax Description

access-list-name	Name of an access list. Names cannot contain either a space or quotation marks and must begin with an alphabetic character to distinguish them from numbered access lists.

Command Default

PfR traffic classes are not defined using match criteria in a PfR map.

Command Modes

PfR map configuration (config-pfr-map)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **match traffic-class access-list** command is used to manually configure a traffic class that matches destination prefixes in an access list used in a PfR map. Only one access list can be specified, but the access list may contain many access list entries to help define the traffic class.

Note The **match traffic-class access-list** (PfR) command, the **match traffic-class prefix-list** (PfR) command, the **match traffic-class application** (PfR) command, and the **match traffic-class application nbar** (PfR) commands are all mutually exclusive in a PfR map. Only one of these commands can be specified per PfR map.

Examples

The following example, starting in global configuration mode, shows how to define a custom traffic class using an access list. Every entry in the access list defines one destination network and can include optional criteria. A PfR map is used to match the destination prefixes and create the custom traffic class.

```
Router(config)# ip access-list extended CONFIGURED_TC
Router(config-ext-nacl)# permit tcp any 10.1.1.0 0.0.0.255 eq 500
Router(config-ext-nacl)# permit tcp any 172.16.1.0 0.0.0.255 eq 500 range 700 750
Router(config-ext-nacl)# permit tcp any 172.16.1.0 0.0.0.255 range 700 750
Router(config-ext-nacl)# permit tcp 192.168.0.0 0.0.255.255 10.1.2.0 0.0.0.255 eq 800
Router(config-ext-nacl)# exit
Router(config)# pfr-map ACCESS_MAP 10
Router(config-pfr-map)# match traffic-class access-list CONFIGURED_TC
Router(config-pfr-map)# end
```

Related Commands

Command	Description
ip access-list	Defines a standard or extended IP access list.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.

match traffic-class application (PfR)

To define a match clause using a static application mapping in a Performance Routing (PfR) map to create a traffic class, use the **match traffic-class application** command in PfR map configuration mode. To remove the match clause entry, use the **no** form of this command.

match traffic-class application *application-name* [*application-name ...*] **prefix-list** *prefix-list-name*

no match traffic-class application *application-name ...* [**prefix-list** *prefix-list-name*]

Syntax Description

application-name	Name of a predefined static application using fixed ports. See Table 22.One application must be specified, but the ellipsis shows that more than one application keyword can be specified up to a maximum of ten.
prefix-list	Specifies that the traffic flows are matched on the basis of destinations specified in a prefix list.
prefix-list-name	Name of a prefix list (created using the **ip prefix-list** command).

Command Default

PfR traffic classes are not defined using match criteria in a PfR map.

Command Modes

PfR map configuration (config-pfr-map)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **match traffic-class application** command is used to manually configure the master controller to profile traffic destined for prefixes defined in an IP prefix list that match one or more applications. The applications are predefined with a protocol—TCP or UDP, or both—and one or more ports and this mapping is shown in Table 22. More than one application can be configured as part of the traffic class.

Note The **match traffic-class application** (PfR) command, the **match traffic-class application nbar** (PfR) command, the **match traffic-class access-list** (PfR) command, and the **match traffic-class prefix-list** (PfR) commands are all mutually exclusive in a PfR map. Only one of these commands can be specified per PfR map.

Table 22 displays the keywords that represent the application that can be configured with the **match traffic-class application** command. Replace the *application-name* argument with the appropriate keyword from the table.

Table 22 Static Application List Keywords

Keyword	Protocol	Port
cuseeme	TCP UDP	7648 7649 7648 7649 24032
dhcp (Client)	UDP/TCP	68
dhcp (Server)	UDP/TCP	67
dns	UDP/TCP	53
finger	TCP	79
ftp	TCP	20 21
gopher	TCP/UDP	70
http	TCP/UDP	80
httpssl	TCP	443
imap	TCP/UDP	143 220
irc	TCP/UDP	194
kerberos	TCP/UDP	88 749
l2tp	UDP	1701
ldap	TCP/UDP	389
mssql	TCP	1443
nfs	TCP/UDP	2049
nntp	TCP/UDP	119
notes	TCP/UDP	1352
ntp	TCP/UDP	123
pcany	UDP TCP	22 5632 65301 5631
pop3	TCP/UDP	110
pptp	TCP	17233
simap	TCP/UDP	585 993 (Preferred)
sirc	TCP/UDP	994
sldap	TCP/UDP	636
smtp	TCP	25
snntp	TCP/UDP	563
spop3	TCP/UDP	123
ssh	TCP	22
telnet	TCP	23

Examples

The following example, starting in global configuration mode, shows how to define application traffic classes in a PfR map named APP_MAP using predefined Telnet and Secure Shell (SSH) application criteria that are matched with destination prefixes specified in a prefix list, LIST1.

```
Router(config)# ip prefix-list LIST1 permit 10.1.1.0/24
Router(config)# ip prefix-list LIST1 permit 10.1.2.0/24
Router(config)# ip prefix-list LIST1 permit 172.16.1.0/24
Router(config)# pfr-map APP_MAP 10
Router(config-pfr-map)# match traffic-class application telnet ssh prefix-list LIST1
Router(config-pfr-map)# end
```

Related Commands

Command	Description
ip prefix-list	Creates an entry in a prefix list.
match traffic-class application nbar (PfR)	Defines a match clause using an NBAR application mapping in a PfR map to create a traffic class.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.

match traffic-class application nbar (PfR)

To define a match clause using an Network-Based Application Recognition (NBAR) application mapping in a Performance Routing (PfR) map to create a traffic class, use the **match traffic-class application nbar** command in PfR map configuration mode. To remove the match clause entry, use the **no** form of this command.

match traffic-class application nbar *nbar-appl-name* [*nbar-appl-name* **...**] **prefix-list** *prefix-list-name*

no match traffic-class application nbar [*nbar-appl-name* **...**]

Syntax Description

nbar-appl-name	Keyword representing the name of an application identified using NBAR. One application must be specified, but the ellipsis shows that more than one application keyword can be specified up to a maximum of ten. See the "Usage Guidelines" section for more details.
prefix-list	Specifies that the traffic flows are matched on the basis of destinations specified in a prefix list.
prefix-list-name	Name of a prefix list (created using the **ip prefix-list** command).

Command Default

PfR traffic classes identified using NBAR are not defined using match criteria in a PfR map.

Command Modes

PfR map configuration (config-pfr-map)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **match traffic-class application nbar** command is used to manually configure the master controller to profile traffic destined for prefixes defined in an IP prefix list that match one or more applications identified using NBAR. More than one application can be configured as part of the traffic class with a maximum of ten applications entered per command line. Enter multiple **match traffic-class application nbar** command statements if you need to specify more than ten applications.

