



# Implementing Performance Management

Performance management (PM) on the Cisco IOS XR Software provides a framework to perform these tasks:

- Collect and export PM statistics to a TFTP server for data storage and retrieval
- Monitor the system using extensible markup language (XML) queries
- Configure threshold conditions that generate system logging messages when a threshold condition is matched.

The PM system collects data that is useful for graphing or charting system resource utilization, for capacity planning, for traffic engineering, and for trend analysis.



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## YANG Data Model

You can programmatically monitor the system resources using `openconfig-system.yang` OpenConfig data model. To get started with using data models, see the *Programmability Configuration Guide for Cisco NCS 5500 Series Routers*.

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- [Prerequisites for Implementing Performance Management](#), on page 1
  - [Information About Implementing Performance Management](#), on page 2
  - [PM Functional Overview](#), on page 2
  - [PM Benefits](#), on page 3
  - [PM Statistics Collection Overview](#), on page 3
  - [How to Implement Performance Management](#), on page 7

## Prerequisites for Implementing Performance Management

Before implementing performance management in your network operations center (NOC), ensure that these prerequisites are met:

- You must install and activate the Package Installation Envelope (PIE) for the manageability software.
- You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.
- You must have connectivity with a TFTP server.

# Information About Implementing Performance Management

## PM Functional Overview

The Performance Management (PM) framework consists of two major components:

- PM statistics server
- PM statistics collectors

## PM Statistics Server

The PM statistics server is the front end for statistic collections, entity instance monitoring collections, and threshold monitoring. All PM statistic collections and threshold conditions configured through the command-line interface (CLI) or through XML schemas are processed by the PM statistics server and distributed among the PM statistics collectors.

## PM Statistics Collector

The PM statistics collector collects statistics from entity instances and stores that data in memory. The memory contents are checkpointed so that information is available across process restarts. In addition, the PM statistics collector is responsible for exporting operational data to the XML agent and to the TFTP server.

[Figure 1: PM Component Communications, on page 3](#) illustrates the relationship between the components that constitute the PM system.

Figure 1: PM Component Communications



## PM Benefits

The PM system provides these benefits:

- Configurable data collection policies
- Efficient transfer of statistical data in the binary format via TFTP
- Entity instance monitoring support
- Threshold monitoring support
- Data persistency across process restarts and processor failovers

## PM Statistics Collection Overview

A PM statistics collection first gathers statistics from all the attributes associated with all the instances of an entity in the PM system. It then exports the statistical data in the binary file format to a TFTP server. For example, a Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) statistics collection gathers statistical data from all the attributes associated with all MPLS LDP sessions on the router.

This table lists the entities and the associated instances in the PM system.

**Table 1: Entity Classes and Associated Instances**

| Entity Classes             | Instance           |
|----------------------------|--------------------|
| BGP                        | Neighbors or Peers |
| Interface Basic Counters   | Interfaces         |
| Interface Data Rates       | Interfaces         |
| Interface Generic Counters | Interfaces         |
| MPLS LDP                   | LDP Sessions       |
| Node CPU                   | Nodes              |
| Node Memory                | Nodes              |
| Node Process               | Processes          |
| OSPFv2                     | Processes          |
| OSPFv3                     | Processes          |



**Note** For a list of all attributes associated with the entities that constitute the PM system, see [Table 4: Attributes and Values, on page 11](#).



**Note** Based on the interface type, the interface either supports the interface generic counters or the interface basic counters. The interfaces that support the interface basic counters do not support the interface data rates.

## Binary File Format for Exporting PM Statistics

This sample describes the binary file format:

```
Version : 4 Bytes
NoOf Entities : 1 Byte (e.g. . 4 )
Entity Identifier      : 1 Byte (e.g NODE=1,Interface=2,BGP=3)
Options                :2 Bytes
NoOf SubEntities      :1 Byte (2)
SubEntity Identifier  :1 Byte (e.g BGP-PEERS )
Time Stamp 4 Bytes (Reference Time : Start Ref Time)
No Of Instances       :2 Byte (e.g 100)
Key Instance          :Variable
                      NoOfSamples: 1 Byte (e.g 10 Samples)
                      SampleNo : 1 Byte (e.g Sample No 1)
Time Stamp 4 Bytes (Sample Time)
                      StatCounterName :1 Byte (PeerSessionsEst=1)
```

```

StatCounterValue :8 Bytes ( for all counters)
Repeat for Each StatCounterName
Repeat for Each Sample No(Time Interval)
Repeat for All Instances
Repeat for All SubTypes
Repeat for All Entities

```

## Binary File ID Assignments for Entity, Subentity, and StatsCounter Names

This table describes the assignment of various values and keys which is present in the binary file.