NBAR is capable of identifying applications based on the following three types of protocols:

- Non-UDP and non-TCP IP protocols—For example, Generic Routing Encapsulation (GRE) and Internet Control Message Protocol (ICMP).
- TCP and UDP protocols that use statically assigned port numbers—For example, CU-SeeMe desktop video conference (CU-SeeMe-Server), Post Office Protocol over Transport Layer Security (TLS), and Secure Sockets Layer (SSL) server (SPOP3-Server).
- TCP and UDP protocols that dynamically assign port numbers and require stateful inspection—For example, Real-Time Transport Protocol audio streaming (RTP-audio) and BitTorrent File Transfer Traffic (BitTorrent).

Use the **match traffic-class application nbar ?** command to determine if an application can be identified using NBAR and replace the *nbar-appl-name* argument with the appropriate keyword from the screen display.

The list of applications identified using NBAR and available for profiling PfR traffic classes is constantly evolving. For lists of many of the NBAR applications defined using static or dynamically assigned ports, see the "Performance Routing with NBAR/CCE Application and Recognition" module.

For more details about NBAR, see the "Classifying Network Traffic Using NBAR" section of the *Cisco IOS Quality of Service Solutions Configuration Guide*.

Note The **match traffic-class application nbar** (PfR) command, the **match traffic-class application** (PfR) command, the **match traffic-class access-list** (PfR) command, and the **match traffic-class prefix-list** (PfR) commands are all mutually exclusive in a PfR map. Only one of these commands can be specified per PfR map.

Examples

The following example, starting in global configuration mode, shows how to define an application traffic class in a PfR map named APP_NBAR_MAP. The traffic class consists of RTP-audio traffic identified using NBAR and matched with destination prefixes specified in a prefix list, LIST1.

The traffic streams that the PfR map profiles for the RTP-audio application are:

```
10.1.1.1
10.2.2.1
172.16.1.1
172.17.1.2
```

The traffic classes that are learned for the RTP-audio application are:

```
10.2.2.0/24
172.17.1.0/24
```

Only traffic that matches both the RTP-audio application and the destination prefixes is learned.

```
Router(config)# ip prefix-list LIST1 permit 10.2.1.0/24
Router(config)# ip prefix-list LIST1 permit 10.2.2.0/24
Router(config)# ip prefix-list LIST1 permit 172.17.1.0/24
Router(config)# pfr-map APP_NBAR_MAP 10
Router(config-pfr-map)# match traffic-class application nbar rtp-audio prefix-list LIST1
Router(config-pfr-map)# end
```

Related Commands

Command	Description
ip prefix-list	Creates an entry in a prefix list.
match traffic-class application (PfR)	Defines a match clause using a static application mapping in a PfR map to create a traffic class.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.
traffic-class application nbar (PfR)	Defines a PfR traffic class using an NBAR application mapping.

match traffic-class prefix-list (PfR)

To define a match clause using a prefix list in a Performance Routing (PfR) map to create a traffic class, use the **match traffic-class prefix-list** command in PfR map configuration mode. To remove the match clause, use the **no** form of this command.

match traffic-class prefix-list *prefix-list-name* [**inside**]

no match traffic-class prefix-list

Syntax Description

prefix-list-name	Name of a prefix list.
inside	(Optional) Specifies that the prefix list contains inside prefixes.

Command Default

PfR traffic classes are not defined using match criteria in a PfR map.

Command Modes

PfR map configuration (config-pfr-map)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **match traffic-class prefix-list** command is used to manually configure a traffic class that matches destination prefixes in a prefix list.

Use the optional **inside** keyword to specify prefixes that are within the internal network.

Note The **match traffic-class prefix-list** (PfR) command, the **match traffic-class access-list** (PfR) command, the **match traffic-class application** (PfR), and the **match traffic-class application nbar** (PfR) commands are all mutually exclusive in a PfR map. Only one of these commands can be specified per PfR map.

Examples

The following example, starting in global configuration mode, shows how to manually configure a traffic class based only on destination prefixes. The traffic class is created using the prefix list LIST1 in a PfR map named PREFIX_MAP. Every entry in the prefix list, LIST1, defines one destination network of the traffic class.

```
Router(config)# ip prefix-list LIST1 permit 10.1.1.0/24
Router(config)# ip prefix-list LIST1 permit 10.1.2.0/24
Router(config)# ip prefix-list LIST1 permit 172.16.1.0/24
Router(config)# pfr-map PREFIX_MAP 10
Router(config-pfr-map)# match traffic-class prefix-list LIST1
Router(config-pfr-map)# end
```

Related Commands

Command	Description
ip prefix-list	Creates an entry in a prefix list.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.
traffic-class prefix-list (PfR)	Defines a PfR traffic class based only on destination prefixes.

max prefix (PfR)

To set the maximum number of prefixes that a Performance Routing (PfR) master controller will monitor or learn, use the **max prefix** command in PfR master controller configuration mode. To return the master controller to default values, use the **no** form of this command.

max prefix total *number* [**learn** *number*]

no max prefix total

Syntax Description

total *number*	Sets the total number of prefixes that the master controller will monitor. The range of values that can be entered for this argument is a number from 1 to 5000. Default value is 5000.
learn *number*	(Optional) Sets the total number of prefixes that the master controller will learn. The range of values that can be entered for this argument is a number from 1 to 2500. Default value is 2500.

Command Default

PfR uses the following default values if this command is not configured or if the **no** form of this command is entered:

- **total** *number*: 5000
- **learn** *number*: 2500

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **max prefix** command is entered on a PfR master controller. This command is used to limit the number of prefix that a master controller will monitor and learn to reduce memory and system resource consumption.

Note If you configure a lower value for the **total** keyword than for the **learn** keyword, the value for the **total** keyword will also set the maximum number of prefixes that a master controller will learn.

Examples

The following example configures PfR to monitor a maximum of 3000 prefixes and to learn a maximum of 1500 prefixes:

```
Router(config)# pfr master
Router(config-pfr-mc)# max prefix total 3000 learn 1500
```

Related Commands

Command	Description
expire after (PfR)	Configures the length of time that learned prefixes are kept in the central policy database.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

max range receive (PfR)

To set the maximum utilization range for all Performance Routing (PfR) managed entrance links, use the **max range receive** command in PfR master controller configuration mode. To return the maximum utilization range for entrance links to the default value, use the **no** form of this command.

max range receive percent *maximum*

no max range receive

Syntax Description

percent	Specifies the maximum utilization range for all PfR entrance links as a percentage.
maximum	Maximum utilization range as a percentage. The range for this argument is from 1 to 100. The default is 20 percent.

Command Default

PfR uses the following default value (20 percent) if this command is not configured or if the **no** form of this command is entered:

percent *maximum*: 20

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **max range receive** command is configured on a master controller. This command is used to set a threshold link utilization range for all entrance interfaces on PfR border routers.

PfR entrance link range functionality attempts to keep the entrance links within a utilization range relative to each other to ensure that the traffic load is distributed. The range is specified either as an absolute value in kilobits per second (kb/s) or as a percentage and is configured on the master controller to apply to all the entrance links on border routers managed by the master controller. For example, in a PfR-managed network with two entrance links, if the range is specified as 25 percent and the utilization of the first entrance link is 70 percent, then if the utilization of the second entrance link falls to 40 percent, the percentage range between the two entrance links will be more than 25 percent and PfR will attempt to move some traffic classes to use the second entrance to even the traffic load.

Examples

The following example shows how to enforce an entrance link selection for learned inside prefixes using the BGP autonomous system number community prepend technique. The **max range receive** command is configured under PfR master controller configuration mode to set a maximum receive range for all PfR-managed entrance links. In this example, the receive range between all the entrance links on the border routers must be within 35 percent.

```
Router> enable
Router# configure terminal
```

```
Router(config)# pfr master
Router(config-pfr-mc)# max range receive percent 35
Router(config-pfr-mc)# border 10.1.1.2 key-chain pfr
Router(config-pfr-mc-br)# interface ethernet1/0 external
Router(config-pfr-mc-br-if)# maximum utilization receive absolute 25000
Router(config-pfr-mc-br-if)# downgrade bgp community 3:1
Router(config-pfr-mc-br-if)# exit
Router(config-pfr-mc-br)# exit
Router(config-pfr-mc)# exit
Router(config)# pfr-map INSIDE_LEARN 10
Router(config-pfr-map)# match pfr learn inside
Router(config-pfr-map)# set delay threshold 400
Router(config-pfr-map)# set resolve delay priority 1
Router(config-pfr-map)# set mode route control
Router(config-pfr-map)# end
```

Related Commands

Command	Description
border (PfR)	Enters PfR-managed border router configuration mode to establish communication with a PfR border router.
downgrade bgp (PfR)	Specifies route downgrade options for a PfR-managed interface using BGP advertisements.
maximum utilization receive (PfR)	Sets the maximum utilization on a single PfR-managed entrance link.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.

maximum utilization receive (PfR)

To set the maximum utilization on a single Performance Routing (PfR) managed entrance link, use the **maximum utilization receive** command in PfR border exit interface configuration mode. To return the maximum utilization on an entrance link to the default value, use the **no** form of this command.

maximum utilization receive {**absolute** *kbps* | **percentage** *bandwidth*}

no maximum utilization receive

Syntax Description

absolute	Sets the maximum utilization on a PfR-managed entrance link to an absolute value.
kbps	Maximum utilization for a PfR-managed entrance link, in kilobits per second (kb/s). The configurable range for this argument is a number from 1 to 1000000000.
percent	Sets the maximum utilization on a PfR-managed entrance link to a bandwidth percentage.
bandwidth	Entrance link bandwidth percentage. The range for this argument is from 1 to 100. The default is 75.

Command Default

PfR uses a default maximum of 75 percent bandwidth utilization for a PfR-managed entrance link if this command is not configured or if the **no** form of this command is entered.

Command Modes

PfR border exit interface configuration (config-pfr-mc-br-if)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **maximum utilization receive** command is entered on a master controller to set the maximum utilization threshold of incoming traffic that can be transmitted over a PfR-managed entrance link interface. This command is configured on a per-entrance-link basis. Use this command with the **downgrade bgp** (PfR) command to configure PfR BGP inbound optimization. This command can also be used with the **max range receive** (PfR) command to configure entrance link load balancing.

If traffic utilization goes above the threshold, PfR tries to move the traffic from this entrance link to another underutilized entrance link.

Examples

The following example shows how to enforce an entrance link selection for learned inside prefixes using the BGP autonomous system number community prepend technique. The **maximum utilization receive** command is configured under PfR border exit interface configuration mode to set a maximum threshold value of 25000 kb/s for packets received through the entrance link Ethernet interface 1/0 on the border router.

```
Router> enable
Router# configure terminal
Router(config)# pfr master
Router(config-pfr-mc)# max range receive percent 35
Router(config-pfr-mc)# border 10.1.1.2 key-chain CISCO
Router(config-pfr-mc-br)# interface ethernet1/0 external
Router(config-pfr-mc-br-if)# maximum utilization receive absolute 25000
Router(config-pfr-mc-br-if)# downgrade bgp community 3:1
Router(config-pfr-mc-br-if)# exit
Router(config-pfr-mc-br)# exit
Router(config-pfr-mc)# exit
Router(config)# pfr-map INSIDE_LEARN 10
Router(config-pfr-map)# match pfr learn inside
Router(config-pfr-map)# set delay threshold 400
Router(config-pfr-map)# set resolve delay priority 1
Router(config-pfr-map)# set mode route control
Router(config-pfr-map)# end
```

Related Commands

Command	Description
border (PfR)	Enters PfR-managed border router configuration mode to establish communication with a PfR border router.
downgrade bgp (PfR)	Specifies route downgrade options for a PfR-managed interface using BGP advertisements.
max range receive (PfR)	Sets the maximum utilization range for all PfR-managed entrance links.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.

max-range-utilization (PfR)

To set the maximum utilization range for all Performance Routing (PfR) managed exit links, use the **max-range-utilization** command in PfR master controller configuration mode. To return the maximum utilization range to the default value, use the **no** form of this command.

max-range-utilization percent *maximum*

no max-range-utilization

Syntax Description

percent	Specifies the maximum utilization range for all PfR exit links as a percentage.
maximum	Maximum utilization range percentage. The range for this argument is from 1 to 100. The default is 20.

Command Default

PfR uses the default value of a 20 percent maximum utilization range for all PfR-managed exit links if this command is not configured or if the **no** form of this command is entered.

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **max-range-utilization** command is configured on a master controller. This command is used to set a threshold link utilization range for all external interfaces on PfR border routers.

PfR exit link range functionality attempts to keep the exit links within a utilization range, relative to each other, to ensure that the traffic load is distributed. The range is specified as a percentage and is configured on the master controller to apply to all the exit links on border routers managed by the master controller. For example, in a PfR-managed network with two exit links, if the range is specified as 25 percent and the utilization of the first exit link is 70 percent, then if the utilization of the second exit link falls to 40 percent, the percentage range between the two exit links will be more than 25 percent and PfR will attempt to move some traffic classes to use the second exit to even the traffic load.