**Table 2: Binary Format Values and Keys**

| Entity        | Subentity              | Key                              | StatsCounters  |
|---------------|------------------------|----------------------------------|--|
| Node (1)      | CPU (1)                | CPU Key <Node ID>                | See <a href="#">Table 3: Supported StatsCounters for Entities and Subentities, on page 6</a> |
|               | Memory (2)             | Memory Key <Node ID>             |  |
|               | Process (3)            | Node Process Key <NodeProcessID> |  |
| Interface (2) | Generic Counters (1)   | Generic Counters Key <ifName>    |  |
|               | Data Rate Counters (2) | Data Rate Counters Key <ifName>  |  |
|               | Basic Counters (3)     | Basic Counters Key <ifName>      |  |
| BGP (3)       | Peer (1)               | Peer Key <IpAddress>             |  |
| MPLS (4)      | Reserved (1)           | —                                |  |
|               | Reserved (2)           | —                                |  |
|               | LDP (4)                | LDP Session Key <IpAddress>      |  |
| OSPF (5)      | v2protocol (1)         | Instance <process_instance>      |  |
|               | v3protocol (2)         | Instance <process_instance       |  |



**Note** <ifName>—The length is variable. The first two bytes contain the size of the Instance ID; this is followed by the Instance ID string (that is, an Interface name).

<IpAddress>—4 bytes that contain the IP address.

<NodeProcessID>—64-bit Instance ID. The first 32 bits contain the node ID, and the second 32 bits contain the process ID.

<NodeID>—32-bit instance ID that contains the Node ID.

<process\_instance>—The length is variable. The first two bytes contain the size of Instance ID followed by Instance ID string (that is, a process name).



**Note** The numbers in parenthesis (the numbers that are associated with each entity and subentity in [Table 2: Binary Format Values and Keys, on page 5](#) ) denote the entity and subEntity IDs that are displayed in the TFTP File.

This table describes the supported statistics counters that are collected in the binary file for entities and subentities.

**Table 3: Supported StatsCounters for Entities and Subentities**

| Entity        | Subentity              | StatsCounters  |
|---------------|------------------------|--|
| Node (1)      | CPU (1)                | NoProcesses  |
|               | Memory (2)             | CurrMemory, PeakMemory   |
|               | Process (3)            | PeakMemory, NoThreads  |
| Interface (2) | Generic Counters (1)   | InPackets, InOctets, OutPackets, OutOctets, InUcastPkts, InMulticastPkts, InBroadcastPkts, OutUcastPkts, OutMulticastPkts, OutBroadcastPkts, OutputTotalDrops, InputTotalDrops, InputQueueDrops, InputUnknownProto, OutputTotalErrors, OutputUnderrun, InputTotalErrors, InputCRC, InputOverrun, InputFrame  |
|               | Data Rate Counters (2) | InputDataRate, InputPacketRate, OutputDataRate, OutputPacketRate, InputPeakRate, InputPeakPkts, OutputPeakRate, OutputPeakPkts, Bandwidth  |
|               | Basic Counters         | InPackets, InOctets, OutPackets, OutOctets, InputTotalDrops, InputQueueDrops, InputTotalErrors, OutputTotalErrors, OutputQueueDrops, OutputTotalErrors   |
| BGP (3)       | Peer (1)               | InputMessages, OutputMessages, InputUpdateMessages, OutputUpdateMessages, ConnEstablished, ConnDropped, ErrorsReceived, ErrorsSent   |
| MPLS (4)      | LDP (4)                | TotalMsgsSent, TotalMsgsRcvd, InitMsgsSent, InitMsgsRcvd, AddressMsgsSent, AddressMsgsRcvd, AddressWithdrawMsgsSent, AddressWithdrawMsgsRcvd, LabelMappingMsgsSent, LabelMappingMsgsRcvd, LabelWithdrawMsgsSent, LabelWithdrawMsgsRcvd, LabelReleaseMsgsSent, LabelReleaseMsgsRcvd, NotificationMsgsSent, NotificationMsgsRcvd, KeepAliveMsgsSent, KeepAliveMsgsRcvd |
| OSPF (5)      | v2protocol (1)         | InputPackets, OutputPackets, InputHelloPackets, OutputHelloPackets, InputDBDs, InputDBDsLSA, OutputDBDs, OutputDBDsLSA, InputLSRequests, InputLSRequestsLSA, OutputLSRequests, OutputLSRequestsLSA, InputLSAUpdates, InputLSAUpdatesLSA, OutputLSAUpdates, OutputLSAUpdatesLSA, InputLSAAcks, InputLSAAcksLSA, OutputLSAAcks, OutputLSAAcksLSA, ChecksumErrors       |