Examples

The following example sets the maximum utilization range for PfR-managed exit links to 25 percent:

```
Router(config)# pfr master
Router(config-pfr-mc)# max-range-utilization 25
```

Related Commands

Command	Description
max-xmit-utilization (PfR)	Configures maximum utilization on a single PfR managed exit link.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

max-xmit-utilization (PfR)

To set the maximum utilization on a single Performance Routing (PfR) managed exit link, use the **max-xmit-utilization** command in PfR border exit interface configuration mode. To return the maximum utilization on an exit link to the default value, use the **no** form of this command.

max-xmit-utilization {**absolute** *kbps* | **percentage** *bandwidth*}

no max-xmit-utilization

Syntax Description

absolute	Sets the maximum utilization on a PfR-managed exit link to an absolute value.
kbps	Maximum utilization for a PfR-managed exit link, in kilobits per second (kb/s). The configurable range for this argument is a number from 1 to 1000000000.
percentage	Sets the maximum utilization on a PfR-managed exit link to a bandwidth percentage.
bandwidth	Exit link bandwidth percentage. The range for this argument is from 1 to 100. The default is 75.

Command Default

PfR uses the default value of 75 percent maximum utilization on a single PfR-managed exit link if this command is not configured or if the **no** form of this command is entered.

Command Modes

PfR border exit interface configuration (config-pfr-mc-br-if)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **max-xmit-utilization** command is entered on a master controller and allows you to set the maximum utilization of outbound traffic that can be transmitted over a PfR-managed exit interface. The maximum utilization threshold can be expressed as an absolute value in kb/s or as a percentage. This command is configured on a per-exit-link basis and cannot be configured on PfR internal interfaces; internal interfaces are not used to forward traffic.

If traffic goes above the threshold, PfR tries to move the traffic from this exit link to another underutilized exit link.

Examples

The following example sets the maximum exit link utilization to 1000000 kb/s on Fast Ethernet interface 0/0:

```
Router(config-pfr-mc-br)# interface FastEthernet0/0 external
Router(config-pfr-mc-br-if)# max-xmit-utilization absolute 1000000
```

The following example sets the maximum percentage of exit utilization to 80 percent on serial interface 1/0:

```
Router(config-pfr-mc-br)# interface Serial 1/0 external
Router(config-pfr-mc-br-if)# max-xmit-utilization percentage 80
```

Related Commands

Command	Description
interface (PfR)	Configures a border router interface as a PfR-managed external or internal interface.
max-range-utilization (PfR)	Sets the maximum utilization range for all PfR-managed exit links.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

mode (PfR)

To configure route monitoring, route control, or route exit selection on a Performance Routing (PfR) master controller, use the **mode** command in PfR master controller configuration mode. To return the PfR master controller to the default monitoring, control, or exit selection state, use the **no** form of this command.

mode {**monitor** {**active** [**throughput**] | **both** | **fast** | **passive**} | **route** {**control** | **metric** {**bgp local-pref** *preference* | **eigrp tag** *community* | **static tag** *value*} | **observe**} | **select-exit** {**best** | **good**}}

no mode {**monitor** | **route** {**control** | **metric** {**bgp** | **eigrp** | **static**} | **observe**} | **select-exit**}

Syntax Description

monitor	Enables the configuration of PfR monitoring settings.
active	Enables active monitoring.
throughput	(Optional) Enables active monitoring with throughput data from passive monitoring.
both	Enables both active and passive monitoring. This is the default monitoring mode.
fast	Enables continuous active monitoring and passive monitoring.
passive	Enables passive monitoring.
route	Enables the configuration of PfR route control policy settings.
control	Enables automatic route control.
metric	Enables the configuration of route control based on the Border Gateway Protocol (BGP) local-preference, EIGRP, or for specific static routes.
bgp local-pref	Sets the BGP local preference for PfR-controlled routes.
preference	A number from 1 to 65535.
eigrp tag	Applies a community value to an EIGRP route under PfR control.
community	A number from 1 to 65535.
static tag	Applies a tag to a static route under PfR control.
value	A number from 1 to 65535.
observe	Configures PfR to passively monitor and report without making any changes. This is the default route control mode.
select-exit	Enables the exit selection based on performance or policy.
best	Configures PfR to select the best available exit based on performance or policy.
good	Configures PfR to select the first exit that is in-policy. This is the default exit selection.

Command Default

PfR uses the following default settings if this command is not configured or if the **no** form of this command is entered:

Monitoring: Both active and passive monitoring is enabled.
Route control: Observe mode route control is enabled.
Exit selection: The first in-policy exit is selected.

Command Modes PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines The **mode** command is entered on a master controller. This command is used to enable and configure control mode and observe mode settings and is used to configure passive monitoring and active monitoring. A prefix can be monitored both passively and actively.

Observe Mode

Observe mode monitoring is enabled by default. In observe mode, the master controller monitors prefixes and exit links based on default and user-defined policies and then reports the status of the network and the decisions that should be made but does not implement any changes. This mode allows you to verify the effectiveness of this feature before it is actively deployed.

Control Mode

In control mode, the master controller coordinates information from the border routers and makes policy decisions just as it does in observe mode. The master controller monitors prefixes and exits based on default and user-defined policies but then implements changes to optimize prefixes and to select the best exit. In this mode, the master controller gathers performance statistics from the border routers and then transmits commands to the border routers to alter routing as necessary in the PfR-managed network.

Passive Monitoring

The master controller passively monitors IP prefixes and TCP traffic flows. Passive monitoring is configured on the master controller. Monitoring statistics are gathered on the border routers and then reported back to the master controller. PfR uses NetFlow to collect and aggregate passive monitoring statistics on a per prefix basis. No explicit NetFlow configuration is required. NetFlow support is enabled by default when passive monitoring is enabled. PfR uses passive monitoring to measure the following information:

- *Delay*—PfR measures the average delay of TCP flows for a prefix. Delay is the measurement of the time between the transmission of a TCP synchronization message and the receipt of the TCP acknowledgment.
- *Packet Loss*—PfR measures packet loss by tracking TCP sequence numbers for each TCP flow. PfR estimates packet loss by tracking the highest TCP sequence number. If a subsequent packet is received with a lower sequence number, PfR increments the packet loss counter.
- *Reachability*—PfR measures reachability by tracking TCP synchronization messages that have been sent repeatedly without receiving a TCP acknowledgment.
- *Throughput*—PfR measures outbound throughput for optimized prefixes. Throughput is measured in bits per second (bps).

Note PfR passively monitors TCP traffic flows for IP traffic. Passive monitoring of non-TCP sessions is not supported.

Active Monitoring

PfR uses Cisco IOS IP Service Level Agreements (SLAs) to enable active monitoring. IP SLA support is enabled by default. IP SLA support allows PfR to be configured to send active probes to target IP addresses to measure the jitter and delay, determining if a prefix is out-of-policy and if the best exit is selected. The border router collects these performance statistics from the active probe and transmits this information to the master controller. The master controller uses this information to optimize the prefix and select the best available exit based on default and user-defined policies. The **active-probe** (PfR) command is used to create an active probe.

The **throughput** keyword enables the throughput data from passive mode monitoring to be considered when optimizing UDP traffic for both performance and load balancing. UDP traffic can be optimized only for performance (for example, delay, jitter, and loss) when active monitoring data is available. To enable load balancing of UDP traffic, throughput data from passive monitoring is required.