| Entity | Subentity      | StatsCounters  |
|--------|----------------|--|
|        | v3protocol (2) | InputPackets, OutputPackets, InputHelloPackets, OutputHelloPackets, InputDBDs, InputDBDsLSA, OutputDBDs, OutputDBDsLSA, InputLSRequests, InputLSRequestsLSA, OutputLSRequests, OutputLSRequestsLSA, InputLSAUpdates, InputLSAUpdatesLSA, OutputLSAUpdates, OutputLSAUpdatesLSA, InputLSAAcks, InputLSAAcksLSA, OutputLSAAcks, OutputLSAAcksLSA |

## Filenaming Convention Applied to Binary Files

These filenaming convention is applied to PM statistics collections that are sent to the directory location configured on the TFTP server:

<LR\_NAME>\_<EntityName>\_<SubentityName>\_<TimeStamp>

## How to Implement Performance Management

### Configuring an External TFTP Server or Local Disk for PM Statistics Collection

You can export PM statistical data to an external TFTP server or dump the data to the local file system. Both the local and TFTP destinations are mutually exclusive and you can configure either one of them at a time.

#### Configuration Examples

This example configures an external TFTP server for PM statistics collection.

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# performance-mgmt resources tftp-server 10.3.40.161 directory
  mypdata/datafiles
RP/0/RP0/CPU0:Router(config)# commit
```

This example configures a local disk for PM statistics collection.

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# performance-mgmt resources dump local
RP/0/RP0/CPU0:Router(config)# commit
```

### Configuring PM Statistics Collection Templates

PM statistics collections are configured through PM statistics collection templates. A PM statistics collection template contains the entity, the sample interval, and the number of sampling operations to be performed before exporting the data to a TFTP server. When a PM statistics collection template is enabled, the PM statistics collection gathers statistics for all attributes from all instances associated with the entity configured in the template. You can define multiple templates for any given entity; however, only one PM statistics collection template for a given entity can be enabled at a time.

#### Guidelines for Configuring PM Statistics Collection Templates

When creating PM statistics collection templates, follow these guidelines:

- You must configure a TFTP server resource or local dump resource if you want to export statistics data onto a remote TFTP server or local disk.
- You can define multiple templates for any given entity, but at a time you can enable only one PM statistics collection template for a given entity.
- When configuring a template, you can designate the template for the entity as the default template using the default keyword or name the template. The default template contains the following default values:
  - A sample interval of 10 minutes.
  - A sample size of five sampling operations.
- The sample interval sets the frequency of the sampling operations performed during the sampling cycle. You can configure the sample interval with the `sample-interval` command. The range is from 1 to 60 minutes.
- The sample size sets the number of sampling operations to be performed before exporting the data to the TFTP server. You can configure the sample size with the `sample-size` command. The range is from 1 to 60 samples.




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**Note** Specifying a small sample interval increases CPU utilization, whereas specifying a large sample size increases memory utilization. The sample size and sample interval, therefore, may need to be adjusted to prevent system overload.

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- The export cycle determines how often PM statistics collection data is exported to the TFTP server. The export cycle can be calculated by multiplying the sample interval and sample size (sample interval x sample size = export cycle).
- Once a template has been enabled, the sampling and export cycles continue until the template is disabled with the no form of the `performance-mgmt apply statistics` command.
- You must specify either a node with the `location` command or enable the PM statistic collections for all nodes using the `location all` command when enabling or disabling a PM statistic collections for the following entities:
  - Node CPU
  - Node memory
  - Node process

### Configuration Example

This example shows how to create and enable a PM statistics collection template.

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# performance-mgmt statistics interface generic-counters template
template 1
RP/0/RP0/CPU0:Router(config)# performance-mgmt statistics interface generic-counters template
1 sample-size 10
RP/0/RP0/CPU0:Router(config)# performance-mgmt statistics interface generic-counters template
1 sample-interval 5
RP/0/RP0/CPU0:Router(config)# performance-mgmt apply statistics interface generic-counters
1
RP/0/RP0/CPU0:Router# commit
```



## Enabling PM Entity Instance Monitoring

Entity instance monitoring gathers statistics from attributes associated with a specific entity instance. When an entity instance is enabled for monitoring, the PM system gathers statistics from only attributes associated with the specified entity instance. The PM system uses the sampling cycle that is configured in the PM statistics collection template for the entity being monitored. Entity instance monitoring, however, is a separate process from that of the PM statistics collection; therefore, it does not interfere with PM statistics collection. Furthermore, the data from entity instance monitoring collection is independent of PM statistics collection. Unlike PM statistics collection, the data from entity instance monitoring is not exported to the TFTP server. For more information about all the attributes associated with each entity instance and commands, see [Performance Management: Details, on page 10](#).

### Configuration Example

This example shows how to enable entity instance monitoring for a node CPU entity instance.

```
RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# performance-mgmt apply monitor node cpu location 0/RP0/CPU0
default
RP/0/RP0/CPU0:Router(config)# commit
```

## Configuring PM Threshold Monitoring Templates

The PM system supports the configuration of threshold conditions to monitor an attribute (or attributes) for threshold violations. Threshold conditions are configured through PM threshold monitoring templates. When a PM threshold template is enabled, the PM system monitors all instances of the attribute (or attributes) for the threshold condition configured in the template. If at end of the sample interval a threshold condition is matched, the PM system generates a system logging message for each instance that matches the threshold condition. For the list of attributes and value ranges associated with each attribute for all the entities, see [Performance Management: Details, on page 10](#)

### Guidelines for Configuring PM Threshold Monitoring Templates

While you configure PM threshold monitoring templates, follow these guidelines:

- Once a template has been enabled, the threshold monitoring continues until the template is disabled with the **no** form of the **performance-mgmt apply thresholds** command.
- Only one PM threshold template for an entity can be enabled at a time.
- You must specify either a node with the **location** command or enable the PM statistic collections for all nodes using the **location all** command when enabling or disabling a PM threshold monitoring template for the following entities:
  - Node CPU
  - Node memory
  - Node process

### Configuration Example

This example shows how to create and enable a PM threshold monitoring template. In this example, a PM threshold template is created for the **CurrMemory** attribute of the **node memory** entity. The threshold condition in this PM threshold condition monitors the **CurrMemory** attribute to determine whether the current memory use is greater than 50 percent.

```

Router# conf t
Router(config)# performance-mgmt thresholds node memory template template20
Router(config-threshold-cpu)# CurrMemory gt 50 percent
Router(config-threshold-cpu)# sample-interval 5
Router(config-threshold-cpu)# exit
Router(config)# performance-mgmt apply thresholds node memory location 0/RP0/CPU0 template20
Router(config)# commit

```

## Configuring Instance Filtering by Regular Expression

This task explains defining a regular expression group which can be applied to one or more statistics or threshold templates. You can also include multiple regular expression indices. The benefits of instance filtering using the regular expression group is as follows.

- You can use the same regular expression group that can be applied to multiple templates.
- You can enhance flexibility by assigning the same index values.
- You can enhance the performance by applying regular expressions, which has OR conditions.




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**Note** The Instance filtering by regular-expression is currently supported in interface entities only (Interface basic-counters, generic-counters, data-rates).

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### Configuration Example

This example shows how to define a regular expression group.