Fast Failover Monitoring

Fast monitoring sets the active probes to continuously monitor all the exits (probe-all), and passive monitoring is enabled too. Fast failover monitoring can be used with all types of active probes: ICMP echo, jitter, TCP connection, and UDP echo. When the **mode monitor fast** command is enabled, the probe frequency can be set to a lower frequency than for other monitoring modes, to allow a faster failover ability. Under fast monitoring with a lower probe frequency, route changes can be performed within 3 seconds of an out-of-policy situation. When an exit becomes OOP under fast monitoring, the select best exit option is operational and the routes from the OOP exit are moved to the best in-policy exit. Fast monitoring is a very aggressive mode that incurs a lot of overhead with the continuous probing. We recommend that you use fast monitoring only for performance sensitive traffic.

Optimal Exit Link Selection

The master controller can be configured to select a new exit for an out-of-policy prefix based on performance or policy. You can configure the master controller to select the first in-policy exit by entering the **good** keyword, or you can configure the master controller to select the best exit with the **best** keyword. If the **good** keyword is used and there is no in-policy exit, the prefix is uncontrolled.

Examples

The following example enables both active and passive monitoring:

```
Router(config)# pfr master
Router(config-pfr-mc)# mode monitor both
```

The following example enables fast failover monitoring:

```
Router(config)# pfr master
Router(config-pfr-mc)# mode monitor fast
```

The following example configures the master controller to enable active monitoring with throughput data from passive monitoring:

```
Router(config)# pfr master
Router(config-pfr-mc)# mode monitor active throughput
```

The following example enables control mode:

```
Router(config)# pfr master
Router(config-pfr-mc)# mode route control
```

The following example configures the master controller to enable control mode and to enable EIGRP route control that applies a community value of 700 to EIGRP routes under PfR control:

```
Router(config)# pfr master
Router(config-pfr-mc)# mode route control
Router(config-pfr-mc)# mode route metric eigrp tag 700
```

The following example configures the master controller to select the first in-policy exit:

```
Router(config)# pfr master
Router(config-pfr-mc)# mode select-exit good
```

Related Commands

Command	Description
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
set mode (PfR)	Configures a PfR map to configure route monitoring, route control, or exit selection for matched traffic.

monitor-period (PfR)

To set the time period in which a Performance Routing (PfR) master controller learns traffic flows, use the **monitor-period** command in PfR Top Talker and Top Delay learning configuration mode. To return the monitoring period to the default time period, use the **no** form of this command.

monitor-period *minutes*

no monitor-period

Syntax Description

minutes	Sets the prefix learning period, in minutes. The range is from 1 to 1440. The default value is 5.

Command Default

If this command is not configured or if the **no** form of this command is entered, the default prefix learning period is 5 minutes.

Command Modes

PfR Top Talker and Top Delay learning configuration (config-pfr-mc-learn)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **monitor-period** command is configured on a master controller. This command is used to adjust the length of time during which a master controller learns traffic flows on border routers. The length of time between monitoring periods is configured with the **periodic-interval** (PfR) command. The number of prefixes that are learned is configured with the **prefixes** (PfR) command.

Examples

The following example sets the PfR monitoring period to 10 minutes on a master controller:

```
Router(config)# pfr master
Router(config-pfr-mc)# learn
Router(config-pfr-mc-learn)# monitor-period 10
```

Related Commands

Command	Description
learn (PfR)	Enters PfR Top Talker and Top Delay learning configuration mode to configure prefixes for PfR to learn.
periodic-interval (PfR)	Sets the time interval between prefix learning periods.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
prefixes (PfR)	Sets the number of prefixes that PfR will learn during a monitoring period.

mos (PfR)

To specify the threshold and percentage Mean Opinion Score (MOS) values that Performance Routing (PfR) will permit for an exit link, use the **mos** command in PfR master controller configuration mode. To reset the threshold and percentage MOS values to their default value, use the **no** form of this command.

mos threshold *minimum* **percent** *percent*

no mos threshold *minimum* **percent** *percent*

Syntax Description

threshold	Specifies a threshold MOS value that represents a minimum voice quality for exit link utilization.
minimum	Number (to two decimal places) in the range from 1.00 to 5.00, where 1.00 represents the lowest voice quality and 5.00 represents the highest voice quality. The default MOS value is 3.60.
percent	Specifies a percentage value that is compared with the percentage of MOS samples that are below the MOS threshold.
percent	Number, as a percentage.

Command Default

The default MOS value is 3.60.

Command Modes

Master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **mos** command is used to determine voice quality. The number of MOS samples over a period of time that are below the threshold MOS value are calculated. If the percentage of MOS samples below the threshold is greater than the configured percentage, PfR determines that the exit link is out-of-policy and searches for an alternate exit link.

Another measure of voice quality is the jitter value. Use the **mos** (PfR) command and the **jitter** (PfR) command in a PfR policy to define voice quality.

Examples

The following example shows how to configure the master controller to search for a new exit link if more than 30 percent of the MOS samples are below the MOS threshold of 3.75:

```
Router(config)# pfr master
Router(config-pfr-mc)# mos threshold 3.75 percent 30
```

Related Commands

Command	Description
jitter	Specifies the threshold jitter value that PfR will permit for an exit link.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
set mos (PfR)	Configures a PfR map to set the threshold MOS value that PfR will permit for an exit link.

periodic (PfR)

To configure Performance Routing (PfR) to periodically select the best exit link, use the **periodic** command in PfR master controller configuration mode. To disable periodic exit selection, use the **no** form of this command.

periodic *timer*

no periodic

Syntax Description

timer	Sets the length of time, in seconds, for the periodic timer. The range of configurable values is from 90 to 7200.

Command Default

Periodic exit selection is disabled.

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **periodic** command is entered on a master controller. This command is used to configure the master controller to evaluate and then make policy decisions for PfR managed exit links. When the periodic timer expires, the master controller evaluates current exit links based on default or user-defined policies. If all exit links are in-policy, no changes are made. If an exit link is out-of-policy, the affected prefixes are moved to an in-policy exit link. If all exit links are out-of-policy, the master controller will move out-of-policy prefixes to the best available exit links.

The master controller can be configured to select the first in-policy exit when the periodic timer expires, by configuring the **mode** (PfR) command with the **select-exit good** keywords. The master controller can also be configured to select the best available in-policy exit, by configuring the **mode** (PfR) command with the **select-exit best** keywords.

The periodic timer is reset to the default or configured value each time the timer expires. Configuring a new timer value will immediately replace the existing value if the new value is less than the time remaining. If the new value is greater than the time remaining, the new timer value will be used when the existing timer value expires.