```

RP/0/RP0/CPU0:Router# configure
RP/0/RP0/CPU0:Router(config)# performance-mgmt regular-expression regexp
RP/0/RP0/CPU0:Router(config-perfmgmt-regexp)# index 10 match
RP/0/RP0/CPU0:Router(config)# commit

```

## Performance Management: Details

This section contains additional information which will be useful while configuring performance management.

This table describes the attributes and value ranges associated with each attribute for all the entities that constitute the PM system.

**Table 4: Attributes and Values**

| Entity                      | Attributes           | Description   | Values                         |
|-----------------------------|----------------------|---|--------------------------------|
| <b>bgp</b>                  | ConnDropped          | Number of times the connection was dropped.               | Range is from 0 to 4294967295. |
|                             | ConnEstablished      | Number of times the connection was established.           | Range is from 0 to 4294967295. |
|                             | ErrorsReceived       | Number of error notifications received on the connection. | Range is from 0 to 4294967295. |
|                             | ErrorsSent           | Number of error notifications sent on the connection.     | Range is from 0 to 4294967295. |
|                             | InputMessages        | Number of messages received.                              | Range is from 0 to 4294967295. |
|                             | InputUpdateMessages  | Number of update messages received.                       | Range is from 0 to 4294967295. |
|                             | OutputMessages       | Number of messages sent.                                  | Range is from 0 to 4294967295. |
|                             | OutputUpdateMessages | Number of update messages sent.                           | Range is from 0 to 4294967295. |
| <b>interface data-rates</b> | Bandwidth            | Bandwidth in kbps.  | Range is from 0 to 4294967295. |
|                             | InputDataRate        | Input data rate in kbps.                                  | Range is from 0 to 4294967295. |
|                             | InputPacketRate      | Input packets per second.                                 | Range is from 0 to 4294967295. |
|                             | InputPeakRate        | Peak input data rate.                                     | Range is from 0 to 4294967295. |
|                             | InputPeakPkts        | Peak input packet rate.                                   | Range is from 0 to 4294967295. |
|                             | OutputDataRate       | Output data rate in kbps.                                 | Range is from 0 to 4294967295. |
|                             | OutputPacketRate     | Output packets per second.                                | Range is from 0 to 4294967295. |
|                             | OutputPeakPkts       | Peak output packet rate.                                  | Range is from 0 to 4294967295. |
|                             | OutputPeakRate       | Peak output data rate.                                    | Range is from 0 to 4294967295. |

| Entity                              | Attributes        | Description                           | Values                         |
|-------------------------------------|-------------------|---------------------------------------|--------------------------------|
| <b>interface<br/>basic-counters</b> | InPackets         | Packets received.                     | Range is from 0 to 4294967295. |
|                                     | InOctets          | Bytes received.                       | Range is from 0 to 4294967295. |
|                                     | OutPackets        | Packets sent.                         | Range is from 0 to 4294967295. |
|                                     | OutOctets         | Bytes sent.                           | Range is from 0 to 4294967295. |
|                                     | InputTotalDrops   | Inbound correct packets discarded.    | Range is from 0 to 4294967295. |
|                                     | InputQueueDrops   | Input queue drops.                    | Range is from 0 to 4294967295. |
|                                     | InputTotalErrors  | Inbound incorrect packets discarded.  | Range is from 0 to 4294967295. |
|                                     | OutputTotalDrops  | Outbound correct packets discarded.   | Range is from 0 to 4294967295. |
|                                     | OutputQueueDrops  | Output queue drops.                   | Range is from 0 to 4294967295. |
|                                     | OutputTotalErrors | Outbound incorrect packets discarded. | Range is from 0 to 4294967295. |

| Entity                        | Attributes        | Description                                      | Values                         |
|-------------------------------|-------------------|--|--------------------------------|
| interface<br>generic-counters | InBroadcastPkts   | Broadcast packets received.                      | Range is from 0 to 4294967295. |