Examples

The following example sets the periodic timer to 300 seconds. When the periodic timer expires, PfR will select either the best exit or the first in-policy exit.

```
Router(config)# pfr master
Router(config-pfr-mc)# periodic 300
```

Related Commands

Command	Description
mode (PfR)	Configures route monitoring or route control on a PfR master controller.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
set periodic (PfR)	Configures a PfR map to set the time period for the periodic timer.

periodic-interval (PfR)

To set the time interval between prefix learning periods, use the **periodic-interval** command in PfR Top Talker and Top Delay learning configuration mode. To set the time interval between prefix learning periods to the default value, use the **no** form of this command.

periodic-interval *minutes*

no periodic-interval

Syntax Description

minutes	Sets the time interval between prefix learning periods, in minutes. The range that can be configured for this argument is from 0 to 10080.

Command Default

Performance Routing (PfR) uses the default value of 120 minutes if this command is not configured or if the **no** form of this command is entered.

Command Modes

PfR Top Talker and Top Delay learning configuration (config-pfr-mc-learn)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **periodic-interval** command is configured on a master controller. This command is used to adjust the length of time between traffic flow monitoring periods. The length of time of the learning period is configured with the **monitor-period** (PfR) command. The number of prefixes that are monitored is configured with the **prefixes** (PfR) command.

Examples

The following example sets the length of time between PfR monitoring periods to 20 minutes on a master controller:

```
Router(config)# pfr master
Router(config-pfr-mc)# learn
Router(config-pfr-mc-learn)# periodic-interval 20
```

Related Commands

Command	Description
learn (PfR)	Enters PfR Top Talker and Top Delay learning configuration mode to configure prefixes for PfR to learn.
monitor-period (PfR)	Sets the time period in which a PfR master controller learns traffic flows.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
prefixes (PfR)	Sets the number of prefixes that PfR will learn during a monitoring period.

pfr

To enable a Cisco IOS Performance Routing (PfR) process and configure a router as a PfR border router or as a PfR master controller, use the **pfr** command in global configuration mode. To disable a border router or master controller process and delete the PfR configuration from the running configuration file, use the **no** form of this command.

pfr {**border** | **master**}

no pfr {**border** | **master**}

Cisco IOS XE Release 3.1S

pfr border

no pfr border

Syntax Description

border	Designates a router as a border router and enters PfR border router configuration mode.
master	Designates a router as a master controller and enters PfR master controller configuration mode.

Command Default

PfR is not enabled.

Command Modes

Global configuration (config)

Command History

Release	Modification
15.1(2)T	This command was introduced.
Cisco IOS XE Release 3.1S	This command was integrated into Cisco IOS XE, Release 3.1S.

Usage Guidelines

The **pfr** command is entered on a router to create a border router or master controller process to enable Cisco IOS PfR, which allows you to enable automatic outbound route control and load distribution for multihomed and enterprise networks. Configuring PfR allows you to monitor IP traffic flows and then define policies and rules based on link performance and link load distribution to alter routing and improve network performance.

Performance Routing comprises two components: the master controller (MC) and the border router (BR). A PfR deployment requires one MC and one or more BRs. Communication between the MC and the BR is protected by key-chain authentication. Depending on your Performance Routing deployment scenario and scaling requirements, the MC may be deployed on a dedicated router or may be deployed along with the BR on the same physical router.

Master Controller—The MC is a single router that acts as the central processor and database for the Performance Routing system. The MC component does not reside in the forwarding plane and, when deployed in a standalone fashion, has no view of routing information contained within the BR. The

master controller maintains communication and authenticates the sessions with the BRs. The role of the MC is to gather information from the BR or BRs to determine whether traffic classes are in or out of policy and to instruct the BRs how to ensure that traffic classes remain in policy using route injection or dynamic PBR injection.

Border Router—The BR component resides within the data plane of the edge router with one or more exit links to an ISP or other participating network. The BR uses NetFlow to passively gather throughput and TCP performance information. The BR also sources all IP service-level agreement (SLA) probes used for explicit application performance monitoring. The BR is where all policy decisions and changes to routing in the network are enforced. The BR participates in prefix monitoring and route optimization by reporting prefix and exit link measurements to the master controller and then by enforcing policy changes received from the master controller. The BR enforces policy changes by injecting a preferred route to alter routing in the network.

Disabling a Border Router or a Master Controller

To disable a master controller or border router and completely remove the process configuration from the running configuration file, use the **no** form of this command in global configuration mode.

To temporarily disable a master controller or border router process, use the **shutdown** (PfR) command in PfR master controller or PfR border router configuration mode. Entering the **shutdown** (PfR) command stops an active master controller or border router process but does not remove any configuration parameters. The **shutdown** (PfR) command is displayed in the running configuration file when enabled.

Cisco IOS XE Release 3.1S

In Cisco IOS XE Release 3.1S, only the **border** keyword is supported.

Examples

Minimum Required PfR Master Controller Configuration

The following example designates a router as a master controller and enters PfR master controller configuration mode:

```
Router(config)# pfr master
Router(config-pfr-mc)#
```

The following is an example of the minimum required configuration on a master controller to create a PfR-managed network:

A key-chain configuration named PFR_KEY is defined in global configuration mode.

```
Router(config)# key chain PFR_KEY
Router(config-keychain)# key 1
Router(config-keychain-key)# key-string CISCO
Router(config-keychain-key)# exit
Router(config-keychain)# exit
```

The master controller is configured to communicate with the 10.4.9.6 border router in PfR master controller configuration mode. The key chain PFR_KEY is applied to protect communication. Internal and external PfR-controlled border router interfaces are defined.

```
Router(config)# pfr master
Router(config-pfr-mc)# border 10.4.9.6 key-chain PFR_KEY
Router(config-pfr-mc-br)# interface FastEthernet0/0 external
Router(config-pfr-mc-br)# interface FastEthernet0/1 internal
Router(config-pfr-mc-br)# exit
```

Required PfR Border Router Configuration

The following example designates a router as a border router and enters PfR border router configuration mode:

```
Router(config)# pfr border
Router(config-pfr-br)#
```

The following is an example of the minimum required configuration to configure a border router in a PfR-managed network:

The key-chain configuration is defined in global configuration mode.

```
Router(config)# key chain PFR_KEY
Router(config-keychain)# key 1
Router(config-keychain-key)# key-string CISCO
Router(config-keychain-key)# exit
Router(config-keychain)# exit
```

The key chain PFR_KEY is applied to protect communication. An interface is identified as the local source interface to the master controller.

```
Router(config)# pfr border
Router(config-pfr-br)# local FastEthernet0/0
Router(config-pfr-br)# master 10.4.9.4 key-chain PFR_KEY
Router(config-pfr-br)# end
```

Related Commands

Command	Description
border (PfR)	Enters PfR managed border router configuration mode to configure a border router.
master (PfR)	Establishes communication with a master controller.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.
shutdown (PfR)	Stops or starts a PfR master controller or a PfR border router process.

pfr-map

To enter PfR map configuration mode to configure a Performance Routing (PfR) map to apply policies to selected IP prefixes, use the **pfr-map** command in global configuration mode. To delete the PfR map, use the **no** form of this command.

pfr-map *map-name* [*sequence-number*]

no pfr-map *map-name*

Syntax Description

map-name	Name or tag for the PfR map.
sequence-number	(Optional) Sequence number for the PfR map entry. The configurable range for this argument is from 1 to 65535.