|                               | InMulticastPkts   | Multicast packets received.                      | Range is from 0 to 4294967295. |
|                               | InOctets          | Bytes received.                                  | Range is from 0 to 4294967295. |
|                               | InPackets         | Packets received.                                | Range is from 0 to 4294967295. |
|                               | InputCRC          | Inbound packets discarded with incorrect CRC.    | Range is from 0 to 4294967295. |
|                               | InputFrame        | Inbound framing errors.                          | Range is from 0 to 4294967295. |
|                               | InputOverrun      | Input overruns.                                  | Range is from 0 to 4294967295. |
|                               | InputQueueDrops   | Input queue drops.                               | Range is from 0 to 4294967295. |
|                               | InputTotalDrops   | Inbound correct packets discarded.               | Range is from 0 to 4294967295. |
|                               | InputTotalErrors  | Inbound incorrect packets discarded.             | Range is from 0 to 4294967295. |
|                               | InUcastPkts       | Unicast packets received.                        | Range is from 0 to 4294967295. |
|                               | InputUnknownProto | Inbound packets discarded with unknown protocol. | Range is from 0 to 4294967295. |
|                               | OutBroadcastPkts  | Broadcast packets sent.                          | Range is from 0 to 4294967295. |
|                               | OutMulticastPkts  | Multicast packets sent.                          | Range is from 0 to 4294967295. |
|                               | OutOctets         | Bytes sent.                                      | Range is from 0 to 4294967295. |
|                               | OutPackets        | Packets sent.                                    | Range is from 0 to 4294967295. |
|                               | OutputTotalDrops  | Outbound correct packets discarded.              | Range is from 0 to 4294967295. |
|                               | OutputTotalErrors | Outbound incorrect packets discarded.            | Range is from 0 to 4294967295. |
|                               | OutUcastPkts      | Unicast packets sent.                            | Range is from 0 to 4294967295. |
|                               | OutputUnderrun    | Output underruns.                                | Range is from 0 to 4294967295. |

| Entity        | Attributes              | Description                         | Values                         |
|---------------|-------------------------|-------------------------------------|--------------------------------|
| mpls ldp      | AddressMsgsRcvd         | Address messages received.          | Range is from 0 to 4294967295. |
|               | AddressMsgsSent         | Address messages sent.              | Range is from 0 to 4294967295. |
|               | AddressWithdrawMsgsRcd  | Address withdraw messages received. | Range is from 0 to 4294967295. |
|               | AddressWithdrawMsgsSent | Address withdraw messages sent.     | Range is from 0 to 4294967295. |
|               | InitMsgsSent            | Initial messages sent.              | Range is from 0 to 4294967295. |
|               | InitMsgsRcvd            | Initial messages received.          | Range is from 0 to 4294967295. |
|               | KeepaliveMsgsRcvd       | Keepalive messages received.        | Range is from 0 to 4294967295. |
|               | KeepaliveMsgsSent       | Keepalive messages sent.            | Range is from 0 to 4294967295. |
|               | LabelMappingMsgsRcvd    | Label mapping messages received.    | Range is from 0 to 4294967295. |
|               | LabelMappingMsgsSent    | Label mapping messages sent.        | Range is from 0 to 4294967295. |
|               | LabelReleaseMsgsRcvd    | Label release messages received.    | Range is from 0 to 4294967295. |
|               | LabelReleaseMsgsSent    | Label release messages sent.        | Range is from 0 to 4294967295. |
|               | LabelWithdrawMsgsRcvd   | Label withdraw messages received.   | Range is from 0 to 4294967295. |
|               | LabelWithdrawMsgsSent   | Label withdraw messages sent.       | Range is from 0 to 4294967295. |
|               | NotificationMsgsRcvd    | Notification messages received.     | Range is from 0 to 4294967295. |
|               | NotificationMsgsSent    | Notification messages sent.         | Range is from 0 to 4294967295. |
|               | TotalMsgsRcvd           | Total messages received.            | Range is from 0 to 4294967295. |
| TotalMsgsSent | Total messages sent.    | Range is from 0 to 4294967295.      |                                |
| node cpu      | NoProcesses             | Number of processes.                | Range is from 0 to 4294967295. |

| Entity       | Attributes | Description   | Values                         |
|--------------|------------|---|--------------------------------|
| node memory  | CurrMemory | Current application memory (in bytes) in use.           | Range is from 0 to 4294967295. |
|              | PeakMemory | Maximum system memory (in MB) used since bootup.        | Range is from 0 to 4194304.    |
| node process | NoThreads  | Number of threads.                                      | Range is from 0 to 4294967295. |
|              | PeakMemory | Maximum dynamic memory (in KB) used since startup time. | Range is from 0 to 4194304.    |

| Entity          | Attributes                               | Description                            | Values                         |
|-----------------|--|--|--------------------------------|
| ospf v2protocol | InputPackets                             | Total number of packets received.      | Range is from 0 to 4294967295. |
|                 | OutputPackets                            | Total number of packets sent.          | Range is from 0 to 4294967295. |
|                 | InputHelloPackets                        | Number of Hello packets received.      | Range is from 0 to 4294967295. |
|                 | OutputHelloPackets                       | Number of Hello packets sent.          | Range is from 0 to 4294967295. |
|                 | InputDBDs                                | Number of DBD packets received.        | Range is from 0 to 4294967295. |
|                 | InputDBDsLSA                             | Number of LSA received in DBD packets. | Range is from 0 to 4294967295. |
|                 | OutputDBDs                               | Number of DBD packets sent.            | Range is from 0 to 4294967295. |
|                 | OutputDBDsLSA                            | Number of LSA sent in DBD packets.     | Range is from 0 to 4294967295. |
|                 | InputLSRequests                          | Number of LS requests received.        | Range is from 0 to 4294967295. |
|                 | InputLSRequestsLSA                       | Number of LSA received in LS requests. | Range is from 0 to 4294967295. |
|                 | OutputLSRequests                         | Number of LS requests sent.            | Range is from 0 to 4294967295. |
|                 | OutputLSRequestsLSA                      | Number of LSA sent in LS requests.     | Range is from 0 to 4294967295. |
|                 | InputLSAUpdates                          | Number of LSA updates received.        | Range is from 0 to 4294967295. |
|                 | InputLSAUpdatesLSA                       | Number of LSA received in LSA updates. | Range is from 0 to 4294967295. |
|                 | OutputLSAUpdates                         | Number of LSA updates sent.            | Range is from 0 to 4294967295. |
|                 | OutputLSAUpdatesLSA                      | Number of LSA sent in LSA updates.     | Range is from 0 to 4294967295. |
| InputLSAAcks    | Number of LSA acknowledgements received. | Range is from 0 to 4294967295.         |                                |



| Entity | Attributes       | Description                                      | Values                         |
|--------|------------------|--|--------------------------------|
|        | InputLSAAcksLSA  | Number of LSA received in LSA acknowledgements.  | Range is from 0 to 4294967295. |
|        | OutputLSAAcks    | Number of LSA acknowledgements sent              | Range is from 0 to 4294967295. |
|        | OutputLSAAcksLSA | Number of LSA sent in LSA acknowledgements.      | Range is from 0 to 4294967295. |
|        | ChecksumErrors   | Number of packets received with checksum errors. | Range is from 0 to 4294967295. |

| Entity          | Attributes          | Description                              | Values                         |
|-----------------|---------------------|--|--------------------------------|
| ospf v3protocol | InputPackets        | Total number of packets received.        | Range is from 0 to 4294967295. |
|                 | OutputPackets       | Total number of packets sent.            | Range is from 0 to 4294967295. |
|                 | InputHelloPackets   | Number of Hello packets received.        | Range is from 0 to 4294967295. |
|                 | OutputHelloPackets  | Number of Hello packets sent.            | Range is from 0 to 4294967295. |
|                 | InputDBDs           | Number of DBD packets received.          | Range is from 0 to 4294967295. |
|                 | InputDBDsLSA        | Number of LSA received in DBD packets.   | Range is from 0 to 4294967295. |
|                 | OutputDBDs          | Number of DBD packets sent.              | Range is from 0 to 4294967295. |
|                 | OutputDBDsLSA       | Number of LSA sent in DBD packets.       | Range is from 0 to 4294967295. |
|                 | InputLSRequests     | Number of LS requests received.          | Range is from 0 to 4294967295. |
|                 | InputLSRequestsLSA  | Number of LSA received in LS requests.   | Range is from 0 to 4294967295. |
|                 | OutputLSRequests    | Number of LS requests sent.              | Range is from 0 to 4294967295. |