Command Default

No PfR maps are created.

Command Modes

Global configuration (config)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **pfr-map** command is configured on a master controller. The operation of a PfR map is similar to the operation of a route map. A PfR map is designed to select IP prefixes or to select PfR learn policies using a match clause and then to apply PfR policy configurations using a set clause. The PfR map is configured with a sequence number like a route map, and the PfR map with the lowest sequence number is evaluated first. The operation of a PfR map differs from a route map at this point. There are two important distinctions:

- Only a single match clause may be configured for each sequence. An error message will be displayed on the console if you attempt to configure multiple match clauses for a single PfR map sequence.
- A PfR map is not configured with permit or deny statements. However, a permit or deny sequence can be configured for an IP traffic flow by configuring a permit or deny statement in an IP prefix list and then applying the prefix list to the PfR map with the **match ip address** (PfR) command.

Tips

Deny prefixes should be combined in a single prefix list and applied to the PfR map with the lowest sequence number.

A PfR map can match a prefix or prefix range with the **match ip address** (PfR) command. A prefix can be any IP network number combined with a prefix mask that specifies the prefix length. The prefix or prefix range is defined with the **ip prefix-list** command in global configuration mode. Any prefix length can be specified. A PfR map can also match PfR learned prefixes with the **match pfr learn** command. Matching can be configured for prefixes learned based on delay or based on throughput.

The PfR map applies the configuration of the set clause after a successful match occurs. A PfR set clause can be used to set policy parameters for the backoff timer, packet delay, holddown timer, packet loss, mode settings, periodic timer, resolve settings, and unreachable hosts. See the "Related Commands" section of this command reference page for a complete list of PfR set clauses.

Policies that are applied by a PfR map do not override global policies configured under PfR master controller configuration mode and PfR Top Talker and Delay learning configuration mode. Policies are overridden on a per-prefix-list basis. If a policy type is not explicitly configured in a PfR map, the default or configured values will apply. Policies applied by a PfR map take effect after the current policy or operational timer expires. The PfR map configuration can be viewed in the output of the **show running-config** command. PfR policy configuration can be viewed in the output of the **show pfr master policy** command.

Examples

The following example creates a PfR map named SELECT_EXIT that matches traffic defined in the IP prefix list named CUSTOMER and sets exit selection to the first in-policy exit when the periodic timer expires. This PfR map also sets a resolve policy that sets the priority of link utilization policies to 1 (highest priority) and allows for a 10 percent variance in exit link utilization statistics.

```
Router(config)# ip prefix-list CUSTOMER permit 10.4.9.0/24
Router(config)# pfr-map SELECT_EXIT 10
Router(config-pfr-map)# match ip address prefix-list CUSTOMER
Router(config-pfr-map)# set mode select-exit good
Router(config-pfr-map)# set resolve utilization priority 1 variance 10
```

The following example creates a PfR map named THROUGHPUT that matches traffic learned based on the highest outbound throughput. The set clause applies a relative loss policy that will permit 10 percent packet loss:

```
Router(config)# pfr-map THROUGHPUT 20
Router(config-pfr-map)# match pfr learn throughput
Router(config-pfr-map)# set loss relative 10
```

Related Commands

Command	Description
ip prefix-list	Creates an entry in a prefix list.
match ip address (PfR)	Creates a prefix list match clause entry in a PfR map to apply PfR policy settings.
match pfr learn	Creates a match clause entry in a PfR map to match PfR learned prefixes.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
set loss (PfR)	Configures a PfR map to set the relative or maximum packet loss limit that PfR will permit for an exit link.
set resolve (PfR)	Configures a PfR map to set policy priority for overlapping policies.
show pfr master policy	Displays configured and default policy settings on a PfR master controller.

policy-rules (PfR)

To apply a configuration from a Performance Routing (PfR) map to a master controller configuration, use the **policy-rules** command in PfR master controller configuration mode. To remove a configuration applied by the **policy-rules** command, use the **no** form of this command.

policy-rules *map-name*

no policy-rules

Syntax Description

map-name	Name of the PfR map.

Command Default

No configuration from a PfR map is applied to a master controller.

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **policy-rules** command allows you to select a PfR map and apply the configuration under PfR master controller configuration mode, providing an improved method to switch between predefined PfR maps.

The **policy-rules** command is entered on a master controller. This command is used to apply the configuration from a PfR map to a master controller configuration in PfR master controller configuration mode.

Reentering this command with a new PfR map name will immediately overwrite the previous configuration. This behavior is designed to allow you to quickly select and switch between predefined PfR maps.

Examples

The following example, starting in global configuration mode, shows how to configure the **policy-rules** command to apply the PfR map named BLUE under PfR master controller configuration mode:

```
Router(config)# pfr-map BLUE 10
Router(config-pfr-map)# match pfr learn delay
Router(config-pfr-map)# set loss relative 900
Router(config-pfr-map)# exit
Router(config)# pfr master
Router(config-pfr-mc)# policy-rules BLUE
Router(config-pfr-mc)# end
```

Related Commands

Command	Description
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.

port (PfR)

To optionally configure a dynamic port number for communication between a Performance Routing (PfR) master controller and border router, use the **port** command in PfR master controller or PfR border router configuration mode. To close the port and disable communication, use the **no** form of this command.

port [*port-number*]

no port

Syntax Description

port-number	(Optional) Specifies the port number. The configurable range for this argument is a number from 1 to 65535.

Command Default

Port 3949 is used for PfR communication unless a dynamic port number is configured on both the master controller and the border router. Port configuration is not shown in the running configuration file when port 3949 is used.

Command Modes

PfR border router configuration (config-pfr-br)
PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.
Cisco IOS XE Release 3.1S	This command was integrated into Cisco IOS XE Release 3.1S.

Usage Guidelines

Communication between a master controller and a border router is automatically carried over port 3949 when connectivity is established. Port 3949 is registered with IANA for PfR communication. Manual port number configuration is required only if you are running Cisco IOS Release 12.3(8)T or if you need to configure PfR communication to use a dynamic port number.

The **port** command is entered on a master controller or a border router. This command is used to specify a dynamic port number to be used for border router and master controller communication. The same port number must be configured on both the master controller and border router. Closing the port by entering the **no** form of this command disables communication between the master controller and the border router.

Cisco IOS XE Release 3.1S

This command is supported only in PfR border router configuration mode.