|                 | OutputLSRequestsLSA | Number of LSA sent in LS requests.       | Range is from 0 to 4294967295. |
|                 | InputLSAUpdates     | Number of LSA updates received.          | Range is from 0 to 4294967295. |
|                 | InputLSRequestsLSA  | Number of LSA received in LS requests.   | Range is from 0 to 4294967295. |
|                 | OutputLSAUpdates    | Number of LSA updates sent.              | Range is from 0 to 4294967295. |
|                 | OutputLSAUpdatesLSA | Number of LSA sent in LSA updates.       | Range is from 0 to 4294967295. |
|                 | InputLSAAcks        | Number of LSA acknowledgements received. | Range is from 0 to 4294967295. |

| Entity | Attributes       | Description                                     | Values                         |
|--------|------------------|---|--------------------------------|
|        | InputLSAAcksLSA  | Number of LSA received in LSA acknowledgements. | Range is from 0 to 4294967295. |
|        | OutputLSAAcks    | Number of LSA acknowledgements sent             | Range is from 0 to 4294967295. |
|        | OutputLSAAcksLSA | Number of LSA sent in LSA acknowledgements.     | Range is from 0 to 4294967295. |

This table describes the commands used to enable entity instance monitoring for different entity instances.

**Table 5: Entity Instances and Monitoring Commands**

| Entity               | Command Description  |
|----------------------|--|
| BGP                  | <p>Use the <b>performance-mgmt apply monitor bgp</b> command to enable entity instance monitoring for a BGP entity instance.</p> <p><b>Syntax:</b></p> <pre> performance-mgmt   apply monitor   bgp   ip-address   template-name   default} RP/0/RP0/CPU0:Router(config)# performance-mgmt apply monitor bgp 10.12.0.4 default                     </pre>  |
| Interface Data Rates | <p>Use the <b>performance-mgmt apply monitor data-rates</b> command to enable entity instance monitoring for an interface data rates entity instance.</p> <p><b>Syntax:</b></p> <pre> performance-mgmt   apply   monitor   interface   data-rates   type   interface-path-id {template-name     default} RP/0/RP0/CPU0:Router(config)# performance-mgmt apply monitor interface data-rates HundredGigE 0/3/0/24 default                     </pre> |

| Entity                     | Command Description  |
|----------------------------|--|
| Interface Basic Counters   | <p>Use the <b>performance-mgmt apply monitor interface basic-counters</b> command to enable entity instance monitoring for an interface basic counters entity instance.</p> <p><b>Syntax:</b></p> <pre> performance-mgmt     apply     monitor     interface     basic-counters     type     interface-path-id {template-name       default} RP/0/RP0/CPU0:Router(config)# performance-mgmt apply monitor interface basic-counters HundredGigE 0/3/0/24 default </pre>         |
| Interface Generic Counters | <p>Use the <b>performance-mgmt apply monitor interface generic-counters</b> command to enable entity instance monitoring for an interface generic counters entity instance.</p> <p><b>Syntax:</b></p> <pre> performance-mgmt     apply     monitor     interface     generic-counters     type     interface-path-id {template-name       default} RP/0/RP0/CPU0:Router(config)# performance-mgmt apply monitor interface generic-counters HundredGigE 0/3/0/24 default </pre> |
| MPLS LDP                   | <p>Use the <b>performance-mgmt apply monitor mpls ldp</b> command to enable entity instance monitoring for an MPLS LDP entity instance.</p> <p><b>Syntax:</b></p> <pre> performance-mgmt     apply monitor     mpls     ldp     ip-address {template-name       default} RP/0/RP0/CPU0:Router(config)# performance-mgmt apply monitor mpls ldp 10.34.64.154 default </pre>   |

| Entity       | Command Description  |
|--------------|--|
| Node CPU     | <p>Use the <b>performance-mgmt apply monitor node cpu</b> command to enable entity instance monitoring for a node CPU entity instance.</p> <p><b>Syntax:</b></p> <pre style="text-align: center;"> performance-mgmt   apply   monitor   node   cpu   location     node-id {template-name     default} </pre> <p>RP/0/RP0/CPU0:Router(config)# performance-mgmt apply<br/>monitor node cpu location 0/RP0/CPU0 default</p>                                    |
| Node Memory  | <p>Use the <b>performance-mgmt apply monitor node memory</b> command to enable entity instance monitoring for a node memory entity instance.</p> <p><b>Syntax:</b></p> <pre style="text-align: center;"> performance-mgmt   apply   monitor   node   memory   location     node-id {template-name     default} </pre> <p>RP/0/RP0/CPU0:Router(config)# performance-mgmt apply<br/>monitor node memory location 0/RP0/CPU0 default</p>                        |
| Node Process | <p>Use the <b>performance-mgmt apply monitor node process</b> command to enable entity instance monitoring collection for a node process entity instance.</p> <p><b>Syntax:</b></p> <pre style="text-align: center;"> performance-mgmt   apply monitor node   process   location     node-id     pid {template-name   default} </pre> <p>RP/0/RP0/CPU0:Router(config)# performance-mgmt apply<br/>monitor node process location p 0/RP0/CPU0 275 default</p> |