Examples

The following example opens port 49152 for master controller communication with a border router:

```
Router(config)# pfr master
Router(config-pfr-mc)# port 49152
```

The following example opens port 49152 for border router communication with a master controller:

```
Router(config)# pfr border
Router(config-pfr-br)# port 49152
```

The following example closes the default or user-defined port and disables communication between a master controller and border router:

```
Router(config)# pfr master
Router(config-pfr-mc)# no port
```

Related Commands

Command	Description
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.

prefixes (PfR)

To set the number of prefixes that Performance Routing (PfR) will learn during a monitoring period, use the **prefixes** command in PfR Top Talker and Top Delay learning configuration mode. To return the number of prefixes to the default value, use the **no** form of this command.

prefixes *number*

no prefixes

Syntax Description

number	Number of prefixes that a master controller will learn during a monitoring period. The range is from 1 to 2500.

Command Default

PfR uses 100 prefixes by default if this command is not configured or if the **no** form of this command is entered.

Command Modes

PfR Top Talker and Top Delay learning configuration (config-pfr-mc-learn)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **prefixes** command is configured on a master controller. This command is used to set the number of prefixes that a master controller will learn during a monitoring period. The length of time of the learning period is configured with the **monitor-period** (PfR) command. The length of time between monitoring periods is configured with the **periodic-interval** (PfR) command.

Examples

The following example configures a master controller to learn 200 prefixes during a monitoring period:

```
Router(config)# pfr master
Router(config-pfr-mc)# learn
Router(config-pfr-mc-learn)# prefixes 200
```

Related Commands

Command	Description
learn (PfR)	Enters PfR Top Talker and Top Delay learning configuration mode to configure prefixes for PfR to learn.
monitor-period (PfR)	Sets the time period in which a PfR master controller learns traffic flows.
periodic-interval (PfR)	Sets the time interval between prefix learning periods.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
pfr-map	Enters PfR map configuration mode to configure a PfR map to apply policies to selected IP prefixes.

resolve (PfR)

To set the priority of a policy when multiple overlapping policies are configured, use the **resolve** command in PfR master controller configuration mode. To disable the policy priority configuration, use the **no** form of this command.

resolve {**cost priority** *value* | **delay priority** *value* **variance** *percentage* | **jitter priority** *value* **variance** *percentage* | **loss priority** *value* **variance** *percentage* | **mos priority** *value* **variance** *percentage* | **range priority** *value* | **utilization priority** *value* **variance** *percentage*}

no resolve {**cost** | **delay** | **jitter** | **loss** | **mos** | **range** | **utilization**}

Syntax Description

cost	Specifies policy priority settings for cost optimization.
priority	Sets the priority of the policy.
value	A number in the range of 1 to 10. The number 1 has the highest priority, and the number 10 has the lowest priority.
delay	Specifies policy priority settings for packet delay.
variance	Sets the allowable variance for the policy, as a percentage.
percentage	A number in the range from 1 to 100.
jitter	Specifies policy priority settings for jitter.
loss	Specifies policy priority settings for packet loss.
mos	Specifies policy priority settings for the Mean Opinion Score (MOS).
range	Specifies policy priority settings for the range.
utilization	Specifies policy priority settings for exit link utilization.

Command Default

Performance Routing (PfR) uses the following default settings if this command is not configured or if the **no** form of this command is entered:

- An unreachable prefix: highest priority
- **delay priority**: 11
- **utilization priority**: 12

Command Modes

PfR master controller configuration (config-pfr-mc)

Command History

Release	Modification
15.1(2)T	This command was introduced.

Usage Guidelines

The **resolve** command is entered on a master controller. This command is used to set priority when multiple policies are configured for the same prefix. When this command is configured, the policy with the highest priority will be selected to determine the policy decision.

The **priority** keyword is used to specify the priority value. The number 1 assigns the highest priority to a policy. The number 10 sets the lowest priority. Each policy must be assigned a different priority number. If you try to assign the same priority number to two different policy types, an error message will be displayed on the console. By default, delay has a priority value of 11 and utilization has a priority value of 12. These values can be overridden by specifying a value from 1 to 10.

Note An unreachable prefix will always have the highest priority regardless of any other settings. This is a designed behavior and cannot be overridden because an unreachable prefix indicates an interruption in a traffic flow.

The **variance** keyword is used to set an allowable variance for a user-defined policy. This keyword configures the allowable percentage by which an exit link or prefix can vary from the user-defined policy value and still be considered equivalent. For example, if an exit link delay is set to 80 absolute and a 10 percent variance is configured, exit links that have delay values from 80 to 89 percent will be considered equal.

Note Variance cannot be configured for cost or range policies.

Note You must configure a PfR active jitter probe for a target prefix using the **active-probe** (PfR) command in order for the **resolve jitter**, **resolve loss**, and **resolve mos** commands to function.

Examples

The following example shows how to set the delay policy priority to 1 and the allowable variance percentage to 20 percent:

```
Router(config)# pfr master
Router(config-pfr-mc)# resolve delay priority 1 variance 20
```

The following example shows how to set the loss policy priority to 2 and the allowable variance percentage to 30 percent:

```
Router(config)# pfr master
Router(config-pfr-mc)# resolve loss priority 2 variance 30
```

The following example shows how to set the jitter policy priority to 3 and the allowable variance percentage to 5 percent:

```
Router(config)# pfr master
Router(config-pfr-mc)# resolve jitter priority 3 variance 5
```

The following example shows how to set the MOS policy priority to 4 and the allowable variance percentage to 25 percent:

```
Router(config)# pfr master
Router(config-pfr-mc)# resolve mos priority 4 variance 25
```

The following example shows how to set the range policy priority to 5:

```
Router(config)# pfr master
Router(config-pfr-mc)# resolve range priority 5
```

The following example shows how to set the link utilization policy priority to 6 and the allowable variance percentage to 10 percent:

```
Router(config)# pfr master
Router(config-pfr-mc)# resolve utilization priority 6 variance 10
```

Related Commands

Command	Description
active-probe (PfR)	Configures a PfR active probe for a target prefix.
cost-minimization (PfR)	Configures cost-based optimization policies on a master controller.
delay (PfR)	Configures PfR to learn prefixes based on the lowest delay.
jitter (PfR)	Sets the jitter threshold value that PfR will permit for an exit link.
loss (PfR)	Sets the relative or maximum packet loss limit that PfR will permit for an exit link.
max-range-utilization (PfR)	Sets the maximum utilization range for all PfR-managed exit links.
max-xmit-utilization (PfR)	Configures maximum utilization on a single PfR-managed exit link.
mos (PfR)	Sets the MOS threshold value that PfR will permit for an exit link.
pfr	Enables a PfR process and configures a router as a PfR border router or as a PfR master controller.
show pfr master policy	Displays user-defined and default policy settings on an PfR master controller.